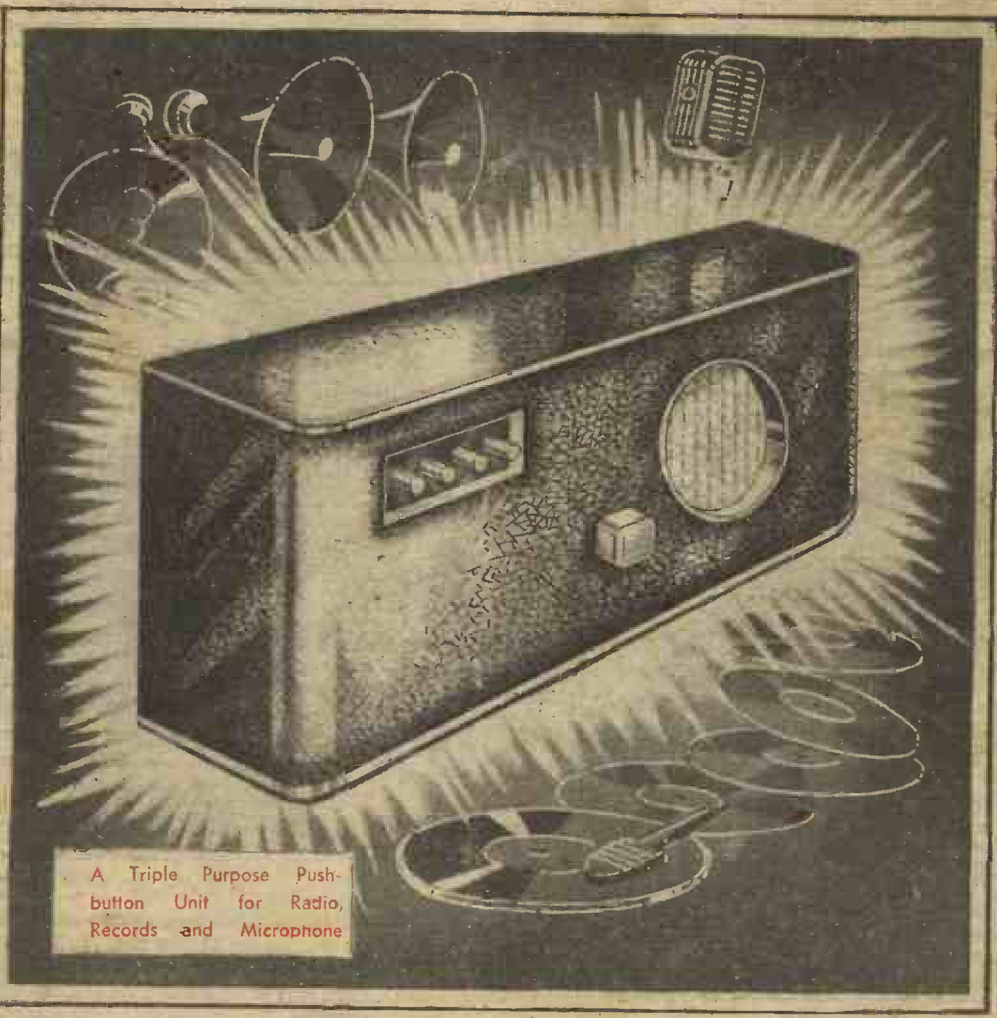
A UNIVERSAL TWO-VALVE MIDGET

Practical Wireless 9D EVERY MONTH
Editor F. J. CAMM
Vol. 20. No. 454 NEW SERIES. APRIL, 1944



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Practical Wireless

and PRACTICAL TELEVISION

12th YEAR OF ISSUE

EVERY MONTH.
Vol. XX. No. 454. APRIL, 1944.

Editor F. J. CAMM

COMMENTS OF THE MONTH BY THE EDITOR

Post-war Television

In a survey of post-war television presented in the form of a paper before the Institution of Electrical Engineers some interesting, if debatable, points are raised. We agree that some of the factors tending to retard the expansion of television in pre-war days were mainly economic and not technical, but they were not entirely so. Tens of thousands of pounds have been readily forthcoming for the experimental work of a costly character, inevitable with the birth of a new science.

It is a matter for debate whether that money was wisely spent, or whether the right personnel were picked for the experiments. It is our view that television in its early days gained too much publicity before it was ready, and that public money was subscribed before a receiver providing reasonable entertainment was ready for the market. If we are right in this assumption it is obvious that the shareholders would not receive dividends, and human nature being what it is shareholders have a natural reluctance to continue to put money into a concern which they feel will not yield reasonable returns; or if they feel that the long-term policy between investment and yield is too long.

That really is a summary of the position. Perhaps, due to the somewhat exaggerated claims for television in its early days by writers in the daily press, a disservice was rendered to the development of television from which it really never recovered. The public had the impression that television in a really perfect form was almost ready for production. After the first public company was formed a number of 30-line television receivers were marketed on the strength of a very poor transmission from the B.B.C. for a few hours a week. We think everyone will agree that those receivers lacked entertainment value although they did arouse scientific interest. We think, therefore, that the real reason behind the comparatively slow development of television was technical rather than economic, in that the B.B.C. did not see its way clear at that stage to devote more programme time to it. Obviously, if there are very few programmes the demand for television receivers will be correspondingly small, and if there is a small demand turnover will be small, and profits small. Thus, the economic difficulty is a secondary, not a prime matter. One follows the other.

Later, the High Definition programmes were instituted and these gave manufacturers a chance to market receivers giving reasonably good results, although the public, in view of the restricted range of the television programmes, did not buy them in large quantities. The television service really only served the Home Counties.

Another factor which impinged upon the problem was that the public, knowing that television was still being developed, did not feel inclined to spend a large sum of money on a television receiver if it was likely to go out of date within a few months. There was a wait and see policy. Had the B.B.C. given more television programmes there would have been a larger demand, and financial backers would not have been slow to perceive the possibilities. Unfortunately the war caused the 1939 Radiolympia to close before the completion of its intended run, and the television programmes were discontinued largely, but not entirely, because the signals from Alexandra Palace could be used by enemy aircraft for direction finding.

The cessation of those programmes in our view has been a good thing for television; it has given the technicians over four years with which to perfect the transmitting and receiving systems, and this time there can be no possible excuse of lack of financial support, for the experiments have almost entirely been conducted at Government expense. We think, therefore, that the author of the paper has based one of his arguments on a false premise in stating that television was retarded mainly by economic factors. If television had been reasonably perfected, the money would have been available. As it is, large sums of money have been lost by shareholders.

It follows that the author is similarly wrong in assuming that the post-war reconstruction of a television service is mainly an economic problem, although we agree that it would be helpful if a statement on post-war television could be made as soon as possible on Government attitude towards radio broadcasts generally, and television in particular. No one can lay post-war plans until the Government has done this. But then this applies to all other industries. Until we have won the war it is going to be difficult for the Government to announce a policy, and quite rightly it believes that it must not spend too much time thinking of post-war industry, although it has a lively eye in that direction.

We agree with the statement of opinion that for the first year of the recommencement of television it will be necessary for the Government to subsidise the building and transmitting of television transmitters. No one will be allowed to transmit programmes except the B.B.C., and it is only right therefore that they should bear part of the cost of developing receivers for those programmes. It is a possibility that in order to provide this money the wireless licence will be increased. It is one of the few things which has not increased during the war, and we do not think that any listener is likely to object to an increase.

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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

Television Inquiry

MR. ATTLEE announced in the House of Commons recently that the Government had appointed a committee to consider the development of television after the war, and make recommendations.

Newspaper Radio Stations

THE U.S. Federal Communications Commission last month voted against any prohibition of the future acquisition of radio stations by newspapers.

New Radio Sets

MR. DALTON, President of the Board of Trade, stated recently that he hoped soon to announce the maximum prices of the new wireless sets shortly to be available. The imported sets and the wartime sets would be distributed to retailers on the basis of pre-war trade.

Mr. H. Taylor, of Mullard's Silica Valve Dept., has been awarded the B.E.M. See paragraph on this page.

Music for Occupied Europe

IN the occupied countries the voices of many national composers are stilled; from Britain they are lifted up and given back to the countries of their origin by the B.B.C.

The European Service of the B.B.C. is essentially a news service, providing Europe with accurate news and information on the war and on world affairs generally. Nevertheless, amid the iteration of political and military truth there is regularly heard the voice of pure music. London has been defined as the "clearing house for music for the entire world," and it is here that the spirit and meaning are kept alive of much music that would seldom be heard if German domination had its way.

Firm to Exploit Television

IT is announced that a large factory has been acquired by a radio firm which intends to put mass-produced television receivers on the market as soon as possible after the war. The firm in question is Philco Radio and Television Corporation of Great Britain, and they have acquired control of Aero Engines, Ltd. For some time Philco Radio have been conducting extensive research in television in their laboratories in America.

European Daily Service Broadcasts

THE B.B.C.'s European Service broadcasts daily a musical programme from 09.30–10.00 G.M.T. From studios in London the Czechs are able to hear the music of Smetana, Suk, Fibich and Janacek; the Poles, Moniuszko, Szymanowski and Maciejewski; the Dutch, van Dieron and Pijper; the French, Roussel and Satie, and so on. But the European Service does not confine itself to representing those countries in which modern music has especially flourished. Each of the small European countries has at one time or another been represented by at least one special musical programme. Modern British works are not omitted from this cosmopolitan scheme. The peoples of Europe are able to tune in not only to the music of established modern composers, but to representative works of the younger English school, such as those of Benjamin Britten, Alan Rawsthorne, Elizabeth Maconchy and others too numerous to mention. Many of these works have, in fact, received their first performance in the broadcasts to Europe.

Polish Girl Radio Commandos

IT is reported that several thousand Polish girls who escaped before the German occupation have been trained in Britain as radio commando troops in preparation for service in Europe after the Allied invasion forces have landed. Many of the girls had previously served as signallers in the Polish army, and they had experience of radio and telephone communications on the battle-front in Poland. Their training base is in Scotland, where they are serving in the Polish women's unit, similar to the British A.T.S. Special mobile field radio stations, some of Polish design, will be operated by these girls when they land in Europe.

R.S.G.B. Membership

IT is interesting to note that during the year ended September 30th, 1943, the membership of the Radio Society of Great Britain increased from 4,480 to 5,835, the total now being about 2,500 in excess of the record pre-war year.

Listening Schools

ACCORDING to a recent report it is likely that the number of listening schools will reach 13,000 by the end of the current school year. There were nearly 11,000 schools registered at the beginning of the 1943-44 session.

B.E.M. Recipient

OF particular interest to the radio industry is the award in the New Year Honours List of the British Empire Medal to Mr. H. Taylor, foreman of the Silica Valve Department at the Mullard factory, in recognition of important work in connection with the war effort Mr. Taylor has been with the company since its earliest days, and it was actually 25 years ago that he started the work on which he has since specialised. He is now 52 years of age and has a son with the Eighth Army in Italy.

North African Radio

THE newly organised broadcasting branch of Army Welfare is reported to be transmitting regular programmes to the troops in North Africa, and will shortly be functioning also in Italy. It is known as studio 3A, after the B.B.C. studio of that name. Much of the earlier equipment had been captured from the Germans and Italians in Tunis. Gear from Britain is arriving, and proper studios, now established in a villa near the Directorate's headquarters, will soon be in service.

Cambridge Wireless Group

THE Council of the Institution of Electrical Engineers have sanctioned the formation of a wireless group for Cambridge and district and have approved a provisional committee, consisting of the following: chairman, C. R. Stonor, B.Sc.(Eng.); vice-chairman, B. J. Edwards; members of committee, R. H. Angus, M.A., R. S. Francis, J. G. Hammond, M.Sc.(Eng). I. F. MacDiarmid, J. T. Randall, D.Sc., E. V. Root, R. W. Wilson, B.Sc.(Eng.); honorary secretary, D. I. Lawson, M.Sc.

An inaugural meeting was held in the engineering laboratories of the university on Thursday, February 17th, at 8 p.m., when Mr. T. E. Goldup repeated his chairman's inaugural address on the subject of "The General Aspects of Radio Engineering Progress."

B.B.C.'s Transmitter Power

TWENTY-ONE years ago the B.B.C. had three transmitters having a total power of 3 kW. To-day the B.B.C. operate over 100 transmitters with a total power of about 5,000 kW.

B.I.R.E. Meeting

AT a special meeting of the British Institution of Radio Engineers, held at 11, Belgrave Street, London, S.W.1, on February 16th, a discussion took place on television standards. The meeting was opened by contributions by two members, L. H. Bedford, O.B.E., M.A., B.Sc., and W. A. Beatty.

Queued for His Own Concert

BENNO MOISEIWITSCH is spending his time travelling about Britain playing great music for eager wartime audiences.

A B.B.C. friend of his told us how the famous pianist arrived the other day in a provincial town about an hour before the time for his concert—at a cinema. No one met him. He walked to the cinema. It was locked, back and front. Presently a queue began to form up. Moiseiwitsch joined it. Eventually the doors were opened, and those in the queue passed up to the box-office window. When Moiseiwitsch got there he explained that he was the pianist. The clerk replied that they had "heard that one before" and demanded the admission money.

But Moiseiwitsch was spotted by a music-lover, introduced to the manager, and all was well.

Symphony Concerts

SHOSTAKOVICH, of "Leningrad Symphony" fame, figures in Sir Henry Wood's concert on March 8th, when his First Symphony (his best, according to many critics) will be broadcast. Eileen Joyce is the soloist in D'Indy's Symphonie Montagnard for piano and orchestra. The concert opens with Wagner's Tannhäuser Overture and Venusberg music, and closes with Liszt's Mephisto Waltz.

The final symphony concert on March 22nd will be notable for another broadcast of Vaughan Williams's lovely and moving Symphony in D, his Fifth; this was first performed at the Promenade Concerts in 1943 under the composer's direction. It at once made a profound impression and one critic wrote: "I doubt if anything more beautiful than the slow movement has been written in this century. . . ." A Mozart piano concerto will be played by Myra Hess, and the concert —and the series—ends with Berlioz's Scherzo "Queen Mab," and Romeo's Reverie and Capulet's Feast from "Romeo and Juliet."

The General Forces Programme

THE General Overseas Service, which started on February 27th, has been organised and designed for the British men and women serving abroad, and will be broadcast in future as the second programme throughout the United Kingdom. It is known as "The General Forces Programme."

On the 8th Army Front, these British gunners receive messages in the wireless communication truck, which is also used as a forward O.P. with ground fire.

Many of the programmes, regularly broadcast in the General Overseas Service, which are to be shared by listeners at home with forces overseas, will be new to listeners in Britain.

South American Listeners' Thanks

FROM Pernambuco comes a letter telling of some listeners overseas who, feeling that they have reason to be grateful to the B.B.C., have shown their gratitude in an extremely practical way. The hon. secretary and treasurer of the Pernambuco Fund in aid of the British Red Cross writes:

"You will remember previous payments to the British Red Cross from this Committee representing contributions from short-wave listeners here as an expression of appreciation and thanks for the B.B.C.'s overseas services.

"This year our 'Radio Owners' Donations' amount to approximately £40 15s. at the present rate for remittance. This sum has been transferred to Rio and will in due course—probably soon—be remitted thence to the British Red Cross and St. John War Organisation."

