HETERODYNE OSCILLATORS

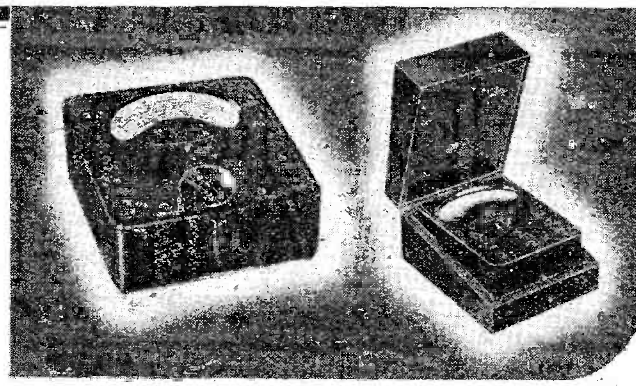
Practical Wireless

and PRACTICAL TELEVISION

9D. EVERY MONTH

Editor F. J. CAMM

Vol. 18. No. 431. NEW SERIES. MAY, 1942.



Practical Wireless
and PRACTICAL TELEVISION
EVERY MONTH
Vol. XVIII. No. 431. MAY, 1942.
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Staff:
L. O. SPARKS.
FRANK PRESTON.

COMMENTS OF THE MONTH BY THE EDITOR

Our Cover Joins Up!

READERS will notice that the familiar yellow cover, which has enclosed the pages of this journal and enwrapped the contents, is missing this month. It has joined up! Statements in the newspapers on the paper shortage have warned readers that the paper position is serious, and a further cut in the ration has forced us to adopt the present style. It is purely a war measure which we have adopted with reluctance. The plan, however, enables us to continue to give the maximum amount of editorial space to the publication of articles of value to the war effort. Alternative methods which presented themselves would have meant a severe cut in the number of editorial pages, and we are certain that our readers will approve the decision we have made in the circumstances which the new paper position provided. We preferred to cut the cover rather than to cut the number of pages or the number of copies printed. Our readers are, we know, greatly appreciative of our efforts to continue to produce this journal in such difficult times and under such difficult conditions.

Demand and Supply

WE are not able to print all of the copies which are in demand. Since the war commenced many tens of thousands of men have become interested in radio. Most of them are in that branch of the Services, and it is understandable that they should wish to subscribe to a journal which deals with their special subjects. We must, however, supply our regular readers, and where in a particular district some readers are unable to obtain copies it would be a friendly act for readers to lend out copies. Those who have written to us complaining that they are unable to purchase issues will understand that it is not due to any negligence on the part of the newsagent, or of our publishing department. We are doing our utmost equitably to distribute our journal over the whole of the country. It is now an offence to waste paper, and this alone should bring to the public an appreciation of the difficulties under which newspaper and periodical proprietors are operating.

Shortage of Servicemen

THERE is still an inadequate supply of service engineers, and it does not seem to us that the position will improve, notwithstanding the attempt which is being made to concentrate retailers in particular districts. The call-up of men is being intensified, and it is inevitable, therefore, that the needs of the civilian population must suffer in the interests of the war effort. We wonder, therefore, whether sufficient attention has been given to the possibility of employing foreign nationals. The International Labour Branch of the Ministry of Labour was set up for the purpose of finding employment for foreign workers, and there was recently a special registration of foreigners of several nationalities, and special employment exchanges have been established for their assistance. The Government training schemes are open to them. It was recently stated in Parliament that the Government recognised that in the foreign population of this country we have a valuable addition to our man- and woman-power of which the most effective use should be made with the same wage standards and working conditions, and the same social services as those which apply to British subjects doing the same work.

Certain security safeguards are indispensable. It seems to us, now that the Government has approved their employment, that such foreign nationals could be employed to service wireless sets.

According to a recent analysis under the International Labour Force Registration Orders large numbers of these foreign nationals were employed in the clothing and textile industries, as well as in the clerical, hotel and distributive trades. Some of these could be diverted for training in the servicing of wireless sets, where they would be performing useful national work. A certain proportion of these foreign nationals are unemployed, and many of these, we understand, possess qualifications which should prove of the greatest value in war-time industry. Employers who are unable to secure British subjects for technical, clerical and certain professional positions are invited to notify their nearest Employment Exchange, or the International Labour Branch of the Ministry of Labour and National Service, Hanway House, Red Lion Square, W.C.1. In employing such foreign nationals, employers will know that they are not acting contrary to Government policy. Disabled men are now being trained for radio service work.

Fourteen Million Sets

AMERICAN radio manufacturers during 1941 produced sets totalling in value nearly £90,000,000, whilst approximately 14,000,000 sets are represented by this sum. This is an increase of 2,000,000 sets over the previous year. It remains to be seen whether America's entering the war will produce an effect on the American industry as it has in this country. No doubt this large increase in American output is accounted for by the drop in manufacture in other countries and the rise in American exports.

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

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

The fact that goods made of raw materials in short supply owing to war conditions are advertised in this paper should not be taken as an indication that they are necessarily available for export.

ROUND THE WORLD OF WIRELESS

New B.B.C. Wavelength

A NEW wavelength of 296.1 metres is now being used by the B.B.C. for the Forces programme in addition to the existing 342.1 metres and 48.86 metres wavelengths. The new wavelength is marked on some receivers as Midland Regional.

Radio Relay Exchanges

IT is reported that on September 30th, 1941, there were 343,593 subscribers to 279 radio relay exchanges, compared with 326,385 subscribers to 280 exchanges on June 30th, 1941, an increase of 17,208 subscribers.

Less B.B.C. News Commentary

OWING to Parliamentary criticism, the B.B.C. is taking steps to cut the amount of comment about war news, and when news is scanty the time given to bulletins will be reduced. The appointment of a special news adviser from outside is being considered.

Radio Cut in U.S.A.

IT is reported that the U.S.A. War Production Board recently ordered the manufacture of wireless sets and gramophones for civilian use to be discontinued from April 22nd.

B.B.C.'s Increased Grant

IN the additional Civil Supplementary Estimates to be brought before Parliament, the Ministry of Information's grant-in-aid to the B.B.C. is to be increased by £1,300,000 to £6,900,000. This amount is needed to extend the Corporation's overseas services.

New U.S. Short-wave Station

ACCORDING to a recent report, the World-Wide Broadcasting Foundation, which operates the American short-wave stations WRUL and WRUV at Boston, Massachusetts, has been radiating test transmissions from its new transmitter, WRUS, on 6.04 Mc.

Russian Guns on Radio

ARTILLERY and machine-gun fire from the Russian front was heard by British radio listeners recently. Commander Klimenko, broadcasting through Moscow Radio, gave a talk about Russian progress in a particular sector. During one part of the broadcast his speech was drowned by the crackling of machine-gun fire.

Station WBOS

THE Westinghouse short-wave station WBOS, at Boston, Massachusetts, has been transmitting the same programmes as the N.B.C. international short-wave stations WNBI and WRCA. At present the station works on 15.21 mc/s (19.72 metres) and 11.87 mc/s (25.26 metres) with its aerial directed towards Europe from 2.0 p.m. to 9.30 p.m.

"Sparks" Has a Voice

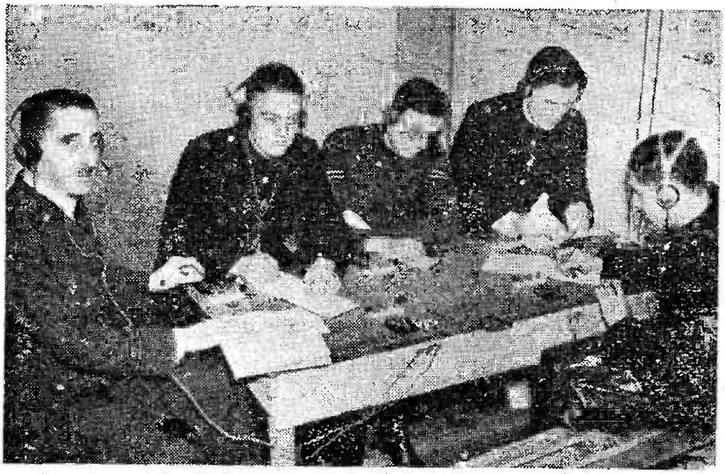
IT is announced that a Radio Officer's panel has been added to the National Maritime Board which deals with such matters as war bonus, leave and differential payments.

Europe Listens to B.B.C. Broadcasts

EVIDENCE that the B.B.C. overseas broadcasts are reaching and are appreciated by listeners all over Europe is provided by the following examples of the kind of messages which are received by the B.B.C.

From Occupied France: "We are very privileged to live here, where it is possible to listen in to London. It is our comfort and our strength."

From Oslo: "If we did not have the B.B.C. to give us the truth, despair might be reigning here now."



Policemen of the A.T.C. undergoing training in Morse transmitting and reception.

From Czechoslovakia: "People who are almost too poor to buy bread now have a radio set. . . . A man told me, 'The stomach is hungry, but the soul still more so—London is the only thing to feed the soul.'"

Trans-Pacific Radiotelegraph

THE recent exchange of messages between President Roosevelt and Mr. J. H. Curtin, Prime Minister of Australia, marked the opening of the first direct radiotelegraph service between the United States and Australia. The companies operating the system are R.C.A. Communications and Amalgamated Wireless (Australasia).

Names of "Missing" in Enemy Broadcasts

THE fate of missing men who may be prisoners of war has a special interest for everyone; their relatives' anxiety merits special sympathy. Much unnecessary suffering is being caused, however, through the enemy's practice of including lists of British casualties in propaganda broadcasts at infrequent intervals.

It is to help the anxious ones and avoid adding to their unhappiness that special steps are taken by the B.B.C. and the Service Departments to note the names broadcast, and inform the waiting next-of-kin immediately the details can be identified. Trained official listeners take down every name. Those of missing airmen are passed to the Air Ministry, of sailors and soldiers to the Admiralty and War Office; the details are checked and the good news telegraphed to anxious parents, wives and relatives.

The B.B.C., or the appropriate Service Department, can always be asked to verify a broadcast name by anyone in doubt; and it is kindest to have a friend's name verified before raising the hopes of his relatives.

Lionel Gamlin Back with B.B.C.

LIONEL GAMLIN, the announcer who left the B.B.C. to go back to school-teaching, has returned to the B.B.C. in the European programmes department. He joined the B.B.C. in 1936 and became extremely popular with listeners as compère in "Monday Night at Seven."

On Wings of Song

DURING his off-duty moments, a 23-year-old night fighter pilot at a North-east station is usually to be found seated at a piano in the mess.

Fellow pilots who stray into the recreation room have a habit of suggesting "a spot of swing." But this pilot prefers to concentrate on Bach, Brahms and Beethoven. Having already passed his preliminary examinations, the pilot has as his goal the passing of the final examinations of the Royal College of Music, which will entitle him to inscribe the words "Mus. Bac." after his name.

Taking his first piano lessons at the age of six, and "graduating" to the organ when 12 years of age, the pilot, who before the war was a buyer in the stationery department of a firm of engineering contractors, found his musical abilities in demand when he went out to Canada under the Commonwealth Joint Air Training Plan.

Visiting a broadcasting station near the training camp, he saw a piano and requested permission to play it. Heard playing by one of the directors of the station he was asked to broadcast a series of pianoforte recitals

To pass his final examination for the degree of Bachelor of Music the pilot will require, among other things, to prepare an exercise on a set theme—a test composition for solo instrument, for full orchestra, or for choral voices. And that is why, turning a deaf ear to entreaties for "Salome," or a "hot number," he gets down to serious work when he seats himself at the piano.

"Brains Trust" of the A.T.S.

THE girls who man observation posts and work out scientific calculations at a gunnery experimental establishment on the East Coast—popularly known as the "Brains Trust" of the A.T.S.—have proved to be better than men at the job. This is, indeed, a high tribute, and comes from one who knows what these girls can do—the Royal Artillery Colonel who is their chief. In addition to the A.T.S. women gunnery specialists at this depot there is one Wren, and her job is that of assistant to the naval commander who deals with naval gunnery experiments. These women are the only ones in the service who are allowed to wear the navy blue and scarlet field service cap of the Royal Artillery. The illustration on this page shows an A.T.S. girl at work with a soldier repairing transmitting and receiving sets.

"Your Voices Clinched It"

"I AM the envy of the Middle East!"

This extract in a letter from a soldier serving in the Middle East to his father in London shows how deeply men overseas welcome B.B.C. message programmes.

Both the father and the mother broadcast to their son, Tony, on November 1st.

Tony wrote: "Somebody else was listening on a set which is not generally used for that range, so consequently reception was not very good. He heard the name, Falvey, and yelled for me. I got your message by gluing the 'phones to my head, but names were not very distinct. However, it was your voices which clinched it. Even after two years I could recognise them in a million. I came away from the set convinced that I had heard my own mother and father speaking to me where civilisation is so very much in the abstract. It was a real time! It was nice to hear the announcer reassure us afterwards that you were both looking very fit and well. That was the main thing I wanted to know. . . . You can rest assured now that I did hear you. . . . It must have been a big day for you. It was for me, and every subsequent day the same. I feel as if I had been home on leave. I can remember almost every word both of you said. . . ."

B.B.C. Overseas Services

THE B.B.C.'s total regular news bulletins in all languages numbered 124 in February and the Corporation may now claim that its Overseas services reach to almost every part of the world where there are radio receiving sets. In overseas languages eighty news bulletins are broadcast daily and twenty are broadcast weekly.

The number of foreign languages used rose from nine on September 1st, 1939, to twenty-six on September 1st, 1940, and to forty on December 31st last.

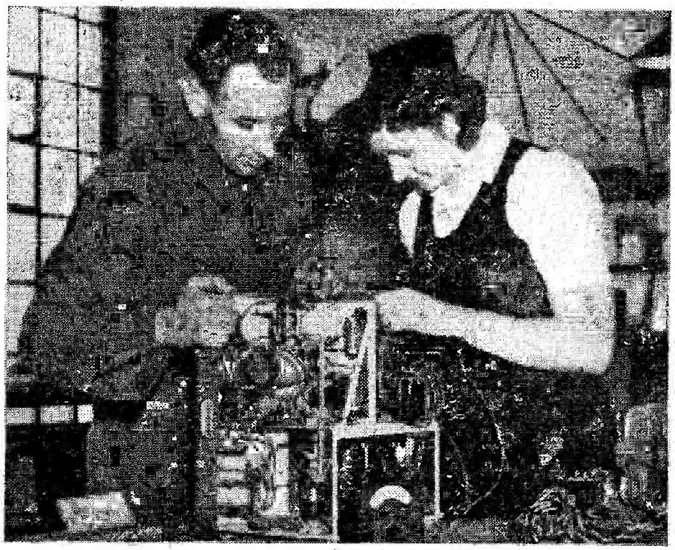
Including English, Welsh and Gaelic, the B.B.C. is now using forty-three languages for its news bulletins.

English language broadcasts on all networks average twenty-three hours thirty-seven minutes daily, and other languages thirty-three hours thirty-five minutes daily.

Overseas language broadcasts are continually being increased and now include Arabic for Morocco, Bengali, Burmese, Cantonese, Hindustani, Kuoyue, Slovak and Slovene, Tamil, Thai and Turkish.

As well as news bulletins there are thirty-seven daily Overseas programmes and three weekly Overseas programmes.

Overseas broadcasts average fifty-seven hours twelve minutes daily, while Empire and North American services in English average twenty hours forty-eight minutes daily. European services in foreign languages are broadcast for twenty-two hours nine minutes daily.



An A.T.S. girl working with a soldier on overhauling and repairing transmitting and receiving sets.

S.W. Reaction Circuits

The Good and Bad Qualities of Feed-back are Discussed in This Article

FEED-BACK, which can be present in a receiver in various forms, plays an important part in determining the overall efficiency of the circuit. When its presence is indicated by unwanted H.F. and L.F. instability, it shows that circuit conditions are unsatisfactory, and that the feed-back is not under the control of the operator. In such circumstances, the obvious remedy is to remove the cause of the trouble by attending to operating voltages, component layout and values, wiring and, possibly, screening. Although feed-back is one of the bugbears of the constructor's activities, and can exert such detrimental influences on a receiver's performance, it can, if kept well under control, compensate for its bad habits by offering, as near as is possible, something for nothing.

When a special circuit is incorporated in a receiver design specifically to introduce feed-back under proper control of the operator, the name more usually associated

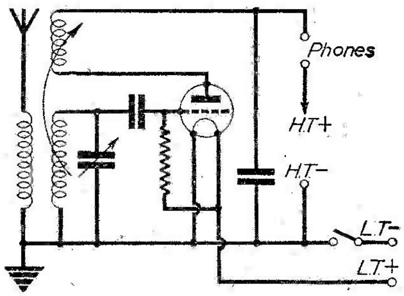


Fig. 1.—The earliest form of inductively-coupled reaction circuit. Its advantages were neutralised by its inherent defects.

with its bad qualities is replaced by the terms reaction or regeneration, and, as such, it gives to the receiver, without, apparently, robbing any other section, a most marked increase in sensitivity and selectivity. As these two qualities are more vital for those S.W. sets which come under the heading of "straight" circuits, for example, those of the 1-V-2, 1-V-1, and especially the 0-V-1 or 0-V's class, we will ignore in this article the superhet and communication outfits.

Essential Features

To secure the utmost efficiency from any reaction circuit there are certain inherent defects for which the operator must be on the watch and for which steps should be taken to eliminate. It is possible for these defects to be tolerated in a medium and long-wave receiver, speaking in a comparative sense, but when the tuned circuit to which the reaction is applied is concerned with the high frequencies of the usual S.W. transmissions, then the defects assume more serious proportions.

The first of these can be described by the term backlash. Most constructors will have experienced this when they have adjusted their receiver to its most sensitive point on a given signal, and, suddenly, for no apparent reason, the circuit breaks into oscillation which can only be stopped by bringing the reaction control towards its minimum setting. The items chiefly responsible for this effect are the characteristics of the detector valve and the operating voltages, although the actual reaction and associated tuning circuits can influence matters.

Smoothness of reaction control is an essential quality. This must not be confused with backlash, although they seem to be closely related, and to a great extent produced by similar conditions. It is often possible to secure the desired smooth continuous building-up effect by paying particular attention to the efficiency of the anode H.F. choke, its associated by-pass condenser and the values of the H.T. anode voltage and impedance of the valve.

Although the next item has been left to the last, it does not mean that it is the least important. In fact, especially when considering S.W. receivers, it could rank as highest in importance. Nothing is more annoying, when tuning in an elusive transmission, to find that any variation in the reaction control setting immediately upsets the tuning of the detector circuit. This, then, is an effect which must be eliminated, otherwise it will be impossible to obtain accurate calibration of the receiver.

Reaction Circuits

What might be termed the basic reaction circuit, so far as receiver design is concerned, is that shown by Fig. 1. It is the arrangement which was used universally in the days of plug-in coils. The coupling between the aerial and grid coils was usually fixed, but the coil-holder was so designed that the reaction coil could be swung to and from the grid coil, thus allowing a variable coupling to be obtained. This method is known as the swinging-coil reaction circuit, but it has now faded right away since the introduction of modern coils and improved systems of control.

Apart from the space required by the arrangement, it did offer the possibility of getting reasonably smooth control but, unfortunately, against that one has to place the great de-tuning effect on the grid-tuned circuit. This chiefly was due to the variation of circuit capacity produced by the presence or absence of the swinging coil with relation to the fixed, plus certain secondary electrical effects. To overcome this defect, and, incidentally, to make possible the solenoid type of coil, the forerunner of our modern types, other circuit arrangements were tried.

The first step forward was when the reaction coil was fixed and the amount of feed-back controlled by some capacity method. There were several methods introduced, but the most successful, and the one which is still probably the most widely used, is that shown in Fig. 2, which depicts the Reinartz reaction system. Speaking in a general sense, the system is very satisfactory, provided the necessary consideration is given to valve characteristics and operating potentials, the capacity of C.1 and C.2 and, of course, the formation and location of the reaction winding. There are certain values which seem to be applicable to the majority of circuits, but as so much depends on layout, wiring, etc., it is best to let experiments govern the ultimate values for individual circuits.

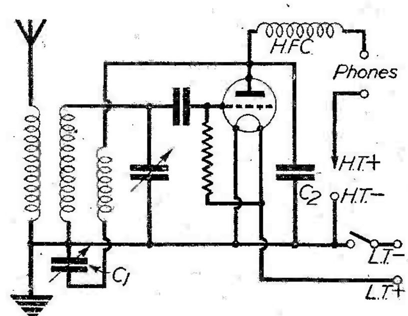


Fig. 2.—The standard Reinartz circuit in which the reaction coil is fixed and the control obtained by the variable condenser C.1.

To avoid (or reduce) hand and body capacity effects, it is usual to connect the reaction condenser between the earthy end of the reaction coil and the common negative-earth line.

Throttle Control

Another form of capacity control is shown in Fig. 3, and it is known as throttle control reaction. The reaction coil is directly in the anode circuit, the high-frequency choke serving the usual purpose of preventing the H.F. currents from passing on to the L.F. coupling and H.T. line. The degree of reaction is controllable by varying the capacity of C.1, which completes the circuit. Many enthusiasts favour this system more than the Reinartz, claiming that smoother control and greater freedom from blacklash is obtained, but on this point the writer would rather not express an opinion as it seems that both circuits are capable of giving very satisfactory control *provided other factors* are correct. One disadvantage of throttle control is that the reaction winding is carrying the H.T.; therefore its insulation must be good and more care taken against short-circuits. In the Reinartz system the H.T. is on the coil if connected as shown in Fig. 2, but the winding is not in series with the H.T. and, if so desired, the reaction condenser can be connected between the anode and the coil, thus effectively preventing any D.C. from flowing into the windings. If the moving vanes of the condenser are connected to the coil, and if the capacity between the reaction and grid coils is very low, no ill effects will be experienced. If a metal panel is used, however, one *must* remember that the spindle of the reaction condenser will be alive (H.T.), and that the fixing must be insulated from the panel to prevent a short-circuit.

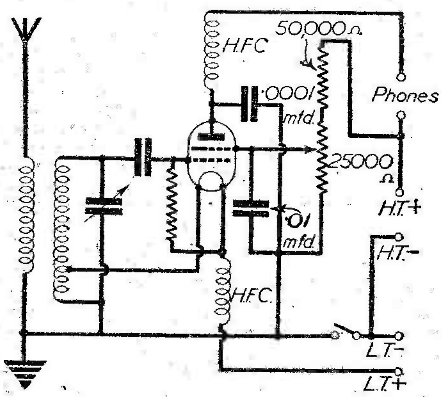


Fig. 4.—One of the most efficient reaction circuits for S.W. work, using the "electron-coupled" system.

Electron Coupled

One system which does not appear to be used widely in this country, especially by owners of battery-operated sets, is that known as electron-coupled reaction or regeneration. The basic circuit is shown in Fig. 4, for both mains and battery sets, and it will be seen that it is not in any way complicated as its name might imply.

The system is really an adaptation of the Hartley oscillator circuit, in which the feed-back is controlled by the potentiometer feeding the H.T. voltage to the screening-grid. A valve of the S.G. or H.F. pentode type has to be used, but in view of the high efficiency of the circuit this is no drawback, in fact, it is quite possible for a 0-V-1 arrangement using this method of reaction to be as efficient as many 1-V-1 Rx's using the systems previously discussed.

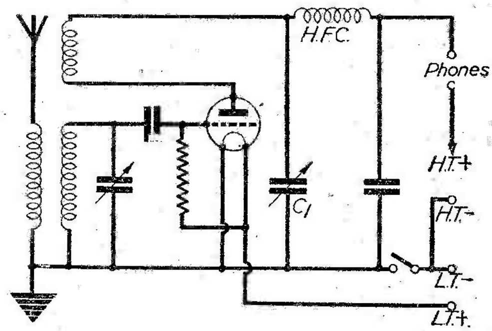


Fig. 3.—Here is a circuit favoured by many S.W. enthusiasts. It uses what is known as "throttle control."

The negative side of the filament is returned to the negative line through the bottom end of the grid-coil, the actual tapping point governs the degree of reaction and is usually best determined by experiment. As a guide, coils for the 12 to 26-metre band should be tapped approximately 1¼ turns from the earth end. The 22 to 45-metre band would require about 2½ turns, but, as mentioned above, tests are the best means of determining the exact point.

The positive side of the filament receives its L.T. through an H.F.C., which can be constructed by winding 30 to 40 turns of 26 S.W.G. enamelled wire on a ½in. diameter former. The winding is put on in a single layer, solenoid fashion, each turn being spaced the thickness of the wire. The choke should be connected close up to the filament terminal on the valve-holder. The fixed condenser connected to the screening-grid plays an important part in the operation of the circuit and it is advisable to adhere to the value shown and use a component of the mica dielectric type.

Books Received

RADIO SIMPLY EXPLAINED. By John Clarricoats. Published by Sir Isaac Pitman and Sons, Ltd. 44 pages. Price 6d. net.

THIS useful handbook is intended as a brief introduction to radio, and will appeal to readers having little previous knowledge of the subject. The elements of radio are told in simple language that anyone can understand, and much of the text is illustrated by diagrams. As a "first-step" book for prospective radio mechanics, wireless operators in the Services, and all who wish to gain an elementary knowledge of radio, this little work admirably achieves its object.

PRACTICAL SOUND CONVERSION FOR AMATEURS. By F. G. Benson. Published by BCM/VALU. 30 pages. Price 5s. od. net.

THIS book is written especially for those home cinematograph enthusiasts who would like to convert their silent machines for sound. For the amateur, the price of professionally made equipment is, of course, prohibitive, and in this book an endeavour has been made to explain how enthusiasts can show sound films by suitably adapting their existing apparatus. In order that the apparatus described may be applied to any gauge of film, dimensions have been omitted. The book is illustrated with several line drawings.

Aids to Selectivity

Further Notes on This Important Subject

(*Continued from page 197, April issue.*)

Using Different Coils

THERE is no doubt that one of the most effective ways of all to increase selectivity, especially with a comparatively old set, is to replace the coils by others of more advanced type. This subject is fully dealt with later in this article under the title of "Choosing Coils."

Modifying the Detector

It is frequently possible to obtain a very useful increase in selectivity by making slight alterations in the detector circuit. The simplest of these is to exchange the detector valve for one of higher impedance, such as an H.L., H.F., or even an R.C. one. This will give the necessary increase in selectivity without introducing any ill effects in other directions, provided that the valve is not preceded by a very powerful high-frequency amplifier, and that the transformer connected in its anode circuit is of an efficient pattern.

If the slight extra expense and wiring modification are not objected to, it is an excellent plan to replace the detector valve by one of the screened-grid type. The method is clearly shown in Fig. 6 (April issue), where the previous connections are shown as broken lines, and the new ones as full lines. A potentiometer is not an absolute essential for supplying the screening-grid potential, but it is well worth while, since it enables the optimum screening-grid potential to be found under working conditions. The connections shown are equally applicable to either battery or mains-operated sets. There is one little point which should be borne in mind when changing over to the S.G. detector, which is that the impedance in the anode circuit of the valve should be as high as possible. For that reason it is most satisfactory to connect the following transformer on the resistance-capacity system, using an anode resistance of not less than 100,000 ohms and connecting this to the highest H.T.+ voltage tapping available.