A Push-button Broadcast Unit

Technical Details of an Interesting Installation Possessing Novel Features.

By R. G. KITCHENN

THIS four-purpose unit has proved of great value at a communications establishment employing about 50 persons in a large sectioned room. A controlling officer is at one end of the room which is "covered" by loudspeakers placed to give even sound distribution. Although the unit was designed to meet these circumstances in particular, the information given below may be of some assistance to those designing a similar system for use under different conditions.

The functions of the four push-buttons are as follow:

Button 1: B.B.C. Home Service on unit and room loudspeakers; gain controlled at unit.

Button 2: B.B.C. Forces Service on unit and room loudspeakers; gain controlled at unit.

Button 3: Unit loudspeaker functions as moving-coil microphone; controller can broadcast over room loudspeakers with preset gain; unit gain control ineffective.

Button 4: Audio amplifier input cut away from detector, and brought out to jacks for a special purpose to be described later. Room loudspeakers cut off, unit loudspeakers effective.

The most convenient power supplies available were 130 v. positive and 85 v. negative D.C. with respect to earth (voltage regulated) and the unit was consequently designed around these unusual supplies. Normal A.C. mains, however, could be used with equal convenience, and still retain the same design principles of the original unit.

Circuit

An external aerial is used, transformer coupled to a 75-ohm coaxial feeder to the unit, where it is transformer coupled to the tuned grid circuit of the pentode RF amplifier. The latter is choke-capacity coupled to the tuned-grid circuit of an infinite impedance detector. The audio output from the cathode load of this stage is transformer coupled to a triode voltage amplifier, which, in turn, is resistance-capacity coupled to a power pentode amplifier. The latter is, of course, transformer coupled to the loudspeakers. When the third button is operated, and the unit loudspeaker is used as a microphone, another triode valve is used, with a preset gain control, as a microphone pre-amplifier (Fig. 1).

RF Amplifier

The low-impedance coaxial line from the aerial is terminated on a tip and sleeve plug, the outer conductor to sleeve, and the inner to tip. As the negative line of the set is at 85 v. negative to earth, a blocking condenser C1 is inserted between the sleeve of the jack and 85 v. negative to prevent D.C. voltages being carried to the aerial system.

C3 and C4 are the preset tuning condensers for the Home and Forces frequencies respectively, and may be connected by pressing the appropriate button. V1 is a Mullard VP13C, connected conventionally, with a radio-frequency choke in the anode circuit, and a coupling condenser C7 to the infinite impedance detector, V2.

Infinite Impedance Detector

V2 is a Mazda HL1320, with the same input circuit as V1. Although giving no gain, an infinite impedance detector is preferable to a diode in that it can handle high values of modulation without distortion, and does not shunt the preceding tuned circuit. The value of the load resistor R3 determines the operation of the stage. If a high value is used, the anode current causes a large voltage drop across it, thus biasing the valve almost to cut-off. A high signal level is therefore required to operate the valve as a rectifier. If a low value of R3 is used, then less of the anode voltage appears across it, and thus less bias is applied to the grid of the valve. Hence a signal of smaller amplitude than before will be able to overcome the bias and cause rectification to take place. The lower the value of R3, however, the lower is the level of modulation which the stage can accept without distortion.

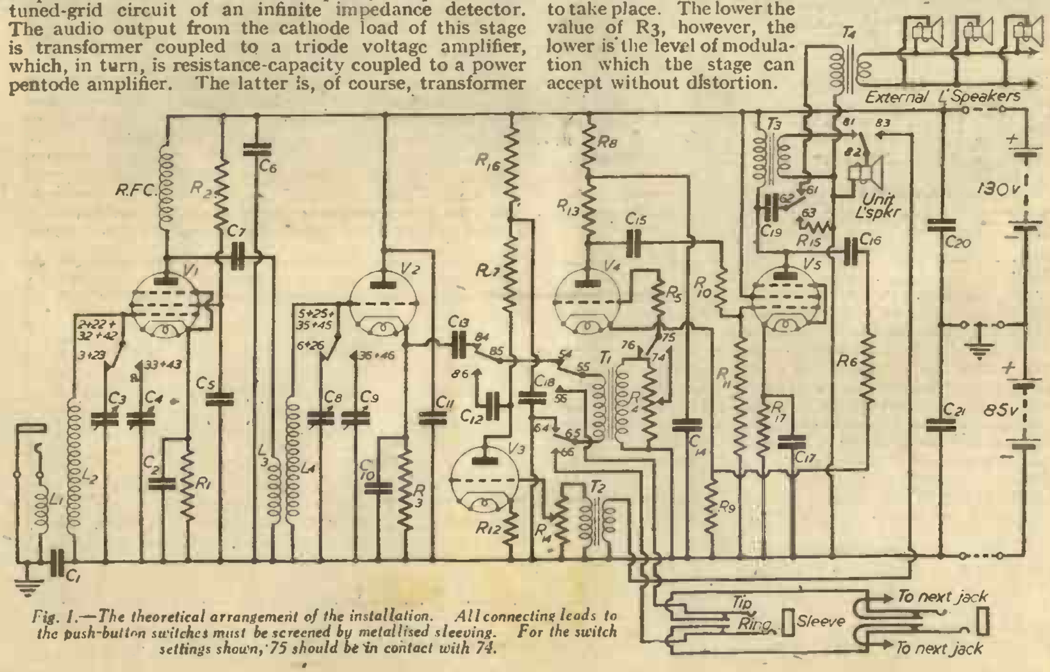


Fig. 1.—The theoretical arrangement of the installation. All connecting leads to the push-button switches must be screened by metallised sleeving. For the switch settings shown, 75 should be in contact with 74.

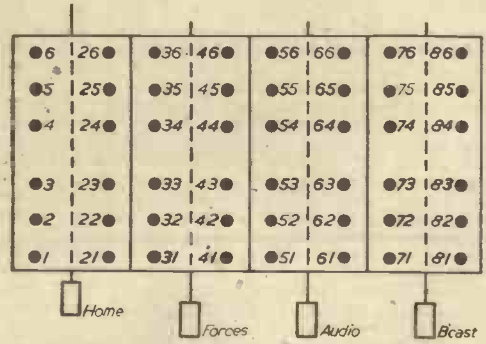


Fig. 2.—The connections on the push-button switch unit. The numbers correspond with those shown on Fig. 1.

The modulation voltages appearing across R3 are coupled to the following stage by C13. Radio frequencies are by-passed across R3 by C10.

As the design was only concerned with reception of local stations, and a stage of RF amplification was in use, a comparatively high value of R3 was chosen (75,000 ohms), with an RF by-pass condenser of .0003 mfd. The highest value of this shunt reactance occurs at the lowest frequency encountered (corresponding to the Home Service wavelength of 449.5 metres). This value is approximately 835 ohms. It will thus be seen that C10 has a very small reactance compared with R3. If C10 is made much less than the given value, its by-passing effect to RF will not be sufficient, and if larger, it will attenuate the higher modulation frequencies.

As the anode of the valve merely acts as a collector for the electrons, it is kept at earth potential with respect to RF and AF by the large condenser C11.

1st Audio Stage

Audio signals are coupled to the input transformer T1 by C13, and across the secondary is the gain control potentiometer R4. The stage is a conventional audio-voltage amplifier, with anode decoupling R8 and C14, and a grid stopper R5.

There is no cathode resistor bypass condenser, as the out-of-phase feedback voltage is introduced to the stage at this point.

Power Amplifier

Coupling to the power amplifier is via C15, grid stopper R10, and grid leak R11. Negative voltage feedback is used on the two audio stages, via the feedback path C16, R6, and R9. V5 is a Mazda Pen 3520, but a beampower valve could be used with advantage. As the use of voltage feedback reduces the load impedance of the stage, the loudspeakers were connected in parallel, and when the external loudspeakers were disconnected, there was no noticeable change in the volume level at the unit. The latter is a midget 3in. diameter unit, and handles high volume levels adequately, while also showing fine performance as a microphone.

Microphone Amplifier

When the third button is operated, the moving-coil of the unit loudspeaker is connected to the primary of a 1 : 60 turns ratio transformer in the grid circuit of the triode (HL1320) pre-amplifier, and the gain of this stage is preset by the potentiometer R14. As the stage gives considerably more gain than can be usefully employed, the cathode by-pass condenser has been omitted both in the interests of economy and quality of reproduction. Decoupling is incorporated in this stage also, at R16 and C18, and coupling to V4 is via condenser C12.

Switching Arrangements

The push-button unit is of the usual type, each button consisting of *four separate single pole change-over contacts*, and the operation of one button releases the previously operated button. The connection plate of the button unit may be represented as in Fig. 2. As there were spare contacts on the " B.B.C. " buttons, two change-over contacts were joined in parallel on each button, as shown in Fig. 2, to make a more reliable contact—an essential consideration at radio frequencies.

The numbering against the change-over switches in Fig. 1 corresponds to the numbering in Fig. 2, therefore by comparing the two diagrams, the circuit connections when any given button is operated may be seen. All contacts in Fig. 2 are shown in the non-operated condition with the exception of those associated with the " B.B.C. Home Service " button, which is operated.

Button 4, as mentioned before, brings the input of the audio amplifier out to a series of jacks in the original

COMPONENT VALUES

C1	.01 mfd.	C7	100 mmfd. (mica)	C12	.01 mfd.	C17	50 mfd. 25v.
C2	.01 mfd.	C8	500 mmfd.	C13	.01 mfd.	C18	2 mfd.
C3	500 mmfd.	C9	350 mmfd.	C14	2 mfd.	C19	2 mfd.
C4	350 mmfd.	C10	300 mmfd.	C15	.01 mfd.	C20	4 mfd.
C5	.01 mfd.	C11	.25 mfd.	C16	1 mfd.	C21	4 mfd.
C6	.01 mfd.						
R1	200 ohms.	R6	10,000 ohms.	R11	.25 megohm	R15	Equivalent external L.S. load.
R2	10,000 ohms.	R7	50,000 ohms.	R12	600 ohms.		
R3	75,000 ohms.	R8	10,000 ohms.	R13	50,000 ohms.		
R4	.25 megohm (Pot.)	R9	600 ohms.	R14	.24 megohm (preset)	R16	10,000 ohms.
R5	10,000 ohms.	R10	10,000 ohms.			R17	250 ohms.

RFC Normal broadcast RF choke. L1, L3, 50 mH. L2, L4, 200 mH.
T1 1-3 Ferranti. T2 1-60 Mic. Xfmr. T3, T4, To suit loudspeaker loads.

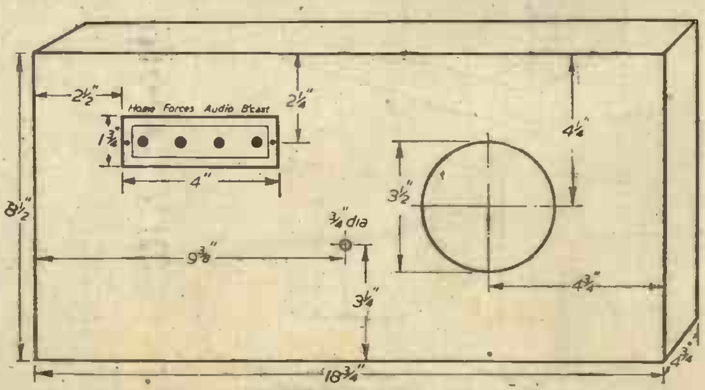


Fig. 3.—The dimensions and panel layout of the cabinet used by the writer.

installation, where the controller has to monitor various audio circuits. This need may not be necessary in other installations, but it may be used to connect a gramophone pick-up to the loudspeaker system; in this case, the contacts disconnecting the external loudspeakers should be omitted.

Miscellaneous Details

The metal chassis of the unit is at earth potential, while the negative side of the H.T. supply is at 85 v. negative with respect to earth. The total H.T. voltage is (130 v. + 85 v.) = 215 v. The heaters of the valves have a total series voltage drop of 87 v. As the 85 v. supply is regulated to within ± 2 v., it may be placed directly across the series connected heaters of the five valves without the need for a barretter or dropping resistance.

With respect to the wiring, all leads to the button unit *must be run in separate earthed screened sheathing*, as high level and low level audio- and radio-frequency circuits are brought into close proximity at this point, and *oscillation* is liable to take place if these precautions *are not taken*. The two leads from C3 and C4 to the button unit should be run together in one screen, and those from C8 and C9 should be treated similarly. All the screens should be bonded to each other at a point as near as possible to the button unit, and the frame of the unit should itself be earthed, as then each section of the switch is screened from its neighbour.

The whole unit is enclosed in a metal cabinet 18½in. × 8½in. × 4¼in., and is attached to the wall (see Fig. 3), power feeds and audio lines being led into it through conduit. In the original unit, service was required continuously, and, therefore, no heater switch was fitted. If only intermittent service is required, a heater switch could be ganged with the gain control on the unit.

When the preset tuning condensers are being adjusted, the operation must be carried out with the chassis in its final position inside the metal cabinet, otherwise capacity due to the cabinet will throw the RF circuits out of tune.

A signal generator should not be used to adjust the aerial circuits; they should be adjusted with the actual aerial to be used with the unit, as a certain amount of capacity is reflected from the aerial into the tuned circuit and any other than the final conditions would reflect a different capacity, with consequent mistuning.

Simple Contrast Expansion Systems

To Obtain High Fidelity Reproduction Some Form of Contrast Expansion is Necessary

By S. O. MAWS

THE range of sound volume of an orchestra, or the difference in volume between the loudest (fortissimo) and the softest (pianissimo) passages is about 70 decibels, and in order to obtain lifelike reproduction of music it is necessary to preserve the full value of this "dynamic range" as it is called. Unfortunately, it is not possible to broadcast the full dynamic range of the orchestra, or record it on discs, because if the loudest passage is adjusted to load the broadcasting or recording amplifier to a satisfactory degree, the weak passages will be drowned by amplifier hiss, etc. Alternatively, if the weak passages are given a good signal-to-noise ratio, then the loud passages will seriously overload the amplifier. Therefore, in order to preserve good quality and a good signal-to-noise ratio, broadcasting authorities and recording companies have to resort to volume compression, and the dynamic range is reduced from its normal value of 70 decibels to something between 12 and 20 decibels, a very serious reduction. There are two reasons why this great amount of volume compression is not obvious to us when listening to orchestral broadcasts or recordings. Firstly, the human ear is a very accommodating organ and permits us to imagine quite large changes in volume even when they are not actually present. As an illustration of this point, there is a well-known experiment in which people are asked to set a volume control knob until the output volume of a loudspeaker is the same as a level they have previously heard. They are frequently as much as 10 decibels out! The second reason why the reduced dynamic range is not obvious—and the importance of this point can hardly be over emphasised—is that we are used to listening to music without it! Once one has listened to reproduced music in which the full dynamic range has been included it is very difficult indeed to go back to the condensed versions normally heard. It is the purpose of this short article to describe two simple units for improving the contrast in mains-driven broadcast receivers or amplifiers. They do not apply, however, to battery-driven apparatus owing to the small output power of such sets.

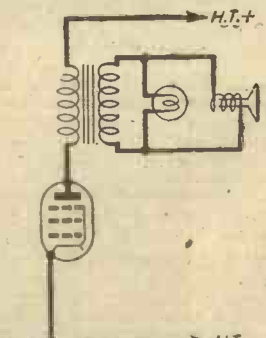


Fig. 1.—The most simple form.