Changing to Anode-bend

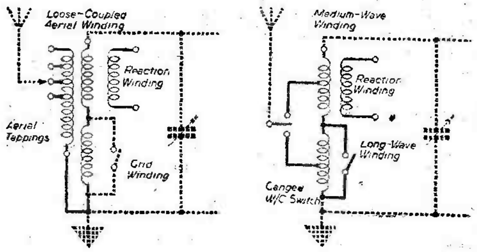
Anode-bend detection is scarcely ever used at the present time, but it is very useful in providing sharpness of tuning, due to the low damping which is imposed on the preceding tuned circuit. Luckily, it is only a matter of moments to change over from leaky-grid to anode-bend, and the necessary alterations are quite simple. The grid condenser is short-circuited and the leak disconnected, whilst the connection from the "earth" end of the grid coil is replaced by a lead going to a tapping on the grid-bias battery. It is sometimes better to include a decoupling resistance in the G.B. lead to prevent instability. When the decoupling resistance is found necessary a .1 mfd. fixed condenser should be connected in the position indicated by broken lines, so that correct tuning is not affected by the modification. The optimum value of grid bias for the detector will depend upon the type of valve employed and also upon the H.T. voltage supplied to its anode, but will generally prove to be either $1\frac{1}{2}$ or 3 volts.

Reaction Improvements

It is widely known that reaction is one of the very best aids to selectivity, and, therefore, it need hardly be stressed that any alteration which improves the "smoothness" of control will be a great help in the quest for interference-free reception. Some of the methods already dealt with, particularly those by which the values of detector grid-circuit components are modified and where an S.G. or anode-bend detector are used, will automatically improve reaction control to a noticeable extent. Another useful idea is to insert a non-inductive fixed resistance of between 100 and 500 ohms between the anode of the detector valve and the reaction condenser, whilst a second way is to connect a .0002 mfd. fixed condenser between the anode and earth. Any of the other well-known methods of "steadying" reaction, such as varying the detector's H.T. voltage and using a more efficient H.F. choke, are well worthy of trial.

Superhet Principle

Where the utmost selectivity is desired, it is obviously essential to employ the superheterodyne circuit, although, where accurate methods of matching can be employed, it is possible to obtain a similar high degree of selectivity with two or more H.F. stages. The latter arrangement, however, requires that all tuned circuits are very accurately matched, and this is not a simple matter for the home-constructor. On the other hand, the superheterodyne feature may be employed by a home constructor with every confidence, as the separate coils which are required can normally be purchased from different firms, and the assembly of correct parts will enable a highly-efficient receiver to be built up. The reason for the selective properties of the superheterodyne circuit is to be found in the method in which the frequency of a received station is changed into some other pre-determined frequency, and subsequent amplification carried out at this new frequency. The circuit consists of a first detector (which may or may not be preceded by a standard H.F. amplifier); an oscillator valve tuned to oscillate at a definite frequency; one or more H.F. amplifiers which are pre-tuned to the new frequency; a second detector; and finally, normal L.F. stages. The intermediate frequency amplifiers which follow the oscillator circuit are provided with H.F. transformers which are tuned to a fixed wavelength and thus there is no necessity for tuning condensers for these stages.



Figs. 7 and 8.—Showing alternative methods of improving selectivity by tapping into the aerial coil.

Choosing Coils

The correct choice and use of coils have, generally speaking, a greater effect upon selectivity than any other items in connection with the receiver. It is fortunate that there is now available an extremely wide range of efficient coils, most of which can be interchanged without much difficulty with older types already fitted in the set. The latest iron-core coils are extremely good from the point of view of selectivity, but as they are also more efficient than most coils of the older kinds it is not always wise to use them as replacements in receivers of the more complicated types, unless one is prepared to make other slight modifications to ensure complete stability. In the case of detector-L.F. types of receivers, however, the change can be made without any difficulty arising. It would be impossible here to mention all the various makes of iron-core coils available, or to give the connections for each, but full details, as well as circuit diagrams, are usually supplied by the manufacturers without charge.

Loose-coupled Aerial Windings

Considering first of all the simple detector-L.F. type of set, it can be said that, in choosing a new tuner, it is wise to obtain one of the kind provided with a loose-coupled aerial winding which has tappings by means of which the degree of selectivity can be varied to suit any set of circumstances. The circuit diagram of a tuner of this type is given in Fig. 7 as an illustration of the statement just made. It will be seen that the aerial can be attached to any one of the tappings on the winding shown on the left, so that the effective size of this winding, and, consequently, the degree of coupling obtained, can be varied.

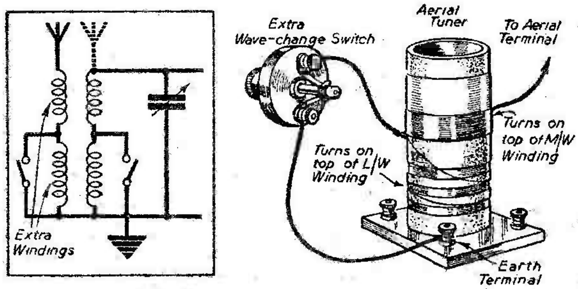


Fig. 9.—Adding aerial coupling coils, as shown here, also improves matters, especially when separate windings are used for M. and L. waves.

Transfer-tappings

Another form of tuner which is particularly good, on account of the fact that it provides an equal degree of selectivity on both long and medium waves, is theoretically shown in Fig. 8. In this case both the medium-wave and the long-wave windings are tapped (to reduce the inevitable "damping" effect of the aerial), and an aerial change-over switch is combined with the ordinary wave-change switch.

Modifying Existing Coils

There will no doubt be many readers who would like to take advantage of the benefits offered by coils of the types just mentioned, but who do not feel disposed to buy or make a set of new ones. A simple method of adding a loose-coupled winding to an existing coil is shown in Fig. 9, whilst Fig. 10 shows how transfer-tappings can be provided and made use of in conjunction with a switch of the single-pole-change-over type. In the latter case a connection can be made to the middle turn of the medium-wave and long-wave windings by scraping away the insulation for a length of ¼in. or so, and soldering on a short length of thin flex. To prevent burning the windings whilst soldering it is a good plan to place a slip of mica underneath the wire. In the case of the long-wave winding, it might in some cases be necessary partly to unwind it, since the turns will not otherwise be so easily accessible. Although it has been suggested that the tappings be taken from the centre of the windings, this is not always the best place, but it is generally effective. If a little experimentation is not objected to, however, it is a good plan to try various tapping points and then choose those which sharpen tuning to the greatest extent. Long-wave selectivity will rarely present any difficulty, and so it will perhaps be sufficient to try alternative medium-wave tappings only. This can be done easily by attaching an ordinary pin to the end of the flex and pressing this between adjacent turns at various points on the winding. The pin will scrape away the insulation and so make contact with the wire.

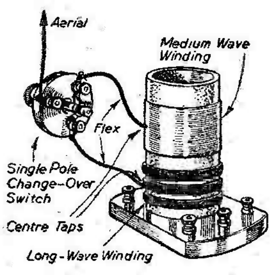


Fig. 10,—Simple switching to allow a tapping to be used on both windings.

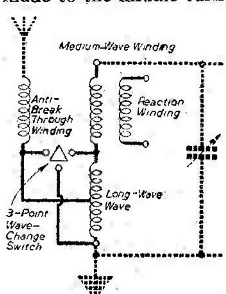


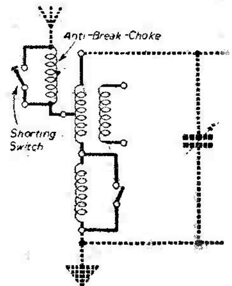
Fig. 11.—One method of connecting the anti-breakthrough choke.

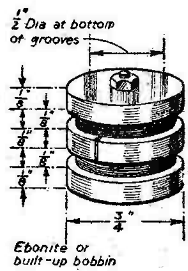
Using Band-pass Tuners

In nearly every case a useful improvement in selectivity, especially with sets not having an H.F. stage, can be secured by replacing the single-circuit aerial tuner by a band-pass one. The connections will, naturally, depend upon the make of the tuner chosen, but all details will be found on the instruction sheet issued by the makers. In most instances the modification will make it desirable to employ a two-gang condenser for tuning, but this is not essential if the owner does not mind operating two separate condensers simultaneously.

Medium-wave Breakthrough.

Breakthrough of a medium-wave transmission when listening to long-wave stations can result in serious interference. The best method of preventing breakthrough is to use coils designed with this end in view; the aerial winding is usually designed so that it does not resonate at any station frequency on the medium waves; they generally give a circuit arrangement similar to that shown in Fig. 11, where a loose-coupled aerial winding is in series between the aerial terminal and the long-wave winding.





Figs. 12 and 13.—The choke is cut out on medium waves when it is wired as shown by diagram on left. The constructional details of the choke are shown on right.

Another way is to include a special anti-breakthrough choke in the aerial circuit, as shown in Fig. 12. The choke is used only for long-wave reception and is short-circuited when it is desired to listen to medium-wave stations. If desired, a suitable choke can be made quite easily, as shown in Fig. 13. The bobbin can be turned in ebonite, or may be built up from five discs of stout cardboard, two of which are ½in. diameter and three ⅞in. The discs can be fastened together with glue, or by means of a 4 B.A. bolt passed through them. The winding consists of 220 turns of 38-gauge enamelled wire, of which 110 turns are placed in each slot.

(To be concluded.)

Errors in Testing Receivers

Incorrect Tests Are Often Applied by Those Not Experienced in Such Work. This Article Explains How to Avoid Such Snags

IT is very easy to make a slip when carrying out even routine tests of a receiver, especially if a copy of the wiring diagram is not kept in sight. An example of this was exemplified recently when a thoroughly experienced experimenter made what he later found to be a foolish blunder in checking through the mains unit of an amplifier.

Before connecting it to the amplifier valves he wished to make a test of the output and to ascertain that all voltages were correct. And as he had made use of a mains transformer which had not been in use for some time he thought it desirable to make sure that this was not below par. A high-grade multi-range meter was used, this being set to read A.C., and the voltage on each side of the centre tap of the H.T. winding of the transformer was measured. A similar reading of slightly under 400 volts was obtained for each half, which was correct, for the component was to be used with a full-wave rectifying valve taking up to 500 volts on each anode.

As a check for leakage between H.T. and filament windings, the meter was temporarily connected between the centre tapping of each. Of course, there was a voltage reading because the valve had not been removed from its holder. The valve was then removed and the test repeated; no reading. Another test was made by connecting the meter to one end of each of the two windings. To his surprise, a reading of approximately 380 volts was shown by the A.C. meter. For a few minutes the experimenter was stumped; and probably you would have been. It was not until he had made some additional tests with the transformer disconnected from its external circuit that he realised why a reading had

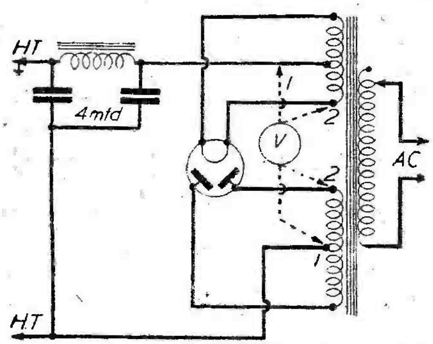


Fig. 1.—Points at which unexpected meter readings were obtained when testing a power unit using a full-wave rectifying valve and mains transformer.

previously been obtained—for there was no doubt that the component was in perfectly good condition and entirely free from inter-winding or core-winding leakage.

The Reason

The explanation should be clear from Fig. 1. Have you spotted the slip? When the transformer was connected and the rectifying valve was removed from its socket there was no reading between the points marked 1, but there was one between those marked 2. If you have not yet "tumbled," the explanation is that the supply was A.C., and that the circuit between the centre tapping of the H.T. winding and the L.T. winding was completed by the two smoothing condensers. These would have been insulators for D.C., but on A.C. an 8-mfd. condenser (the capacity of the two in parallel) has an effective resistance of only about 400 ohms at 50 cycles. When using a high-resistance meter such a resistance is negligible as far as the reading is concerned.

Measuring Anode Voltage

A mistake is often made in determining the voltage applied to the anode of a valve. Even when a battery is used for H.T. supply you cannot tell the voltage by noting the tapping used to feed that anode, for there is always a resistance of some kind in the anode circuit. This might be only a few hundred ohms, through the primary winding of an L.F. transformer, or several thousand ohms, through a coupling and/or decoupling resistor. Thus, an initial voltage of 100 would be reduced to 50 if there were a series resistor of 5,000 ohms and the valve passed 10 mA. In the same conditions the voltage drop would be only 5 if the total anode resistance were only 500 ohms.

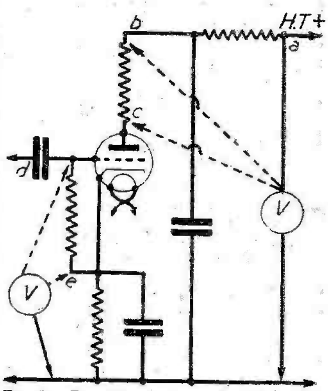


Fig. 2.—Especial care must be taken when attempting to measure anode and grid voltages.

The matter is not greatly simplified even when a good-quality high-resistance voltmeter is available, for reasons which are shown diagrammatically in Fig. 2. If the negative terminal of the meter were connected to the earth line, and the positive one to H.T.+ (the point marked a), the reading would be valueless. In the first place, the reading would not take into account the voltage drop across the two series resistors in the anode lead. In the second place, the resistance of the meter would be in parallel with that of the valve and its anode resistors in series; consequently, part of the H.T. supply would pass through the meter so that the reading would be slightly less than the voltage provided by the H.T. point.

Parallel Resistances

The position is not improved by transferring the positive lead from the meter to the points marked b and c.

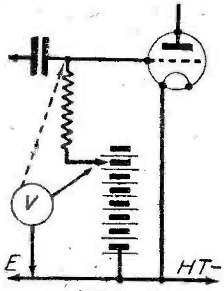


Fig. 3.

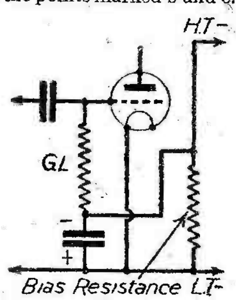


Fig. 4.

Fig. 3.—Full lines indicate the voltmeter leads when measuring the bias voltage in a battery set. There may not be any reading when the meter is connected as shown by the broken line.
Fig. 4.—Usual connections for automatic bias in a battery set. The bias voltage is developed across the resistor.

When connected to b there is still the anode resistance in series with the valve anode, and when connected to c there are actually three resistances in parallel; that of the valve (A.C. resistance or impedance), that of the meter, and that of the two resistors and H.T. supply all in series. It will be seen, therefore, that the indicated voltage might differ appreciably from the actual voltage. In fact, the only value of this test would be in finding whether or not an anode voltage was being applied to the valve. With a cheap, low-resistance meter it is even possible that no voltage reading would be given.

Voltage from Current

The only convenient method of determining the correctness of the applied anode voltage is, peculiarly enough, by measuring the anode current by means of a milliammeter. If this were inserted at the point marked c, the current consumed by the valve could easily be found (provided that the resistance of the meter were not high by comparison with that of the anode-circuit load). By comparing the current with that shown on the curves for the particular valve in use it would be possible to obtain a fairly accurate indication of the actual plate voltage.

To permit of this being done, however, it would be necessary to know the grid-bias voltage. This could be measured with sufficient accuracy for most purposes by connecting a high-resistance voltmeter between the earth line and the upper end of the bias resistor—in the case of a mains set—to the point marked e in Fig. 2. It is important that the meter should have a very high resistance compared with the value of the bias resistor, because if this were not the case we should again have the position of two parallel resistances, the overall value of which is less than that of either component separately. A factor which might easily be overlooked is that a correct reading might not be obtained if the negative side of the meter were connected directly to the grid of the valve. In that case the grid-leak resistor would be in series with the meter, and since this might have a value up to one megohm or so its effect would be marked. In normal running conditions there is not, of course, any voltage drop across the leak due to the fact that grid current does not flow—the bias is merely a potential applied to the grid.

The same conditions apply when dealing with a battery receiver, and in this case the meter should be connected between the positive end of the bias battery and the tapping point employed, not to the grid of the valve. This is illustrated in Fig. 3. When dealing with a battery set having automatic grid bias, as shown in Fig. 4, measurements should be taken in the same manner as for a mains set; that is, the high-resistance meter should be joined across the bias resistor.

Anode Current Totals

A mistake is sometimes made when checking the total of individual valve anode currents against the total current found by inserting the milliammeter in the H.T.— lead. It is frequently found that the sum of the currents is appreciably smaller than the single total reading. A search might then be made to find where leakage is taking place, but without result. This is because it has probably been overlooked that there is a potentiometer across the H.T. supply, used to feed the screening grids of the frequency-changer and I.F. valves, or to feed the S.G. of the H.F. valve. A correction must be made by connecting a milliammeter in series with the potentiometer to find exactly what current it is passing.

Coil Testing

Another fairly common mistake is often made by constructors wishing to check the resistance of coil windings, and also the change in resistance when the wave-change switch is operated. When an ohmmeter is not available—and few constructors have one—the best course is to use a low-resistance ammeter in series with a small dry battery, as shown in Fig. 5. Thus, if a 1½-volt dry cell were used in conjunction with an ammeter reading up to one amp., the readings at long- and medium-wave positions of the switch for a coil with resistances of 2 and 5 ohms for the M.W. and L.W. windings would be approximately .75 and .2 amp. If the method of using a milliammeter in series or parallel with a fixed resistor were employed (and this is often convenient and sufficiently accurate) the difference in readings probably could not be detected.

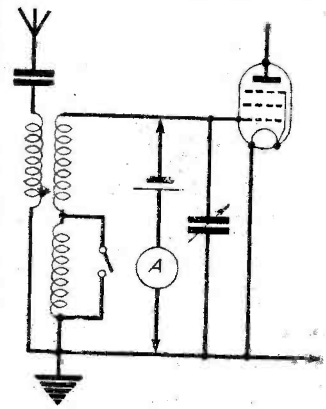


Fig. 5.—A simple method of measuring the resistance of a tuning coil set to medium and long waves.

NEWS AND NOTES

Wireless Operator's Self Sacrifice

THE self sacrifice and initiative of a sergeant wireless operator have been commended by the Commander-in-Chief of Bomber Command in his Routine Orders.

The sergeant was one of the crew of a bomber recently sent to attack an enemy target. While the aircraft was crossing the English coast on the outward journey the oxygen apparatus began to leak, and all the oxygen would have been exhausted in about 40 minutes. It was only by wrenching away the pipe through which he himself was supplied with oxygen, and sealing the end of it with a pair of pliers, that the sergeant was able to stop the leak.

For the rest of the journey he relied on two hand bottles, each with only enough oxygen to last for ten minutes, to keep himself going. Yet he managed to carry on with his wireless and other duties, and the bomber's mission was successfully completed.

By the time the aircraft had returned to base he was showing signs of distress, but the pilot made a gradual descent and after he had landed the sergeant was found to be none the worse.

Austrian Listeners to B.B.C.

EVIDENCE is still accumulating that the B.B.C. broadcasts to Europe are being heard by an ever-increasing audience in the German-occupied countries.

Latest reports come from Austria where it is reliably estimated that 75 per cent. of the people of Vienna are strongly anti-Nazi. They include not only the workers, but the middle-class, formerly so favourable to the Nazi cause, and they regularly listen in to B.B.C. broadcasts.

The latest joke in Vienna is about a maid, who on applying for a position asked a wage of sixty marks a month. When told that the current rate was only forty marks, she replied, "Yes, but I have to charge ten marks extra for keeping silent about 'black market' purchases, and another ten for keeping silent about listening in to the B.B.C." When the householder said that they lived on their rations and listened only to Nazi broadcasts, the maid answered angrily, "Well, I am certainly not going to work in a house where the people are both hungry and stupid."

Diode-grid Detection

Details of Some Interesting Experiments

By D'ARCY FORD

FOR some years past the writer has had in mind a new method of detection which suggested itself with increasing force as the time went by. The method has recently been put through some practical tests, and the results may prove interesting to readers.

Before carrying out any experiments, the writer drew a circuit of diode detection, and also a proposed circuit on the new method. The new circuit worked first time, but was disappointing in the loss of volume as compared with the diode. Since then a number of experiments have been carried out with results both good and bad. Some tests were surprisingly selective, others extremely stable, and others were indifferent.

Simple Circuits

Fig. 1 is a simple diode circuit, the load resistance R1 being shunted by a by-pass condenser C1. The resistance R2 is included for the purpose of stabilising the circuit.

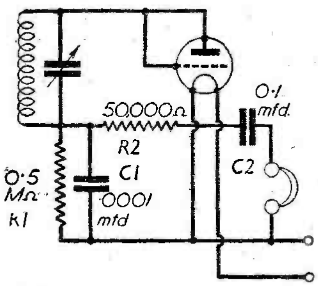


Fig. 1.—A simple diode circuit.

Fig. 2 shows an extremely simple diode-grid detector circuit. This is like the circuit which was drawn before testing, but a load resistance was first included in the position of the 'phones. If, however, a load resistor is used, the low value of 50,000 ohms could be tried, and the output taken via a coupling condenser to the L.F. One simple method of coupling Fig. 2 to the L.F. stage would be to direct-couple the grid to the primary of an L.F. transformer, and the bottom end of the primary taken to earth, the L.F. transformer secondary to be used in the ordinary way. In other words, substitute the L.F. transformer primary for the 'phones of Fig. 2.

Fig. 3 shows the grid, instead of being connected through the phones or load resistance to earth, connected through the load resistance to H.T. positive. This requires a higher value, and various resistors between 0.5 meg. and 5 meg. could be tried according to the value of the H.T. and other reasons. Fig. 2 appeared to be quite stable, even more than ordinary diode detection, but Fig. 3 appears to require stabilising as normal diode detection sometimes does. The stabilising resistor R2 of the value of 50,000 ohms is incorporated for that purpose. A switch is shown to switch out the by-pass condenser of Fig. 3 for experimental purposes. In the early experiments the by-pass condenser appeared to reduce the volume of the audio output.

All methods of detection appear to have their limitations, but diode-grid detection seems to be capable of being used in more types of detector circuits than any other method. For instance, an ordinary screen-grid valve has been used with the anode proper of the valve as a diode-anode, and the output from the control grid taken through the 'phones to earth as in Fig. 2, but it seemed to make no difference how the screening-grid was connected or disconnected. The same screen-grid valve was used with the screening-grid connected to the top of the coil (as a diode-anode), and the H.T. taken to the anode proper of the valve.

Reaction

Several attempts were made to apply reaction to the new method in circuits using H.T., so that it could be used as a detector on the aerial, but without definite results up to present. This is further proof of the stability of the circuits. There is plenty of scope, however, for further experiments to obtain reaction effects, as the matter has not been fully explored. Possibly the type of circuit of Fig. 4, which has not been tried for reaction, might be found to be a little more suitable for that purpose. Or a centre-tap coil might be tried in other circuits.

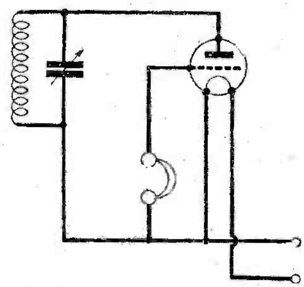
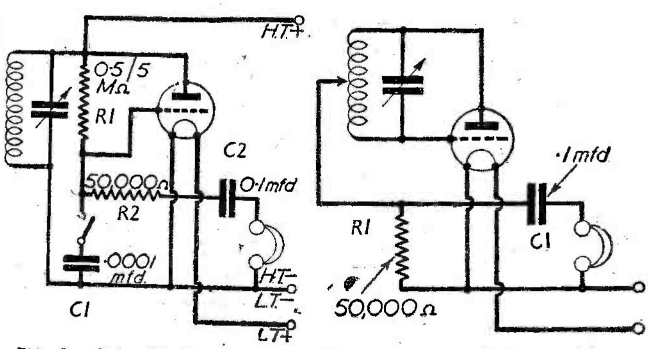


Fig. 2.—A simple form of diode-grid detector circuit.

The writer has for some time been of the opinion that radio frequencies pass through a valve (and also through a condenser) *in both directions*, and it was that view which led to the development of the present method of detection. These circuits tend to support that view, but they do not prove it. When a valve is so biased, or so operated that it offers a greater opposition to the radio frequencies in one direction (say from grid to filament) than it does in the other (i.e. from filament to grid), then the valve appears to be working under conditions of detection or partial detection.

Fig. 4 was the last circuit to be developed, and has been the most difficult. After the circuits in Figs. 2 and 3 had been tested a few times, the writer felt that there was still another different type of circuit which could be used with advantage. It seemed to be connected with a circuit in which the top of the coil was taken to the anode, and the bottom of the coil to the grid of the valve. When it was first connected up in that manner a pair of 'phones was placed between the grid and earth —with the only result of dead silence. The grid was afterwards taken through a load resistor to H.T. positive, and (forgetting for a moment that the H.T. was also on the anode) sufficient results were obtained to offer promise of better.



Figs. 3 and 4.—Modifications of the diode-grid detector circuit shown in Fig. 2.

About this time the experiments on reaction were also being tried, and the whole matter was becoming troublesome.

Audio Output

Then an interested friend of the writer's, on being informed of the difficulty of the tuned circuit, when connected to the anode and the grid of the valve, being "up in the air," suggested tying it down to earth by a centre-tap. After that idea had been digested for a few days, it seemed that the audio output could possibly be taken not from the grid, but from the centre-tap of the coil itself. When a pair of 'phones was placed between the centre-tap of the coil and earth, the result was that it worked. Several load resistors were tried in place of the 'phones, and strangely enough the low value of 50,000 ohms was decided on, which is the same value as the one that appeared to work best in the place of the 'phones in Fig. 2.

As the centre-tapped coil began to give trouble for some reason, another coil was tried with a tap which was not in the centre, and it also worked. The output was afterwards taken from the top and from the bottom of the coil, and it still gave results with the load resistor in position. It is suggested that the tap on the coil in Fig. 4 be tried in different positions for the best results.

This new method can probably be applied or used with diode-triode valves and double-diode valves, but an extra grid would have to be provided, and that appears to be a simple matter with modern valve makers.

The invention, or a portion of it, may possibly also be used or applied to the half or full-wave rectification of A.C. mains, with a quite possible improvement in stability or smoothing.

[*We publish the foregoing as a basis of experiment, although we are unable to express an opinion of the merits of the system. The author freely presents the idea to the public.*—EDITOR.]