The first method is extremely simple indeed: it simply consists of connecting an ordinary torch bulb across the speech coil of the loudspeaker as shown in Fig. 1. In most commercial receivers this can be done by connecting the bulb holder to the external loudspeaker sockets as shown in Fig. 2. Normally, a 2.5 volt bulb will be suitable, but in order that the correct voltage may be obtained for all types of sets, it may be said that the bulb should light brilliantly on loud passages of music and should not light at all on soft passages. Readers should thus choose a bulb which will do this when the receiver is giving normal volume. If a bulb with too low a volume rating is used, then it will burn out on loud passages; if the bulb has too high a voltage rating, then the full improvement in contrast will not be obtained until the set's volume is much higher than

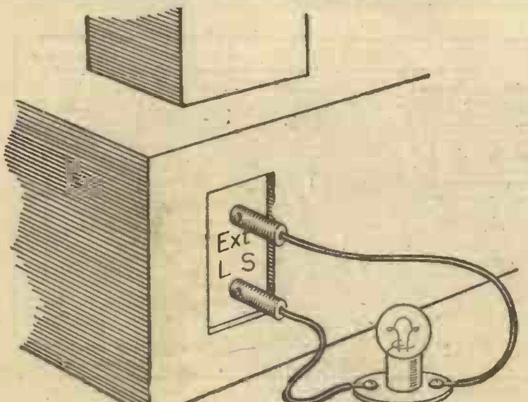


Fig. 2.—Practical application of Fig. 1.

usual. Of course some loss in volume is inevitable when the bulb is connected up, for a 2.5 volt torch bulb takes 1 watt of power to light it brilliantly, but as most mains sets give 4 watts output this can easily be spared. The improvement in contrast given by this simple device is usually about 12 decibels with a 2.5-volt bulb and a speech coil of 5 impedance. This is a very noticeable amount and is well worth while. When used on reproduction of gramophone records it will be found that the chief improvement will be a great reduction of needle hiss. The bulb reduces the volume during the quiet passages in which the needle hiss is most apparent and increases the volume in the loud passages in which the needle hiss is not apparent anyhow. Generally speaking, the inclusion of contrast expansion does not greatly improve reproduction of dance music in which the volume usually remains fairly constant so that there is little contrast to be improved. The circuit should not therefore be used on such programmes or records. It can conveniently be switched off by removing one of the plugs or unscrewing the bulb slightly. Some readers may like to include a switch on the set by means of which the bulb circuit may be broken when desired.

If more contrast expansion is wanted than can be given by this single-bulb arrangement it is possible to use two bulbs in a bridge circuit, as shown in Fig. 3. This type of contrast expander employs two similar bulbs and two identical resistances R, arranged as shown. With this circuit it is possible to obtain almost any degree of expansion desired by correct choice of bulbs and by using resistances of the correct value, but it should be noted that this bridge circuit can only be used when the amplifier or receiver to which it is connected has adequate output power. The circuit is rather wasteful of power, since it contains two bulbs and two resistances instead of one bulb as before, and it is recommended, for best results, that the receiver or amplifier to which it is connected should have an undistorted output of at least six watts. The amplifier should preferably contain a push-pull output as suggested in Fig. 3. Practically the circuit may be built up as a unit on a small piece of wood carrying four soldering tags, as shown in Fig. 4. When completed this can then be mounted inside the cabinet of the receiver close to the loudspeaker. It will be necessary, of course, to disconnect the wires which normally connect the secondary winding of the output transformer to the speech coil of the loudspeaker and to insert the contrast expansion unit, as indicated in Fig. 4. For a 5 ohm. speech

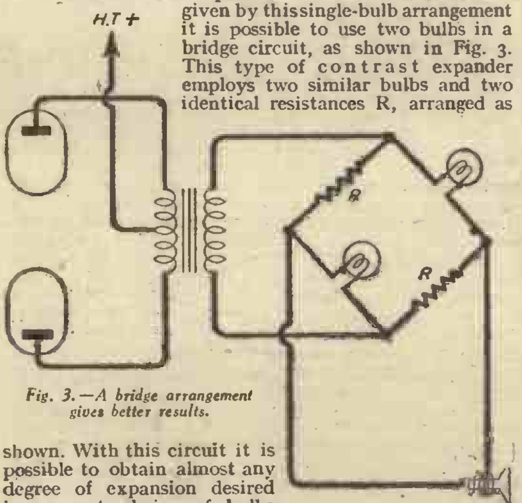


Fig. 3.—A bridge arrangement gives better results.

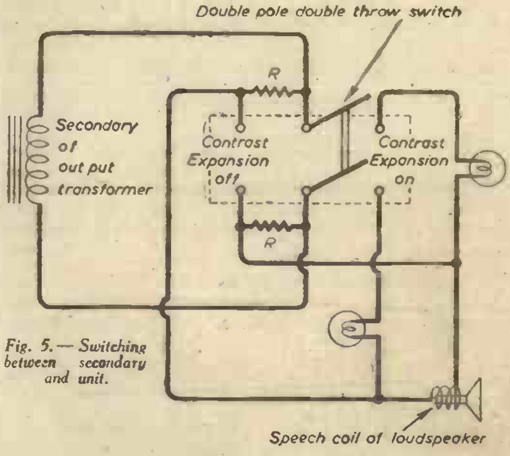


Fig. 5.—Switching between secondary and unit.

coil it will be convenient to use two bulbs with a rating of 6 volts and .3 amps each, and the resistances should be about 1.5 ohms each. These values will give about 20 decibels improvement in expansion, far more than is possible using a simple bulb. A very convenient way of constructing these is as indicated in Fig. 4. 14in. of gauge 28 Eureka wire gives a resistance of 1.5 ohms, and this can be wound in a small rectangular piece of cardboard as shown, the ends passing through small holes in the card and being then soldered to the tags. Some readers will, no doubt, desire a switching arrangement by means of which the contrast expansion unit can be switched off when not required. For the benefit of these, Fig. 5 is included, which shows how a double-pole double-throw switch may be used for this purpose.

This bridge circuit is a particularly convenient one, for, by altering the value of the resistances R it is possible to obtain almost any degree of expansion. If two very low resistance potentiometers are available it would be a very good thing to gang them together and to calibrate the control knob to decibels expansion. Readers who intend trying this, however, are warned that the maximum value of R should never exceed one-tenth of $\frac{E}{I}$ when E equals the voltage and I the current ratings of the bulbs, or else volume compression will result instead of volume expansion!

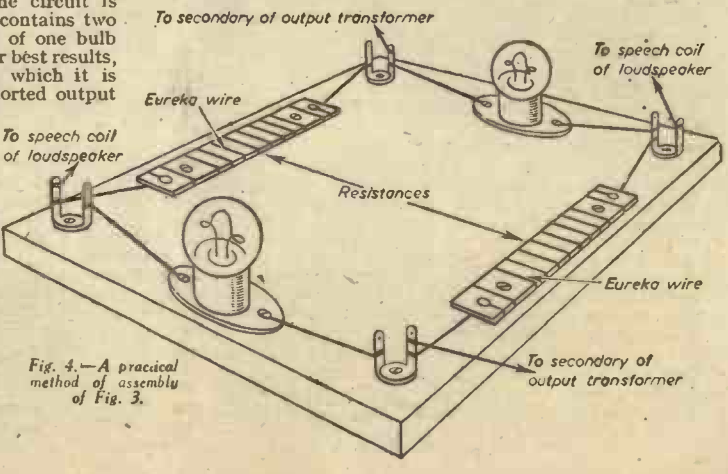


Fig. 4.—A practical method of assembly of Fig. 3.

A Moving-coil Microphone

Constructional Details of a Sensitive Instrument

By G. M. JONES

ONE of the most useful microphones for amateur use is the moving-coil. It is capable of a much better frequency range than the transverse-current type, and does not suffer from the two main disadvantages of the latter, namely, background hiss

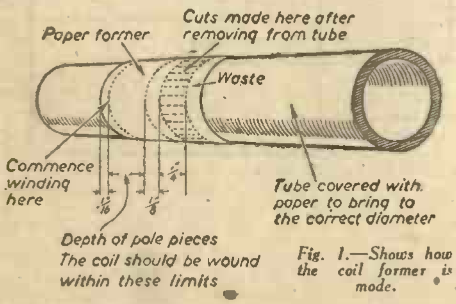


Fig. 1.—Shows how the coil former is made.

and blasting, and it does not require a polarising current.

The first requirement is a suitable magnet assembly. This may be taken from an old moving-coil speaker and the smaller it is, the better, provided that it is fairly powerful. The speaker must be one having a centring "spider" outside the speech-coil, unless, of course,

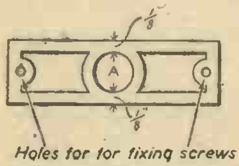


Fig. 2.—The "spider."

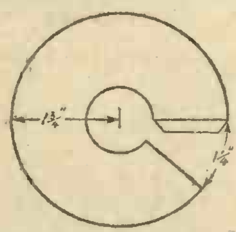


Fig. 3.—Dimensions of cone and method of cutting.

there are suitable holes drilled in the magnet on either side of the gap for holding the new spider.

The Coil

The speech-coil of the speaker will not be suitable for the microphone owing to its weight, therefore a new one must be wound. With a pair of outside calipers, the diameter of the gap should be ascertained and a short piece of tubing, as near as possible to, but not more than this diameter, should be found on which to hold the paper former, if necessary, winding a strip of gummed paper on the tube to bring it up to the diameter required.

Gummed paper of the kind used for protecting windows is handy for making the coil former, as it is thin and fairly stiff. A piece should be wrapped once round the tube with the minimum of overlap required to hold it. It will be necessary to have a greater clearance on the outside of the former than on the inside when it is placed in the gap, in order to allow for the space taken up by the coil which is to be wound on it, and a little experimenting may have to be done before a former is made which is judged to be the exact size.

The depth of the pole pieces must then be measured to find the correct width for the coil, and the former should be marked out as shown in Fig. 1. The wire used by the writer for winding the coil was S.W.G. 42 S.S.C. It should be wound by holding the tube on a rod fixed in a vice and slowly rotating it. The former must be coated first with some form of adhesive; shellac dissolved in methylated spirits is suitable. Great care is necessary to ensure that the turns lie evenly against each other. When the first layer has been completed, it should be coated with the shellac solution and a second one wound back over it, and when the shellac has set the former may be slid off the tube.

Making the Cone

Cartridge paper is suitable for making the cone and "spider," the latter being cut as shown in Fig. 2, and in order to give it stiffness, dipped in the shellac solution and allowed to dry. The diameter of the centre hole A will depend upon that of the speech-coil, but it should just slip over the end of the latter. The measurements of the cone are given in Fig. 3, the centre hole being the same size as that in the "spider."

To assemble the coil, "spider," and cone, the cuts in the former shown in Fig. 1 should be made, and first the "spider" then the cone placed over the end of the coil former. The ends of this can then be cemented to the cone and the "spider" cemented in the position indicated in Fig. 4. The leads from the coil may be brought out along the "spider" and cemented to it. After being centred in the gap of the magnet, the coil should move freely, when the cone is blown upon. It is helpful to have the microphone connected up whilst centring, the quality of speech indicating when the correct setting has been obtained.

The dimensions of a case for the microphone will, of course, depend on those of the magnet used. The latter should be fixed to the back of the case so that the

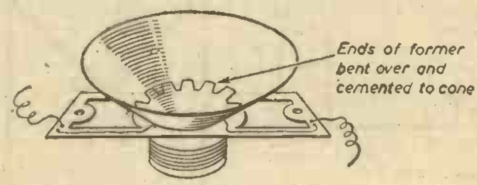


Fig. 4.—The "spider" and s/coil former fitted to cone.

whole instrument will slide out of the case when the back is unscrewed. A number of holes should be drilled round the case behind the cone as shown in Fig. 5, and cotton wool packed round the magnet, care being taken that it does not touch the cone.

Amplification Required

The microphone should be used with a 60 : 1 transformer and to give a good loudspeaker output, three R.C. coupled stages are recommended, although two stages transformer coupled may be found sufficient if a pentode output valve is used.

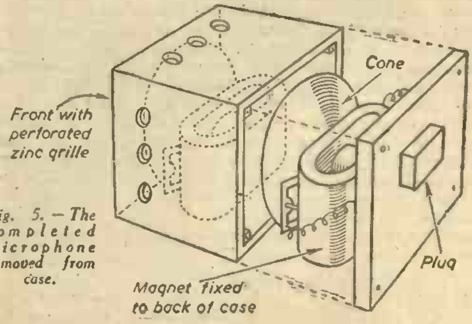


Fig. 5.—The completed microphone removed from case.

A Turntable Speed Tester

A Novel Device Which Operates on the Stroboscope Principle

By P. W. BAKER

THE writer recently had occasion to doubt the accuracy of his pick-up turntable speed tester which, on investigation, proved to be inaccurate. Rather than be reduced to checking the speed of the turntable by means of counting the revolutions against a stopwatch, a little thought evolved an arrangement whereby the exact speed of 78 r.p.m. could be checked in a moment by the mere turning of a switch. The device works on the stroboscope principle, and all that is visible to the eye is a small luminous area on a ground-glass screen, which remains either in or out if the turntable motor is on exact speed. Should the motor be running either fast or slow then the light slowly appears and disappears at a rate depending on the amount the motor is running out of speed.

The sectional elevation shown on this page should give the reader sufficient detail to enable him to form a good idea of the construction. The illustration is purposely left undimensioned, since each particular installation will vary in detailed measurements according to the variations in design of the baseboard and the existing fittings thereon. Nevertheless, the main dimensions should be somewhat similar in each case. Apart from one or two rather fine clearances, therefore (i.e., at " a " and " b " as shown in the illustration), the reader may vary the design accordingly.

In its essentials the arrangement consists of a small commercial type neon lamp such as is sold at any well-stocked electrical store, as a pilot light for electric ovens, etc. A small holder should be obtained for the lamp at the time of purchase. Also necessary are an electric switch, a few pieces of mirror and ground glass, some putty or plastic material, a sheet of not-too-thick cardboard and a vulcanite screw top from a glass bottle.

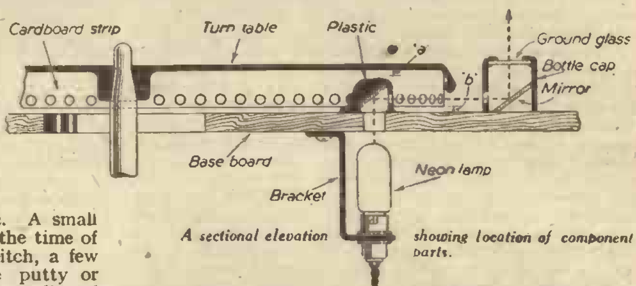
Construction

The neon lamp is first secured by means of a bracket to the underside of the baseboard. The lamp should be situated somewhere between the turntable spindle and the outer edge of the turntable as shown. The lamp is wired in series with the electric switch which is to control it, the source of current being taken from the leads which supply the turntable motor. The neon lamp provides a source of orange light flickering in and out at a rate of 50 times per second due to the 50 cycle alternating current. It should be noted that an ordinary wire filament lamp cannot be used, as it provides an almost constant source of illumination which is unsuitable for a stroboscopic effect.