P.A. EQUIPMENT—10

Operation and Maintenance. By "SERVICE"

(Concluded from page 224, April issue)

ALL large P.A. installations should be thoroughly warmed up for about half an hour before the programme is required in order to prevent variations of the signal strength and possible overloading and distortion. Small equipment, such as portable apparatus, may need only ten minutes or so to stabilise, but it is unwise to attempt to go straight ahead with a "broadcast" without an initial warming up. Certain types of faults, such as smoothing condenser shorts, valve heater failures, etc., often occur when the switching off and on surges take place. A generous warming-up period will generally give sufficient time to carry out component replacements should a failure of this nature occur.

If things proceed normally, the input signal may be fed into the amplifier just before the time due for the programme to commence. When the input signal is coming from an external source, such as a radio transmission, the operator should tune-in the station by headphone or a monitor loudspeaker and then gradually mix the signal into the amplifier by means of the fader controls.

Volume Control

Where gramophone records are being used for programme matter, just as much care should be taken so as to prevent disturbing noises at the commencement and at the finish of each record. It is advisable to have the volume control at zero, place the needle on the smooth edge of the record, and then turn up the volume control as the needle enters the first groove of the record. Towards the end of the record the position of the pick-up should be watched and the volume control turned to zero just before the needle enters the run-off groove, which is provided to actuate automatic brakes and automatic record changers.

In cases where the input to the amplifiers is from one or more microphones a constant watch must be maintained on the anode current milliammeters, and an attentive ear turned to the loudspeakers so as to detect instantly any signs of overloading due to a speaker or crooner speaking or singing too loudly into the microphone. Installations which are served by long microphone cables with a microphone amplifier at the remote end should be controlled at the first amplifier. It is not much good turning down the master volume control on the output stages if the earlier stages are being overloaded and are passing on a distorted signal to the following valves.

All newcomers to the microphone should be given a few tips on microphone technique and, if possible, a rehearsal.

Where the equipment is being used to supply music or reproduce speeches in a hall where the audience is constantly varying in numbers, care must be taken to prevent too loud a reproduction from the loudspeakers when the audience is small or too low in volume when the audience increases. Only by actually listening in the hall can the right amount of power is judged, although where seating is provided and the installation is a permanent one, such as in a cinema, the "box-office returns" will indicate the size of the audience, and the volume controls can be set to predetermined positions found by experiment for the size of the audience.

The Log Book

With regard to maintenance of equipment, whether large or small, a log book should be kept in which are entered all particulars of times of operation, valve replacements, breakdowns with their causes and cures, and periodic readings of any meters incorporated in the equipment.

The weekly analysis of the log book will not only allow running costs to be calculated but will prevent many a breakdown. By keeping a record of the number of hours which the equipment has operated, valves may be replaced (in peace-time) when they have been run a thousand hours or so. They can then be used for emergency spares or in amplifiers where a breakdown would not be serious to the prestige of the owners of the equipment.

Despite care taken in maintenance, breakdowns may occur, and speed is essential in tracking down the cause of the trouble. In most equipment, as has been mentioned, meters are provided on the amplifier panels so that the anode currents and voltages of the various valves may be quickly measured by means of a switch or plug-and-socket arrangement. If the readings obtained are low for all the valves, then this would point to a low emission rectifying valve or to a leakage on the H.T. smoothing circuit.

In the latter case, the emission of the rectifying valve will be high, if not high enough to blow fuses or trip any relays provided to protect the valve and mains transformer.

Checking Current Consumption

If the anode current is low, and the anode voltage high on only one valve, then this would indicate that that particular valve is faulty and a spare one should be put in its place. Should both current and voltage be low, it is evident that there is a fault in the anode supply circuit to that valve which has increased the resistance of the circuit and so lowered the voltage and the anode current to the valve.

If the anode current is abnormally high then the grid circuits should be suspected of being open-circuited, or, in the case of output valves, the valves may have become soft. In all large installations at least one complete set of valves should be available as spares and for rapid replacement tests, as the time factor is extremely important where a public service is being maintained.

Service equipment which should be available for carrying out repairs and maintenance work follows very closely along the lines of the equipment which the radio service engineer has by him. The only difference is that in the case of the D.C. voltmeter the ranges should go up to 1,000 or 1,500 volts where large installations are to be cared for.

Universal Meter

A multi-range or universal meter incorporating A.C. or D.C. ranges is very useful, although in some cases it is convenient to have separate meters where, for example, the effect of varying the grid voltage applied to the output stage is being compared with the anode current of the valves. The resistance of the meter should be at least 1,000 ohms per volt, as in most amplifiers the resistance capacity type of inter-stage coupling is used, and in such high-impedance circuits a low resistance meter connected in parallel with any of the high resistances in the anode circuit will completely alter the voltage distribution and give false readings.

Where inter-valve transformers are engaged, and where the primary is in the anode circuit of a valve, a break in the primary will break the anode supply circuit to the valve. A break in the secondary circuit will deprive the following valve of bias and will cause the valve to have a high anode current and to probably burn its anodes at white heat until the valve collapses.

Generally, however, where inter-valve transformers are used either to step up voltage or to feed push-pull valves, the primary of the transformer is resistance-capacity fed from the anode circuit of the preceding valve. If volume of reproduction falls to a mere high-pitched whisper, and all voltages and currents check up O.K., the coupling condenser or transformer may be open-circuited. Both these faults will have no effect upon the preceding or following valves and can only be deduced by negative tests on other parts of the circuit.

Audio-frequency Oscillator

It is for faults such as these that an audio-frequency oscillator is so useful, as by injecting a signal from it into one stage after another it is quickly apparent where a breakdown has occurred. This method of fault finding is similar to signal tracing with a service oscillator in a radio receiver, and is a sure way of locating a fault which does not show up after preliminary tests have failed to indicate anything wrong.

Fault finding on the wiring networks feeding loudspeakers has been dealt with already. The logical application of normal servicing procedure will quickly locate a breakdown on the distribution networks, and spare loudspeakers will enable faulty units to be replaced quickly so as to give immediate service. The faulty speakers can then be repaired in the service workshop or by the manufacturers.

This article concludes the present series dealing with P.A. Equipment, and it is hoped that much of the mystery surrounding large installations has been dispersed and that many service men will now feel better able to enter this interesting and profitable branch of radio.

British Air Cadets, training at the South-east Air Corps Training Centre, at Montgomery, Ala., recently had the opportunity of sending their greeting to their relatives in England recorded on gramophone records. Before being sent the records were heard by some of the cadets, four of whom are seen in the above illustration.

B.B.C. MUSIC LIBRARY

THE B.B.C. Music Library has for some months now been in a place of safety, it hopes. Bombed in London, it was evacuated to the country, where it was promptly damaged again. It was, therefore, moved once more, and up to the present has been left in peace.

But though there is comparative peace outside the Library, there is very little in the office of the men in charge. Their telephone seldom stops ringing; questions are fired at them all day and every day. They are, in fact, liable to be asked anything at any moment about any kind of music or song, and they can, as a rule, provide the required information in a few minutes.

They are able to do this because of the efficient filing and indexing systems which they have evolved. It has to be a water-tight system because there are about 25,000 copies of sheet music and albums in the library, as well as a vast quantity of valuable manuscripts. And the number keeps on growing.

At any moment some music may be wanted in a hurry. It may be by Bach or Irving Berlin, Grieg or Gershwin; it is supplied. A script-writer may telephone to ask what songs some famous music-hall star sang in 1887; he is told. A producer may ask if they can find, and let him have, a song about a cabbage; they can and do.

In addition to sheet music, there are thousands of records of all kinds, including some made by Dan Leno, Marie Lloyd, Eugene Stratton, T. E. Dunville, and many other famous old-timers.

ON YOUR WAVELENGTH

By THERMION

The Drain Bust

I SEE that Mr. Joad has been getting into trouble over one of his broadcasts. A Member of Parliament felt that Joad's reference to an alleged remark of Confucius was perhaps a little *risqué*, and he raised the matter in the House, but without satisfaction. Joad's comment was: "Would it not be better if the Member confined his attention to winning the war?" This does not strike me as being a particularly brainy retort, for, as I suggested last month, the Member could equally suggest that it would be better for Mr. Joad to do the same! Joad also said, when asked, that the remark to which exception was taken was, "to the best of his belief," taken from the writings of Confucius. In my view Confucius did not write the remark quoted. I have read a fair amount of the translated writings of Confucius, but I have never come across this one.

Listeners to this feature will no doubt have heard the disclaimer that Mr. Joad is not a professor. I quite thought he was, and that he held a Chair in a university. As the Brains Trust has admitted that this is not so it seems rather late in the day for the announcement to be made, for all the newspapers and the B.B.C. have referred to him as Professor Joad. However, I have had a number of letters of approval on my criticisms of the Brains Trust from members of the British public.

The Silent Sets

THERE must be millions of sets in this country which are silent because spare valves or other components are not obtainable. Promises have been made by the Government that this state of affairs would be rectified, but in my conversations with dealers I understand that there has been no general release of the more vulnerable components which are in frequent demand. It is important to the Government that wireless receivers should be maintained in working order. The B.B.C. has become the official Government mouthpiece. The problem is not so acute in London and its environs, because there are plenty of editions of newspapers, but in the North of Scotland, and the remoter districts of England where newspapers are delivered perhaps once a week, the news bulletins keep the residents in touch with events. In most of these remote districts electric supply is not available, and a census taken before the war showed that battery sets preponderated in such districts. There must be a greater supply of batteries and valves. Owing to the difficulty of obtaining crystals it is almost impossible now to build a stand-by crystal set. Where are all those crystals of yesteryear? Those natty little pieces of scintillating metal which one explored with the latest in catswhiskers, guaranteed to receive America.

What a racket it was. A trifling piece of bornite, practically valueless before broadcasting commenced, was sold for half a crown or more. Gold wire was sold for catswhiskers, in a neat little tube carefully packed in cotton wool. More ingenious were the mechanisms for searching the crystal, and a crystal detector of this type cost as much as 15s. There were those who thought that a loudspeaker could be operated from a crystal set. One or two attempts were made to do so, notably with those small microphone transmitter buttons which had a variety of other uses. Do you remember the unit sets that you built on the lines of an expanding book-case? You built the detector unit and the amplifying unit and an extra H.F. stage in separate boxes, and coupled them together according to what you wanted. Those were the days of bright emitter valves which would blue glow at anything beyond 50 volts on the plate. They were 6-volt valves at that. We were instructed always to use a soft valve for the detector stage. When low consumption valves came in the 2-volt range, a marked advance was made, for our 6-volt valve consumed anything up to half an ampere, and the power valve as much as three-quarters of an ampere. Now we can obtain superior effects from dull emitters which scarcely glow. There must be many of these old sets in the limbos of the early wireless experimenters which could be made to perform useful work with a little modification. The war has caused many amateurs to live upon their memories, and to dream of post-war plans. There are silent sets and silent keys. I should like to receive some photographs of early sets built by readers, and I will award book prizes to those whose photographs I publish. There is a lot of fascination in reflecting upon these old sets, and publication of photographs of them may provide some pleasant retrospect for those now in the Services.

Retailers to Combine?

THERE is a possibility as this issue goes to press that retailers in particular districts may have to combine. A meeting was held between the Board of Trade and representatives of the radio industry. They are endeavouring to seek a practical formula for the duration of the war. There is, of course, a great shortage of wireless technicians, in spite of the plan to reserve them. If such a plan could be found it would be appreciated by the public.

Jocular Jibbering

MR. JOAD, of the B.B.C., has a cure for critics. He thinks that the function of criticism should now pass from the newspapers to the B.B.C.

Come, listen to me,
And you'll giggle with glee,
I'm Joad, don't you know,
Of the great B.B.C.
So join in my capers,
We'll squash all newspapers,
Their editors sink in the sea!

We will then abrogate
The sole right to state
Opinions on that
Or on this.
And the things we will say,
In our imbecile way,
Will certainly add to your bliss.

What! You will not agree?
You prefer to be free—
To listen to men with some sense?
Oh, what shocking bad taste!
Must our "Brains" run to waste?
How *can* you cause us such offence?

"TORCH."

Our Roll of Merit

Readers on Active Service—Twenty-third List

R. J. Tossell (A.C.2, R.A.F.), Canewdon.
H. Bright (A.C., R.A.F.), Millom.
S. E. Janes (Sigm., R.C.O.S.), Croydon.
E. J. Roberts (Cpl., R.A.F.), Northwood.
H. A. Martin (A.C.2, R.A.F.), E. Lothian.
L. F. Halliday (A.B., Royal Navy).

Radio Examination Papers—6

A Further Set of Random Questions, with Suitable Answers Provided by the Experimenters

1.—Reception of C.W. and R.T.

A CONTINUOUS wave, as the name suggests, is a steady wave of fixed frequency. In practice the wave is "chopped-up" into dots and dashes which form the characters of the Morse code. The wave transmitted is at radio frequency, this being considerably above the highest frequency to which the human ear will respond; for example, when working on 50 metres the frequency is 6,000,000 cycles per second, which compares with the highest audible frequency, which is in the region of 20,000 cycles per second.

When the receiver is oscillating, or when a heterodyne oscillator is combined with the receiver, this also produces a continuous wave. By combining the two it is possible to produce a beat frequency or heterodyne at a frequency equal to the difference between the signal and the locally-generated frequency. In practice, the receiver is tuned to a frequency of about 1,000 cycles per second different from the frequency of the incoming signal. As a result a note or a "chirp" becomes audible at this difference frequency.

In the case of R.T. (radio telephony) a steady note would not be produced. Instead, there would be two fluctuating beat notes, due to the beating together of the locally-generated oscillation with the side-band frequencies, in addition to the beat note produced with the carrier frequency. All three beat notes would be mixed to produce an unintelligible whole. If the side-band theory (which is really more than a theory, and which can be proved) is not fully understood it is sufficient to state that the steady local oscillation is mixed with the incoming modulated wave to produce a beat note which does not resemble the original modulation.

SPECIMEN QUESTIONS

1.—*Why must a receiver be in a state of oscillation for the reception of C.W., and why cannot intelligible speech be received while the set is in the same condition?*

2.—*What is meant by variable-selectivity control? Briefly describe two systems of providing control of selectivity in a superhet.*

3.—*Explain the working principle of a moving-coil speaker, pointing out the difference between permanent-magnet and electrically-energised types.*

4.—*Show the essential difference between a heptode and a triode-hexode frequency-changer, and mention the chief advantage of the latter.*

5.—*With the aid of a diagram, show how simple tone control can be provided in the output circuit of a receiver. Explain the behaviour of the control system described.*

6.—*How is it possible to determine the percentage modulation of a transmitted wave by reference to the aerial ammeter? With a certain small transmitter the aerial current is 2 amp. when the P.A. is not modulated, and 2.4 amp. when modulated; calculate the percentage modulation.*

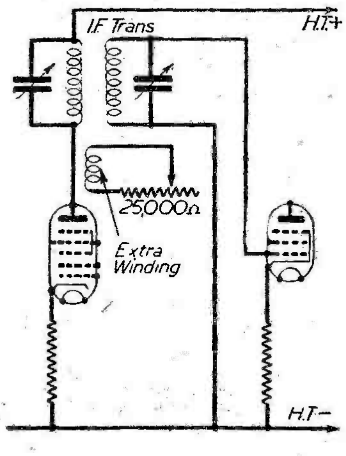
2.—Variable Selectivity

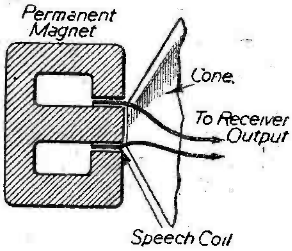
Selectivity can be defined broadly as being proportional to the frequency band over which a receiver will respond for any given setting of the tuning control. If the band is narrow, selectivity is said to be of a high order, while if the band is wide selectivity is poor.

To provide variable-selectivity control, therefore, it is necessary to have a means of varying the band; in other words, a method of varying the sharpness of tuning. In a superhet this control can best be applied to the intermediate frequency tuning circuits. One method is to mount the primary winding of one or more of the I.F. transformers in such a manner that it can be moved relative to the secondary. When the two are closely coupled selectivity is low, and when they are loosely coupled selectivity is relatively high. This method of control can be applied by placing the primary winding on a former which can be rotated within a second former carrying the secondary.

Another method is to place a third winding on the transformer, connecting the ends to a variable resistor, as shown in Fig. 1. When the value of the resistor is high the third coil provides little damping, and, therefore, selectivity is relatively high. By reducing the value of the resistor damping is increased and the degree of selectivity is reduced.

These are probably the most widely-used forms of selectivity control, but there are others. One of these consists of connecting a small variable condenser between





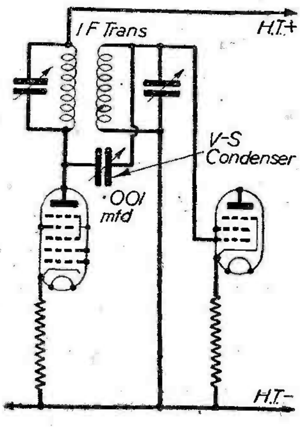


Fig. 1.—(Left) Method of providing variable selectivity by the provision of a third, or tertiary, winding with shunted variable resistor, to an I.F. transformer.

Fig. 2.—(Right) Variable-selectivity control by the use of a variable or semi-variable condenser to provide "top-capacity" band-pass coupling between the two windings of an I.F. transformer.

Fig. 3.—(Above) Diagrammatic section through a permanent magnet moving-coil speaker.

the two high-potential ends of the I.F. transformer windings. Both windings are pre-tuned by means of the usual pre-set condensers and together act as a band-pass filter, the small variable condenser providing "top-capacity" coupling. Selectivity is progressively reduced as the capacity of the variable condenser is increased. The circuit arrangement referred to is shown in Fig. 2.

3.—Moving-coil Speakers

The cone of a moving-coil speaker carries a winding which is described as the speech coil, since it is into this that the output from the receiver is fed. The speaker is so constructed that the speech coil is in a strong magnetic field, see Fig. 3. Alternating audio-frequency currents through the speech coil cause an alternating magnetic field to be built up round the coil. As a result the polarity at either end of the coil is rapidly changing from North to South. At the same time, the intensity of the fluctuating magnetic field is proportional to the A.F. input to the speech coil.

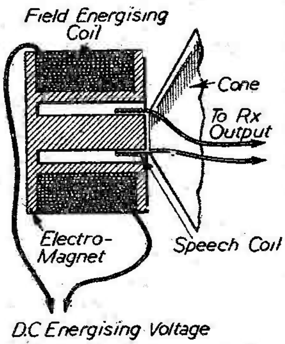


Fig. 4.—Details of construction for an electrically-energised moving-coil speaker.

Since "unlike poles attract; like poles repel," the speech coil moves backward and forward within the steady magnetic field provided by the permanent magnet. In consequence, the cone vibrates and produces sound waves corresponding to the audio-frequency input.

In a P.M. type of speaker the magnet is made from special alloy steel. With the energised type an electro-magnet is employed, this being made from soft iron with a winding through which direct current is passed. The electrically energised type of speaker is shown diagrammatically in Fig. 4.

4.—Frequency Changers

A heptode frequency changer consists essentially of a triode oscillator and a pentode first detector. Both grid and anode of the triode are made in the form of grids and are interposed in the main electron stream between the cathode and the pentode screening grids. There is no electrical connection between the triode and pentode sections of the valve.

In the triode-hexode frequency changer the grid of the triode is electrically connected to a fourth grid in the first detector, this being placed between screening grids. Diagrams of the two types of valve are shown in Fig. 5, where the electrode dispositions are approximately similar to those used in the valves themselves.

The chief advantage of the triode-hexode is that there is appreciably less electrostatic coupling between the oscillator and first-detector sections, due largely to the fact that the oscillator electrodes are further spaced from the hexode electrodes. As a result of this, there is less tendency for the signal-frequency circuit to "pull" the oscillator tuning circuit. This is particularly marked on short waves, where the effect of capacity coupling is far more pronounced, due to the fact that capacitative reactance becomes less as the frequency is increased.

5.—Tone Control

The usual method of tone control in the output circuit of a modern receiver is to connect a variable resistor in series with a fixed condenser between the anode of the output valve and earth. This does not provide complete tone control, since at any setting of the variable resistor the tone is lowered. But since pentode and tetrode valves tend to give emphasis to the higher frequencies, it does provide the necessary compensation and does permit of a gradual lowering of pitch as the value of the resistor is reduced.

This is explained by the fact that the condenser has a lower reactance to high than to low frequencies. Thus, by correctly choosing the capacity of the condenser it is possible to provide that the higher audio frequencies shall be partially by-passed to earth instead of being fed into the speaker. Increasing the ohmic value of the resistor has practically the same effect as reducing the capacity of the condenser. Thus, by varying the setting of this control it is possible to alter the extent to which the higher frequencies are by-passed.

As a matter of interest it can be added that the reactance of a condenser, in ohms, is $\frac{1}{2\pi fC}$, where π is 3.14, f is the frequency in cycles per second, and C is the capacity in Farads. The .02 mfd. condenser in Fig. 6 can therefore be seen to have a reactance at 5,000 c/s of about 1,600 ohms.

6.—Measuring Modulation Depth

Power in the aerial of a transmitter is proportional to the square of the aerial current—which is indicated by the aerial ammeter. When a carrier wave is modulated the power is increased, and there is a corresponding increase in aerial current. It is not a difficult matter to prove that the ratio of the current resulting from the modulated wave to the current due to the carrier is equal to the square root of: $1+\frac{m^2}{2}$, where m is the modulation depth represented as a fraction. Thus, 50 per cent. modulation would give m a value of $\frac{1}{2}$ or .5, or 80 per cent. would give m a value of .8.

Substituting the values given in the question, we obtain the formula: $\frac{2.4}{2.0}=\sqrt{1+\frac{m^2}{2}}$. To simplify the calculation, we can remove the square root sign by squaring both sides of the equation. This gives us:

$\frac{5.76}{4.00}=1+\frac{m^2}{2}$. We can re-write this as: $\frac{m^2}{2}=\frac{1.76}{4.00}$, or $m^2=\frac{3.52}{4.00}$, or $m=\frac{19}{20}$ approx. By multiplying this fraction by 100 we get the answer as a percentage: 95.

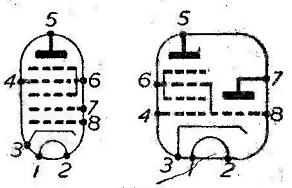


Fig. 5.

Fig. 5.—Diagrams of a pentagrid or heptode (left) and a triode-hexode (right). The electrodes are: 1 and 2, heater; 3, cathode; 4, signal grid; 5, main anode; 6, screening grids; 7, oscillator anode; 8, oscillator grid.

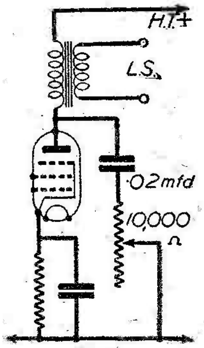


Fig. 6.—A conventional output circuit tone-control circuit.

Fig. 6.

It is interesting to note that for 100 per cent. modulation the aerial current for the modulated wave must be 1.23 times the current for the carrier or unmodulated wave. This is easily shown by substituting the value of 1 (unity) for m in the formula: $\frac{\text{Current in modulated wave}}{\text{Current in unmodulated wave}}=\sqrt{1+\frac{m^2}{2}}$, which gives the answer as the square root of 1.5, or 1.23 to the second decimal place.

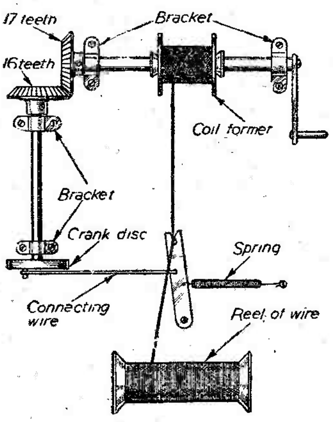
Note especially that the aerial currents employed are R.M.S. values; these are given directly by thermo-ammeters which are invariably employed in the aerial.

Practical Hints

Winder for Honeycomb Coils

WITH reference to the "Winder for Honeycomb Coils," which appeared in the Practical Hints page in the February issue of PRACTICAL WIRELESS, I submit the following improvement.

The crank on the end of the coil-former shaft should be removed, and a bevel or pin wheel with an odd number of teeth, say, seventeen, fitted in its place.



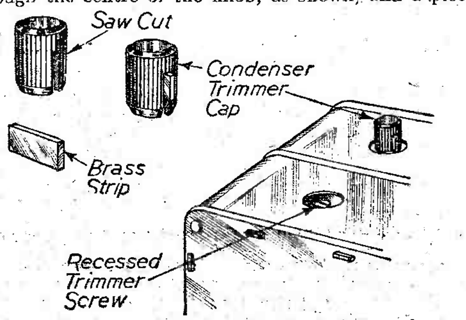
An improved winder for honeycomb coils.

Another shaft fitted with a bevel or pin wheel of an even number of teeth, say 16, should be fixed at right angles to the former in a position to mesh with previously-mentioned wheel. This second shaft could be mounted in two right-angled brackets screwed to the baseboard. On the other end of this shaft the crank (removed from former shaft) may be fitted. The thread may then be fitted direct from the wire-feeder to the crank pin, and the machine will then wind true honeycomb coils.—W. W. HORSNAIL (Cambridge).

An Adjusting Knob for Gang Condensers

THERE are occasions when it may be found impossible to adjust the trimming condensers of the gang condenser in a set from the top, by means of an insulated screw-driver, in the normal manner, and the operation may have to be carried out from the side. This is frequently the case with some portables, where the set is located inside the frame carrying the frame aerial. It is then that an adjusting knob such as shown in the accompanying sketch will be found very useful.

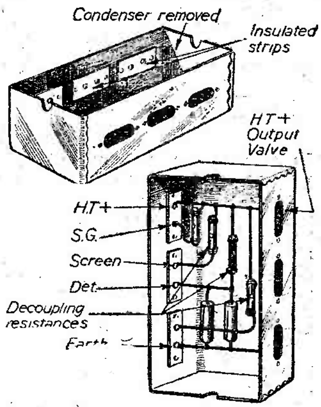
A small ebonite knob or an insulating top from a large type of terminal, is first drilled with a clearance hole, so that the knob will slip freely over the adjusting nut heads of the trimmers. A saw cut is then made through the centre of the knob, as shown, and a piece of flat brass strip forced to the top end of the slit. This brass strip is made of such a length as to project slightly at each side of the knob. A certain amount of initial experiment is necessary, to determine the depth of the saw cut, so that the bottom of the knob will just clear the condenser body, when the trimming condenser is screwed to maximum. The constructive work is so simple that several knobs can be made up in as many minutes, so that one can remain on each section of the condenser, if desired.—R. L. GRAPER (Chelmsford).



A method of making adjusting knobs for trimming condensers.

An H.T. Distributor

WHILE going through my junk for salvage material I came across an old ganged condenser which no longer functioned. After dismantling it, it occurred to me that it would make an excellent high tension distributor, particularly suitable in a home-made mains receiver, as short circuits might cause irreparable damage. All the screws were first removed, then the moving vanes of the condenser, and finally, the fixed plates. This left me with a small chassis with twelve insulated spots suitable for tapping off the H.T., as shown in the sketch. This distributor is very efficient, and if the ganged condenser is large enough decoupling condensers as well as resistances might be inserted. When mounted on the chassis other components may be mounted above.—W. AUSTIN (Paddington).



A H.T. distributor unit devised from an old ganged-condenser case.

Tapping a Coil

IT is very often found that for experimental purposes a coil has to be tapped and the best position found by trial. A good way of doing this is to wind the coil with D.C.C. wire in the usual way, ignoring all tappings. When completed, the lead which has to be tapped to the coil is threaded through the eye of a large darning needle and the end of the needle wrapped with insulation tape.

It may then be pushed through the cotton covering of the wire at various points without damaging the coil winding and a good electrical connection made as the needle will pierce the actual copper wire. When the best tapping point has been found, the thin blade of a penknife should be slipped between the two turns and the required turn carefully prised upwards, when the copper wire will stretch just enough to permit of a match-stick being slipped under it. The cotton may then be scraped away and a neat soldered joint made between the tapping lead and the winding turn. Care should be taken to see that the insulation of adjacent turns is not damaged by the hot iron or excessive flux. A fine pencil-pointed soldering-iron is to be recommended for such work.—R. H. WATERS (Purley).

Screening in Radio Receivers

The Necessity for Efficient Screening, and the Various Methods Used to Achieve It, are Fully Explained

By F. P. RESTON

SCREENING in a radio receiver consists essentially of preventing the magnetic or electrostatic field of one component from extending and linking with the field of another component or with the field of an unwanted signal. That somehow bald explanation might be rather confusing to the non-technical reader, so it would be well to explain that when an alternating or radio-frequency current is passed through a component such as a coil, transformer, or even a length of wire, a magnetic field is set up round that component. Fig. 1 shows the idea in a diagrammatic way, and the field of a coil is compared with that of an ordinary bar magnet.

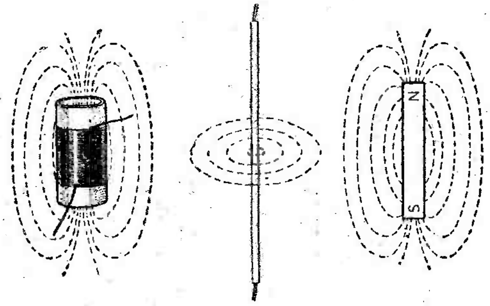


Fig. 1.—Diagrammatic magnetic fields round a coil, wire and a bar magnet.

The real difference between the two fields is that the field of a coil, when connected in a receiver circuit, is constantly fluctuating in strength, whereas that of a permanent magnet remains constant. Actually, the field produced by a coil would be constant if a steady direct current were passed through the windings.

Iron for A.C. Screening

In the case of the magnetic field produced by a permanent magnet, or by an electro-magnet created by passing a steady current through a coil, screening or shielding can be effected by encasing the magnet in a soft-iron box; the iron "absorbs" the magnetism which surrounds the magnet. If the magnet were so screened it would have little or no effect on a compass placed near to it but outside the screen. Partial screening could be effected simply by placing a soft-iron sheet near the magnet. That is, of course, the customary method of shielding or screening a component such as an iron-cored choke or a mains transformer.

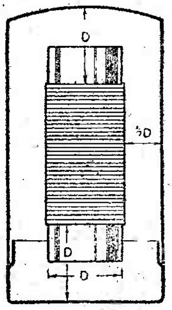


Fig. 2.—Suitable relative dimensions for a coil and its screening can.

The screening of components carrying radio or high frequencies is not as easy, however, due partly to the fact that the field is of constantly varying intensity and also to the fact that it is often of far greater extent. As an example of this, consider the electro-magnetic field set up round a transmitting aerial; its effect spreads for hundreds or even thousands of miles. And yet the field of, say, a huge power transformer handling the same amount of power as the aerial is limited in most cases to a matter of yards.

Non-ferrous Metals for H.F.

To screen high-frequency components it is customary to use a non-ferrous metal such as aluminium or copper. This is because iron is more "absorbent" and takes away most of the energy passed into the coil. The non-ferrous metals act as what are known as electrostatic screens, preventing the spreading of the field without seriously reducing the efficiency of the component that is screened. Nevertheless, the screen does reduce the efficiency of the component to a certain, if limited, extent, especially if it is placed very near to the component. The reduction in efficiency is proportional to the frequency of the current being handled. Thus, screening can cause greater losses on short waves than on medium and long waves.

For a screen to be completely effective it must entirely enclose the component. That is why coil screens are made in the form of small metal canisters with tightly fitting lids. Holes through which connecting wires are taken are kept as small as possible. Another essential if the screen is to be effective is that it be well earth-connected. It is often found when testing a receiver which has become unstable or prone to incurable self-oscillation that the only trouble is that one of the screening cans is loose or that the earth connection has come adrift.

Minimising Losses

In screening a coil it is always desirable to have the screen as far as possible away from the ends of the winding, although it can be much nearer to the winding at the sides. It will be clear from Fig. 2 that the field is most concentrated at the ends of the winding, and that a screen placed there completely breaks the circuit of the imaginary so-called "lines of force." A fair rule concerning coil screens is that the screen should not be nearer than the diameter of the coil to the ends of the winding; it can be about one-half the diameter from the sides. This is a very general statement, and should not be considered as a fixed rule.

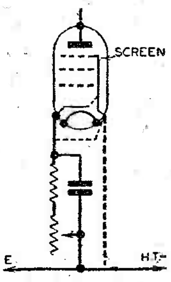


Fig. 3.—(Left) The suppressor-grid screen in a pentode is placed between the anode and auxiliary grid. Three different connections for it are shown by broken lines.

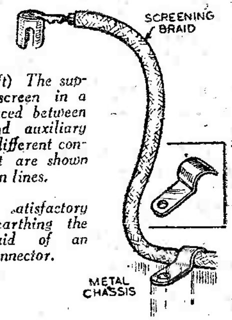


Fig. 4.—A satisfactory method of earthing the screening braid of an anode connector.

Apart from the external screens—among which should be included the metallised coating of valves—there are various internal ones which are concerned with the design of the components. Thus, there is the so-called suppressor-grid in a pentode, as shown in Fig. 3. This is placed between the auxiliary grid and the anode, and is earthed, either due to its internal connection to the filament or cathode, or by an external wire. In some instances it is worth while to experiment with the most satisfactory method of earthing this screen; sometimes it is better to connect it directly to the earth terminal by the shortest and most direct wire that can be arranged, whereas in other instances results are more satisfactory when it is simply joined to the cathode—from there it connects to earth through the bias resistor and, often, the variable-mu volume-control resistor.

Valve Anode Screens

In spite of the metallised coating of the valve it is generally desirable to screen the anode lead. This is

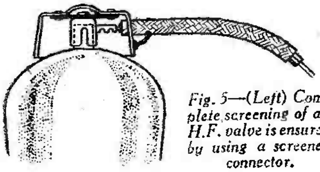


Fig. 5—(Left) Complete screening of an H.F. valve is ensured by using a screened connector.

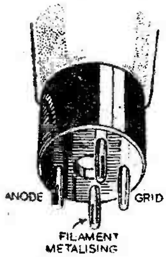


Fig. 6.—(Right) In wiring a battery receiver it is wise to ensure that the filament pin to which the metallising is joined is earth-connected.

done by using a special connector with braided metal covering, care being taken that the braid is earth-connected; a convenient method of ensuring this when using a metal or metallised chassis is shown in Fig. 4. If the chassis is not a metal one a short earth lead should be taken from the braid to an earth terminal. Even this screened lead is often insufficient, and many cases come to light during experimental work of the screening being inadequate. The trouble is best overcome by using a screened anode connector of the type shown in Fig. 5. This is a copper or aluminium "helmet" completely covering the connector and in contact with the screening braid covering the wire. The "helmet" screens the anode terminal (or grid terminal in some valves) itself, and also completes the metallised screen provided by the coating, which does not extend right up to the top terminal or connector.

In connection with the metallised screening fitted as standard on the majority of valves it should be noted that when it is not brought out to a separate terminal it is internally connected to a particular filament terminal in the case of battery-operated valves of the four-pin type. The terminal in question is shown in Fig. 6, and it is desirable that this should be the earthed side of the filament. Although it is found in some instances that results are not affected whether the screen is connected directly to earth or is earthed through the filament and L.T. supply, it will save time and trouble to see that it is earthed directly in the first place.

Variable Condensers

Variable condensers are generally of the screened type nowadays, but care should be taken that the screen (through the mounting pillars) is in good contact with the metal chassis or with an earth terminal. It is also well to make sure that the screening cover is pressed tightly into position, so that it fits correctly all the way round. When using separate, unscreened condensers it is usually sufficient to erect a vertical screen between them. In the case of short-wave receivers additional screening is often provided by the slow-motion drive—make sure that this is earthed. A metal panel is frequently used to provide additional screening, but this is not always necessary, since if two or three earthed connecting wires run fairly close to the panel and right across it they act as a screen of fairly effective type.

Connecting Leads

The screening of connecting wires in grid and anode circuits is often desirable in a highly efficient receiver, but this can be overdone. It will be realised that the screen is very close indeed to the wire, and if this is fairly long the damping effect can be pronounced. For that reason it often pays to use a minimum of screened leads in the first place, screening additioual leads if and when it is found necessary; if the receiver is unstable, that is. Remember that the screening must be well earthed; if the lead is more than a few inches long it is not sufficient to earth the screening braid at one end only, but earthing clips should be fitted at about every 6in. Also bear in mind that proper screening braid is necessary. If an attempt were made to provide a screen by coiling a length of copper wire round the insulated lead, instability would be encouraged instead of prevented, because the coiled wire would pick up energy from the connecting lead and increase the field. If a length of wire is used as an expedient it should be bare, and solder should be run along it to short-circuit all the turns.

Screening Boxes

When two or more portions of a receiver are to be shielded one from the other it is generally desirable that separate screening boxes or partitions be used for each portion. If screens were arranged as shown in Fig. 7, for example, the common screen between two sections would probably provide an effective means of coupling together the fields of components on its two sides. The correct method is shown on the right in Fig. 7. Another point, if screening boxes are built up from sheet aluminium care should be taken that the corners are a good fit and that they are riveted or bolted in a number of places.

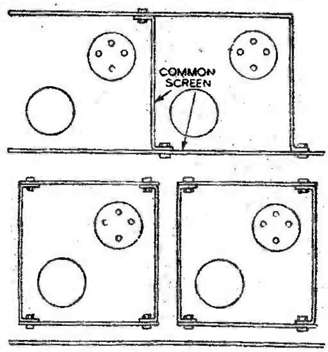


Fig. 7.—Correct and incorrect methods of screening sections of a highly sensitive receiver.

Transformer Windings

It is not always realised that screens are often provided between the windings of a mains transformer. Their purpose is to prevent hum from the primary winding from being induced into the H.T. secondary. The screens in this case generally consist of what might be described as large copper washers with a small portion cut out of each; if they were complete circles they would merely "short-circuit" the transformer, causing considerable over-heating and reducing its output to a mere fraction of what it should be. The screens should, of course, be earthed. Another method of screening, which is often perfectly effective, is to place the L.T. winding between the primary and H.T. secondary windings. In use this is earthed and therefore is effective in preventing the induction of hum into the H.T. circuit.

Notes from an Amateur's Log-book

2CHW Tells How He is Attempting to Overcome the Meter Shortage, and Also Gives Details of the New Amplifier for His Rx.

Test Gear

ONE of the chief problems confronting the constructor at the present time is how to make up suitable test equipment to enable experimental work and fault elimination to proceed. The solution is not just a matter of obtaining comprehensive constructional details; very fine articles providing such information have appeared in past issues of PRACTICAL WIRELESS, but, unfortunately, they cannot overcome the shortage of suitable meters which form the very foundation of the most widely used type of test equipment, namely, the multi-range general purpose meter.

The design and assembly of a moving-coil meter movement is rather beyond the capabilities of most of us, so I admit that the work I am undertaking in this direction is causing me some anxiety, though it is being tackled with the optimism common to amateur radio enthusiasts. Many others must be in a similar position of requiring a low-reading milliammeter having a maximum reading of, say, 0 to 1 or 0 to 2 mA's, to form the basis of a multi-range meter. If my activities produce the instrument I have in mind, the details will be passed along, if only to serve as a guide to those constructors who are blessed with a good mechanical skill, and who will, no doubt, make a much better job than my initial effort.

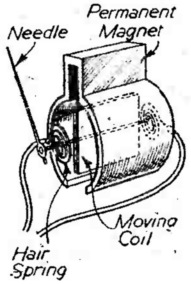


Fig. 1.—The basic moving-coil meter movement, using a specially shaped magnet.

Before finally deciding to undertake this (at least to me) formidable task, all the various types of meter movements came under observation and many ideas presented themselves, each appearing to offer some simplification of the constructional work. Further investigation, however, proved that the hopes of easy work thus raised were false; snags became apparent, the chief one being the scale law.

A moving-iron meter, which is cheaper to buy and make, can be used on A.C. and D.C. supplies and it is usually more robust than those of the moving-coil type. Its disadvantages are: it does not provide a high degree of accuracy and the scale reading is proportional to the square of the current or voltage being measured. This means that at the bottom end of the scale the divisions are cramped close together and at the other end they open out. A scale of this formation makes it very difficult to read low measurements with any degree of accuracy.

A meter incorporating a moving-coil movement can be used only on D.C. supplies, unless it is used in conjunction with a suitable type of rectifier, when A.C. supplies can be measured. It is highly sensitive—a large-scale deflection being obtained for a low power consumption—and the scale reading is proportional to the current or voltage being measured. This applies over the whole scale, and it means that the divisions are spaced equally, thus making it as easy to observe a low reading as a high one, with a very good degree of accuracy. This feature is of particular importance when one has in mind the construction of a multi-range meter, therefore, I finally decided to settle on the moving-coil type and hope that my patience and slight mechanical skill would be sufficient to see me through.

Basic Design

The sketch shown in Fig. 1 shows the basic requirements for the movement: I am using a permanent magnet, fitted with the two shaped pole pieces; a rectangular coil of fine wire which is pivoted at its two shortest ends, so that it is free to rotate in the magnetic field between the two pole pieces. Small hairsprings are fitted at each pivoting point, to control or steady the movement of the coil and to cause it to return to its predetermined position of rest on the current ceasing to flow. To one short end of the coil is fixed the pointer or needle which sweeps over a conveniently placed scale, thus giving an indication of the current value. To allow perfect movement of the rectangular coil, the electrical connections are usually made to it via the hair-springs.

A commercially produced meter has, of course, many refinements not even mentioned above, but their making and fitting calls for definite craftsmanship and years of experience, so I do not think one can expect them on an initial amateur attempt.

Amplifier for the Rx

Some readers might have wondered why I was devoting time to meters when the Rx still remained incomplete so far as the original specification is concerned. Well, circumstances beyond my control have prevented me from finishing the two-valve L.F. amplifier, which I was hoping to be able to include in my notes for the past month. I can say, however, that it is well on the way to completion, so for the benefit of those who wish to analyse the circuit or, perhaps, get on with the constructional part, the theoretical circuit is shown in Fig. 2.

Resistance-capacity coupling is used between V.1 and V.2, not solely on account of quality of reproduction, but because I fancied that the core and windings of an L.F. transformer might pick up any stray A.C. fields from the mains unit or the table-lamp.

Jacks are incorporated so that phones or speaker can be plugged into the anode circuits of V.1 and V.2 at will, but these are *not* wired so that they break the filament circuit of V.2 when the phones are in the circuit of

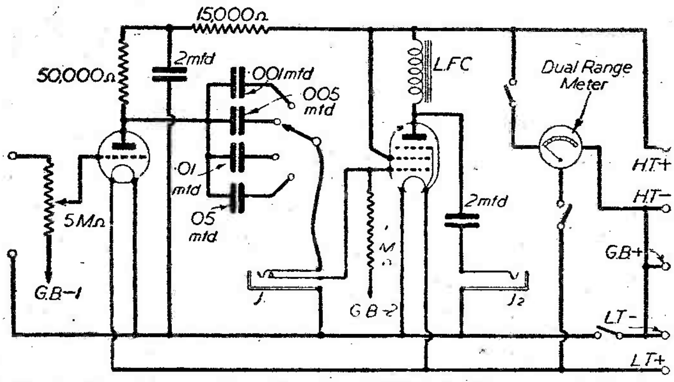
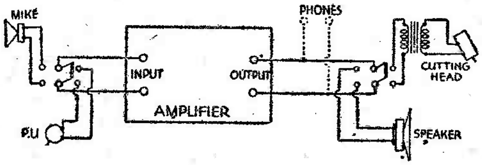


Fig. 2.—The battery-operated amplifier which 2CHW is building to complete his Rx. Note the tone control arrangement.

V.1, because I hope to incorporate automatic grid-bias at a later date. If, under those conditions, the H.T. current for the output valve was cut off, the total anode current consumption of the complete set would be reduced, with the result that the H.T. voltage would rise slightly and the bias voltages would be upset completely.

It should be noted that the phone circuit for V.1 utilises the R.C. coupling as an output filter, thus keeping H.T. voltage and current from the phone windings. It also enables the four-position tone-selector circuit to be used, which provides a simple means of varying the bass response of the output to suit taste or prevailing conditions. The system consists of a rotary switch which allows me to select an output coupling condenser of .001 mfds., .005 mfds., .01 mfds. or .05 mfds. The whole idea is purely to satisfy a personal fad, if you like to call it such, but I have found that certain



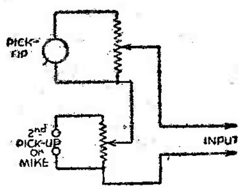


Fig. 3. (Top).—The switching used for the recording amplifier.

Fig. 4 (Left).—Shows how the mixer circuit was wired.

reception can be rendered more intelligible, and definitely more pleasing, by cutting or increasing the bass response.

The volume control is placed across the input to V.1. There was little option on this matter, bearing in mind the alternative output circuits and the need to control the signal passed on from the detector. The L.F. stage already in use will, of course, be cut right out as soon as this 2-valve amplifier is ready.

The dual range meter, which is already fitted in the centre of the metal panel, is a touch of luxury in which I have been able to indulge owing to the fact that it became available at a bargain price. It reads 120 H.T. and 6 volts L.T., the two circuits being controlled by neat little push-button switches. Fortunately the meter has a reasonably high resistance, otherwise, in view of the misleading results a low-resistance one can give when measuring H.T., I would not have taken the trouble to fit it, let alone buy it.

Home Recording

Although this subject is not directly associated with short-wave work, it does form part of the activities of many amateurs and, personally, I think it is an item which offers great interest. The reason why it is included in these notes is because a colleague of mine has recently taken it up, and, as he is not yet too familiar with the operation of the equipment involved, he asked me to give him a hand.

His gear consists of an electrically-driven turntable, fitted with the necessary tracking device, an A.C.-operated amplifier having a rated output of 5 watts, a transverse current microphone, two electro-magnetic pick-ups, a 9in. and a midget permanent-magnet speaker, plus, of course, the usual components we amateurs collect.

The turntable and tracking gear is fitted to a small but rigid table, which also carries the amplifier. The microphone is supported by an adjustable floor-stand, whilst the 9in. speaker is fitted to a baffle-board, which is fixed to the wall just above the table. The trouble he was experiencing was in the form of completing such wiring and switching as would allow rapid change over to be made from recording to play-back and the provision of a satisfactory form of mixer input circuit. He was using for the cutting-head one of the pick-ups, which, to prevent any D.C. from flowing through its winding, was coupled to the output from the amplifier via a suitable output transformer.

Finding that two double-pole double-throw switches were available, the first thing we did was to rig up the wiring as shown in Fig. 3. This allowed the switch on the left to select for the input to the amplifier the microphone for recording or the pick-up for playing back the cut record blank. The switch in the output circuit brought the cutting head or the speaker into operation according to whether recording or play-back was being carried out. By the turntable he had fixed the two pick-ups, i.e., the cutting head and the reproducer, therefore, to complete the change over it was only necessary to put the tracking gear out of action and place the reproducing pick-up on the record. This system is quite simple, yet sufficiently effective for normal amateur purposes, although if a second turntable is available it would be better to use that for playing back.

To enable the recording to be monitored, and this is very desirable to prevent blasting, or overloading of the cutting head, and to enable the microphone input circuit to be controlled, a pair of 'phones could be fitted as shown in the diagram, which was what my friend had done, although it would be far better to include them in the anode circuit of, say, the first L.F. stage in the amplifier, as the total output would be far too much for comfortable or faithful 'phone work.

Mixer Circuit

The next requirement was a mixer circuit to allow two microphones, a microphone and a pick-up, or two pick-ups to have their outputs mixed or controlled before feeding into the amplifier. The arrangement shown in Fig. 4 was tried out and worked quite well. In fact, by using potentiometers of 0.25 megohms each the control and blending was smooth and even. As the amplifier was fitted with its own volume and tone controls, we made up a small sloping desk type of box, complete with an aluminium panel cut from a discarded set panel, and housed the two controls, thus making quite a neat job of the little unit.

Moving-coil "Mike"

The transverse current microphone was quite good and very sensitive, but, as with most microphones of this type it was susceptible to the slightest form of "sound" feed-back which set up that awful microphone howl. Its background noise was a shade too high for best results, therefore, we experimented with the midget permanent moving-coil speaker as a microphone. It gave far better tonal response though, as one would expect, it was not nearly as sensitive as the carbon model. Fortunately, the amplifier had sufficient gain to enable the required output to be obtained, so after various tests the amplifier circuit was modified to that shown in Fig. 5. It will be seen that the moving-coil "mike" is connected to the first stage of the amplifier, and the pick-up, which has a reasonably high output, was coupled via another triode to the anode circuit of the second L.F. valve, thus providing a more equal amplification. As we afterwards found, the new arrangement provided an almost perfect mixing circuit, still, as the other unit had been made it will be put to good use when my friend is able to obtain another turntable.

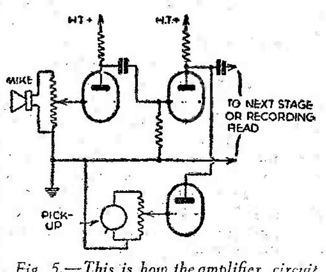


Fig. 5.—This is how the amplifier circuit was modified when the moving-coil "mike" was used. This arrangement provides a very satisfactory method of levelling up the amplification of the two inputs.

Heterodyne

A General Explanation of Radio-frequency and of the Oscillator System Employed in

By "TECHNI

THE superhet is so well known—in name at any rate—that any reference to the term heterodyne generally brings to mind the superheterodyne circuit. But there is a more correct use of the word, and this has not necessarily any connection with the superhet. A heterodyne is a resultant frequency obtained by mixing together oscillations of two different frequencies, and there are two principal uses of the heterodyne system in radio receivers. In one, the object is to produce an audio-frequency, and in the other to produce a frequency well outside the range of audibility. It is the latter which is known as a *supersonic* heterodyne, for the reason which will now be obvious. The name superheterodyne is used with reference to a receiver in which an oscillator is employed to produce a heterodyne frequency outside the audio range.

Frequency-changing

In the case of a superhet an oscillation is generated locally within the receiver, and this is of such a frequency

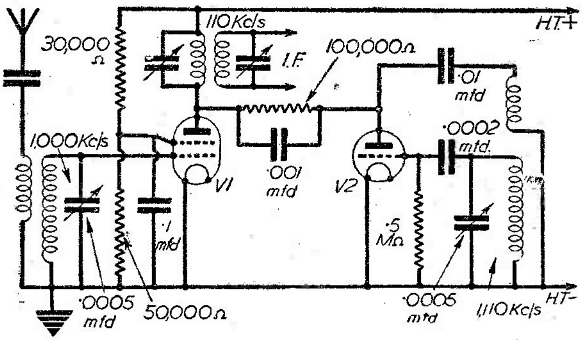


Fig. 1.—A triode oscillator used in conjunction with a tetrode first detector for frequency-changing in an early type of superhet.

that, when mixed with the frequency of the incoming signal, a heterodyne, or intermediate, frequency is produced. This heterodyne generally has a frequency of around 500 kc/s in a modern receiver, but frequencies between 100 and 600 kc/s are employed. To produce a heterodyne of 500 kc/s from an incoming signal having a frequency of, say, 1,000 kc/s it is necessary to generate a local oscillation having a frequency of either 1,500 or 500 kc/s; it is the higher frequency which is generally employed.

Making C.W. Audible

The other use of a heterodyne frequency occurs when reception of C.W. is required. As most readers are aware, C.W., or continuous wave, consists of an oscillation of constant frequency "chopped up" into dots and dashes which represent symbols of the morse code. And the transmission is at a radio frequency, so that it could not be heard with a simple detector valve. The reason is, of course, that the frequency is much too high. In order to render the C.W. transmission audible it is necessary to "beat" with it an oscillation at a frequency removed from the transmission frequency by an audible frequency.

Let us make that explanation a little simpler. Again, assume that the transmission is on a frequency of 1,000 kc/s. The audible range of frequencies extends up to about 20 kc/s, but on the average it is true that the ear responds most readily to a frequency in the region of 1 kc/s. So, in order to make "sense" out of the C.W. transmission we should mix with it an oscillation of 999 or 1,001 kc/s. It will be seen that although it is wished to produce an audible frequency we make use of two inaudible frequencies. The method of generating the local oscillations we will leave till later, and for the moment consider the question of superheterodyne reception.

R.F. Oscillators

We have seen that a local oscillator is required inside the receiver, and since we are to maintain a constant frequency difference between this and the incoming signal our oscillator must be tuneable. Any form of oscillator could be used—Hartley, Colpitts, Meissner, Tuned Anode-Tuned Grid, and so on—but the Meissner or a modified form of it is most often employed because of its simplicity. The Meissner oscillator circuit is very similar to that of a detector valve with reaction, and the connections can be seen on the right of Fig. 1, where V.2 is the oscillator. One of the first questions which arises concerns the method by which we are going to mix the local oscillations with those of the signal.

A method which was used fairly extensively in the earlier days of the superhet was as shown in Fig. 1. Here it will be observed that the output from the anode of the oscillator is fed into the anode circuit of the first detector—for which a screen-grid valve is used in the circuit under review. The H.T. current for the oscillator is passed through the primary winding of the I.F. transformer, which also carries the anode current for the first detector. As a result, the anode current to the detector can be said to be "modulated" by the anode current of the oscillator. This gives us anode-circuit mixing. In passing, it should be mentioned that the 100,000 ohm resistor between the two anodes is merely to cut down the oscillator anode voltage and to prevent excessive "modulation" of the S.G. anode supply.

Other Mixing Systems

There are various other possible methods of "mixing," one of which is to feed back the oscillator output into the grid circuit of the first detector. This could be done by taking the oscillator anode resistor directly to H.T.+

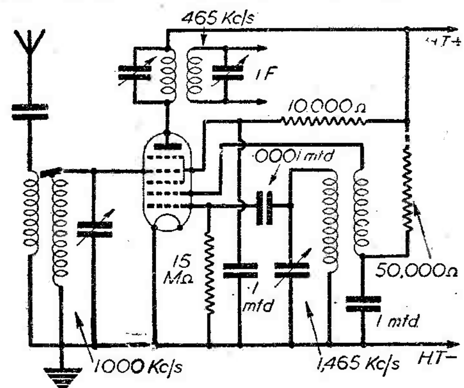


Fig. 2.—A more modern frequency-changer circuit, in which electronic mixing takes place within the valve; a heptode or pentagrid is shown but the principle is the same when using an octode or triode-hexode.