The light from the neon lamp is directed vertically upwards through a hole in the baseboard and is reflected radially outwards underneath the turntable by a small mirror situated above the hole by means of the putty substance and set at an angle of 45 degrees to the horizontal. The horizontal beam of light, after leaving the mirror, is interrupted at the edge of the turntable by a rim of cardboard secured by adhesive to the underside of the turntable and running round the inner periphery of the heavy beading at the edge of the table. The cardboard rim is sufficiently deep to intercept the beam of light but *not deep enough* to rub against the automatic stopping mechanism if such is fitted. A careful adjustment will be necessary as the clearances involved are rather small but a little experiment will achieve the desired condition.

Making the Light Interrupter

A strip of cardboard should be cut slightly longer than the circumference of the table and, as a rough guide, about ½in. to ¾in. deep. When the strip is fitted and gummed in position, the two ends should overlap about ⅛in. Before fitting, the cardboard strip should be punched with 78 equally spaced holes, and here again some care will be necessary to ensure the right number of holes in their correct positions, since the working principle of the device depends upon the precise number and spacing of the holes. The writer found it best to determine the length of cardboard strip necessary then, by means of trial and error with a pair of fine dividers, to split up this length into 78 equal parts. When the exact setting of the dividers has been obtained the distance can be again stepped-off, but this time making a slight puncture with the points of the dividers at each place where a hole is to be punched. Each hole should be about ⅛in. in diameter, and an ordinary paper punch of the pliers type will be found to make a suitably sized hole. The height of the pitch-circle line of the holes above the lower edge of the cardboard strip should be such that the beam of light is either interrupted



A sectional elevation showing location of component parts.

by the blank spaces between the holes or is allowed to pass through the holes as the table rotates. If now, when the lamp is switched on and the turntable is rotating at something like the correct speed, the eye is placed radially in line with the beam of light coming from the mirror (the head will obviously have to be placed level with the turntable to do this) then the light from the lamp will be seen to wink slowly in and out. A touch of the finger on the speed regulator will achieve the effect of making the light remain in or out (either condition representing the exact turntable speed of 78 r.p.m.) due to the number of holes and the alternations of the neon lamp at mains frequency.

The Reflecting Device

Since it is obviously undesirable to lower the head to the turntable each time the speed is checked, a further mirror is provided to reflect the horizontal beam upwards on to a small ground-glass screen which, being non-directional, can be viewed from any angle with ease. To accommodate this second mirror and the ground glass screen, and to provide a presentable additional fitting to the top of the baseboard, the vulcanite screw cap of a bottle was found suitable. Two holes are bored in the cap in the positions shown in the illustration, i.e., one horizontally in the side and one vertically in the top. A small disc of ground glass slightly less in diameter than the interior diameter of the cap was cut to shape with a glass cutter and secured to the inside of the bottle cap with adhesive. The second mirror, cut to a suitable size, was also secured in position as shown. The whole is fixed about an inch away from the edge of the turntable and in line with the beam of light which, passing through the hole in the side of the bottle cap, is reflected upwards by the second mirror and becomes visible on the ground-glass screen.

U.S.W. Reception

A General Explanation of Two Systems of Detection, Together With Details of Practical Circuit Arrangements

DESPITE the almost universal adoption of superheterodyne circuits for all the more sensitive types of broadcast receiver, the simple detector L.F. arrangement still has many valuable applications. The most important of these is for ultra-short-wave receivers. In designing a receiver for operation on frequencies above about 30 mc/s—and even more especially in dealing with frequencies in the region of 300 mc/s—simplicity of construction is often the keynote of success. Normal superhet operation is complicated and "tricky," and probably out of the question for the average amateur.

The single-valve set, with well-controlled reaction, will often give the results desired; due to the small number of components required, and the simple nature of the wiring, it is not difficult to ensure that there shall be a minimum of unwanted capacity between different parts of the circuit. The ordinary triode detector with Reinartz-type reaction operates perfectly well down to around 15 metres (20 mc/s), but is not quite so reliable on lower wavelengths. When we come down to wavelengths of one metre or thereabouts, this type of circuit is scarcely worthy of serious consideration. Reaction is not easily obtained; if it is, the control is by no means smooth over even a narrow frequency range. It is then that the super-regenerative circuit becomes extremely valuable.

It is not suggested that there is any sharp dividing line between the frequencies at which the ordinary oscillating or reacting detector is suitable and those on which a super-regenerative circuit is essential for satisfactory reception, but it can generally be taken that for wavelengths of less than 10 metres (30 mc/s) the super-regenerative circuit is to be preferred. On wavelengths of 5 metres or less the regenerative detector is of little use unless special valves and components are available.

The Future of U.S.W.

Of course, there is very little of interest being transmitted on ultra-short-waves at the present time, but it seems reasonable to suppose that this part of the frequency spectrum will come into prominence after the war. If history is to repeat itself, amateurs will be pressed lower down the wavelength range when their transmitting licences are renewed. In consequence, this is perhaps an appropriate time to collect some information about ultra-short-wave (or V.H.F., meaning very high-frequency) work. It is very interesting, and great strides have been made with it since September, 1939, but little publicity has been given to the progress made, since much of it has been of a secret nature. It is, however, an open secret that even micro-waves (the name generally accepted as applying to those shorter than one metre) have been successfully employed.

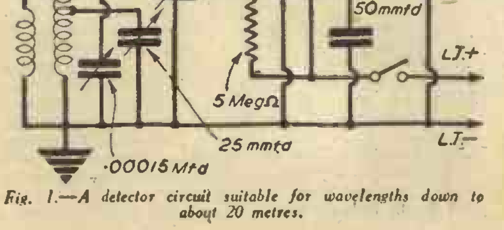


Fig. 1.—A detector circuit suitable for wavelengths down to about 20 metres.

A 20-metre Receiver

We can start our examination of the subject by considering an ordinary regenerative detector, suitable for use on wavelengths down to around 15 metres. A circuit is shown in Fig. 1, and it will be seen at once that this differs very little in general characteristics from the circuit used for broadcast reception in the simplest types of receiver. Component values are somewhat different, and a certain amount of useful experimental work can be applied to the construction of a coil. The number of turns required for the grid winding is clearly fixed by the wavelength to which the coil is to tune, but the number of turns on the reaction and aerial coupling windings, as well as the distance between the windings, makes a vast difference to the smoothness of reaction control.

A coil for 20 metres can well be made on a ribbed ceramic former of 1½in. in diameter by placing a grid coil consisting of seven turns of 18-gauge enamelled or bare copper wire in the centre of the former. The aerial winding can be started ½in. above the grid winding and may consist of four turns of 26-gauge enamelled wire, whilst a reaction winding of five turns of similar wire may be started the same distance below the grid winding. The turns of the grid winding should be spaced by the diameter of the wire, but those for the other two windings should be side by side. If it is available, silver-plated copper wire is better for the grid winding, since this does not readily oxidise, and has a lower H.F. resistance than has plain copper wire.

Bandspread Tuning

The aerial is connected to the aerial winding through a 25 m.mfd. variable condenser. This gives a good control of aerial coupling in a far more convenient manner than by making the aerial winding movable in relation to the grid winding. The condenser need not have a slow-motion drive, and its capacity need not be varied over any particular wavelength band. Bandspread tuning is provided, and a .0001-mfd. variable condenser is for band selection, while a 25 m.mfd. condenser is used for fine tuning. In some instances it is found that it is better to connect the fine-tuning condenser across only a portion of the grid winding; it will then give a smaller variation in wavelength, but the tuning will be "finer." That is, the condenser can be turned through a wider arc to produce a given frequency change. This method of connection is especially useful when a really high-class slow-motion tuning drive is not available. Hand-capacity effects are also slightly reduced due to the condenser being connected between the earth end of the coil and another point of comparatively low H.F. potential.

A .00015 mfd. condenser is used for reaction control, and there is a 50 m.mfd. by-pass condenser between the anode and earth. The H.F. choke is included in the telephone leads and helps to prevent "head-capacity" effect. When the detector is followed by an L.F. amplifier a 100,000 ohm stopper should be used in its grid circuit. In addition, it is sometimes wise to use an H.F. choke (S.W. type) between the anode of the L.F. valve and the phones.

Any high-impedance triode is suitable for use in a detector circuit of the type described, whilst a pentode or tetrode is sometimes even better, especially if a "silent" 100,000 ohm potentiometer is used to apply the screen potential; this control also provides a vernier reaction control. When working on wavelengths down to about 10 metres, it is worth while to employ a midget valve, which has low inter-electrode capacity, or to remove the base from an ordinary valve and make connection directly to the leading-out wires.

A Super-regenerative Detector

For wavelengths below 10 metres the super-regenerative circuit is excellent, and one suitable for frequencies up to about 120 mc/s is given in Fig. 2. Before describing this circuit it might be a good plan to make sure that we have a clear idea of the difference between regenerative and super-regenerative circuits. In the former type, the detector valve is operated just below the point of oscillation, except when receiving C.W., in which case it must oscillate in order to produce a beat note with the desired signal. We know that the sensitivity of a detector is greater when oscillation takes place, since in that condition the H.F. resistance of the tuned circuit is cancelled out by the negative resistance introduced by the application of reaction.

But, of course, intelligible telephony cannot be received when the detector is oscillating; that is why the regenerative detector is normally operated just below the oscillation point. In the super-regenerative receiver the detector is allowed to oscillate at the frequency on which reception is required. And then, in order to make telephony intelligible, a means is provided of stopping and starting the oscillation at a frequency above that of audibility. This is often done by applying to the valve a strong oscillation at supersonic frequency. Each time the grid of the valve is swung sufficiently negative by this supersonic oscillation, the valve ceases to oscillate at signal frequency.

Self-quenching Oscillators

The supersonic oscillation can be provided by a separate valve coupled to the grid circuit of the detector. But it is possible to cause the oscillating detector itself to start and cease to oscillate. This process is known as "quenching," and when the valve is self-controlled it is described as a self-quenching oscillator. In the circuit shown in Fig. 2 the oscillatory circuit comprised by L1 and C1 is connected between the grid and anode in a standard Hartley arrangement. The grid condenser is of low value, and the grid leak has a resistance of 5 megohms or thereabouts. High-tension current is applied to the oscillator anode through the short-wave H.F. choke which is in series with the tuning coil. There is also a by-pass condenser, marked C2, between H.T.+ and earth.

When the set is switched on the valve commences to oscillate. The amplitude of oscillation rapidly rises, and the charge on the grid of the valve becomes increasingly negative. Eventually, a point is reached at which the negative bias is so high that anode-current cut-off occurs; even if this ultimate point is not reached, anode current is reduced to such an extent that the valve ceases to oscillate. But the grid leak then comes into action, allowing the negative charge on the grid to leak away. Although several seconds are taken up in describing this process, it takes place in practice at a rate of several thousand cycles per second. The actual frequency of the charging and discharging process is governed by the value of the grid leak and the capacity of C2.

The action described is known as "squegging," and an oscillator acting on this principle is described as a "squegging oscillator," the name being practically synonymous with the name "self-quenching oscillator" previously given.

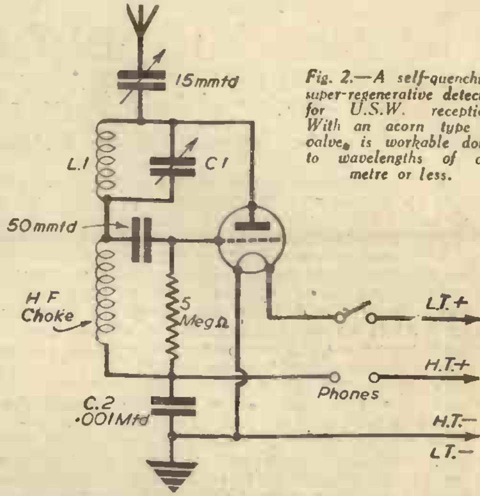


Fig. 2.—A self-quenching super-regenerative detector for U.S.W. reception. With an acorn type of valve, is workable down to wavelengths of one metre or less.

Practical Details

For a frequency range of about 110 to 120 mc/s, the coil L1 should consist of five turns of 14-gauge copper or silver-plated wire of ¼in. diameter, the turns being slightly spaced so that the length and diameter of the winding are equal. For tuning, C1 should have a maximum capacity of between 3 and 5 m.mfd. If a midget variable condenser of such low capacity is not available it would be necessary to remove some of the vanes from a larger condenser, or to wire a low-capacity fixed condenser, with air dielectric, in series with the variable one. In any case, a good slow-motion drive is required.

A suitable ultra-short-wave H.F. choke can be made by winding 20 turns of 24-gauge enamelled wire side-by-side on a glass or ceramic rod ¼in. in diameter. This small diameter is specified because it is necessary that there shall be a minimum of inductive coupling between the choke and the coil or other components. A small variable condenser is shown in series with the aerial lead, but this may well be a pre-set having a maximum capacity between 10 and 15 m.mfd. It is used simply to adjust the aerial coupling to ensure reliable oscillation over the waveband covered.

Preliminary Adjustment

In setting up a receiver of this type, it will be found that if it is squegging properly there will be a marked "hiss" in the phones. With the aerial disconnected, it should be ascertained that the "hiss" is equally loud over the full range of the tuning condenser. If not, the value of the grid leak, or of the condenser C2, should be varied; it should also be made sure that C2 is properly earthed to the chassis and to H.T.—

When the set appears to be operating properly, the aerial can be connected and the aerial series condenser adjusted until the "hiss" is audible over the full tuning range. It is worthy of note that when a signal is tuned in the background noise will undergo a reduction in volume proportional to the strength of the incoming signal. It is also of interest that a fair measure of A.V.C. is provided due to the action of the self-quenching oscillator.

In making up a receiver of this type, it is obviously essential that all leads should be kept as short as possible, particularly those to the coil, and in the grid and anode circuits. For this reason, the ends of the tuning coil should be soldered directly to the terminals of the tuning condenser, while the aerial series condenser should be placed as near as possible to the coil. All earth connections must be well bonded, for which reason it is best to employ a small metal chassis. It is also desirable that the receiver should be enclosed in a metal container, this being well earthed and bonded to the chassis.

Heaviside Layer or Ionosphere?

The Behaviour of Radio Waves in the Ionised Regions of the Atmosphere

By CAMPBELL BEGG, M.Sc.

IF asked: "What makes wireless waves curve round the earth and be picked up with apparent ease in America?" I rather fancy that few PRACTICAL WIRELESS readers would hesitate. I think, too, that very few of the answers would fail to blame the Heaviside Layer for the phenomenon. Prepare then at once for disappointment. In short-wave communication to America from England our old friend the Heaviside Layer hinders rather than aids the transmission of the waves! Perhaps it is a fine point, but is it not time we got the picture clear and up to date?

Let's start at the beginning. Around 1900 everybody —or nearly everybody—knew that wireless waves travelled out in straight lines like light; the visible horizon was therefore the obvious limit to their useful range. After that the earth curved away and the wireless waves carried on on their straight path into space. Marconi, however, remained silent and quietly prepared for a test with America. This test took place in 1901 and was successful. Straight lines or no straight lines, America received his signals and scientists started thinking. Soon A. E. Kennelly, in U.S.A., and Oliver Heaviside, in England, independently suggested that the result would be explained by a conducting layer in the outer atmosphere which would reflect the radio waves back to earth—hence the Kennelly-Heaviside Layer, or more often the Heaviside Layer.