Oscillators

audio-frequency Heterodyning, With Details Straight" and Superhet Receivers

US"

and connecting the control grids of the two valves together by means of a small fixed condenser. In general, however, this system is not very satisfactory.

The more modern method of mixing is by using a pentagrid, triode-hexode or similar type of valve, which combines the functions of first detector and oscillator. Fig. 2 shows the usual connections for a pentagrid, where

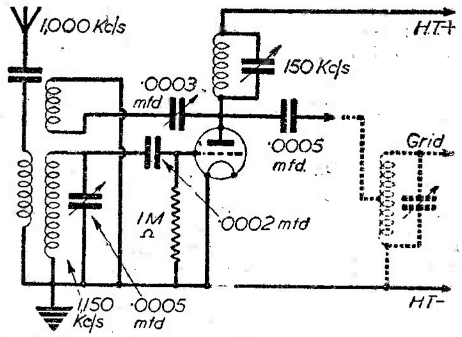


Fig. 3.—A form of oscillating first detector of the type at one time fairly widely used as a superhet converter in conjunction with a "straight" receiver.

the lowest two grids serve as control grid and anode of the oscillator portion. These "modulate" the electron stream from the common filament or cathode to the anode and grid of the first detector which is a pentode. The "mixing" is then said to be electronic. This form of mixer, or frequency-changer as it is commonly called, is very satisfactory, and is almost universally employed in present-day superhet receivers. It will be seen, however, that the oscillator tuning circuit is the same as that shown in Fig. 1.

The intermediate frequency indicated in Fig. 2 is that generally employed in modern receivers, while that indicated in Fig. 1 is the frequency which was widely employed in earlier types of superhet. In both cases it will be noticed that the oscillator is tuned to a higher frequency than is the input circuit.

Combined First Detector-oscillator

An entirely different form of frequency-changing—one which is not very satisfactory although at one time widely used in short-wave converters—is illustrated in Fig. 3. In this case the oscillator is precisely the same as a leaky-grid detector with reaction. At first glance it would appear that this could not possibly provide any mixing; because there is only a single frequency to be dealt with. Actually, however, the valve is made to oscillate, by tightening the reaction coupling, and it is not tuned to the signal to be received, but to a frequency remote from it by the intermediate-frequency. For example, to receive a signal on 1,000 kc/s the set is tuned to 1,150 kc/s if an intermediate frequency of 150 kc/s is to be used. The I.F. mentioned is a convenient one in the case of a converter for use with a "straight" receiver, because the latter can easily be tuned to it; 150 kc/s is equivalent to a wavelength of 2,000 metres.

One marked disadvantage of this circuit is that any station can be received at two different settings of the input tuning condenser, one 150 kc/s above and one 150 kc/s below the frequency of the required signal.

Producing an Audio-frequency

The same general principles can be applied to a heterodyne oscillator as to a superheterodyne oscillator of the kind discussed. Fig. 4 shows one arrangement, where V.1 is the detector or second detector, and V.2 is the oscillator. With a "straight" receiver tuned to 1,000 kc/s the oscillator may be tuned to about 1,001 kc/s to produce an audible C.W. note at 1 kc or 1,000 cycles per second. It will be seen that the oscillator must be tuned along with the detector.

When a superhet is employed the second detector is tuned to a fixed frequency of, say, 465 kc/s, so that the

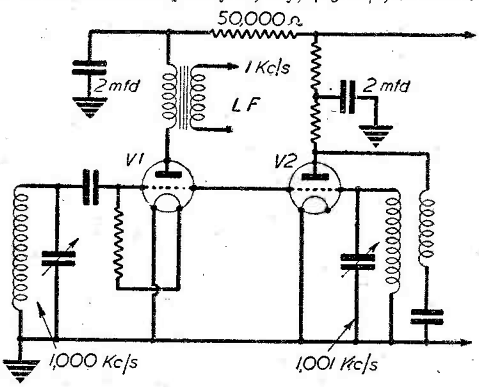


Fig. 4.—A separate oscillator (V.2) used in conjunction with a triode detector or second detector (V.1) to produce a C.W. note at audio-frequency.

oscillator could be tuned to a fixed frequency of 466 kc/s. In practice, some form of fine tuning would be provided, however, so that there would be some control over the audible note. But a separate oscillator is not required in a "straight" receiver, because the detector can be used as a combined detector and oscillator simply by providing reaction.

To obtain an audible note it is necessary only slightly to de-tune the detector. As many readers have discovered for themselves, if an oscillating detector is tuned "dead on" a C.W. signal, the signal is inaudible. But by moving the tuning condenser very slightly toward either side of the "dead space" setting, the note becomes audible. This can be checked by tuning the receiver a little distance from the signal and then moving the tuning knob *very slowly*; at first a high

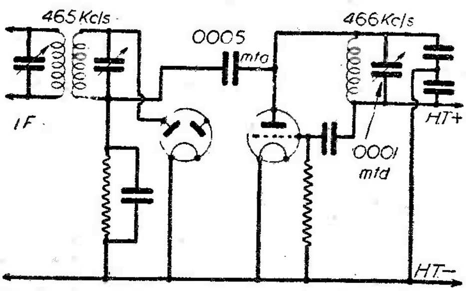


Fig. 5.—A method of using a triode heterodyne oscillator in conjunction with a diode or double-diode second detector in a superhet. The diode circuit is shown in skeleton form only in the interests of simplicity.

note will be heard; this will gradually fall in pitch and become inaudible; continued movement of the tuning control will cause a repetition of the rise in note. It is when tuned to the "silent point" or "dead space" between the two notes that the set is at the frequency of the transmission.

Het. Oscillators in a Superhet

Even with a superhet it is possible to use an oscillating second detector by adding a reaction winding to the last I.F. transformer and using a variable condenser to give reaction control. This is not ideal, however, since reaction control slightly alters the tuning of the transformer. This difficulty can be partially overcome in practice by mounting a very small variable condenser on the front of the set and connecting this in place of the trimming condenser across the secondary of the I.F. transformer. Such an arrangement has been used with reasonable success.

The method just outlined could not be applied when using the diode or double-diode second detector, which is now almost universal in superhets. In that case a separate heterodyne oscillator is a practical essential, and one method of using it is shown in the skeleton circuit of Fig. 5.

The oscillator could have the same circuit as that shown in Fig. 4, or it could have one of the other alternative circuits referred to earlier in this article. The oscillator circuit shown in Fig. 5 is that known as the Colpitts, which has the advantage of being very satisfactory on low and medium frequencies. It is provided with a tuning control, in order that the pitch of the note can be varied, but this need have only a small range; the same would apply if any other oscillator circuit were employed instead of the Colpitts shown.

The Rapid Two

In Response to Many Requests for an Efficient Two-valve Receiver, Using a Coil Which Can be Made Quite Easily, We are Reprinting the Details of This Popular Set

To help our readers overcome the component shortage we give here the constructional details of an efficient battery-operated two-valver which can be constructed quickly and very cheaply. The parts required will, no doubt, be found in most spares-boxes, and as the circuit is in no way critical as regards component values, it offers sufficient latitude to allow practically any parts to be used.

The valve specification is triode for the detector position, and a pentode for the output, but if it is desired to use a power valve in place of the latter, then it will be quite in order to do so, provided one does not mind a slight reduction in the strength of the ultimate output.

The circuit follows the lines of the standard well-tried detector and L.F., as this combination, when a reasonable L.F. transformer is used for the coupling between the two valves, gives something like the maximum efficiency obtainable from such a simple arrangement.

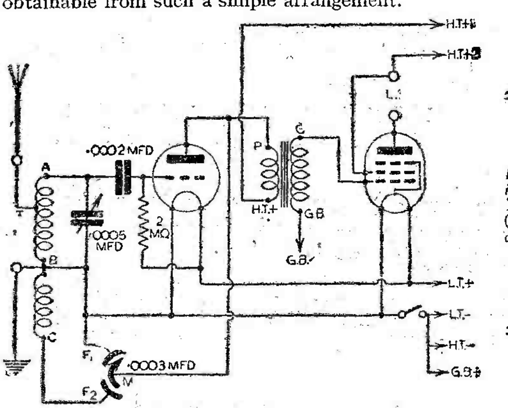
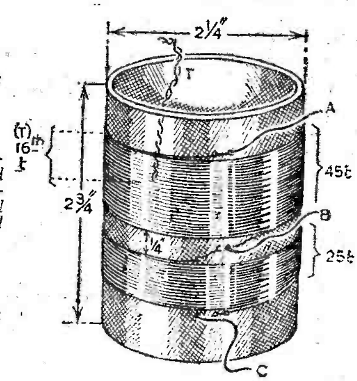


Fig. 1.—(left) Theoretical circuit of the Rapid Two, and Fig. 2.—(right) Constructional details of the tuning coil for medium waves only.



The number of components has been reduced to a minimum, and consequently the wiring involved has been simplified as much as possible, and therefore no difficulty should be experienced by even the veriest beginner.

The Coil

To prevent any unnecessary correspondence, it should be noted that we fully realise that any efficient commercial coil of the aerial plus reaction type could be used in the circuit being described, *but* if such modifications are to be made, we cannot undertake to provide details of the connections necessary for any particular coil which might be on hand. However, the coil which we used was made up on a piece of ordinary postal tubing, measuring 2¼in. in diameter and 2¾in. in length. The coil was wound in two sections, one for the grid winding, and the other for reaction, and 26 S.W.G. enamelled wire was used. The grid winding consists of 45 turns, and the reaction winding 25 turns, the two being wound in the same direction, and separated by ¼in. The junction of the two windings is bared, and is a common earth point. If desired the windings may both be terminated at that point and the bared ends of the wires twisted together and soldered to form the earth point. A tapping is made in the grid winding 16 turns from the "top" end, as shown in the diagram of the coil, Fig. 2.

The coil was mounted horizontally by piercing the ends of the coil, and passing long bolts through from the underside of the baseboard, the necessary spacing being obtained by slipping insulated sleeves from L.T. wander plugs over the bolts. Alternatively, nuts could be used to provide the spacing, or lengths of ebonite tubing, cane, or similar material could be adapted for the purpose.

Construction

The baseboard is plywood for preference, although ordinary wood may be used. To avoid warping and consequent risk of short-circuit, however, plywood is preferable, and a thickness of ⅜in. or ½in. is adequate. The overall size of the baseboard is 5½in. by 8in., and the panel, also of plywood, is the same size. The panel need not, however, be so thick as the baseboard and ¼in. is ample. If thicker wood is used you may find difficulty in locking up the components in view of the amount of thread which is left on the fixing bushes. Baseboard mounting valveholders, one 4-pin and one 5-pin, are needed, together with an L.F. transformer. This may be of any make and with any ratio, preferably 3 to 1 or greater. Two short lengths of ebonite 2in. wide should be attached to the rear of the baseboard and two insulated terminals mounted on each. The tuning condenser is a bakelite dielectric .0005 mfd. component and the reaction condenser a .0003 mfd. differential pattern, but a standard air condenser may be used, if desired, for the tuning circuit. In the practical wiring diagram the grid condenser is shown joined to the top of the coil, and this will necessitate soldering. If you are unable to make soldered connections, or feel that your soldering is likely to be inefficient, you can avoid making use of this type of joint in the following manner. Leave sufficient wire at the ends of the various windings so that the beginning of the coil may be connected direct to the fixed-vane terminal of the tuning condenser, and use a wire-end tubular or mica fixed condenser. The ends of this component should then reach from the tuning condenser terminal direct to the grid terminal of the valveholder, and therefore before the latter is screwed in position, carefully measure the overall length of the wire-end condenser so that the valveholder will be placed in a suitable position on the baseboard. The tapping loop on the coil should be left long enough to reach direct to the aerial terminal, and the earth connection on the coil may be also taken direct to the earthed filament terminal on the detector valveholder. The end of the reaction winding may be also taken direct to the reaction condenser, and thus all soldering is avoided.

Battery Leads

Ordinary lengths of flex may be used for the battery leads, or a commercial set of battery cords may be employed. These will have suitable indicating plugs on the ends, but if ordinary flex is used you will have to purchase named plugs to complete the leads. H.T.1 should be plugged into the H.T. battery at about 60 or 66 volts and H.T.2 at 120 volts. A standard 2-volt accumulator should be used for the filaments, and for G.B. a 9-volt battery will be required, inserting the G.B.— plug into the 4.5 or 6-volt socket, according to the particular valve which you use. The valve-maker's leaflet will indicate the appropriate bias voltage for the H.T. in use. Connect aerial and earth, and a loudspeaker or 'phones to the output terminals, and when the on/off switch is pulled out the receiver is ready for tuning. Remember that reaction will not only increase the strength of signals, but will also sharpen the tuning, so that if a distant station is required, and there is any slight interference, it may be worth while increasing reaction to cut out the interference. A slight readjustment of the tuning condenser must, of course, be made to allow for the slight modification of the tuning which is experienced when reaction is used.

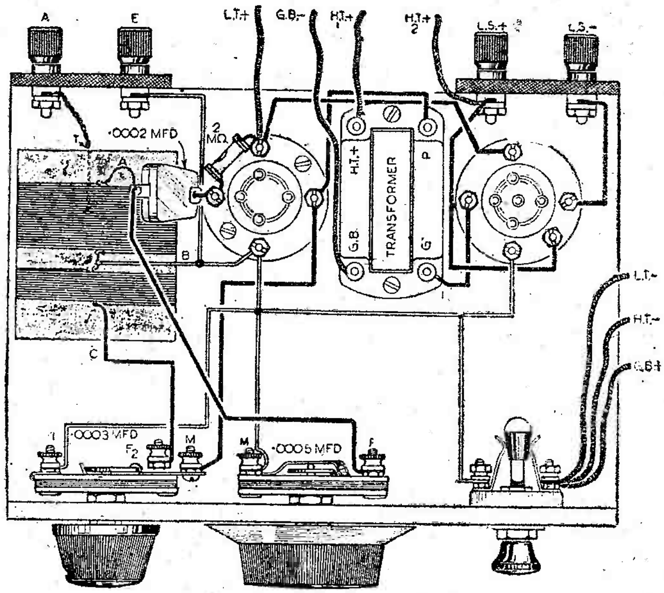


Fig. 3.—Wiring diagram of the Rapid Two.

LIST OF COMPONENTS

One .0005 mfd. solid dielectric condenser.
One .0003 mfd. differential reaction condenser.
One .0002 mfd. fixed condenser.
One 2 megohm grid leak—½watt type.
One L.F. transformer (see text).
One 4-pin valveholder, baseboard mounting type.
One 5-pin valveholder, baseboard mounting type.
One on-off push-pull switch.
Four insulated head terminals.
Two strips of ebonite for terminal mounts.
One medium-wave tuning coil (see text).
One plywood baseboard, 8in. by 5½in.
One plywood panel, 8in. by 5½in.
One Cossor 210 H.F. valve.
One Cossor 220 H.P.T. valve.
Connecting wire, flex, wander plugs, screws, etc.

PRIZE PROBLEMS

Problem No. 431

ROBINS was devoting some of his spare time to improving his theoretical knowledge of radio, and he had become very interested in the calculations connected with the elementary laws. For example, he felt quite safe on the various applications of Ohm's Law, knowing that $I=\frac{E}{R}$ $E=I\times R$ and $R=\frac{E}{I}$. He also knew that the wattage consumed by a circuit equalled I×E, but he came across a little problem which he could not solve, although it involved only the application of the formulæ he knew already. The problem was this: There is a circuit which has a resistance of 2,000 ohms and in which the power consumption is 5 watts, what are the values of the current and voltage? Can you show Robins how to solve the problem by giving the actual working out of the calculations involved?

Three books will be awarded for the first three correct solutions opened. Entries should be addressed to The Editor, PRACTICAL WIRELESS, George Newnes, Ltd., Tower House, Southampton Street, Strand, London, W.C.2. Envelopes must be marked Problem No. 431 in the top left-hand corner, and must be posted to reach this office not later than the first post on Monday, April 13th, 1942.

Solution to Problem No. 430

The formula for condensers connected in series is: $\frac{1}{C}=\frac{1}{C1}+\frac{1}{C2}+\frac{1}{C3}$, etc. but when considering a case involving only two condensers, this can be rearranged in the following manner, $C=\frac{C.1.\times C.2.}{C.1.+C.2.}$

Applying this to Jones's problem, and expressing .001 mfds. as 1,000 m.mfds., we get: $C=\frac{150\times 1{,}000}{150+1{,}000}=\frac{150{,}000}{1150}=130.434$, etc., m.mfds., which is the resultant capacity when .001 mfds. is connected in series with 150 m.mfds.

The following three readers successfully solved Problem No. 429, and books have accordingly been forwarded to them: W. Robertson, 2, White Street, Partick, Glasgow, W.1; 1020119 A.C.1 G. Ashley, R.A.F.; N. F. Sherlock, 32, Heath Road, Salisbury, Wilts.

Frequency Modulation—2

The Effects of the "Limiter" and "Discriminator" Stages are Given Here, Thus Concluding the Article Which Appeared in Our April Issue

By L. O. SPARKS

As the majority of interference due to man-made and natural static takes the form of amplitude modulated signals (Fig. 5, April issue), the interference cannot be eliminated from the wanted signal during its passage through the receiver. It is reproduced by the speaker—in spite of the many static rejector circuits which have been tried—and the entertainment value of the reception is governed by the signal/noise ratio. This is a variable quantity, depending on the transmission, the reception area and the type of set in use, but nevertheless it is an item with which every listener outside the effective service area of a station has to contend.

The greatest interference from man-made static is, naturally, experienced by listeners in large cities or industrial towns due to the number of electrical devices in use. In the congested areas of America, the trouble was much worse than in this country, therefore one can well understand the great desire of Major Edwin H. Armstrong to find a system of transmitting which would be immune from such forms of interference

F.M. Circuits

The general design of F.M. receivers appears to follow the normal ultra short-wave superhet principle up to the end of the I.F. stages. It should be mentioned, however, that a stage of R.F. amplification usually precedes the frequency-changer.

After the I.F. stages, instead of the signal being fed into the second detector, it passes through one or more "limiter" stages and then on to another valve circuit which can be classified as the "discriminator-detector." It is these two or three additional valves which represent, so to speak, the heart of the F.M. receiver.

On the low-frequency side, particular attention is given, in the best receivers, to the design of the L.F. equipment, including the speaker(s) and acoustic properties of the cabinet. As mentioned in the previous article, one of the features of F.M. is the exceptionally wide range of musical frequencies which can be transmitted, therefore the additional cost involved in providing high-fidelity reproducing apparatus is well worth while, whereas with an A.M. receiver the proposition—up to a certain limit—would be a doubtful investment.

Another important item in the receiver design is the tuner. This must be capable, especially when receiving the Armstrong wide-swing F.M. transmissions, of accepting the full frequency swing without danger of clipping, yet at the same time a reasonable degree of selectivity is also essential.

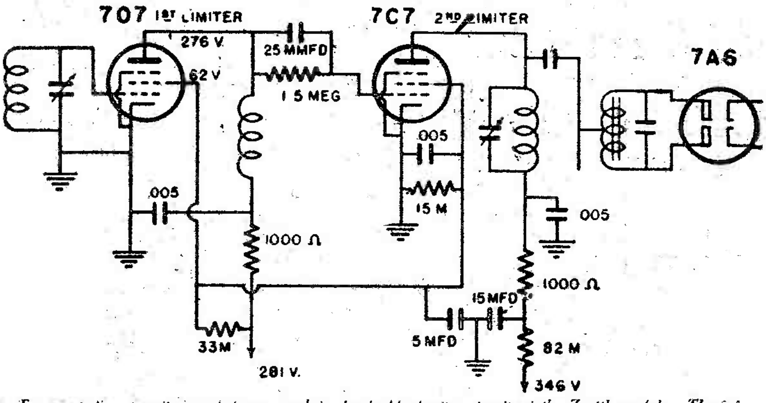
The "Limiter" and "Discriminator" Effects.

The object of the limiter and discriminator circuits is to produce the effect shown by the diagram Fig. 6 (April issue), plus the items mentioned below.

All amplitude variations are ironed out or cut off, thus eliminating the static interference mentioned above. The *strongest* incoming signal having a frequency the same as that to which the receiver is tuned, is accepted and all others rejected. Any A.M. transmission, even if on the same frequency, would also be rendered inoperative.

Absence of Static

If these very brief and non-technical descriptions are analysed, it will be seen that the resultant total effect is something unobtainable with A.M. transmissions and receivers. For example, static no longer mars the quality of reproduction which, in itself, is of a much higher order than that obtainable from A.M. receiver. The fact that the strongest incoming signal takes control, means that interference from other stations, even when they are operating on the same wavelength, is eliminated completely. This is a very important item, when one considers that owing to the limited effective service area of F.M. stations, it is necessary for them to be comparatively close together. I understand that certain American authorities carried out a most stringent test to prove this point, by operating a F.M. receiver in an area in which three F.M. transmitters were radiating, the stations only being 12 to 17 miles apart. During the test no interference was experienced, except in one area whose width could be measured in inches.



Two pentodes, capacity coupled, are used in the double limiter circuit of the Zenith models. The 7A double-diode discriminator-demodulator is shown on right.

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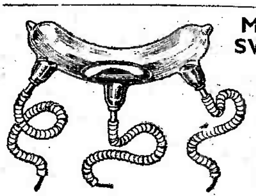

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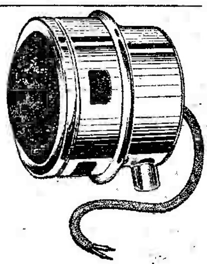

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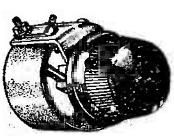

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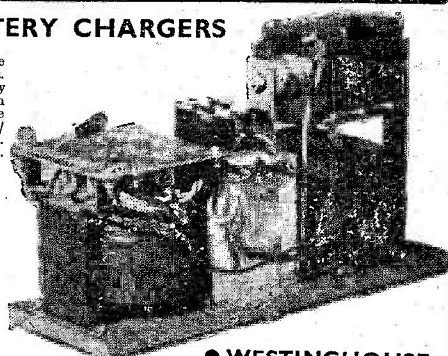

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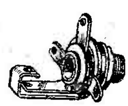

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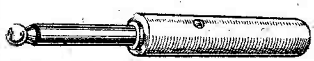

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Tables of Valve Equivalents

(Continued from page 237, April issue)

5

RECTIFIER VALVES (U.X. and Octal Bases) (Continued)

BRIMAR	EVER-READY	FERRANTI	COSSOR	MARCONI-OSRAM	MAZDA	MULLARD
6ZY5G	—	—	6ZY5G	—	—	—
5X4G	—	—	5X4G	U52	—	5X4G
5Z3	—	—	5Z3	—	—	5Z3

MAINS VALVES (U.X. and Octal Bases)

BRIMAR	EVER-READY	FERRANTI	COSSOR	MARCONI-OSRAM	MAZDA	MULLARD
6A7	—	—	6A7	—	—	6A7
6A8G, 6A8EG	—	6A8G	6A8G	X63	—	6A8G
6F7B	—	—	6F7B	—	—	6F7B
36	—	—	36	—	—	36
24	—	—	24	—	—	24
6J7G	—	—	6J7G	Z63, KTZ63	—	6J7G
78	—	—	78	—	—	78
39/44	—	—	39/44	—	—	39/44
6K7G	—	6K7G	6K7G	—	—	6K7G
77	—	—	77	—	—	77
6B8G	—	—	6B8EG	—	—	6B8G
6B7	—	—	6B7	—	—	6B7
6R7G	—	6R7G	6R7G	DL63	—	6R7G
75	—	—	75	—	—	75

6

MAINS VALVES (U.X. and Octal Bases) (Continued)

BRIMAR	EVER-READY	FERRANTI	COSSOR	MARCONI-OSRAM	MAZDA	MULLARD
85	—	—	85	—	—	85
6Q7G	—	6Q7G	6Q7G	DH63	—	6Q7G
6K5G	—	—	6K5G	—	—	—
76	—	—	76	—	—	76
27	—	—	27	—	—	27
37	—	—	37	—	—	37
6J5G, 6C5G	—	6C5G	6J5G	L63	—	6J5G, 6C5G
45	—	—	45	—	—	45
6B4G	—	—	6B4G	—	—	—
6A3	—	—	6A3	—	—	6A3
42	—	—	42	—	—	42
41	—	—	41	—	—	41
2151	—	—	2151	—	—	—
6F6G	—	6F6G	6F6G	KT63	—	6F6G
—	—	—	38	—	—	—
43	—	—	43	—	—	43
47	—	—	47	—	—	47
—	—	—	—	—	—	—
6N7G	—	—	6N7G	—	—	6N7G, ECC31
79	—	—	79	—	—	79

7

D.C./A.C VALVES (British Bases)

BRIMAR	EVER-READY	FERRANTI	COSSOR	MARCONI-OSRAM	MAZDA	MULLARD
—	—	—	202 V.P.	—	VP1321	—
9.D.2	C.50.N	—	13 V.P.A.	—	VP1322	VP13C
8D2	C5DB	—	13 S.P.A.	—	—	SP13C
15 D.1	C.80.B	—	13 P.G.A.	—	—	F.C.13C
—	C.36.A	—	202 S.T.H.	—	—	T.H.21C
—	C.36.B	—	302 T.H.A.	—	TH.2331	T.H.30C.
11.D.3	—	—	13 D.H.A.	—	—	—
—	C.23B (13v.)	H.A.D. (13v.)	202 D.D.T.	—	HL/DD1320 (13v.)	TDD.13C. (13v.)

RECTIFIER VALVES (British Bases)

BRIMAR	EVER-READY	FERRANTI	COSSOR	MARCONI-OSRAM	MAZDA	MULLARD
R.1	S.11A	—	506 B.U.	U.10	—	D.W.2
R.3	A.11C	—	43 I.U.	M.U.14	U.U.5	IW4/500
—	—	—	460 B.U.	U.4		D.W.4 / D.W.4/500
R.3	A.11.C	—	44 I.U.	M.U.12/14	U.U.5.	I.W.4/500
1.D.5	C10B	R.Z	40 S.U.A.	—	U.4020	U.R.1.C

8

USING THE TABLES

WHEN using these tables, it must be understood that the equivalent types do not necessarily represent a valve capable of giving a precisely equivalent performance. They have, however, reasonably similar electrical characteristics and, speaking in a general sense, should give satisfactory results. The greatest variation in performance is likely to be experienced with frequency changers when used in receivers covering the short waves. In all sets, the use of alternative types of H.F. and frequency-changers might call for the retrimming of the tuned circuits, but we do not advise readers to upset the trimmers—especially on commercially produced receivers—unless it is absolutely essential. Even in those circumstances, such adjustments are best undertaken by experienced service engineers if their services are available. Failing this, great care must be exercised, otherwise more harm than good will be done.