Very soon experiment showed the explanation to be true, but all was not quite as simple as that. Methods were devised for measuring the height at which the waves were reflected; the chief of which consisted of sending short, sharp pulses of waves vertically into the sky and noting on a cathode ray oscilloscope the time delay between sending the pulse and receiving its echo from the sky. The heights thus obtained were many and various, ranging from about 80 to 250 kilometres. This "layer" looked as if it was going to take some unravelling! The frequency used affected the result. Sometimes the layer would appear to jump up to a great height, then quickly come back and settle for a while at a new level. The time of day made a difference so did the season. Even the latitude and the particular year in which the measurements were made seemed to influence the height.

Over recent years results taken on different frequencies at all times of the day and night, in all seasons, and at different places on earth, have been continually co-related, and so the broad structure of the "Ionosphere" (as it is now called) has gradually been worked out.

Let us now see what picture all this investigation has given us of the reflecting region, how the radio waves behave when they enter it, and the great influence this knowledge has on practical long-distance communication by radio.

Ionised Region

The molecules and atoms of the gases that go to make up our air are normally electrically neutral, that is, each molecule or atom contains an equal number of positive and negative charges of electricity. In the upper atmosphere, however, there seems to be a force (or forces) at work which keeps pulling electrons out of the atoms, thus leaving them with an excess of positive charges. The atom split up like this is said to be "ionised," the two bits being called "ions"; the force that splits them up is called the "ionising agent." In any gas the atoms and molecules are in continual motion, so these ions, in rushing about, are in constant collision, and when the oppositely charged ions collide they combine again into the neutral atom. We picture, then, a region in the upper air where the atoms are constantly being split up into ions under the influence of some ionising agent, and constantly recombining due to collisions. Thus the region consists of the main part of the atoms which are the heavy positively charged ions, and hosts of free, very light, negatively charged electrons.

What happens to the radio waves on entering this ionised region? Well, the radio wave can be considered as simply a rapidly alternating electric field. This field will naturally set the electrons vibrating with it, just as the electric field between the plate and filament of a valve sets the electrons moving in the direction of the field—towards the plate in this case. The field of the radio wave will also exert its influence on the heavy positive ions, but these are so much heavier, and have so much inertia, that they cannot follow the rapidly varying field. Now, an electron vibrating up and down in the sky is just like an electron moving up and down in an aerial wire near the earth—it is a little transmitter radiating on its own. Even the electron, although extremely light, has sufficient inertia to make its vibrations lag behind the pulsing of the field, with the result that its wireless waves, reacting on the incident wave, cause the direction of propagation of the original wave to be altered. If the wave enters the ionised region nearly vertically it is bent away from the vertical by an amount that depends upon the number of electrons influencing the wave. If the wave enters a dense layer of free electrons it will be bent a lot.

Low-frequency Waves

If the frequency of the radio wave is low, the electrons have time to reach a large amplitude in their vibrations, and, in consequence, have a greater effect in altering the path of the wave, i.e., *low frequency waves are bent more than high frequency waves.*

Another thing: The electrons in their vibrating often collide with some of the heavy ions, atoms, or molecules around them, and so give up their energy to them. As this energy originally came from the radio wave, the wave is weakened—"attenuated" is the usual term. Obviously if the path of the electron in its vibration is a long one there is more likelihood of collision; so from what we have just said, *the low frequency waves will be attenuated more than the high frequency waves.* Also the number of collisions will obviously depend upon the density of the air in which the electron is vibrating. This is greatest near the earth's surface, so *most of the attenuation will take place at the low edge of the ionised region.*

There is still another effect, due to the earth's magnetic field. In the same way that a wire carrying a current in a magnetic field is pulled in a direction at right angles to the direction of the field (as in an electric motor), the moving electron is deflected by the earth's magnetic field, so that instead of vibrating in a straight line, its path becomes an ellipse. The amount of deflection may be sufficient to make the path a circle instead of a straight line; in fact, there are some frequencies where the strength of the magnetic field and the mass and velocity of the electron are such that the electron, instead of vibrating along the same line or round the same ellipse or circle, actually goes into a widening spiral with ever-increasing velocity. With such a path as this its chances of collision are large, and the energy given up is large, so that the energy in the radio wave becomes almost entirely absorbed. This "gyro frequency," as it is called, occurs at about 1,300 kc/s (i.e., about 230 metres), which is at the high frequency end of the medium-wave band.

(To be continued)

Cathode-ray Tubes—4

Ageing. Testing. Time Bases. Procedure.

By LAURENCE ARTHUR

(Continued from page 161, March issue)

ON the large rotary pumps dealing with 64 small tubes simultaneously, there is one oil pump for each pair of tubes. Fixed gas or electric ovens bake them for the necessary time and heater current is switched on and off automatically. The getter firing and the sealing-off are done by hand.

Bases

There has been very little standardisation of the bases fitted to cathode-ray tubes. There are types having 7, 8, 9, 10 and 12 pins, some short and solid, some long and springy: others with 12 springy side contacts and still others with 6 spring clips. The material of the base is usually a black phenolic resin compound which is non-hygroscopic, homogeneous and which has a high surface resistivity. There are other bases made from brown paxolin on which shellac varnish is baked. The pins or contacts are of brass, nickel plated, and to ensure that the tube is inserted in the holder correctly, the pins are spaced like valve pins, or the base is fitted with a locating key on a central projecting spigot, or there is a square key on the side, or the base has a bayonet fitting. Fig. 25 shows some types of bases in common use to-day, and as the holders or sockets vary with each type they are included in the drawings. Despite the various styles the dimensions of all the bases in use in this country are strictly defined by British Association Standards Specifications.

Bases are held on with a cement not likely to loosen or crumble on exposure to a moist or warm atmosphere. There are two varieties—one mainly made from shellac and the other in the form of a bakelite paste. A small amount of the cement is applied to the inside rim of the base which is slipped on the neck of the bulb and firmly pressed down. It is very essential that the locating device shall bear a definite relative position to the assembly. A tolerance of 10 deg. is permissible but the base must be on straight. The cement must now be baked and for this purpose the smaller cathode-ray tubes are fitted on to a rotary machine which passes the base through an electrically heated oven, the period of rotation being calculated to ensure that baking is complete. The larger tubes are baked in individual stationary electric ovens. The shellac cement is still somewhat soft after baking, setting hard when cold, but the bakelite variety is baked hard. If the base is one fitted with hollow pins it is necessary, prior to slipping it into position, to thread the copper connecting wires through the pins. Where there are a large number of wires—as is generally the case with cathode-ray tubes—this is a job requiring considerable care because damage may be done if the tube is put into use with electrodes connected to wrong pins. It is usual to cover the wires in the foot with short lengths of systoflex, sometimes colour coded, or lengths of thin glass tubing.

Soldering Connections

From baking the tubes go to the soldering benches. Wires through hollow pins are cut off short and then soldered in a shallow electrically heated soldering pot which deals with all the pins simultaneously, flux having been applied previously with a pad. Bases having solid pins or side contacts have the wires soldered to projecting lugs. After soldering some bases have a thin disc either sprung in or screwed on to protect the vulnerable tip of the seal-off and to keep away dust or other foreign matter. The tube is now roughly cleaned and checked for overall length. The length is rather important because most cathode-ray tubes are used in specific equipment with only the screen end visible externally. If the tube were too long it would not fit and if it were too short there would be difficulty in clearly observing the phenomena being investigated.

In the manufacture of cathode-ray tubes the chemical laboratory, with its associated physical laboratory, plays a very important part. Each batch of raw materials must be analysed to see that it comes up to the standard of purity required. The production laboratory is responsible for the preparation of coatings for heaters and cathodes, screen powders and mixtures, wall coatings and the cement for fixing bases to bulbs. Some of the preparation is very prolonged as it is necessary to grind or mill the constituent parts for 24 hours in order to achieve the requisite fineness.

The process of ageing or thermal activation is of considerable importance as on its success depends the effective life of the cathode ray tube and the stability of its characteristics during life. As previously described, the cathode is coated with a compound of barium and strontium, which are broken down into oxides when the heater is raised to a high temperature in the exhausted bulb. These oxides either do not emit electrons or have only poor initial activity and it is necessary to reduce them to metallic barium and strontium. This is done by heating the heater with a voltage of 50 per cent. higher than the normal for the tube and applying between the cathode and grid a supply in the region of 15 volts, the positive side to grid. The emission, measured on a milliammeter, is very low at first, but the activation proceeds as the temperature of the heater is increased and as ageing nears completion the temperature can be progressively lowered without reducing the emission. The time taken is usually half an hour, although the schedule of time and voltages is carefully worked out for each type of tube by trial and error methods until the desired degree of stabilised emission is reached. At this stage it is usual to "burn off" the cathode ray tube and this is done by applying a lead from one side of a Tesla high-frequency coil (the other

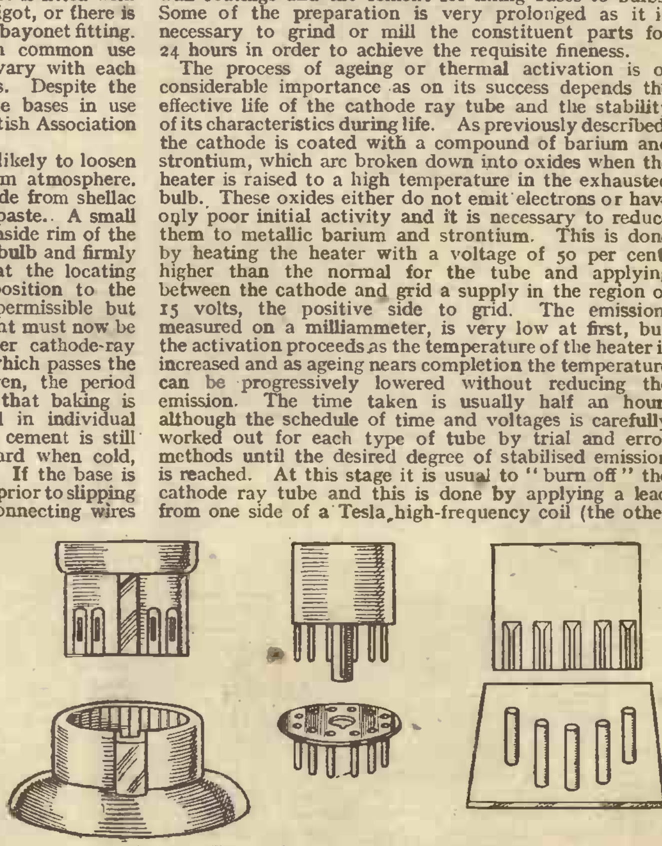


Fig. 25.—Types of base generally used for C.R. tubes.

side being earthed) to each connection on the base. The discharge inside the bulb has the effect of burning off any high resistance leaks across micas or between foot wires, caused by the deposit of metallic vapours from the getters during volatilisation.

Testing

The tube is now completely made and ready for testing. The first check is on the resistance between electrodes when cold. With a D.C. voltage of 250 there must be a minimum resistance of 150 megohms between any two electrodes. The next test, which is only applied to a percentage of the tubes made, is for inter-electrode capacities. The capacities measured are those between individual deflector plates and all other electrodes; grid or modulator and all other electrodes; and between pairs of deflector plates with all other electrodes strapped to earth. The capacities, which are measured in micro-microfarads, or picafarads, are checked against a standard condenser in a bridge circuit, the instrument most frequently used being the Sullivan Capacity Bridge. A separate oscillator driven from the mains passes a 1,600 cycle note through the bridge and a pair of headphones is used to indicate the null point where the capacity of the standard condenser is equal to that being measured. The value of the inter-electrode capacity is read directly from the dial of the standard. Representative capacities are 1 to 3 m.mfds between pairs of deflector plates 10 to 15 m.mfds between separate deflector plates and all the other electrodes; 12 to 20 m.mfds. between grid and all the other electrodes.

Each type of cathode ray tube has its rating, that is the list of voltages and currents at which it is designed to run. Owing to manufacturing difficulties it is not possible to make every tube exactly similar in all respects, so a test specification is worked out which allows for tolerances in permissible values. As a general rule the rating is midway between the two values quoted in the specification and the percentage tolerance varies according to the work which the tube is required to do. There are several types of test board, but all usually have high quality individual meters for indicating heater volts, heater current, grid volts, preliminary accelerating anode volts, final accelerating anode volts, focusing anode volts, deflector plate shift volts, beam current, cathode-heater current and a sensitive meter for measuring photo-electric light cell voltage, the purpose of which will be described later.

(To be continued)

Secondary Batteries—8

Rotary Converters, Mercury Arc, Metal Rectifiers.

By G. A. T. BURDETT, A.M.I.I.A.

(Continued from page 158, March issue.)

HAVING discussed the constant potential method of charging batteries, it is now proposed to deal as fully as possible with the chief methods by which batteries may be charged.

D.C. Mains

The simplest method of charging is where a D.C. supply is available. With the increasing adoption of A.C. supplies by electricity supply authorities, D.C. systems are gradually disappearing, and it seems fairly obvious that they will eventually cease to exist. As the outbreak of the present war retarded the scrapping of existing D.C. supplies, and as they will continue to serve for some years to come, every consideration should be given to the utilisation of this method of charging. It was pointed out in a previous article that charging from D.C. mains may be carried out with a minimum of outlay for plant by the use of lamps, radiators, or ordinary wire resistances. The chief objection to the adoption of such simple charging plants is that the total supply voltage, viz., 200 volts, must be utilised and the operating costs are high unless the maximum possible number of batteries and cells are connected in series and charged simultaneously. In the previous article, examples were given to show that the energy consumed in charging one 2.0 volt cell at 2 amps. is identical to the cost of charging 20 similar cells simultaneously when they are connected in series on the same circuit.

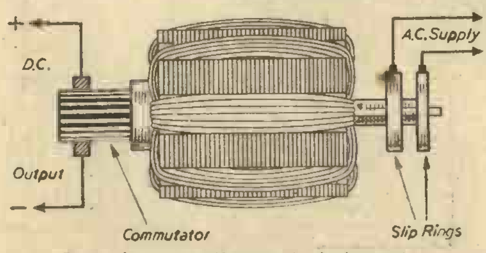


Fig. 1.—Simple diagram to illustrate the fundamental arrangement of a rotary converter.

Assuming it is required to charge on a 200 volt D.C. supply one 6 volt 40 amp-hour (actual capacity) battery at the 10 hour rate. The charging current will therefore be 4 amps. To obtain the current on a lamp resistance board, eight 32 candle power carbon filament lamps are required. Assuming the battery is fully charged after a period of 12 hours.

Energy consumed = Volts × Amps. × Time in hours = 200 × 4 × 12 = 9,600 watt hours = 9.6 KW. or B.O.T. units.

Price of electricity, say = 4d. per B.O.T. unit. Cost to charge battery = 9.6 × 4d. = 3s. 2½d.

For the same cost 24 6-volt batteries of the same capacity could be charged simultaneously where connected in series. The cost of energy would then be approximately three-halfpence per battery, or a halfpenny per cell.

In practice it is not usually possible to charge simultaneously 24 such batteries except in the larger stations. In order to enable a charging station of this type to be run in an economic manner some modification is necessary. As it is not possible to reduce the pressure of D.C. current by static means, e.g., transformer, a "rotary converter" must be employed. It was pointed out earlier in this series that the wire wound ohmic resistance is wasteful since it only "absorbs" the unwanted "pressure," which is dissipated in the form of heat.