Where the original valve is of the metallised type, it is always advisable to try to find a metallised equivalent, but if this should prove impossible, then a non-metallised one could be used providing the absence of the metallising does not introduce any trace of instability. When seeking equivalents for those valves enclosed within metal screening cases, such valves being of the non-metallised type, it is not satisfactory to use metallised equivalents unless the screening case is removed. In general, rectifiers of the directly and indirectly heated types can be used to replace each other.

The Importance of a Milliammeter

An Article for Beginners, in Which the Choice and Uses of a Milliammeter are Discussed

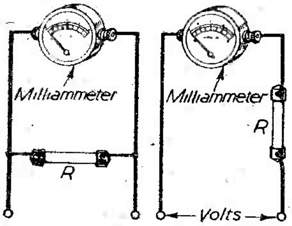
It is no exaggeration to say that, given a good milliammeter, one can carry out the majority of essential tests on a receiver, but there is a ruling clause which must be added—the statement only applies if one knows how to use a milliammeter, and how to adapt it to enable such tests to be applied.

To commence with, a few words about the meter itself. Like other components, there are good, fair and hopeless models, and, unfortunately, one cannot always secure the type one desires, owing to cost and available cash.

Knowing this, we can only advise the intending purchaser of a meter to delay the transaction—if one's budget won't run to a good instrument—until such times as the reserve fund and the supply is large enough to allow a reasonable choice. Don't snap up a so-called bargain unless you are quite sure of all its details and condition.

Moving-coil versus Moving-iron

Meters for direct-current use can be divided into two classes, moving-coil and moving-iron, and where reliability and accuracy are required, it is essential to use the moving-coil type. As the name implies, the needle of the meter is made to traverse the dial by the movement of a coil of wire, usually rectangular in shape, through which passes the current to be measured. The ill effects of a cheap instrument have been stressed so frequently in these pages that there is no need for one to elaborate on the inaccurate readings they can produce. For serious work they are useless, and no serious constructor or experimenter would think of using one when reliable information is required.



Figs. 1 and 2 show the method of connecting shunts and series resistances for multiplying the range.

Assuming that you have to get a good quality meter, the next thing to decide is what range—i.e., what maximum reading—is the most useful for general work.

One cannot do better than select a meter having a range of 0 to 1 mA. or, say, 0 to 1.5 mA., as it will then be possible to adapt it to all the ranges likely to be required.

Now supposing a current of twice the maximum scale deflection is applied, and that some means are provided which allow exactly half the current to be by-passed; in other words, only half the current flows through the meter, so that although the meter is showing a full-scale deflection, there is actually twice the current flowing in the circuit under test. Providing the conditions are known, it is an easy matter to multiply the scale readings by two and thus get a true indication of the current in the circuit.

By-passing

This is what happens in a multi-range meter, though it is not necessary for the amount by-passed to be half. It can be any portion of the total—so long as one knows the exact ratio—but it is easier for calibration purposes if the ratio is made an even figure.

The by-passing can be provided by the simple arrangement shown in Fig. 1, where it will be seen that the resistance R is connected across the meter terminals (or in *shunt*). The value of R can be determined by experiment or by calculation. If one favours the practical method, it is only necessary to connect the meter in series with a low-voltage supply and a resistance, the value of each being so adjusted that an exact full-scale deflection is obtained (Fig. 3). To one terminal of the meter is then connected one end of a short length of fine resistance wire, and contact made between the other terminal and any part of the wire until it is found what length of wire (resistance) is required to reduce the needle deflection to, say, half, one-third, one-quarter, or one-tenth its full value. Once the correct length has been determined, and the ratio has been decided on, then the meter readings must be multiplied by two, three, four or ten when the resistance is in position. It is, of course, vitally necessary to carry out these experiments accurately and make frequent checks until the resistance element is made up and fixed securely. By the way, it is always advisable to coil the wire, if its length permits, in the manner shown in the sketch, thus making it non-inductive.

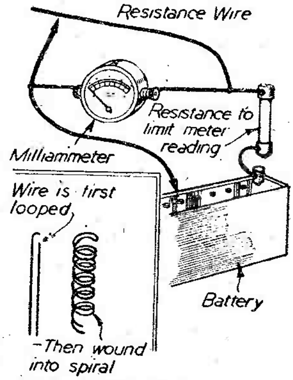


Fig. 3.—Method of making accurate shunts from resistance wire.

Using Shunts

Several shunts can be made to allow different full-scale ranges to be obtained, each being brought into circuit, when required, by switches, but be sure to use good definite action switches, otherwise they themselves will introduce additional resistance—through bad contacts—and thus upset the effects of the shunts. All the above procedure can be avoided by using the simple formula $R = \frac{Rm}{(n-1)}$ where R is the shunt to be determined; Rm the resistance of the meter, obtainable from the makers; and "n" the number of times it is desired to increase the full-scale reading. For example, if the normal maximum reading of the meter is 1.5 mA and it is wished to make it 150 mA, then "n" equals 100.

Voltage Measurement

The reading of current having been considered, we will now discuss the measurement of voltage with the same instrument.

A voltmeter is nothing more than a milliammeter with a suitable resistance connected in series. The resistance can be embodied in the construction of the meter, in which case it is sold as a voltmeter, or it can be external, thus allowing the meter to be used for current or voltage reading. The arrangement is shown in Fig. 2.

To enable various

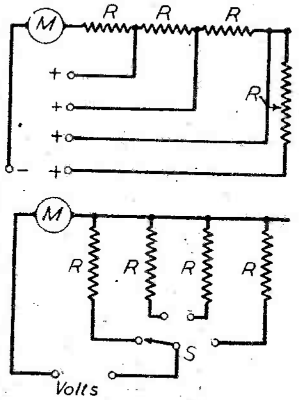


Fig. 4.—How to arrange the separate resistances to provide alternative readings.

volt-reading ranges to be obtained with the one meter, a series of resistances can be used, each being brought into circuit by switches or plugs and jacks as desired. A suggested arrangement, together with an alternative not requiring switches, is shown in Fig. 4, while Fig. 5 shows a complete multi-range milliammeter and voltmeter.

To determine the value of resistances required, one can again apply a practical or theoretical method. For the first, a definite known voltage supply is required, say, 100 or 150 volts, and that is used to feed the milliammeter with a resistance in series, as in Fig. 2, but as the value of R is likely to be high it is not wise to consider winding or making them.

The object of the experiment is to determine the value of R which will give a full-scale, or certain pre-desired part of, deflection of the meter needle for the known voltage supply. If the normal full-scale reading is 1 mA, then it would be advisable to select a value for R that will allow 100 volts to cause the maximum deflection. Low voltages can, of course, be provided for by lower values of R; for example, it would be wise procedure to have one maximum reading of, say, 10 volts. Much time and bother can be saved by applying the formula $R=\frac{1{,}000\times E}{I}$ where E is the desired full-scale reading, and I the normal full-scale reading of the milliammeter.

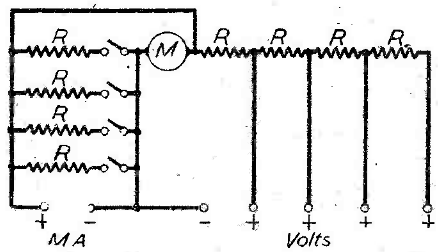


Fig. 5.—Complete circuit of the all-purpose meter as described.

It sometimes happens that it is desired to increase the range of an existing *voltmeter*, therefore it becomes necessary to apply a different formula which reads:

$$R = Rm \times (n - 1)$$

where R is the additional resistance required, Rm the resistance of the voltmeter, and n, as before, the number of times it is required to increase the full-scale reading.

The resistance of the meter can be obtained by multiplying the normal full-scale reading by the "ohms-per-volt," which is usually specified by the makers on the instrument.

Precautions

When taking measurements of doubtful or unknown quantities, always have the shunts or series resistances set for the highest readings, and then adjust to the most suitable range. If the procedure is not adopted, serious harm can be caused to the meter by applying, possibly, excessive current or voltage. It will, no doubt, be obvious to many that it would not be a difficult matter to measure resistances with a milliammeter or voltmeter. In fact, all that is necessary is an external voltage supply; a small dry battery is quite sufficient.

One of the easiest methods is to use a voltmeter and apply the following formula, but it is essential for the applied voltage to have a known and constant value.

R (in this case the resistance under test) $=\frac{e\times Rm}{E}-Rm$ where Rm is the resistance of the meter, e = the value in volts of the applied voltage, and E = the voltage as shown on the normal scale reading of the meter.

A Refresher Course in Mathematics

By F. J. CAMM

(*Continued from page 209, April issue.*)

Logarithms—The Metric System—Arithmetical Progression

Multiplication by Logarithms (*continued*)

MULTIPLY 789.36 by 284.87. As we are using four figure tables we must *contract* the two quantities to four figures. Thus 789.36 becomes 789.4, and 284.87 becomes 284.9.

The log. of 789.4 is 2.8973
The log. of 284.9 is 2.4547
Adding 5.3520
Antilog. of .352 = 2249.

As the characteristic is 5 there will be six places before the decimal point, and the answer therefore is, 224,900.0, which is approximately correct.

In the two preceding examples the characteristic is positive. In cases where the characteristic of one quantity is positive and in the other negative, slightly different treatment is necessary. For example: Multiply 37.65 by .0135.

Log. 37.65 = 1.5758
and log. .0135 = $\bar{2}$.1303
adding $\bar{1}$.7061

Here it will be seen that the positive characteristic, added to the negative produces $\bar{1}$.
Antilog. .7061 = .5083.

As the characteristic is $\bar{1}$ there will be no cyphers before the decimal point.
Answer .5083.

Similarly, when adding two negative characteristics: Suppose the two logs were $\bar{2}$.3064 and $\bar{5}$.0913.

Adding $\bar{2}$.3064
$\bar{5}$.0913
$\bar{7}$.3977
Antilog. = 2499
Answer .000000249.

The treatment is different in cases where the addition of the two mantissas provides a "carry over."

For example, in adding the following two logarithms:

2.3164
$\bar{3}$.9112
Adding .2276

Here it will be seen that, in adding the 9 and 3 of the mantissa, there is a positive 1 to carry to the left of the decimal point. (We have already seen that the mantissa is always positive.)

Adding this 1 to the positive 2, we obtain 3, which cancels out the negative $\bar{3}$. Another example: Add together log. $\bar{3}$.1654 and $\bar{1}$.9733.

$\bar{3}$.1654
$\bar{1}$.9733
$\bar{3}$.1387

The two negative characteristics added together equal $\bar{4}$, and as there is a positive 1 carried from the addition of the mantissas, the characteristic of the addition becomes $\bar{3}$, because $\bar{4}+1=\bar{3}$.

Division by Logarithms

Division by logarithms is effected by subtracting the logarithm of the divisor from that of the dividend, the result of the subtraction being the logarithm of the quotient.

Example: Divide 37.65 by 19.01.

Log. 37.65 = 1.5758
Log. 19.01 = 1.279
Subtracting 0.2968
Antilog. = 1981

As the characteristic is 0, there will be one digit (0+1) before the decimal point, and the answer is 1.981.

Divide 5.065 by .0015.

Log. 5.065 = 0.7046
Log. .0015 = $\bar{3}$.1761
Subtracting 3.5285
Antilog. of .5285 = 3377
Answer 3377.0.

As the characteristic is 3, there will be four figures before the decimal point. Note that the characteristic of the log. being subtracted is changed from negative to positive.

In subtraction, change the sign of the characteristic being subtracted and add.

Involution

Logarithms may be used to perform the functions of involution and evolution. The rule is: *To evaluate the power of a number (as 7.5^3), multiply the logarithm of the number by its index, and the result is the logarithm of the number required.* Consult the table of anti-logarithms for the number corresponding.

Example: Find the number which equals 7.5^3.

Log. 7.5 = 0.8751
Multiply by index 3 3
2.6253
Antilog. .6253 = 4220

Characteristic is 2, therefore there will be three figures before the decimal point.

Answer 422.0

Evaluate $.0735^5$
Log. .0735 = $\bar{2}$.8663
Multiply by index 5
$\bar{6}$.3315
Antilog. .3315 = 2145

Characteristic is $\bar{6}$, so there will be five cyphers after the decimal point. Answer .000002145.

Remember that the mantissa is always positive, so in multiplying the carry over from the decimal part will be positive and must be *subtracted* if the characteristic is negative. In the above example there was 4 to carry; $5 \times \bar{2} = \bar{10}$, and subtracting the 4 leaves $\bar{6}$.

When the index of a number consists of several figures, and the number is less than unity (the characteristic thus being negative) the whole logarithm must be converted into a negative number before proceeding to multiply by the index.

Example: Evaluate $.735^{-3.75}$

Log. .735 = $\bar{1}$.8663
= −1 + .8663
= −.1337 (.8663 has been subtracted from 1)

$$
\begin{array}{rr}
 & -\ .1337 \\
\text{Multiply by index} & -3.75 \\
\hline
 & .6685 \\
 & 9359 \\
 & 4011 \\
\hline
 & .501375
\end{array}
$$

Antilog. .5014 = 3173

Answer 3.173

Remember: *When negative signs are multiplied together the result is positive; but when the mantissa of a logarithm is positive and the index negative, the product is negative. In the latter case the mantissa must be made positive before referring to the table of antilogarithms.*

Example: Evaluate $(7.5)^{-1.5}$

$$\text{Log. } 7.5 = 0.8751$$
$$-1.5 \times 0.8751 = -1.31265$$

Here the mantissa is negative, and it is made positive in the following way:

$$-.31265 = \bar{1}.68735$$
$$\text{Therefore } -1.31265 = \bar{2}.68735$$
$$\text{Antilog } .6874 = 4868$$

Answer .0468

The expression $(7.5)^{-1.5}$ can, of course, also be written $\frac{1}{7.5^{1.5}}$, and by working it out in this form verification of the above result can be obtained.

Evolution

The root of a number can be obtained by dividing the logarithm of the number, by the required root.

Example: Evaluate $\sqrt[3]{28.06}$

$$\text{Log. } 28.06 = 1.4481$$
$$\text{Divide by root } 3 = .4827$$
$$\text{Antilog. } .4827 = 3.039$$

Answer 3.039

The beginner finds no difficulty in evolution by logs when characteristic and mantissa are both positive. When the characteristic is negative it must be adjusted so that the logarithm is exactly divisible by the root.

Example: Find the cube root of .625.

$$\text{Log } .625 = \bar{1}.7959$$

The characteristic is negative and the mantissa positive in this case. Therefore we must add the smallest number to the characteristic to make it divisible by 3. We, hence, add $\bar{2}$ to $\bar{1}$, making $\bar{3}$. To preserve balance we must add + 2 to the mantissa; thus $\bar{1}.7959$ now becomes $\bar{3}+2.7959$.

Dividing by 3 the expression becomes:

$$\bar{1}.93196..$$
$$\text{Antilog. } .932 = 8551$$

Answer .8551

The adjustment of the characteristic is, of course, performed mentally once the principle is mastered.

It is important to remember that, when dividing a logarithm by a number which is greater than the first figure in the mantissa a cypher must be added. For example: Find the seventh root of 4.

$$\text{Log. } 4 = .6021$$
$$\frac{1}{7}(.6021) = .08601$$
$$\text{Antilog. } .08601 = 1219$$

Answer 1.219

Here it will be seen that 7 will not divide into 6, so a cypher is added; 7 divided into 60 gives 8, and so on.

Find the 5th root of .009, or $.009^{\frac{1}{5}}$

$$\text{Log. } .009 = \bar{3}.9542$$
$$\frac{1}{5}(\bar{3}.9542) = \frac{1}{5}(\bar{5}+2.9542)$$
$$= \bar{1}.5908$$
$$\text{Antilog. } .5908 = 3897$$

Answer .3897

The principle of logarithms was discovered by Napier, but Naperian logarithms (sometimes termed hyperbolic or natural logarithms, as distinct from *common* logarithms calculated to base 10) are calculated to a base which is the sum of the series:

$$2+\frac{1}{2}+\frac{1}{2\times3}+\frac{1}{2\times3\times4}+\frac{1}{2\times3\times4\times5}\ \cdots\cdots$$

The sum of this series to five places of decimals is 2.7183, denoted by the symbol e. To convert common into Naperian or hyperbolic logarithms multiply by 2.3026, or more accurately 2.30258509.

To convert Naperian into common logarithms, multiply by .4343....

To convert logarithms calculated to base a to logarithms of base b proceed algebraically, letting x=one base and y the other.

$$\text{Let } N=\text{the number}$$
$$\text{Then } N=a^x$$
$$\text{and } N=b^y$$
$$\text{Therefore } a^x=b^y$$
$$\text{and } b=a^{\frac{x}{y}}$$
$$\frac{x}{y}=\log_a b$$
$$\frac{y}{x}=\frac{1}{\log_a b}$$

Common logarithms were calculated in this way from Naperian logarithms.

The Metric System

The French or metric system used on the Continent, and which is gradually being introduced in this country, is a great improvement on the British systems of measurement. It is a decimal system in which 10 is the unit. The unit of length is the *metre*, which is one 10,000,000th part of the length of the meridian on the north and south line extending from the equator from one of the poles. Later it was found that this determination was wrong, and nowadays the metre is defined as the distance at 0 deg. cent. between two marks on a bar of platinum. This bar is kept at Paris, and is known as the *Metre des Archives*. The unit of square measure is the *are*, the unit of weight the *gramme*, and the unit of capacity the *litre*.

Prefixes of these units denote multiples and sub-multiples.

mega means a million times.
kilo means a thousand times.
hecto means a hundred times.
deca (or *deka*) means ten times.
deci means a tenth part of.
centi means a hundredth part of.
milli means a thousandth part of.
micro means a millionth part of.

Length

10 millimetres (mm)	=1 centimetre (cm.).
10 centimetres	=1 decimetre (dm.).
10 decimetres	=1 metre (m.).
10 metres	=1 decametre (Dm.) (sometimes dekametre).
10 decametres	=1 hectometre (Hm.).
10 hectometres	=1 kilometre (Km.).
10 kilometres	=1 myriametre (Mm.).

Square Measure

100 sq. metres	=1 are.
10,000 sq. metres	=1 hectare.

Weight

10 grammes	=1 decagramme.
10 decagrammes	=1 hectogramme.
10 hectogrammes	=1 kilogramme.
1,000 kilogrammes	=1 tonne.

A gramme is the weight of a cubic centimetre of water at 4 deg. C.

Capacity

1 litre	=1 cubic decimetre.
10 litres	=1 decalitre.
10 decalitres	=1 hectolitre.
10 hectolitres	=1 kilolitre.

A litre is a kilogramme of water at 4 deg. C.

The simplicity of being able to multiply and divide in the metric system is apparent, for it is only a question of moving the decimal point. Thus, the metre is 39.37 inches approximately. A millimetre will be a thousandth part of that, or .03937, and a kilometre will be one thousand times 39.37, or 39,370.000 inches.

METRIC CONVERSION FACTORS

Equivalents of Imperial and Metric Weights and Measures

Linear Measure

IMPERIAL		METRIC	
1 Inch	= 25.400 Millimetres.	1 Millimetre (mm.) (1/1000 m.)	= 0.03937 Inch.
1 Foot	= 0.30480 Metre.	1 Centimetre (1/100 m.)	= 0.3937 „
1 Yard	= **0.914399 Metre.**	1 Decimetre (1/10 m.)	= 3.937 Inches.
1 Fathom	= 1.8288 Metres.	**1 Metre (m.)**	= **39.370113 Inches.** **3.280843 Feet.** **1.0936143 Yards.**
1 Pole	= 5.0292 „	1 Decametre (10 m.)	= 10.936 Yards.
1 Chain	= 20.1168 „	1 Kilometre (1,000 m.)	= 0.62137 Mile.
1 Furlong	= 201.168 „		
1 Mile	= 1.6093 Kilometres.		

Square Measure

1 Square Inch	= 6.4516 Square Centimetres.	1 Square Centimetre	= 0.15500 Square Inch.
1 Square Foot	= 9.2903 Square Decimetres.	1 Square Decimetre	= 15.500 Square Inches.
1 Square Yard	= 0.836126 Square Metre.	1 Square Metre	= 10.7639 Square Feet. 1.1960 Square Yards.
1 Rood	= 10.117 Ares.	1 Are	= 119.60 „ „
1 Acre	= 0.40468 Hectare.	1 Hectare	= 2.4711 Acres.
1 Square Mile	= 259.000 Hectares.		

Cubic Measurement

1 Cubic Inch	= 16.387 Cubic Centimetres.	1 Cubic Centimetre	= 0.0610 Cubic Inches.
1 Cubic Foot	= 0.028317 Cubic Metre.	1 Cubic Decimetre (c.d.)	= 61.024 Cubic Inches.
1 Cubic Yard	= 0.764553 „ „	1 Cubic Metre	= 35.3148 Cubic Feet. 1.307954 Cubic Yards.

Measure of Capacity

1 Pint	= 0.568 Litre.	1 Centilitre (1/100 litre)	= 0.070 Gill.
1 Quart	= 1.136 Litres.	1 Decilitre (1/10 litre)	= 0.176 Pint.
1 Gallon	= **4.5459631 Litre.**	**1 Litre**	= **1.75980 Pints.**

Weight

Avoirdupois		*Avoirdupois*	
1 Grain	= 0.0648 Gramme.	1 Milligramme (1/1000 grm.)	= 0.015 Grain.
1 Dram	= 1.772 Grammes.	1 Centigramme (1/100 grm.)	= 0.154 „
1 Ounce	= 28.350 „	1 Gramme (1 grm.)	= 15.432 „
1 Pound (7,000 Grains)	= **0.45359243 Kilogramme.**	**1 Kilogramme (1,000 grm.)**	= **2.2046223 Lb.** **or 15,432.3564 Grains.**
1 Hundredweight	= 50.80 Kilogramme. 0.5080 Quintal.	1 Quintal (100 kilog.)	= 1.968 Cwt.
1 Ton	= 1.0160 Tonnes or 1,016 Kilogrammes.	1 Tonne (1,000 kilog.)	= 0.9842 Ton.
1 Grain (Troy)	= 0.0648 Gramme.	1 Gramme (1 grm.)	= 0.03215 Oz. Troy. 15.432 Grains.
1 Troy Ounce	= 31.1035 Grammes.		

METRIC TO ENGLISH CONVERSION FACTORS

To Convert—

Millimetres to inches	× 0.03937 or ÷ 25.4
Centimetres to inches	× 0.3937 or ÷ 2.54
Metres to inches	× 39.37
Metres to feet	× 3.281
Metres to yards	× 1.094
Metres per second to feet per minute	× 197
Kilometres to miles	× 0.6214 or ÷ 1.6093
Kilometres to feet	× 3,280.8693
Square millimetres to square inches	× 0.00155 or ÷ 645.1
Square centimetres to square inches	× 0.155 or ÷ 6.451
Square metres to square feet	× 10.764
Square metres to square yards	× 1.2
Square kilometres to acres	× 247.1
Hectares to acres	× 2.471
Cubic centimetres to cubic inches	× 0.06 or ÷ 16.383
Cubic metres to cubic feet	× 35.315
Cubic metres to cubic yards	× 1.308
Cubic metres to gallons (231 cu. in.)	× 264.2
Litres to cubic inches	× 61.022
Litres to gallons	× 0.2642 or ÷ 3.78
Litres to cubic feet	÷ 28.316
Hectolitres to cubic feet	× 3.531
Hectolitres to bushels (2,150.42 cu. in.)	× 2.84
Hectolitres to cubic yards	× 0.131
Hectolitres to gallons	÷ 26.42
Grammes to ounces (avoirdupois)	× 0.035 or ÷ 28.35
Grammes per cubic centimetre to pounds per cubic inch	÷ 27.7
Joules to foot-pounds	× 0.7373
Kilogrammes to ounces	× 35.3
Kilogrammes to pounds	× 2.2046
Kilogrammes to tons	× 0.001
Kilogrammes per square centimetre to pounds per square inch	× 14.223
Kilos per lineal metre	× 0.672 = pounds per lineal foot.
Kilos per lineal metre	× 2.016 = pounds per lineal yard.
Kilos per lineal metre	× 0.0003 = tons per lineal foot.
Kilos per lineal metre	× 0.0009 = tons per lineal yard.
Kilos per kilometre	× 3.548 = pounds per mile.
Kilos per square centimetre	× 14.223 = pounds per square inch.
Kilos per square millimetre	× 0.635 = tons per square inch.
Kilos per square metre	× 0.2048 = pounds per square foot.
Tonnes per square metre	× 0.0914 = tons per square foot.
Tonnes per square metre	× 0.823 = tons per square yard.
Kilos per cubic metre	× 1,686 = pounds per cubic yard.

Kilos per cubic metre	×	0.0624	= pounds per cubic foot.
Tonnes per cubic metre	×	0.752	= tons per cubic yard.
Grammes per litre	×	70.12	= grains per gallon.
Kilos per litre	×	10.438	= pounds per gallon.
Litres per square metre	×	0.0204	= gallons per square foot.
Kilogrammetres	×	7.233	= foot-pounds.
Kilogrammetres	×	0.0387	= inch-tons.
Tonne-metres	×	3.23	= foot-tons.
Force de cheval	×	0.9863	= horse-power.
Kilos per cheval	×	2.235	= pounds per H.P.
Square metres per cheval	×	10.913	= square feet per H.P.
Cubic metres per cheval	×	35.806	= cubic feet per H.P.
Calories	×	3.968	= heat units.
Calories per square metre	×	0.369	= heat units per square foot.

English to Metric Conversion Factors

1 inch	= 2.54 centimetres, or 25.4 millimetres.
1 foot	= 30.4799 centimetres, 304.799 millimetres, or 0.3047 metre.
1 yard	= 0.914399 metre.
1 mile	= 1.6093 kilometres = 5280 feet.
1 millimetre	= 0.03937 inch.
1 centimetre	= 0.3937 inch.
1 decimetre	= 3.937 inches.
1 metre	= 39.370113 inches. 3.28084 feet. 1.093614 yards.
1 kilometre	= 0.62137 mile.
1 decametre (10 metres)	= 10.936 yards.

Compound Conversion Factors

Pounds per lineal foot	×	1.488	= kilos per lineal metre.
Pounds per lineal yard	×	0.496	= kilos per lineal metre.
Tons per lineal foot	×	3333.33	= kilos per lineal metre.
Tons per lineal yard	×	1111.11	= kilos per lineal metre.
Pounds per mile	×	0.2818	= kilos per kilometre.
Pounds per square inch	×	0.0703	= kilos per square centimetre.
Tons per square inch	×	1.575	= kilos per square millimetre.
Pounds per square foot	×	4.883	= kilos per square metre.
Tons per square foot	×	10.936	= tonnes per square metre.
Tons per square yard	×	1.215	= tonnes per square metre.
Pounds per cubic yard	×	0.5933	= kilos per cubic metre.
Pounds per cubic foot	×	16.020	= kilos per cubic metre.
Tons per cubic yard	×	1.329	= tonnes per cubic metre.
Grains per gallon	×	0.01426	= grammes per litre.
Pounds per gallon	×	0.09983	= kilos per litre.
Gallons per square foot	×	48.905	= litres per square metre.
Inch-tons	×	25.8	= kilogrammetres.
Foot-pounds	×	0.1382	= kilogrammetres.
Foot-tons	×	0.309	= tonne-metres.
Horse-power	×	1.0139	= force de cheval.
Pounds per H.P.	×	0.477	= kilos per cheval.

British Units of Length

The Imperial Standard Yard is the distance between the centres of two gold plugs or pins in the bronze bar used for determining the Imperial Standard Yard, measured when the bar is at a temperature of 62 deg. F. It is supported on bronze rollers placed under it to avoid flexure of the bar and to facilitate its free expansion and contraction from variations of temperature. The Imperial Standard is a solid square bar 38in. long and 1in. square in section. Near to each end a cylindrical hole is sunk exactly 26in. from centre to centre. At the bottom of each hole is inserted a gold plug about $^1/_{10}$th of an inch in diameter, and upon the surface of the pins are cut three fine lines at intervals of $^1/_{100}$th of an inch, transverse to the axis of the bar and two lines at nearly the same interval parallel to the axis of the bar. These are the datums from which the measurement is taken. There is no need to give here a complete list of British weights and measures.

Arithmetical Progression

A series of numbers which increase or decrease by a constant difference is known as an *Arithmetical Progression*. Thus, 1, 4, 7, 10, 13, 16, . . . is an arithmetical progression, the common difference being plus three. The series 12, 10, 8, 6, 4, 2, is also an arithmetical progression, the difference here being -2. We can reduce this to a formula so that when we wish to know the *sum* of such a series we do not need to add each term of the series together separately. Of course, in a simple series like that given the addition sum could be performed mentally, but in a complicated series where each term of the series is a large number or consists of decimals, it is more convenient to use the formula.

Let a = the first term of the series, z the last term, n the number of terms, d the constant difference and S the sum of all the terms. We can now arrive at a series of formulæ from which we can find the first term of a series from a total representing the sum of the series, or we can find the last term, knowing the first and the number of terms and the difference; we can find the number of terms from the sum, the difference or, in fact, any function of the series. Here are the formulæ:

$$a=z-d\,(n-1).\quad a=\frac{2S}{n}-z.\quad a=\frac{S}{n}-\frac{d}{2}\,(n-1).$$

$$z=a+d\,(n-1).$$

$$z=\frac{2S}{n}-a.\quad z=\frac{S}{n}+\frac{d}{2}(n-1).\quad n=\frac{z-a}{d}+1.$$

$$n=\frac{2S}{a+z}.$$

$$d=\frac{z-a}{n-1}.\quad d=\frac{(z+a)\,(z-a)}{2S-a-z}.\quad d=\frac{2\,(S-an)}{n\,(n-1)}.$$

$$d=\frac{2\,(z\,n-S)}{n\,(n-1)}.$$

$$S=\frac{n\,(a+z)}{2}.\quad S=\frac{(a+z)\,(z+d-a)}{2\,d}.\quad S=n\left[a+\frac{d}{2}(n-1)\right].$$

$$S=n\left[z-\frac{d}{2}\,(n-1)\right].\quad a=\frac{d}{2}\pm\sqrt{\left(z+\frac{d}{2}\right)^2-2dS}.$$

$$z=\frac{d}{2}\pm\sqrt{\left(a-\frac{d}{2}\right)^2+2dS}.$$

$$n=\frac{1}{2}-\frac{a}{d}\pm\sqrt{\left(\frac{1}{2}-\frac{a}{d}\right)^2+\frac{2S}{d}}.$$

$$n=\frac{1}{2}+\frac{z}{d}\pm\sqrt{\left(\frac{1}{2}+\frac{z}{d}\right)^2-\frac{2S}{d}}.$$

When the series is decreasing make the first term = z, and the last term a.

The Arithmetical Mean of two quantities, A and B, $=\frac{A+B}{2}$

(To be continued)

Impressions on the Wax

A Review of the Latest Gramophone Records

Columbia

AMONG the numerous releases this month is a record which revives several famous Scottish songs sung by Delya. It is called "Scottish Song Memories," and introduces "My Ain Folk," "Loch Lomond," "Angus Macdonald," "Coming thro' the Rye," "Annie Laurie" and "Road to the Isles." The vocalist has organ and piano accompaniment—*Columbia FB2766*.

You can always rely on Turner Layton to choose up-to-the-minute songs for his new recordings, and this month he sings "By Candlelight," coupled with "Baby Mine" from the Disney film "Dumbo"—*Columbia FB2771*. Bing Crosby revives an old favourite, "Waltzing in a Dream," on *Columbia DB2074*. On the reverse side he sings "We'll Make Hay While the Sun Shines."

If you like dancing then you should get "Anniversary Waltz" and "Elmer's Tune," played in strict dance tempo by Victor Silvester and his Ballroom Orchestra on *Columbia FB2776*. Speaking of dance tunes, I liked a piano medley of popular hits of the moment played by Carroll Gibbons on *Columbia FB2768*. Called "Carroll Calls the Tunes," it features "Rustic Rhapsody," "Concerto for Two," "What More Can I Say?" "Elmer's Tune," "I Know Why" and "Tropical Magic." Carroll Gibbons has also made a recording of "Two in Love" and "Rustic Rhapsody" on *Columbia FB2777*, but this time he is with his Savoy Hotel Orpheans.

Parlophone

IVOR MORETON and Dave Kaye, those two popular pianists, on two pianos with string bass and drums, have made yet another "Tin Pan Alley Medley" on *Parlophone F1899*. The medley consists of "Wrap Yourself in Cotton Wool," "Shepherd Serenade," "Elmer's Tune," "That Lovely Week-end," "Sand In My Shoes" and "Do You Care?" A comedy song which is extremely popular at the moment is "Ma, I Miss Your Apple Pie," and Geraldo and his Orchestra play it as a quickstep on *Parlophone F1895*. "By Candlelight" is played on the reverse side of this disc. An old favourite, "The Sheik of Araby," appears in the Parlophone 1942 Super Rhythm Style Series played by Harry Parry and his Radio Rhythm Club Sextet on *Parlophone R2834*, whilst, on the other side, is "Some Day, Sweetheart."

H.M.V.

LESLIE A. HUTCHINSON ("Hutch") has made a recording this month of "I Know Why" from the film, "Sun Valley Serenade," coupled with "A Rose and a Prayer," on *H.M.V. BD999*. Florence Desmond, one of the radio stars in "Big Time," sings "When I Love I Love" from the film, "Week-end in Havana," and "The Bleeding Heart" on *H.M.V. B9263*.

Among the dance tunes recorded this month I recommend "Baby Mine" and "When I See an Elephant Fly," played by Joe Loss and his Orchestra on *H.M.V. BD5734*; the same band also play "What More Can I Say?" and "Concerto for Two," on *H.M.V. BD5735*.

Brunswick

BING CROSBY heads the Brunswick list with "Shepherd Serenade" and "Do You Care?" on *Brunswick O3278*. I conclude my notes by recommending three records, all of which feature women vocalists. Firstly we have Carmen Miranda singing "A Week-end in Havana" and "Ella diz que Tem," on *Brunswick O3271*; secondly, Frances Langford singing an old favourite, "Smilin' Through" and "A Little Love, a Little Kiss," on *Brunswick O3277*; and finally Ella Fitzgerald singing "Jim" and "This Love of Mine," on *Brunswick O3281*.

BRITISH LONG DISTANCE LISTENERS' CLUB

A "Zeppelin" Aerial

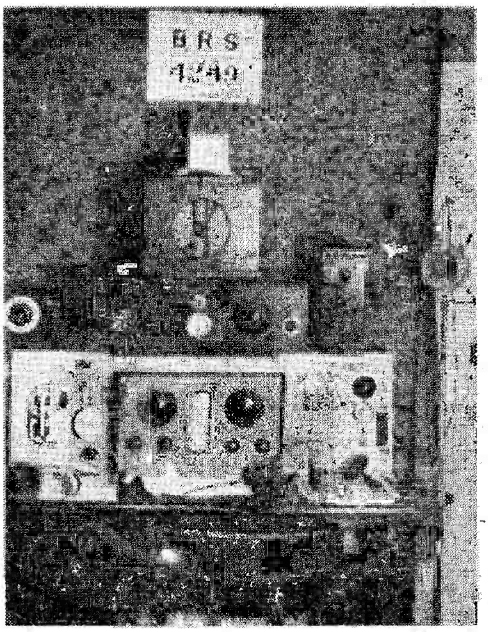
MEMBER 6,187, of 32, Beaudesert Road, Handsworth, Birmingham, 20, sends us details of the "Zepp" aerial with which he has been experimenting. Most members will know that it is a type quite widely used by amateur transmitters in pre-war days, and, like most other transmitting aerials, it is very satisfactory for reception purposes. Here is what 6,187 has to say about it:

"As it is so difficult to build an efficient RX these days, I have obtained an 8-valve commercial superhet and have concentrated my efforts on an efficient aerial design.

"This takes the form of a 48ft. top fed by a transposed feeder about 36ft. long, as per sketch. The lead in is transposed with a wire attached to the insulators on the supports and connected to earth on the RX, no other earth being used. The transposition is effected by means of the blocks mentioned in the February issue of PRACTICAL WIRELESS. The aerial is successful in obliterating most of the man-made static, previously experienced here, both in the form of persistent loud crackles and background 'mush.' The general conditions have not, however, favoured DX results lately, although South Africa on the 30 m., Radio-Brazzaville on the 25 m. and the usual Americans on the 19 m. band have been consistent with Australia at R6 on the 30 m. band early in the morning occasionally.

"I should be glad if you could find space to print in PRACTICAL WIRELESS the fact that my QRA has moved again from Huyton, Lancs, to the above address.

"I should be glad if any B.L.D.L.C. members about 17 around Handsworth would write or 'phone me ('Phone No. NOR 0093) with a view to meeting each other."



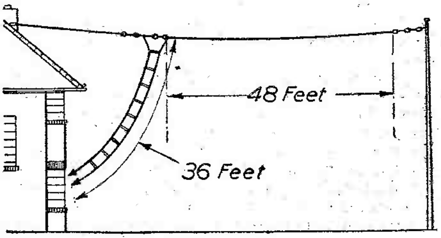
The equipment of the receiving station owned and operated by Mr F. Taylor.

A New Member's Den

F. TAYLOR, 7,158, of Tottenham, N.15, who has recently joined the Club, sends us the photograph reproduced on this page. The description of his station, to use his own words, is: "The RX in the centre is a four-stage straight rig, its power pack being situated on the right. On the left of it is the frequency-meter, and to the left of that is the aerial panel.

"On top of the set is a 6-watt push-pull amplifier, which incorporates proper mixing controls and circuits. The medium and long-wave set is to the left of the amplifier. The microphone, complete with adjustable floor stand, is of the transverse current type, and I use it in conjunction with the amplifier.

"Many thanks for the articles by 2CHW, to which I look forward with pleasure."



Details of the "Zepp" aerial used and described by Member 6,187

From Devon

W. A. JUBB, 7,168, does not seem to have made contact with any other members down Exeter way. Perhaps those residing in or near that area will get in touch with us so that we can determine whether a group could be formed.

Here are 7,168's remarks:

"I think your idea of forming B.L.D.L.C. groups is excellent. I do not know if there are sufficient members here in Exeter; so far I have not met one.

"My receiver is a three-valver, similar to Member 7,009's, described in PRACTICAL WIRELESS 430. I am using coils covering from 11 metres to 170 metres. The aerial is 20ft. long, indoors, and the earth goes to a water-pipe. In the R.F. stage is a Tungsram, type S.E. 211C; detector, metallised Hivac triode, type unknown; and, as output, a Marconi pentode. These three prove most efficient, reaction being smooth, and quite a large output being obtained, with small H.T. consumption. During the last three days I have received quite a large number of stations, some of the best of which are HVJ, WCRC, WNBI, WCW, Radio-Brazzaville, CR7BE, and quite a number of others. Station CR7BE is located in Mozambique. I received it on about 40 metres, at quite good strength, about 9.30 p.m."

The Right Spirit

WE give below extracts from a very interesting letter received from Member 7,194, L. Stoney, of 202, Valley Road, Sheffield, 8, who is 15 years of age. We admire the spirit with which he tackled the hobby and wish him every success in his activities.

"I hope you will be interested in the following description of my activities during the past year.

"With infantile paralysis as a setback to most physical hobbies, I decided to make up for this by studying an interesting hobby of a different type, and radio was the satisfactory answer to this need.

"Beginning by studying books on the subject and carefully examining theoretical circuits of different types of receivers, I quickly acquired a sufficient knowledge of radio to enable me to attempt the construction of various types of battery receivers. After many interesting experiments, I succeeded in obtaining fairly good results with a 1—v—1 long and medium wave receiver, which was constructed from old parts collected from a friend's disused 'junk box.' To improve reception I paid particular attention to aerial erection.

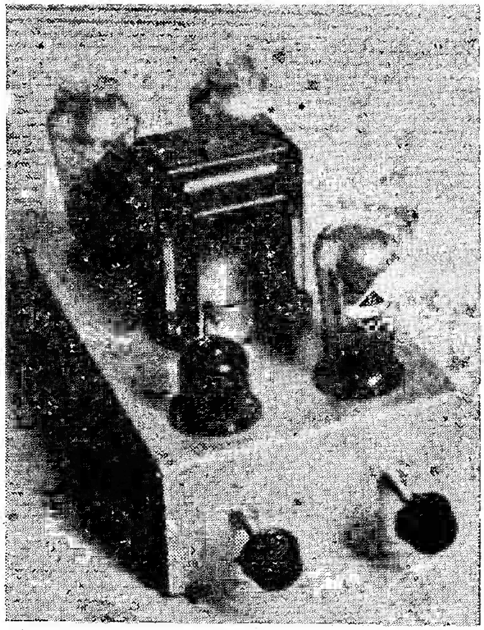
"Well, after a few months of this kind of work, I turned to what I found the more interesting side of radio—long-distance S.W. reception. Using an 'inverted L' type of aerial I have logged all continents on a commercial 1—v—1 RX, using a metal rectifier for H.T. supply. At present I am rearranging the reaction control, which is not too smooth. Finally, would you please insert my request for contacts about my own age (15 years).

"I think group working is a necessity to enable complete co-operation among members."

A Useful Amplifier

FOR those requiring a useful general-purpose battery-operated amplifier, we show the theoretical circuit and a view of the completed unit, of a simple yet very efficient three-valve arrangement. It is suitable for use with a detector or H.F. and detector unit, a pick-up or a transverse current microphone, therefore it forms a most useful unit for any station using battery-operated equipment.

One triode of the H.F. or H.L. type is required for the first stage and two power or super-power valves for the output circuit. Straightforward Class A push-pull is employed and normal decoupling precautions have been incorporated, thus making it quite suitable for use with a reliable make of H.T. eliminator. The actual output will depend on the type of valves used in the push-pull stage and the H.T. applied, but, even with ordinary power valves and 120 volts H.T., adequate output for ordinary purposes can be obtained when a magnetic type of pick-up or a carbon microphone is used.



The completed amplifier. Note the neat layout and the balanced arrangement of the valves.

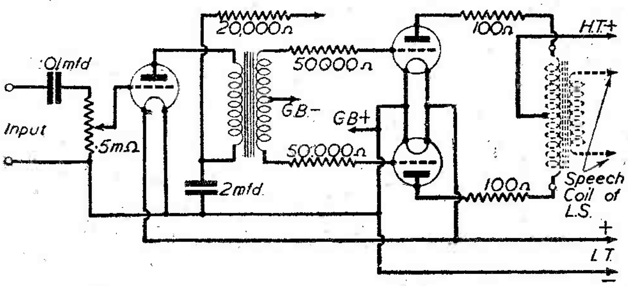


Fig. 2.—The Class A push-pull amplifier circuit, which is intended for good quality reproduction rather than high gain.

A good idea of the layout can be obtained from the illustration, which shows how the two output valves are placed at the rear of the chassis and fairly close to the secondary side of the push-pull input transformer.

The four-pin plug which is seen plugged into a valve holder on the front of the chassis, was used in the original model for battery supply. The additional control—left-front—was the variable resistance of a tone control. This is not shown in the theoretical circuit as it is purely optional; it consists of a 25,000 ohm potentiometer connected in series with a .04 mfd. fixed condenser, joined between the anode of the input valve and the common negative line.

If a powerful input is applied to the first valve, it would be better to disconnect the input volume control from the negative line and take it to a low negative voltage for grid bias.

Medium-wave Transmissions

MANY members are now seeing what can be done in the way of receiving long-distance medium-wave transmissions. This opens up another sphere of activities and helps to compensate for the absence of amateur S.W. signals. Perhaps those members who are interested in this wave-band and who have been able to log some of the stations, will be good enough to let us have details of the results obtained, with times of transmissions and call signs, etc., so that we can pass on the information to all members.

The A.T.C.

MORE praise for the A.T.C., which many B.L.D.L.C. members have joined, is contained in two letters received from members in Manchester and Romford, Essex. It is very obvious that, in addition to the other valuable training given to members of the Corps, those interested in radio secure tuition which will stand them in good stead when their peace-time activities are resumed.

Member 8,115 of Manchester says: "I have not had much time lately to write. I volunteered for the R.A.F. in January, but did not pass my medical, so I have now joined the A.T.C. Through the training and practice I am receiving I have improved a lot in morse sending and receiving, and I would like to say what a good thing the A.T.C. is.

The Romford member, No. 7150, should not be a "lone wolf" operator much longer, bearing in mind the many other radio enthusiasts he is likely to meet in the A.T.C.

"At present I am a lone wolf, except for a correspondent in Staffordshire, member 6900, who is the same age as I (17 years). We are both in the A.T.C. and hope to become radio mechanics in the R.A.F. I might mention that all my knowledge in radio has been gained through your fine paper PRACTICAL WIRELESS."

Loudspeaker Impedances

In View of the Interest Shown Recently in Output Transformers and Speaker Matching, the Following Notes Will be Found Useful

IMPEDANCE is the property of opposing or impeding the flow of changing or alternating current.

The voice-coil of a loudspeaker, like everything else, has impedance, but not very much of it—only a few ohms. Passage of pulsating or alternating current through this impedance causes electrical power to be converted to sound power.

If we were to connect the voice-coil directly in the plate circuit of the output valve we would get very little electrical power converted to sound, because the fluctuations of current are very small.

Greater Impedance

We need a much greater impedance in order to convert efficiently the electrical power to sound. We therefore use a transformer—called the output transformer—which "steps up" the low impedance of the voice coil connected to the secondary, making the primary behave as if it were actually a voice coil of much higher impedance.

The effective impedance of the primary depends, of course, on the impedance connected to its secondary, and on the square-root of the turns-ratio of the transformer.

The transformer acts in the electrical circuit just as a gear-box does in a mechanical device.

A certain type of power output valve is capable of delivering the maximum power output to a "load"—the loudspeaker—when the load has a particular value of impedance, provided that the output valve is supplied with enough input from the preceding valves. But at full power output the distortion would be excessive, and to keep the distortion within reasonable limits we would have to be satisfied with considerably less than the maximum power output, by reducing the input to the valve. Fortunately, we can choose another value of load impedance which, while enabling almost the maximum output to be obtained, gives the best compromise between power output and distortion; this is the "Optimum load impedance" specified by the valve manufacturer.

The determination of this load impedance is beyond the scope of the amateur experimenter, but he should know what will be the effect of slight departures from the published figure, and what modifications can be made for improved performance under special conditions.

Ideal Conditions

It must be borne in mind that the specified load impedance is a compromise giving the most acceptable result under ideal conditions.

The ideal conditions assume that the load impedance is purely resistive and remains constant for all frequencies.

Actually, neither is ever true in practice; the impedance of a loudspeaker contains reactance as well as resistance, and varies widely over the range of audio frequencies.

The impedance of a speaker is measured at some particular frequency, usually 400 cycles per second. At most other frequencies, higher or lower, the impedance is in general greater.

There is thus no point in attempting to be precise in specifying the exact nominal speaker impedance.

Another point to be remembered is that a particular load impedance is specified for the maximum power output consistent with moderate distortion.

In reproducing a musical programme it is only rarely that a large power is required for the volume peaks, and it is surprising how little power is required to give loud volume over the bulk of a programme. It is therefore only at occasional loud passages that it is possible to notice by ear even large departures from the theoretically ideal load impedance.

The effect of different load impedances depends on the class of valve and its method of operation, and the commonest examples of class "A" operation are treated separately:

Single triode, no feedback.—Increased load impedance will reduce the maximum available output, but will reduce the distortion also. Lower impedance will enable very slightly greater output, with increased distortion.

If the nominal speaker impedance is equal to the recommended load, high and low frequencies will be slightly weakened, with low distortion—a desirable condition.

Push-pull triodes, no feedback.—As the distortion of triodes is largely cancelled in a balanced push-pull circuit, it is possible to reduce the load below the usual figure (which is twice the impedance of a single valve), and thus get slightly greater maximum output without increased distortion.

To allow for some unbalance in the circuit it is advisable to keep the impedance nearly twice that for a single valve.

Output Transformers

In the case of push-pull output transformers and valves we always speak of the total impedance, plate to plate, except in the case of true class "B" operation.

Single pentode or beam valve, no feedback.—Pentodes and beam tetrodes are much more critical than triodes in their load impedance. At full power output the distortion increases rather rapidly as the load is either increased or decreased from the recommended figure, but the distortion with higher impedance is of a more objectionable type than that with lower impedance. Especially as the impedance of most speakers rises above the nominal value at both high and low frequencies, it is better to err on the low side than the high side.

In any case, a variation of 10 per cent. from the ideal is unlikely to be noticed on a programme by even the most critical listener.

Push-pull pentodes or beam valves, no feedback.—The type of distortion caused by low load impedance with a pentode is eliminated by perfectly-balanced push-pull, although allowance must be made for some lack of balance.

It is therefore permissible and usually desirable to operate with a load less than twice the load recommended for a single valve.

All types, with feedback.—The use of inverse feedback modifies the properties of output valves so much that it is impossible to lay down any hard and fast rules which would hold for the various degrees of feedback used in practice, especially when the feedback circuit is used also for tone-compensation purposes.

Use Same Load Impedance

In general, the same load impedance should be used as without feedback, but, except at full maximum output, quite large variations of load impedance have very little effect.

Inasmuch as most forms of feedback make the output stage comparatively insensitive to changes of load, the variation of speaker impedance with pentodes is not nearly as serious as without feedback.—*Australasian Radio World.*

Open to Discussion

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

Dry Cells for Battery Sets

SIR,—I was interested in the letter of Mr. P. P. Horwood in your issue dated April, and I must thank him for his reply.

Several years ago (if I remember rightly), I tested the output of an R.F. oscillator, and found that the R.F. output did not drop much when using between 2 volts and 1.4 volts on the filament. This suggests that 1.4 volts is the *minimum* which should be used. The whole thing depends on the number of valves in the set, and the length of time it is used each day. I am still of the opinion that a dry bell-cell with a one- or two-valve headphone set should last, with occasional use, for 12 months.

One naturally treats with respect the opinions of valve makers and others, but the writer has derived much pleasure in doing things which orthodox opinion does not approve—at least, has not approved until some time afterwards, when some of the writer's ideas have been used by others to their advantage, and then, I suppose, they became strictly orthodox!

If the L.T. section of the battery in an all-dry type of receiver will not last more than three months with reasonable use, and not as long as the H.T. section, then in my opinion it is up to the manufacturers to endeavour to improve on the L.T. section of the "all-dry" batteries.

No one can expect "mains volume" from any dry cell, but if the filament voltage after the set has been switched on is not much less than the original battery voltage, then the dry cells should be suitable for use under *economy* conditions, not forgetting the grid bias adjustment.

There is a point which is raised with regard to inferior results given by 1.5 volt cells in two-volt portable sets. It is possible that some portable sets rely for their volume of output on a small amount of instability or overall feedback, and this instability would not be present with 1.5 volts on the filament. Sets using 1.5 volt dry cells may probably be capable of providing a "reserve of reaction effects" which can be increased by other means.—D'ARCY FORD (Exeter).

Some Suggestions

SIR,—May I express my approval of the new form of PRACTICAL WIRELESS. I hope that it will never go back to the old style.

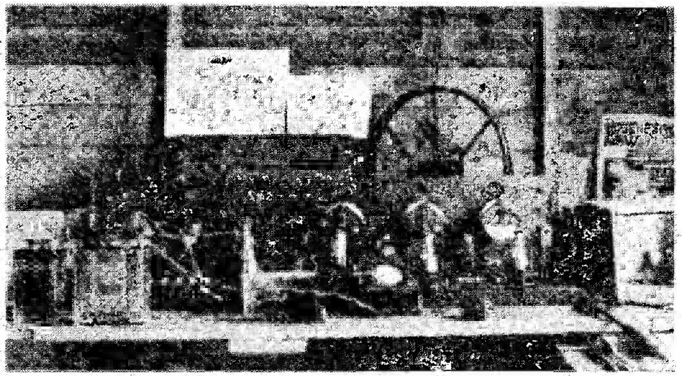
Before the war I knew nothing at all about radio and much of my present knowledge was obtained from this journal. I have built several sets from short-wave circuits that you have published and I must say they all worked fine. And now for a suggestion. What about some more advanced circuits and articles on superhet receivers? Articles on the theoretical working and practical construction of such circuits as: Bandpass Crystal Filters, Noise Limiters, Amplified A.V.C., Single Side-band Reception, etc. I would especially like to see a battery-operated receiver incorporating the first three above mentioned, as they are not commercially available in battery sets. My present receiver is a four-valve superhet, which performs well, but is liable to oscillator drift, picks up a lot of noise on short wave, and lacks just that little extra "bit of punch" required for short-wave broadcast reception. Hence the above requests. I find that I get the best reception on 19, 25 and 31 metre bands, 41 and 49 metres seem to be almost non-existent except for German stations.—RAYMOND GROSART (Liverpool).

B.B.C. Announcers

SIR,—A short time ago readers will recall that we were informed in the press that an Axe Controller had been appointed to assist the B.B.C. to cut down its bloated war-time staff.

We are now informed that five more women announcers are to be appointed, bringing the total of same up to 16, and this suggests a little enquiry as to what "cutting down" consists of. The ostensible reason given for these increases is that male announcers have been called up for military service, but, is this really a fact?

For instance, were there as many as 16 male announcers prior to this "cutting down," and if there were, have they all been called up without any exception? Or have some of them been left, so that we have them, plus the women announcers? And how are these women announcers selected. By competition and examination, or by personal selection by influential high-ups in the B.B.C.?



A corner of Mr. Parker's den, showing some of the apparatus with which he carries out his experiments and tests.