Motor Generator. Rotary Converters

This comprises two machines. One a D.C. electric motor which operates at mains voltage, viz., 200 volts in the case in question. The other is a D.C. generator supplying D.C. current at the desired pressure. The voltage of the generator component will be as required by the purchaser, though 36 volts may be termed a very adaptable pressure and is used almost universally. The D.C. generator employed does not differ from that of the usual petrol sets which are universally employed where no power supply is available. Motor generators have the advantage, however, of requiring very little attention as compared with the petrol sets, while the output is steady since the pressure of the supply does not vary as with petrol sets. Rarely does the amount of business dealt with by the usual charging station warrant the installation of a large motor generator set. Instead a rotary converter is more suitable. This comprises a single machine having two commutators; one at each end of the machine. Actually the machine consists of two generators in one, since the armature has two windings—a high voltage winding and a low voltage one. The supply at mains pressure is fed in at one end via one commutator and excites the high voltage winding, thus giving it the characteristics of a D.C. motor. When operating, the low voltage armature winding cuts the magnetic field thus created, in the manner of a single shunt generator, and delivers a current at the low voltage commutator and therefore at the terminals via the brushes. The capital outlay in

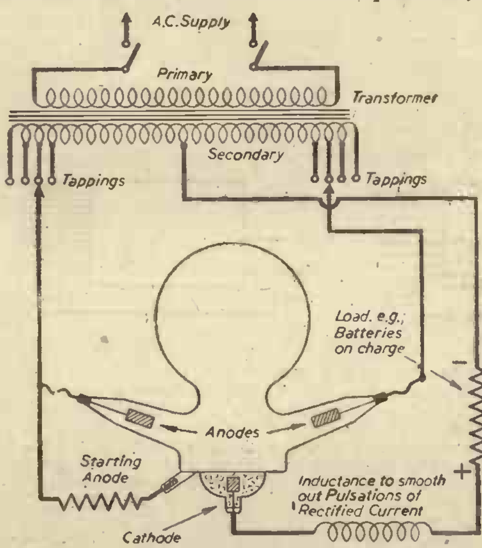


Fig. 2.—The basic circuit of a mercury vapour rectifier which provides a uni-directional current.

respect of a motor generator, and more particularly a rotary converter, is well justified and pays for itself in a very short period in view of the saving in running cost.

Charging from A.C. Supplies

It is not, of course, possible to charge batteries direct

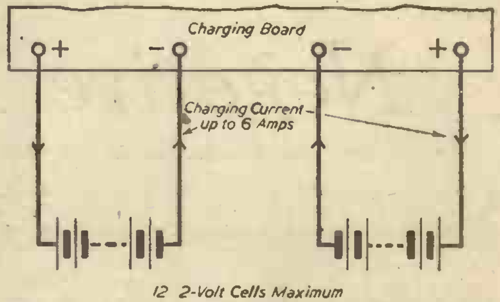


Fig. 3.—Two independent output circuits using two mercury rectifiers.

from alternating current, it being necessary first to rectify it to D.C.

The motor generator may be employed and is similar to that described above except that the motor unit is an A.C. machine. Alternatively, a rotary converter may be employed, the initial cost of which is lower than the motor generator. This machine has only one armature winding, one end being connected to slip rings through which the A.C. supply is fed, the other end being connected to a commutator which "delivers" the D.C. current. Fig. 1 gives a simple illustration of the method employed, it being borne in mind that all generators in the first instance generate alternating current, while D.C. machines are provided with commutators which act as automatic "rectifiers." That is, they reverse the current each half cycle, giving in fact full wave rectification.

The static type of rectifier is largely replacing the motor generator and rotary converter types, particularly for small charging stations. There are two main types of static rectifier—(1) The mercury vapour, and (2) The metal rectifier.

Mercury Vapour Rectifier

Fig. 2. An illustration of the fundamental mercury vapour method of rectification is shown in Fig. 2. These sets are, in effect, self-contained charging plants. The mercury vapour valve comprises the rectifier portion, while the necessary switches, fuses and ammeters are housed on the panel.

Since the current obtained from these sets is not continuous, but only *uni-directional*, they are not suitable for use on more than one charging circuit, with each circuit being controlled by separate variable resistances. Where more than one circuit is required, additional valves are incorporated in the apparatus, each having an independent resistance. Figs. 3 and 4 show how three alternative methods may be used for connecting batteries to a set using two mercury vapour valves (75 volts 12 amps. output). Two entirely independent circuits are shown in Fig. 3, each providing a charging current up to 6 amps, at 75 volts.

(*To be continued.*)

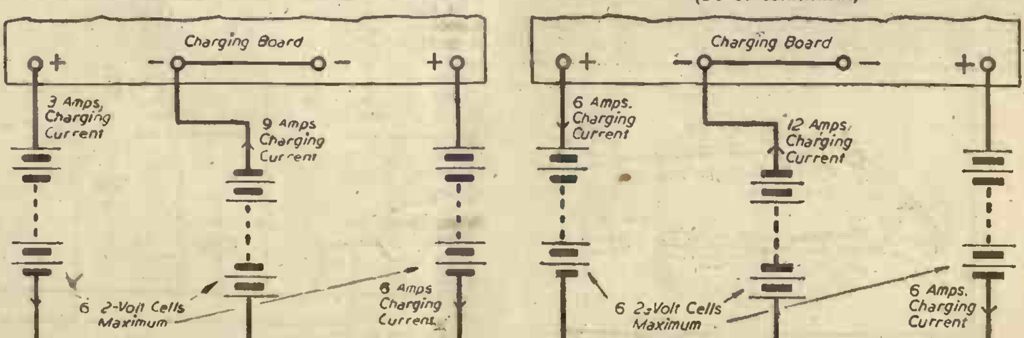


Fig. 4.—Two arrangements for providing three output circuits from two rectifiers.

Negative Feed-back

An Introduction to This Interesting Subject. By C. HEYS

AN amplifier is said to be of high fidelity when the output is a perfect reproduction of the input, or when there is very little or no distortion appearing in the output. This is not easy to obtain in a straight amplifier, due to distortion appearing at the output, which may be caused by harmonics introduced into the amplifier by fluctuating supply voltage, valve characteristics, or unequal amplification at certain audio frequencies. The fidelity of an amplifier can be improved if a small proportion of the output is fed back into the input so as to be in opposition to it. This is known as degeneration, commonly termed negative feedback.

Analogy of Feedback

Consider the simple block diagram of Fig. 1 (A). If the input to the amplifier can be represented by three lines and the output by 12, then the gain of the amplifier must be four. If a small amount—say one line—is fed back from the output to oppose the input as in Fig. 1 (B), the effective input to the amplifier now becomes two lines, thus with an amplifier gain of four the output is eight lines of which seven is the useful output.

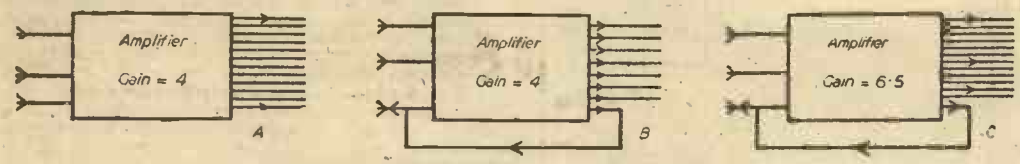


Fig. 1.—A simple block diagram to show the effect on gain.

The overall gain of the stage with feedback now becomes: input three lines, output seven lines, therefore the overall stage gain is two and a half as compared to four before the presence of feedback.

Should we require the output to be 12 lines as it was in the first case, the gain of the amplifier will have to be increased to six and a half, as the total output is 12 plus one which is fed back making a total output of 13; as the effective input is two, the gain of the amplifier will have to be six and a half. This is shown by Fig. 1 (C). The total stage gain being four as in the very first case, as the total input is three lines and effective output 12.

The above is a simple explanation of feedback principle, and we can see that if the amplifier gain is not increased when feedback is applied, then there will be a decrease in output. On the other hand, if we wish to have the same output with feedback as we had without feedback, then the gain of the amplifier must be increased. It is in most cases easier to construct an amplifier with a high gain which has a high percentage of distortion and improve it by feedback than it is to build a straight amplifier with the same overall gain and a low percentage distortion. The amplifier with feedback will certainly be more free from distortion and have a more linear output, the loss in gain is not important considering the advantages in fidelity and stability of the amplifier. Typical graphs of what may be expected of stage gain $= \frac{\text{Output Voltage (V)}}{\text{Input Voltage (v)}}$ plotted against frequency is shown in Fig. 2.

The conditions stated previously can be proved as follows. Consider the diagram of Fig. 3, showing a feedback circuit. Feedback being obtained by returning the A.C. component of the output valve through all or part of the first valve's cathode bias resistor. The block diagram is represented by Fig. 4.

Let:

m = Gain of the amplifier.

v = Input to the stage.

V = Output of the amplifier.

$-BV$ = Amount fed back to be in opposition to input.

The input to the amplifier when feedback is applied now becomes $v - BV$

The output of the amplifier with feedback will be the product of the input and the gain of the amplifier.

$\therefore V = m(v - BV) = mv - mBV$ or $V(1 + mB) = mv$.

$$\therefore \frac{V}{v} = \frac{m}{1 + mB} = \frac{1}{1/m + B}$$

As V/v is the overall stage gain of the amplifier the gain with feedback is equal to $1/1/m + B$

If, in the above equation, the gain m of the amplifier is large, then $1/m$ tends to be very small or approach zero; we can say that the overall gain V/v is proportional to $1/B$; that is, if 1/50th of the output is fed back the gain is equal to $1/1/50 = 50$. In other words, the gain becomes

(Continued on page 195).

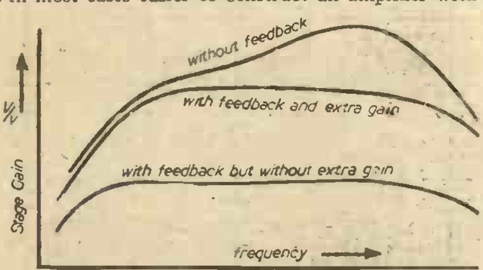


Fig. 2.—Typical curves showing what may be expected if stag gain is plotted against frequency under the conditions shown.

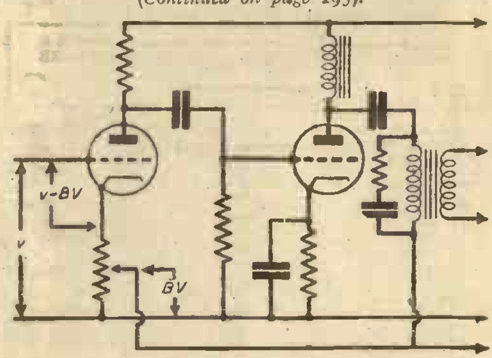


Fig. 3.—The theoretical form of a circuit employing negative feed-back.

equal to the inverse of the amount fed back. There is one stipulation to the latter statement, and that is for the gain to be equal to the inverse of the feedback, the product of $m\text{B}$ must be large compared with unity.

Consider an amplifier first without feedback and then with feedback applied. Suppose we have a 5mV signal and wish to amplify it to 500mV, the gain without feedback will have to be 100.

To provide the same output from the same input with feedback, we shall have to increase the gain of the amplifier; the gain is dependent on B, and assuming we feed back .008 of the output, i.e., $\text{B} = .008$, we have:

The overall gain has to equal $100 = \frac{m}{1 + m\text{B}}$

or $100(1 + m\text{B}) = m$

or $m(1 - 100\text{B}) = 100$

$\therefore m = \frac{100}{1 - 100\text{B}} = \frac{100}{1 - 100 \times .008} = 500.$

Therefore to obtain the same output with .008 feedback the amplifier gain will have to be increased from 100 to 500. The increase in amplification necessary to provide the same output as we had without feedback is the main disadvantage, but in most cases sufficiently outweighs the advantages.

We can prove the above by substituting the figures in the block diagrams of Fig. 5.

The main advantage of a feedback amplifier is the reduction in the percentage distortion. Consider the previous amplifier without feedback, if due to com-

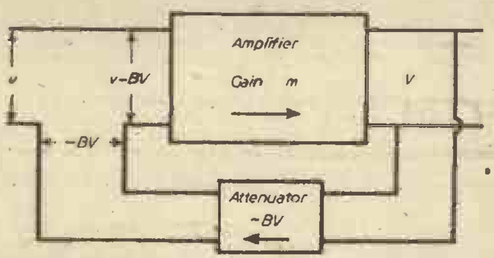
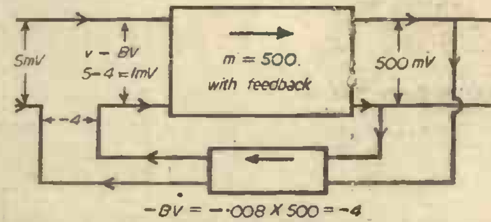


Fig. 4.—The block diagram of the circuit shown by Fig. 3.

ponent characteristics, etc., the output increase to 600mV then we have present a $\frac{600 - 500}{500} \times \frac{100}{1} = 20$ per cent. distortion. When feedback is applied a portion of this distortion is fed back to the input to be re-amplified so as to appear to cancel out some of the original distortion.



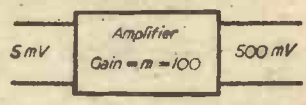


Fig. 5 (Above).—Amplifier incorporating feed-back. (Right) a straight amplifier.

Let:

d = amount of distortion appearing at the output without feedback.

D = amount of distortion appearing at the output when feedback is applied.

$-\text{B}D$ = amount of distortion fed back.

m = gain of amplifier when distortion is present.

The actual amount of distortion now appearing at the output will be d minus the amplified amount BD,

or $D = d - m\text{B}D$

$\therefore D = \frac{d}{1 + m\text{B}}$

In this case d = 20 per cent., $\text{B} = .008$ and $m = 600$ and not 500, as the input to feedback amplifier is 1mV, due to distortion 600mV appears at the output, therefore the gain of amplifier will be 600 when this distortion appears.

Therefore the percentage distortion when feedback is applied will be:

$$D = \frac{d}{1 + m\text{B}} = \frac{20}{1 + 600 \times .008}$$

$$= \frac{20}{5.8} = 3.4 \text{ per cent.}$$

or we can say the distortion is reduced by the amount $1/1 + \text{B}m$.

OBITUARY

J. M. G. Rees, A.M.I.E.E.

WE regret to record the death of Mr. J. M. G. Rees, A.M.I.E.E., on February 6th, after a short but severe illness. He was a director of Oliver Pell Control, Ltd., and also of Tok Switches, Ltd., and Varley Dry Accumulators, Ltd. (associated companies of Oliver Pell Control, Ltd.). He was widely known in the radio and electrical industry. Mr. Rees joined Oliver Pell shortly after the last war when they were largely engaged in the manufacture of arc lamps and switch gear remotely controlled by the ripple system, together with general coil winding. He was subsequently largely responsible for the successful development of the name of Varley and other products. All those who came in contact with Mr. Rees, as did every member of the staff of this journal, will feel his loss.

Mr. H. Boon

MR. H. BOON, Publicity Manager of the Chloride and Electrical Storage Co., Ltd., manufacturers of the well-known Exide and Drydex batteries, recently died after a short illness. He was well known in the radio and automobile industries, and did a great amount of work for charity. His passing will be regretted by all of his wide circle of friends in those industries.

Col. Ozanne

WE record with regret also the passing of Col. Ozanne, for so many years associated with the Radio Manufacturers' Association, and the Radio Components Federation. A director of the firm manufacturing Polar Condensers, and many associated companies, Col. Ozanne was well known throughout the radio industry.

PRIZE PROBLEMS

Problem No. 454.

JONES built himself a fine three-valve S.W. receiver, taking particular care with its construction, but when the time came to test it he found that the reaction control was not as smooth as he thought it should be. The reaction condenser was connected between the earth end of the reaction coil and earth, and Jones thought it might be better if he removed the condenser and connected it between the detector anode and reaction coil. After completing all connections, he switched on and found he could not obtain any results. What had he overlooked?

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. 454 in the top left-hand corner and must be posted to reach this office not later than the first post on Monday, March 13th, 1944.

Solution to Problem No. 453.

Matthews failed to take the elementary precaution of testing the D.C. mains for polarity. If he had reversed the mains plug all would have been well.

The three following readers successfully solved Problem No. 452 and books have accordingly been forwarded to them: Cpl. Byrne, Gosberton, Spalding; N. Morris, Delverne, Leek Road, Norton-le-Moors, Staffs; B. Robinson, 193, St. Margaret's Road, Ward End, Birmingham.

Practical Hints

Insulated Connecting Clip Condensers

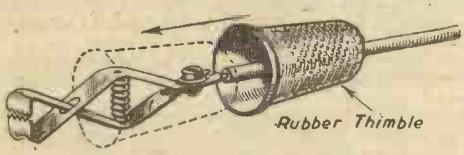
I USE a large number of bulldog clips of the type shown in the sketch for my oddl eads required for hook-ups and testing, etc., but sometimes I used to forget that I was holding the bare metal and put them across the power supply, with startling results. Fortunately, very little damage resulted to me or the apparatus, but it was a sharp reminder.

I prefer these clips for their strength and rigidity, so I obtained some rubber thimbles (commonly known as "bankers' friends") from the local stationers, and made a hole in the top, forcing the wire through. When the wire is connected to the clip and the rubber thimble slid completely over the clip, this forms a very effective protection against shocks, as it covers the metal and allows full use to be made of them.

I have not used anything else for the past five years, and they have stood up to really hard wear. The hole in the end of the thimble must not be made too large or the rubber will tear and the metal end of the clip project through, thus defeating the purpose of the rubber thimble.

As all my sets have been A.C. operated, I have often found that a little extra smoothing was necessary, and to test this I wanted another condenser in circuit. Accordingly, I mounted three condensers underneath the panel of my test meter and connected them to four sockets on the panel. When required, I connect the condenser selected to the set with a pair of leads without having to disturb any of the wiring. If extra smoothing is required and hum present in some part of the circuit, it is easily traced with these extra condensers. I use 0.1 mfd., 1.0 mfd. and 4.0 mfd., 500 vdc. paper, but these are only what I had in stock at the time. If electrolytics are used for the higher capacities, polarity should, of course, be strictly observed. It is also wise practice to short the condensers used on completion of a test to save any possibility of a shock.

These condensers have been in constant use for the past six years, so I cannot complain of their quality.—R. T. BOWLER (Uxbridge).



A simple dodge for insulating connecting clips.

THAT DODGE OF YOURS!

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

SPECIAL NOTICE

All hints must be accompanied by the coupon cut from page iii of cover.

A Vertical Dial

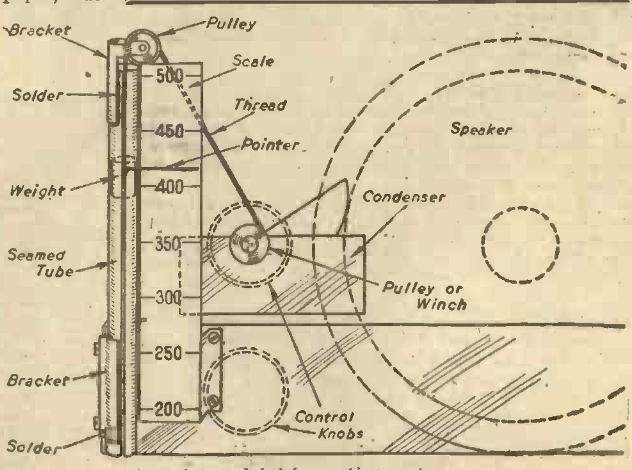
THE accompanying sketch shows a drawing of a vertical dial for use with midget type receivers.

As the speaker very often determines the size of a midget receiver, and very frequently makes the use of a tuning dial impossible, I made up a vertical dial as shown, which requires very little space. The seamed tube is a 4¾in. length of curtain rod with the brass covering stripped off. The seam was then opened a little with a knife blade to allow the thin metal of the pointer to slide freely up and down. The pointer was sweated into a saw-cut in the weight and bent at a suitable angle to bear on the scale. The weight is a piece of brass rod which easily slides in the tube with only a little side wobble. Attached to the weight is the thread or fine cord which rides in a pulley mounted in the bracket at the top of the tube, the thread being fixed to the pulley or winch which is fixed to the condenser knob spindle. The size of this pulley is governed by the speed of the knob in relation to the speed of the moving vanes. In my case I was using an epicyclic drive as advertised in PRACTICAL WIRELESS and the size of pulley was ½in. diameter.

The dial is made from a cocoa tin and painted a matt-white. The calibration was printed in Indian ink, using known station wavelengths as a guide.—T. O. PICK (Nth. Berwick).

Combination Volume Control

WHEN an efficient aerial-earth system is used, it is often found that the normal grid bias volume control on the variable-mu valve does not prove entirely satisfactory. It is possible, however, to connect a potentiometer in such a manner that it controls both the aerial input voltage and the bias voltage of the H.F. valve. This type of control is easily applicable to the mains type of valve and should be connected in the following manner. Using a potentiometer having a value of between 3,000 and 5,000 ohms, one end terminal should be connected to the aerial terminal, the other end terminal to the earth end of the cathode bias resistance of the H.F. valve, and the centre terminal to earth terminal. A study of the theoretical circuit of this control will indicate that the aerial coil is short-circuited when the H.F. valve bias voltage is at maximum.—R. STUDLEY (Watford).



A novel vertical dial for a midget receiver.

ON YOUR WAVELENGTH

By THERMION

Sympathetic Listening

THE changes announced by the B.B.C. in the Home and Forces programmes, now changed to the Overseas programmes, have given rise to some lively criticisms. The B.B.C. states that it will enable those serving overseas to listen in to programmes at the same time as those of their good folk at home, and thus the programmes will establish a sympathetic link between home and abroad. Now, somewhere within the precincts of that pompous portal the B.B.C. there is a clock which gives International Time, and it should be fairly obvious to the B.B.C. that most people in this country will be listening in when those abroad will be asleep, quite apart from difficulties of reception, and lack of listening opportunities as well as listening apparatus.

These points apart, I quite fail to see why it should be necessary to abolish the Home and Forces programmes and substitute another under another name. Surely those serving overseas also listen to the Home and Forces programmes? Or does the B.B.C. wish to imply that those programmes were not listened to by those serving overseas? It seems to me that the real reason for the change has yet to be announced. I certainly do not accept the explanation at present given. There may be sound reasons for the change, but I think we are entitled to know them. I have listened on a number of occasions to the Home and Forces programmes, and have enjoyed them. There is a suggestion that the B.B.C. is anxious to cut expenses, and to employ cheaper artists. No doubt they will suitably reply to this.

Dismissed Artists

I UNDERSTAND that the B.B.C. has dismissed a number of its resident artists, and particularly those who took part in broadcast plays. I suppose also that there is a good reason for this, although in these days when most artists are either serving Ensa, or touring abroad entertaining the troops, I should have thought that the B.B.C. would have been anxious to retain the services of skilled artists, who, after a number of years, have become thoroughly accustomed to broadcasting technique. Evidently there is a shake-up going on in the B.B.C., and sooner or later, I suppose, we shall know why.

Radio as an Implement of War

THIS is the title of a lecture given to the A.T.C. and members of the Home Guard, Sea Cadets and Civil Defence personnel, by Mr. H. de A. Donisthorpe of The General Electric Co., Ltd., at Newbury, Berks, on Friday, January 21st.

The meeting was presided over by the officer commanding the Newbury branch of the A.T.C.—Major Tempest, D.S.O.—who, it may be remembered, was responsible for bringing down the second Zeppelin at Potter's Bar, in the war of 1914-18.

Wireless direction finding played a prominent part on that occasion, and during the course of his address, Mr. Donisthorpe explained how it was employed to find the positions of the raiding Zeppelins and thus successfully bring about their destruction.

Throughout his address Mr. Donisthorpe made full use of lantern slides as illustrative media, and to still further clarify many points a number of experiments and demonstrations were carried out on the spot.

British Radio Research Institute

THE British Institution of Radio Engineers have formulated a proposal for the formation of a British Radio Institute, and this recommendation having been lodged with the Government and radio manufacturers is available for general information. The institution recommends that the function of the Research Institute be the pursuit of basic research of the type that has hitherto suffered restriction owing to its high cost, absence of obvious or immediate practical applications, or the poor prospect of early financial returns.

Progress reports describing the results of the work of the institute be published at regular intervals and that no restriction be placed upon access to these reports or upon the private, commercial or industrial employment of the information contained therein.

The institute be financed by industrial subscriptions supplemented by a Government grant of at least equal amount.

The work of the institute be directed by an impartial board comprising representatives of Governmental authorities (e.g., G.P.O. and D.S.I.R.), B.B.C. and the Services; the industry; representatives of the Brit.I.R.E. and associated professional institutions, and universities of the Empire.

The research programme be revised periodically by the board, and new subjects added at any time according to demand. In this way, a "subject of research" will become a broad field of continuous investigation, frequently leading to investigation of other problems.

In addition to a permanent qualified scientific staff, arrangements be made through industry and the universities for the assistance and engagement of extra workers.

A WELCOME B.B.C. REFORM

[Press Item.—It is suggested that each week the B.B.C. should include, at the end of its news items, another feature to be known as "Airata," in which would be corrected errors made by speakers over the air during the previous week.]

In future when mistakes are made,
And through the ether we transmit them,
Their authors we will soon correct,
And critics get no chance to twit them.
For we can't endure the rude horse-laugh
When Brains Trust slips and listeners chaff.

So closely listen on the air,
For we announcement soon may make:
"Re statements made in so-and-so;
Will listeners please no notice take.
For though the Brains Trust told you so,
We find, in fact, it did not know."

When we discover where they've erred,
At once we'll rectify mistake.
Not even *we* infallible,
Not even Homer stays awake;
Omnipotence we will abjure—
A fool is wise when less cocksure.

"TORCH."

Our Roll of Merit

Readers on Active Service—Fortieth List.

R. Cheshire (A.C. R.A.F.).
A. J. Stuart (Cpl., R.A.F.).
E. James (Cfn., R.E.M.E.).
S. Wilson (A.C.1., R.A.F.).
J. Honniball (F.O., R.A.F.).
G. G. Woodward (F.O., R.A.F.).
H. Macmillan (L.A.C., R.A.F.).
G. L. Holloway (L.A.C , R.A.F.).

A Universal T

A Handy Receiver, Using Two Dual-purpose

THIS receiver is the result of two years' experimenting to produce a receiver having the smallest dimensions for operation off A.C. or D.C. mains, using standard "bantam" type valves.

The usual tuning condenser was dispensed with by using a two-pole two-way Yaxley switch to select the Home or Forces programme as desired, the station to which the receiver was tuned being shown by a station indicator.

The speaker used is a 3½in. Goodman's P.M. moving-coil. The valves are a triode-pentode and a pentode-diode.

The Circuit Diagram

This is shown in Fig. 1. V1 (12B8GT) is a triode-pentode, and acts as an R.F. amplifier—the pentode section—and an anode head detector—the triode section. V2 (25A7GT), a pentode-diode, acts as the output valve—the pentode section—and a half-wave rectifier

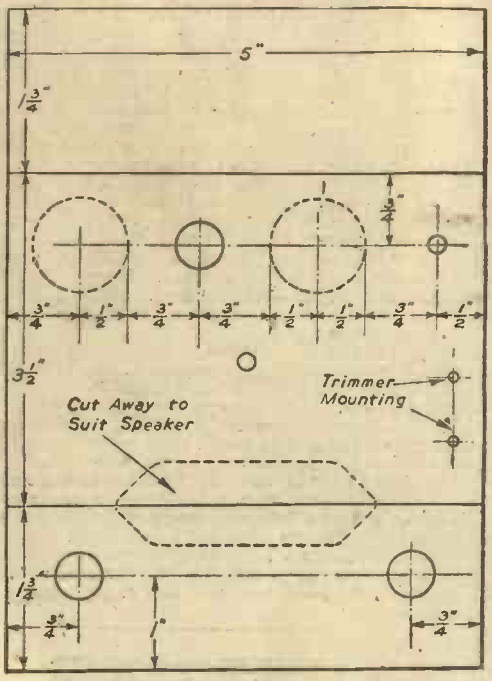


Fig. 2.—Dimensions and drilling plan of the chassis.

on A.C.—the diode section. C1 and C2 are isolating condensers, C1 also increasing the receiver's selectivity.

The coupling and tuning coils are shown by L1 and L2, the latter being tuned to either the "Home" or "Forces" programme by switching in C4 or C5 by means of S1. L3, L4 with C8, C9 and S2 fulfil the same purpose in the pentode section's anode circuit.

The safety bias for the pentode section of V1 is provided by R2, whilst R1—a potentiometer—controls the volume by aerial circuit damping and bias voltage control, and R4 sees to the necessary biasing voltage for anode-bend detection in the triode section of V1. R7 provides the biasing voltage for the output section of V2.

R8, the mains dropping resistance being in series with the valve heaters and indicator lamps, will limit the current to the required value. The indicator lamps may be switched to give station indication—as shown —when an extra bank or set of contacts will be required upon the wave-change switch.

The high tension line to the rectifier anode is taken to a tapping about half-way along the mains dropping resistance, R8, this gives a reduction in mains hum, and is also necessitated by the use of low anode voltage valves.

Construction

The chassis size and hole positions are shown in Fig. 2; the chassis may be of aluminium or steel plate, care should be taken to ensure rigid construction. The intending constructor is strongly advised not to cut and drill the chassis until he has *all* the components in his possession, and can then discover the best layout with the parts available.

Two small brackets to hold the station indicator lampholders were bolted to the speaker in such a position that light from the lamps shone through the Cellophane covered holes in the front of the cabinet. See Figs. 3 and 7.

Switching

The Yaxley switch to give two stations *without* indicator switching must be a two-pole two-way; if switching of indicators is desired, the three-pole two-way type of switch is required. Fig. 4 shows the connections for switching two stations and indicator lamps.