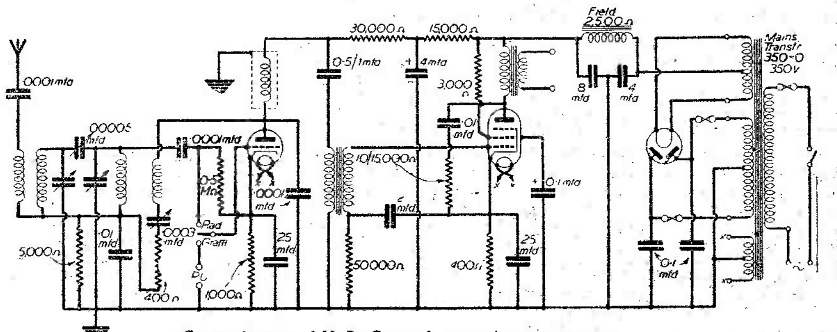
Presuming that at least four of the male announcers are not called up, they, with the 16 women announcers, provide the B.B.C. with no less than 20 announcers in all! And I think folks may be forgiven for asking whatever on earth can be found to keep all them reasonably occupied. Not the programmes surely? for, in addition to the actual "announcer," there are usually one or more others concerned in the production of most of the items, who chip in with their comments as soon as the "announcer's" voice comes to a stop, giving us a little chat about the item which the announcer has just announced; and will announce a second time as soon as the item ends. They first announce what we *are* going to listen to! Then, later, they tell us what we *have* been listening to. So that between these two announcements by the real honest-to-goodness announcer, and the chatty little comments by various other parties (all on salary, of course), there can be no possible doubt left in the mind of the simple and stupid listeners as to what they have been actually listening.

Contrary to the fixed complex of the B.B.C. that outsiders have no brains, there are quite a whole lot of listeners with sufficient intelligence to add two and two together, and arrive at the correct result. Such people are fully justified in asking if the B.B.C. must not be positively cluttered up with announcers already, and insisting that any further appointments are entirely redundant, and would only serve for further evidence of favouritism, and the provision of still more well paid and cushy jobs for people who ought to be employed in other directions much more likely to assist our war efforts. This, at any rate, suggests a useful question for the "Famous" Brains Trust. Possibly some of the eminent professors concerned may be able to inform us how the engagement of further employees is able to assist in "cutting down" the bloated war-time staff of the B.B.C.? And, perhaps, be able to convince us that it is not all bunkum and eyewash when there is talk of any such long overdue reductions.—K. T. Hardman (Birkenhead).

Two-valve Mains Receiver

SIR,—For the past six years I have been a regular reader of Practical Wireless, besides having at hand the complete set of P.W. books.

Many Practical Wireless readers have shown interest in my circuit. There remains an improvement which can be carried out on the B.P. tuner in the wiring detail (gauge, etc.), and great care should be taken in matching the coils. To use 28 gauge enamelled wire is best. Last, but not least, a metal screen must be placed between the two coils of the B.P. tuner.—H. De Cransay (Woking).



Circuit diagram of H. De Cransay's two-valve mains receiver.

The valve sequence is 41 MHL ; MP Pen and 442 BU. The coil windings, proceeding from aerial to detector, are : 40 turns—40 turns—40 turns, and 20 turns, using 28 S.W.G. wire on a 3in. diameter former. If a 1½in. former is used, 80 turns—80 turns—80 turns, and 60 turns of 36 S.W.G. will be required.

Medium-wave DX Reception

SIR,—Since there appears to be an increased interest taken in medium-wave DX reception, readers may be interested in the following log of trans-Atlantic stations which I have received during December and January, at times between 00.00 and 03.00 hours, B.S.T.:

246 metres WCAU, Philadelphia (C.B.S.).
275 „ WBAL, Baltimore (N.B.C.).
286 „ WHN, New York (Independent station).
341 „ WABC, New York (C.B.S.).
426 „ WOR, New York (M.B.S.).

The wavelengths given are approximate ones, since the dial of the receiver was not accurately calibrated, and no announcements of frequencies were heard.

On several evenings station CBA, Maritime, Canada (282 metres), was clearly received as early as 22.30 hours B.S.T.

Programmes were also heard from the following stations (owing to poor reception and interference I am not certain of the call-signs; I should be glad if any reader could verify those given below):

Approximately—
195-205 metres Buffalo, WKBW.
195-205 „ Boston, WMEX.
195-205 „ Washington D.C., WJSV.
277 „ Hartford (Conn.), WPIC.
470 „ St. John's (Newf.), CONS.

All reception was carried out on a normal 4-valve A.C. broadcast receiver (all-wave superhet). The aerial was an inverted L, open end pointing east. Signals were QSA2-4, and all of the stations logged were received on at least two separate nights.—John L. Goldberg (Formby, Lancs).

From an Old Timer

SIR,—As one of your oldest readers, may I express my appreciation of the compilation of the new series of Practical Wireless. I began experimenting in 1922 at a time when one had to get three persons to sign a long blue form issued to bona fide experimenters, and I have watched the progress of wireless as the years have gone on. What a change now from the old days of large drum coils and headphones, zincite and bornite crystals, and valves which took from your accumulator .75 amp. (per valve). I have had Dutch valves, German valves (Telefunken oblong type), and, in fact, all types that were worth trying out. I regret to say that through overstudy of radio I was forced to give it up and take a rest, and at last I have come back to start afresh. I might add that I have an increased desire to study the construction of all types of mains and battery receivers. I have built my own test panel, which has 22 separate plug-in terminals, all coloured, and this instrument took me months of careful thought to construct; however, it has been well worth the trouble, as I am able to detect practically any fault which may arise in a commercially built set. I enclose a photograph of my den, which may interest other readers.—L. Parker (Rainham, Essex).

S.W. Stations

SIR,—Here are some details of short-wave stations recently received which might interest readers. Sydney, Australia, is "on the air" at the following times: 06.55 to 07.40 on 25.51 m., 19.59 m.; 11.40 to 12.15 on 25.27 m.; 15.25-16.10 on 31.32 m. Programmes consist of news and music. Radio Saigon operates 11.15-11.45, 16.30-17.00 on 10.24 mc/s in the 29 m. band. HSP5 (Bangkok), 25.61 m., can be heard from 12.30 till 16.00. XGOY, "The Voice of China," can be heard in the afternoon with news at 15.00 and 17.15 on 25.21 m. L. Marques operates on 19.66 m. and 30.88 m. News is given on 30.88 m. at 21.00 (19.45 Sundays); the 19 m. wavelength is used in early evening.

ZOY, Accra, Gold Coast, 49.78 m., from 18.00 till 20.45, with news at 18.40. "The Voice of Guatemala" (TGWA) can be heard from 17.45 to 19.45 on 19.78 m. COK (Havana), 25.93 m., gives news at 21.00; reception is not good but improves later. WCW, Press Wireless, New York, testing 15.00-16.00 on 18 m. All times are B.S.T.—S. R. Smith (Crewe).

Correspondent Wanted

C. FORRESTER, 58, Redsull Avenue, Deal, Kent, who is a beginner in radio, would like to get in touch with another young enthusiast who is interested in short-wave receivers.

Replies to Queries

Indirectly Heated Valves

" I shall be very glad if you will solve a problem for me. What is the advantage of using indirectly heated valves, and why is it that in some circuits a resistor and condenser are included in the cathode lead and in others they are omitted ? "—K. L. S. (Harrow).

INDIRECTLY heated valves are usually more robust than directly heated types, and, owing to the inclusion of a cathode in their formation, they offer a very convenient method of providing individual valves with automatic grid-bias. Normally, the cathode has to be connected to the common negative line to complete the cathode-anode circuit and to allow the anode (H.T.) current to flow. If the valve does not require any bias on its grid then those connections hold good, but if, as in the case of the majority of the valve stages, bias is required, then a resistor has to be connected between the cathode and the negative line. The value of the resistor depends on the bias required and the total current (H.T.) of the valve. A condenser should be connected in parallel with the resistor to by-pass the L.F. or H.F. current component.

Single or Dual Range Coils?

" I am about to construct a three-valve receiver for general purpose listening, and as I wish to make the coils myself, according to the information given in the December, 1941, issue of P.W., I would like to know whether you think it is worth while going to the trouble of calculating and winding a long-wave section ? "—G. B. B. (Aberdeen).

AT the present time we do not think it would be worth while. Apart from the additional work and components involved, the efficiency of the coil is likely to be less than when it is wound for medium wave only.

Vertical *versus* Indoor Aerials

" Will you please settle a little debate a few of us S.W. enthusiasts have been having ? It concerns aerials ; and the question is : ' Which is better for general S.W. reception—a vertical aerial outside the house or an indoor aerial ? ' Various arguments have been put forward for each type ; and I personally favour the vertical system, but your opinion will be appreciated as none of us has sufficient experience of the subject to speak with authority." —J. B. L. (Woolwich).

THE efficiency of both types of aerial will depend on so many local conditions that it is not possible to make a definite statement one way or the other. Assuming average conditions, however, we would put more faith in a vertical aerial, but this opinion holds good only if the following points are observed.

To be efficient a vertical aerial must have height ; it must be free from surrounding earthed objects and the insulation at all points of fixing must be good—in all weathers. The actual aerial, i.e., the metal rod or tube, must be, at least, ten feet in length and of sufficient rigidity to resist tendency to swaying or " whipping." If, for example, the aerial has to be fixed to a point only ten feet above the ground level, then its efficiency will be reduced considerably, and it is highly probable that an efficient indoor aerial in the upper rooms of a house would be better. On the other hand, an indoor arrangement on the ground floor will also have a low efficiency, and, what is also noteworthy, any form of man-made static is likely to have more effect on reception. A vertical aerial fixed to a chimney-stack should be very satisfactory, provided reasonable care is given to the lead-in.

Mains and Output Transformers

" The output transformer in my set has broken down, and I wish to re-wind it. I have dismantled it and removed both windings, and I shall be pleased if you will tell me how many turns I require on the primary and secondary. The stampings are approximately 2ins. by 1½ins., and the speaker is a permanent magnet type."—C. V. (Bolton).

THE replies given on this page are usually of general interest, but although in this instance we cannot give the required help, we are including this query in our reply with the sole object of making the position quite clear to other readers who might have a similar problem.

We cannot, especially in the existing circumstances, devote the amount of time which such queries involve to answering, individual queries of a constructional nature. The problem of transformer design is far too comprehensive to be dealt with in a letter, and, as in the case in question, it is absolutely impossible for anyone to determine the information from the totally inadequate data provided.

RULES

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

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

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

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

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

In our issue for December, 1941, we published an article dealing with the main factors governing the winding of output and mains transformers, and previous to this several constructional articles have appeared. The subject is dealt with in a more comprehensive manner in our book, " Coils, Chokes and Transformers."

Crystal Receivers

" I am thinking of constructing a crystal receiver, but before purchasing the parts and devoting the time necessary to its making, I wish to ask you if you can give a guarantee regarding the range of reception of the crystal receivers mentioned in your list of blueprints ? "—T. L. (Hayes).

WHILE all the designs of the crystal receivers given in our blueprint list are very efficient, we are afraid that you are asking rather too much by requesting a definite guarantee regarding their effective range of reception. In the early days, one used to think of 10 or 15 miles as being a reasonable range for the reception of telephony, but nowadays, with the modern high-powered transmitters, this distance is, of course, greatly increased. With a crystal set so much depends on local conditions, the aerial system and even the crystal detector, but when these factors are satisfactory, a distance of 50 miles would be quite feasible although, naturally, the closer one is to the station the more powerful the results.

Book for Beginner

" I wish to purchase a book which will allow me to understand the general technicalities of radio with a view to improving and servicing modern commercial sets. I have in mind the ' Encyclopaedia,' but am not quite sure whether this will be too technical. Perhaps you would be kind enough to send me details of the book which will meet my requirements."—L. W. (Leyland, Lancs).

THE Encyclopædia explains all the terms met with in modern radio, as well as giving principles, diagrams, etc. In conjunction with this, if you wish to carry out servicing, we would suggest the Service Manual. We think that armed with these two books you should be able to understand modern circuit design and practice.

Impedance Formula

" In looking up theory, in particular impedance, of a tuned circuit which has R, C and L in series, I find a variation in at least two books which are considered good authorities on the subject.

The formulæ given are :

$$Z = \sqrt{R^2 + (X_L X - _C)^2} \text{ and } R^2 + (X_L \backsim X_C)^2$$

The sign enclosed within the brackets of the latter indicating ' whichever is the greater in value.' Can you please tell me which is correct ? "—F. W. J. C. (Belmont, Harrow).

THE two formulæ are identical, and the query appears to be due to misinterpretation of the sign mentioned by the reader. If reference is made to the first of the series of articles " A Refresher Course in Mathematics," in our issue for February, 1942, the sign will be found on page 105, with the explanation that it indicates " difference of " which makes the second formula identical with the first.

Classified Advertisements

ADVERTISEMENTS are accepted at 2s. per line or part of a line. Minimum 4s. Advertisements must be prepaid and addressed to Advertisement Manager, "Practical Wireless," Tower House, Southampton Street, London, W.C.2.

PUBLIC APPOINTMENTS

APPLICATIONS are invited by the Home Office for the following posts, connected with a system of wireless communications.

Technical Assistant (Wireless) (D.314). Applicants should have had a good education and possess sound knowledge of modern wireless theory and practice, including transmitters, especially V.H/F. At least 3 years' executive experience in a commercial research and development laboratory, or in the engineering branch of a Government or commercial wireless station, is essential.

Regional Wireless Engineer (D.316). Applicants must be of good education and have sound knowledge of wireless transmission and reception, including radio-telephony. Practical experience in both medium and V.H/F. Good knowledge of Morse (20 w.p.m.) and installation and electrical work. Must have sufficient organising ability to administer the station and staff.

Station Engineer (Wireless) (D.317). Applicants must be of good education, have sound knowledge of wireless, including radio-telephony, both medium and V.H/F. and of electrical fitting work. Good knowledge of Morse (18 w.p.m.). The salaries offered will be according to qualifications and experience. Applications giving details of experience and salary required should be addressed to the Secretary, Central Register, Section D.314/6/7, Queen Anne's Chambers, Westminster, S.W.1.

CABINETS

WE regret that, owing to all our employees having joined H.M. forces, we are unable to accept orders for cabinets except to callers. Limited stock only. We have a large stock of radio components.—H. L. Smith & Co., Ltd., 289, Edgware Road, London, W.2. Tel.: Pad. 5891.

LOUDSPEAKER REPAIRS

LOUDSPEAKER repairs, British, American, any make, moderate prices.—Sinclair Speakers, 12, Pembroke Street, Copenhagen Street, N.1.

LITERATURE, MAPS, etc.

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WEBB'S Radio Map of the World. Locates any station heard. Size 40" by 30", 4/6, post 6d. On linen, 10/6, post 6d.—Webb's Radio, 14, Soho Street, London, W.1. GERrard 2089.

RADIO SOCIETY OF GREAT BRITAIN invites all keen amateurs to join. Reduced war-time subscriptions. Send 1s. for latest "T. & R. Bulletin" and details.—16, Ashridge Gardens, London, N.13.

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This aerial's a packet o' mixtures.
Hand up the FLUXITE,
Or we'll be here all night,
And I want to go to the pictures."

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AUTO. CHARGING CUT OUT AND VOLTAGE REGULATOR, ex.-R.A.F., suit any dynamo up to 20 v. at 15 amps., fully adjustable, with wiring instructions, complete in metal case, **3/6**, post 9d.

BLOCK CONDENSER, large size, 1 MF., 4,000 v. working, **15/-**, carriage 2/-.

2 kW TRANSFORMER, complete with clamps, suitable for rewinding, **25/-** each; 1 kW. ditto, **17/-**, both carriage forward.

DYNAMO for lighting or charging, shunt wound and interpole, output 110 volts 66 amps., price **£20**, carriage forward.

¼ H.P. A.C. MOTORS, 220/30 volts, 50 cycle, single phase, guaranteed sound windings, but the centrifugal starter switch is broken and wants repair, otherwise motors are in working order. Price **30/-** each, carriage 2/6.

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HIGH TENSION TRANSFORMER, input 110/220 v., 50 cycle, single phase; output 45,000 volts at 7 milliamps, in first-class condition, small portable type. Price **£12/10/-**, carriage paid.

D.C. MOTORS LAMINATED fields, approx. ½ h.p., 110/220 volt. Price **20/-**, carriage 2/-.

LARGE TRANSFORMERS with round windings. Output 10 to 70 volts, Ex. Tungar Chargers. Size 1 kW, **45/-**; size 2 kW, **£3/15/-**, both carriage forward.

AUTO TRANSFORMER, size 2,000 watts, tapped, common, 100, 200, 220 and 240 volts. As new. Price **£6/5/-**. Carriage paid.

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TUBULAR CONDENSERS. .25 mfd. 350 volt working, **9d.** each. Also .0001, .0002, .0003 and .0005 mfd. **4d.** each.
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12 ASSORTED volume controls, **5/-** dozen.
RESISTANCES. Brand new, 500, 1,200 and 100 ohms. **3/-** dozen.
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VARIABLE CONDENSERS, mica dielectric, brand new, **6d.** each, **5/-** dozen.
MICROPHONES. Complete with transformer. Solid ebonite job, full instructions included. **5/6** each.
PYE mains dropping resistances, suit any receiver. New. **3/6** each.
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CRYSTAL Detectors, permanent type, **1/6** each. New.
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T.C.C. wire-end Tubulars, 0.1 mfd., **7d.** each, **6/6** dozen, also .01 mfd. at **6d.** each, **5/-** doz.
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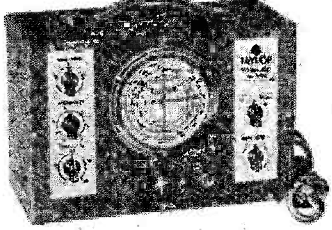

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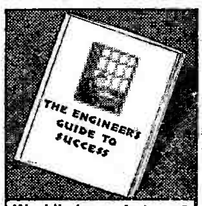

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STAMPED ENVELOPE must accompany all enquiries.
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PHILIPS Speech transformers for pentode output, **4/6** each.
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FLEXIBLE DRIVES. Well-made shielded cable drives for remote control. Ideal for radiogramophones. Approx. 2' long. To clear, **4/-** each.
ELECTRO-MAGNETIC COUNTERS. Resistance 500 ohms. From 1-12,999. Size 4½" x 2" x 1¼". Ex-G.P.O. Invaluable for countless purposes, **9/6** each. A smaller type, 1-1,999, size 4½" x 1½" x 1⅛", **5/6.**
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VARIABLE CONDENSERS. 2 and 3 gang. Die cast frames in first-class condition. **5/6** each.
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(Continued on page 284.)

RECEIVERS AND COMPONENTS

(*Continued from page 283.*)

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(*Continued top of column 3.*)

RECEIVERS AND COMPONENTS

(*Continued from column 1.*)

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Practical Wireless
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	Date of Issue.	No. of Blueprint.
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STRAIGHT SETS. Battery Operated.

One-valve: Blueprints, 1s. each.

All-Wave Unipen (Pentode)	—	PW31A
Beginners' One-valver	19.2.38	PW85
The "Pyramid" One-valver (HF Pen)	28.8.38	PW93

Two-valve: Blueprint, 1s.

The Signet Two (D & LF)	24.9.38	PW76

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Selectone Battery Three (D, 2 LF (Trans))	—	PW10
Summit Three (HF Pen, D, Pen)	—	PW37
All Pentode Three (HF Pen, D (Pen), Pen)	—	PW39
Hall-Mark Three (SG, D, Pow)	—	PW41
Hall Mark Cadet (D, LF, Pen (RC))	—	PW48
F. J. Camm's Silver Souvenir (HF Pen, D (Pen), Pen) (All-Wave Three)	—	PW49
Cameo Midget Three (D, 2 LF (Trans))	—	PW51
1936 Sonotone Three-Four (HF Pen, HF Pen, Westector, Pen)	—	PW53
Battery All-Wave Three (D, 2 LF (RC))	—	PW55
The Monitor (HF Pen, D, Pen)	—	PW61
The Tutor Three (HF Pen, D, Pen)	—	PW62
The Centaur Three (SG, D, P)	—	PW64
F. J. Camm's Record All-Wave Three (HF Pen, D, Pen)	—	PW69
The "Colt" All-Wave Three (D, 2 LF (RC & Trans))	18.2.39	PW72
The "Rapide" Straight 3 (D, 2 LF (RC & Trans))	—	PW82
F. J. Camm's Oracle All-Wave Three (HF, Det, Pen)	—	PW78
1938 "Triband" All-Wave Three (HF Pen, D, Pen)	—	PW84
F. J. Camm's "Sprite" Three (HF Pen, D, Tet)	26.3.38	PW87
The "Hurricane" All-Wave Three (SG, D (Pen), Pen)	—	PW89
F. J. Camm's "Push-Button" Three (HF Pen, D (Pen), Tet)	3.9.38	PW92

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Fury Four (2 SG, D, Pen)	—	PW11
Beta Universal Four (SG, D, LF, Cl.B)	—	PW17
Nucleon Class B Four (SG, D (SG), LF, Cl. B)	—	PW34B
Fury Four Super (SG, SG, D, Pen)	—	PW34C
Battery Hall-Mark 4 (HF Pen, D, Push-Pull)	—	PW46
F. J. Camm's "Limit" All-Wave Four (HF Pen, D, LF, P)	—	PW67
"Acme" All-Wave 4 (HF Pen, D (Pen), LF, Cl. B)	12.2.38	PW83
The "Admiral" Four (HF Pen, HF Pen, D, Pen (RC))	3.9.38	PW90

Mains Operated

Two-valve: Blueprints, 1s. each.

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A.C.-D.C. Two (SG, Pow)	—	PW31
Selectone A.C. Radiogram Two (D, Pow)	—	PW19

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Double-Diode-Triode Three (HF Pen, DDT, Pen)	—	PW23
D.C. Ace (SG, D, Pen)	—	PW25
A.C. Three (SG, D, Pen)	—	PW29
A.C. Leader (HF Pen, D, Pow)	7.1.39	PW35C
D.C. Premier (HF Pen, D, Pen)	—	PW35B
Unique (HF Pen, D (Pen), Pen)	—	PW36A
Armada Mains Three (HF Pen, D (Pen))	—	PW38
F. J. Camm's A.C. All-Wave Silver Souvenir Three (HF Pen, D, Pen)	—	PW50
"All-Wave" A.C. Three (D, 2 LF (RC))	—	PW54
A.C. 1936 Sonotone (HF Pen, HF Pen, Westector, Pen)	—	PW56
Mains Record All-Wave 3 (HF Pen, D, Pen)	—	PW70

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A.C. Fury Four Super (SG, SG, D, Pen)	—	PW34D
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Mains Sets: Blueprints, 1s. each.

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D.C. £5 Superhet (Three-valve)	—	PW42
Universal £5 Superhet (Three-valve)	—	PW44
F. J. Camm's A.C. Superhet 4	—	PW59
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"Qualitone" Universal Four	—	PW73

Four-valve: Double-sided Blueprint, 1s. 6d.

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SHORT-WAVE SETS. Battery Operated.

One-valve: Blueprint, 1s.

Simple S.W. One-valver	23-12-39	PW88

Two-valve: Blueprints, 1s. each.

Midget Short-wave Two (D, Pen)	—	PW38A
The "Fleet" Short-wave Two (D (HF Pen), Pen)	27.8.38	PW91

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Experimenter's Short-wave Three (SG, D, Pow)	—	PW30A
The Prefect 3 (D, 2 LF (RC and Trans))	—	PW63
The Band-Spread S.W. Three (HF Pen, D (Pen), Pen)	—	PW68

PORTABLES

Three-valve: Blueprints, 1s. each.

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Parvo Flyweight Midget Portable (SG, D, Pen)	3.6.39	PW77

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MISCELLANEOUS

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Full-volume Two (SG det, Pen)	—	AW392
A Modern Two-valver	—	WM409

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Lucerne Ranger (SG, D, Trans)	—	AW422
£5 5s. Three: De Luxe Version (SG, D, Trans)	19.5.34	AW435
Transportable Three (SG, D, Pen)	—	WM271
Simple-Tune Three (SG, D, Pen)	—	WM327
Economy Pentode Three (SG, D, Pen)	—	WM337
"W.M." 1934 Standard Three (SG, D, Pen)	—	WM351
£3 3s. Three (SG, D, Trans)	—	WM354
1935 £6 6s. Battery Three (SG, D, Pen)	—	WM371
PTP Three (Pen, D, Pen)	—	WM389
Certainty Three (SG, D, Pen)	—	WM393
Minitube Three (SG, D, Trans)	Oct. '35	WM396
All-Wave Winning Three (SG, D, Pen)	—	WM400

Four-valve: Blueprints, 1s. 6d. each.

65s. Four (SG, D, RC, Trans)	—	AW370
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Lucerne Straight Four (SG, D, LF, Trans)	—	WM350
£5 5s. Battery Four (HF, D, 2LF)	—	WM381
The H.K. Four (SG, SG, D, Pen)	—	WM384
The Auto Straight Four (HF, Pen, HF Pen, DDT, Pen)	Apr. '36	WM404

Five-valve: Blueprints, 1s. 6d. each

Super-quality Five (2 HF, D, RC, Trans)	—	WM320
Class B Quadradyne (2 SG, D, LF Class B)	—	WM344
New Class B Five (2 SG, D, LF, Class B)	—	WM340

Mains Operated.

Two-valve: Blueprints, 1s. each

Consoelectric Two (D, Pen) A.C.	—	AW403
Economy A.C. Two (D, Trans) A.C.	—	WM286
Unicorn A.C.-D.C. Two (D, Pen)	—	WM394

Three-valve: Blueprints, 1s. each.

Home Lover's New All-Electric Three (SG, D, Trans) A.C.	—	AW383
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£15 15s. 1936 A.C. Radiogram (HF, D, Pen)	—	WM401

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Harris' Jubilee Radiogram (HF, Pen D, LF, P)	May '35	WM386

SUPERHETS.

Battery Sets: Blueprints, 1s. 6d. each.

'Varsity Four	Oct. '35	WM395
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PORTABLES

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Family Portable (HF, D, RC, Trans)	—	AW447
Tyers Portable (SG, D, 2 Trans)	—	WM367

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One-valve: Blueprints, 1s. each.

S.W. One-valver for America	P.W.15.10.38	AW429
Roma Short-Waver	—	AW452

Two-valve: Blueprints, 1s. each.

Ultra-short Battery Two (SG, det, Pen)	Feb. '36	WM402
Home-made Coil Two (D, Pen)	—	AW440

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Experimenter's 5-metre Set (D, Trans, Super-regen)	—	AW438
The Carrier Short-waver (SG, D, P)	July '35	WM390

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Empire Short-waver (SG, D, RC, Trans)	—	WM313
Standard Four-valver Short-waver (SG, D, LF, P)	—	WM383

Superhet: Blueprint, 1s. 6d.

Simplified Short-wave Super	—	WM397

Mains Operated.

Two-valve: Blueprints, 1s. each.

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Three-valve: Blueprints, 1s.

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MISCELLANEOUS

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PRACTICAL WIRELESS, MAY, 1942.

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