The Tuned Circuits

If the constructor wishes to make his own coils, those described for the "All Mains Midget Three,"

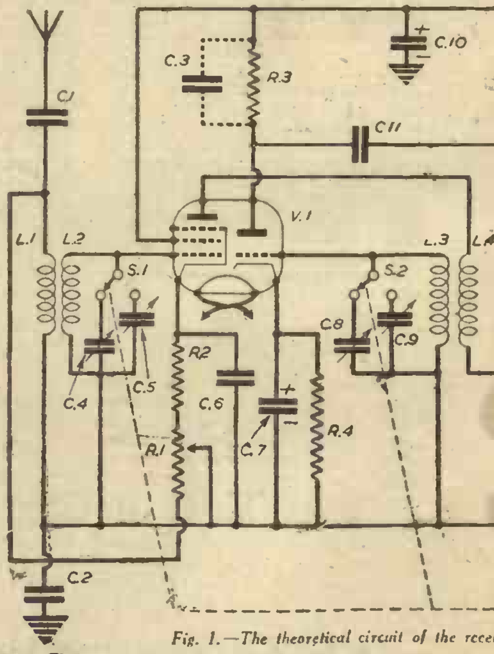


Fig. 1.—The theoretical circuit of the rece

'wo-valve Midget

Val[illegible]s. Ideal for the Experimenter. By JOHN JAY

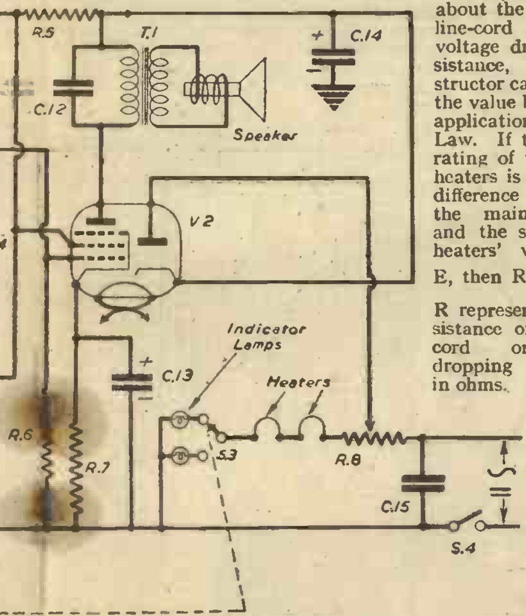
PRACTICAL WIRELESS, December, 1943, will be quite suitable. In the original, L1 L2 is a PA2 type and L3 L4 a PHF2 type, both obtained from Premier Radio. C4, C5, C8 and C9 are 350 m.mfd. trimmer condensers; 250 m.mfd. trimmers may be used, but a 100 m.mfd. fixed condenser must then be placed in parallel with each 250 m.mfd. trimmer used to obtain the " Home " programme. These four trimmers are mounted on the chassis as shown in Figs. 2 and 5. Care should be taken to see that all tuning circuit connections are kept as short as possible, to prevent instability and general oscillation. Improvement in stability, if necessary, may be obtained by connecting a 0.0003 mfd. or 0.0001 mfd. fixed condenser across the detector load, R3. A general reduction of " hiss " will also be effected by this connection.

Wiring Details

Tinned copper wire, 22 S.W.G., and 1 mm. systoflex were used for all connections with the exception of heater, loudspeaker and mains lead connections. The latter were completed with ordinary 5 ampere lighting flex. Leave a small space between all leads and connections, in case systoflex insulation breaks down, thus causing short circuits, particularly around the rectifier, mains resistance, and other parts which become warm.

The current flowing in the heater circuit should be checked, if a meter is available, and should be approximately 0.3 amperes. Do not solder connections to R8, use terminals or bolts.

If the constructor can obtain a line cord resistance instead of a fixed mains dropper, he is advised to do so. If any doubt exists about the value of a line-cord or mains voltage dropping resistance, the constructor can calculate the value by a simple application of Ohm's Law. If the current rating of the valves' heaters is I, and the difference between the mains voltage and the sum of the heaters' voltages is E, then $R = \frac{E}{I}$, when R represents the resistance of the line-cord or mains dropping resistance in ohms.



...eiver which is actually a three-valver plus rectifier.

The heat developed by the mains dropping resistance is considerable and can cause serious deterioration of component values, electrolytic condensers, trimming constants, etc., if confined to the interior of the cabinet.

Valve Pins

Fig. 6 gives the valve pin analysis for the valves stated. As shown, the chart gives an *underside* view of the valveholder.

Testing and Trimming

Check all connections against the circuit diagram by tracing connection from each valve pin in turn. Pay special attention to the rectifier and heater circuits. Check the tuned circuits for correct connection and possible causes of loss of efficiency, instability and self-

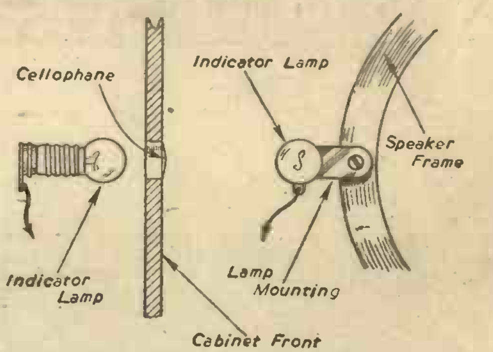


Fig. 3.—Shows how the station indicator lamps are mounted.

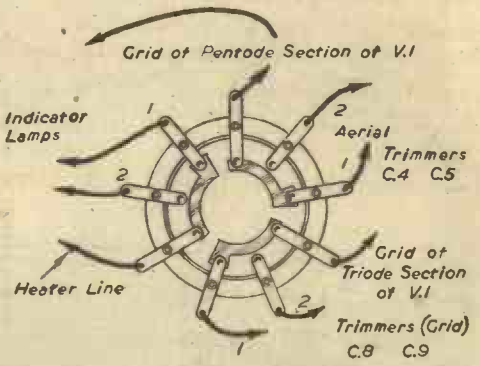


Fig. 4.—Rear view of Yaxley switch used for station selection and indication.

oscillation of detector or R.F. amplifier, i.e., long leads, parallel runs, proximity to L.F. circuits, anode and grid coupling in either detector or R.F. amplifier circuits. Ensure that the switch connections are *really* correct.

Switch on, watch the valve heaters, note that they light to normal brilliancy. These circuits will be protected by the indicator lamp. Watch the rectifier anode and anode-cathode space for signs of overheating or blue glow, if either symptoms are present, a H.T. short-circuit exists and must be cleared before proceeding—switch off quickly to avoid rectifier damage and locate the fault. Operate the wave-changing switch and observe that the indicator lamps function correctly.

Turn the trimmers for the switch position in use with an aerial affixed—no earth necessary—and listen for an increase of background noise (mush) from the speaker;

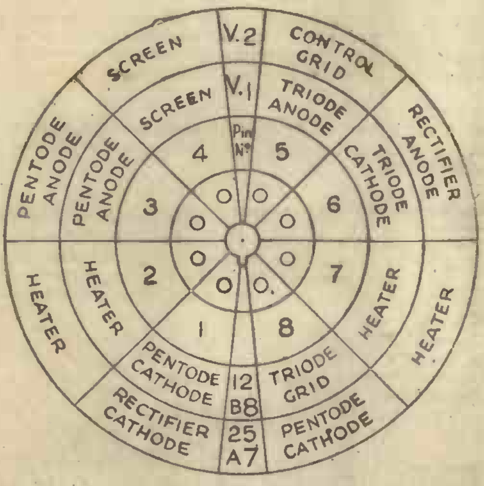


Fig. 6.—Pin connection chart for the specified valves.

COMPONENT VALUES

C1	0.0003 mfd. mica.	R1	5,000 ohms potentiometer with switch.
C2	0.001 mfd. mica.	R2	200 ohms ½ w.
C3	0.0001 mfd. tubular.	R3	1 megohm ½ w.
C4	350 m.mfd. trimmers.	R4	40,000 ohms ½ w.
C5	350 m.mfd. trimmers.	R5	5,000 ohms 1 w.
C6	0.1 mfd. tubular.	R6	850,000 ohms ½ w.
C7	5 mfd. electrolytic.	R7	150 ohms ½ w.
C8	350 m.mfd. trimmers.	R8	600 ohms tapped at 300 ohms.
C9	350 m.mfd. trimmers.	L1 L2	Type PA2 } Wearite
C10	16 mfd. electrolytic.	L3 L4	Type PHF2 } Wearite
C11	0.1 mfd. tubular.	T1	To match speaker.
C12	0.01 mfd. tubular.	S1, 2 & 3	Yaxley 3 pole 2 way.
C13	25 mfd. 25v. electrolytic.	S4	On-off upon R1.
C14	32 mfd. electrolytic.	V1	12B8GT.
C15	0.1 mfd. tubular.	V2	25A7GT.

ALTERNATIVE VALVES

V1—25B8GT. V2—70L7GT. R8 must now be 1,000 ohms 0.15 amperes tapped at 500 ohms.

V1—12B8GT. V2{ 25A7GT. 32L7GT. R8—600 ohms tapped at 200 ohms down. .3 ampere.

Dial lamps—6.3 v. 0.3 ampere.

turn the trimmers together, keeping maximum background noise until the desired station is obtained, adjust each trimmer for maximum volume or reading if an output meter is available. Switch to the second switch position and proceed to trim this in the same way for the other station. If "motor-boating," etc., occurs, decouple R3 with a 0.0003 mfd. condenser, and ensure that C12 is satisfactory. A 0.25 megohm ½ w. resistance may also be connected from C11, R6, junction to the grid of the output pentode section.

The Cabinet

Fig. 7 shows the general details of the cabinet, all dimensions being *inside* measurements.

A baffle may be fitted to the speaker if desired, the speaker being screwed to it, and the cabinet front, by suitable countersunk bolts, or the speaker may be fixed to the chassis and the use of a baffle and bolts through the cabinet's front dispensed with.

Good quality plywood should be used for the cabinet and baffle, the outside of the cabinet being thoroughly smoothed with decreasing grades of sandpaper, stained and polished with white-wax or given a coat of copal varnish. Rubber feet may be screwed to the cabinet's bottom, a speaker cloth tightly glued over the speaker aperture, and coloured Cellophane with the station names inked upon it glued over the station indicator holes.

Alternatives

A simple set of this type provides a suitable basis for various designs, and it is quite natural that constructors who have alternative parts on hand will wish to use them, especially during these days when parts are difficult to obtain. While it is quite permissible to modify the circuit and substitute other components, provided they have similar characteristics and the values specified, such alterations must be undertaken by the constructor, and if any loss in efficiency is experienced experiments must be carried out to overcome the defects due to the modified circuit arrangement.

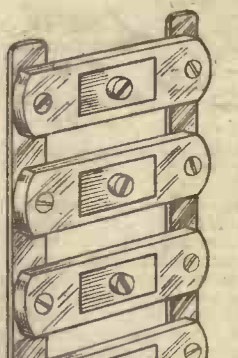


Fig. 5.—Method of mounting trimmer condensers.

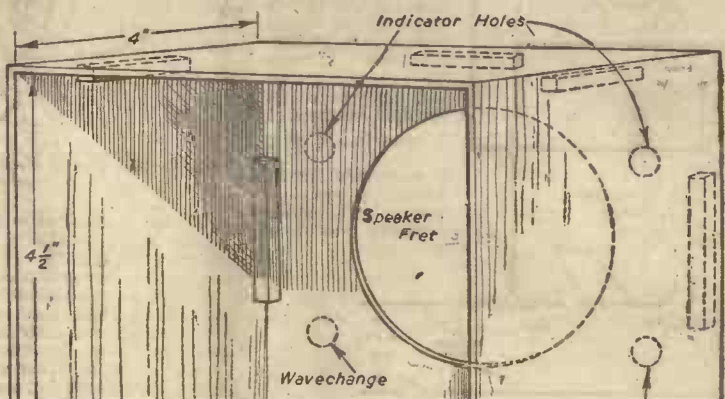
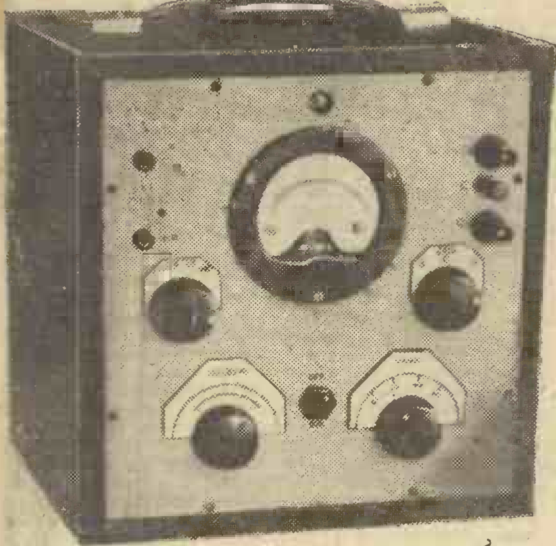


Fig. 7.—The cabinet dimensions are given here, together with approximate location of controls.

YOUR SERVICE WORKSHOP—12

Coil Matching and Trimming

Further Details of the Standard Capacity Condenser. Trimming Straight and Superhet Receivers. By STANLEY BRASIER



The valve voltmeter described in the July, 1943 issue.

FROM this, and the actual calibration in micro-microfarads, it is a simple matter to prepare a graph from which the capacity at intermediate points on the scale will be shown. Some advantage is gained by using a test condenser of 50 m.mfd. which would provide more calibration points, thus enabling a more accurate graph to be drawn.

Applications

In a previous article, dealing with the capacity bridge, it was stated that the instrument ceases to be accurate when measuring capacity below about 50 or 75 m.mfd. This is where the S.C. comes in, for, although it may suffer from the same disadvantage at the extreme low end of the scale, a method of measuring small values of capacity is available whereby the results are quite accurate. It is known as the "difference" method, and the apparatus required is the same as that used previously for calibration purposes except that the fixed test condenser would now become a small one of unknown value. In order to find out what this value is the S.C. is joined to the "condenser" terminals of the receiver and adjusted to, say, 100 m.mfd. and the oscillator tuned to resonance so that a maximum deflection is given on the V.V. Without disturbing anything else, the unknown capacity is connected in parallel with the S.C. and the wavelength of the oscillator increased until resonance is again indicated. After making a careful note of the exact capacity of the S.C., the unknown capacity may then be removed and its value compensated for by increasing the capacity of the S.C. Then, obviously, the unknown value is the *difference* between the first and second reading of the S.C. The reason why this method is accurate is because any stray capacity existing in the various leads, etc., are present before *and* after the connection of the unknown capacity. The difference in readings of the S.C. can therefore be due only to that of the value of the unknown condenser.

The same method may be employed for checking the minimum and maximum capacities of tuning condensers, reaction condensers, etc., and, in fact, is one of the best means of matching up the various sections of a ganged condenser. Each section in turn may be joined in circuit and the split end vanes adjusted until the V.V. reading is the same for all sections.

Matching Coils

When home-made tuning coils are used in a superhet or T.R.F. receiver it is important that the various inductances are matched reasonably well and the set-up of Fig. 3, March issue, may be used for the purpose. After disconnecting the coil in the receiver the first coil to be checked is joined across the S.C., which is also connected to the "condenser" terminals of the receiver. The S.C. may then be adjusted to about 250 m.mfd. and the oscillator tuned to indicate resonance on the V.V. After checking the reading and leaving everything else undisturbed, the first coil is disconnected and the others joined in turn across the S.C. They may then be adjusted, if required, by removing or increasing slightly the number of turns. It is advisable to check all coils at about three different points of the S.C.'s dial in order to ensure that when in use they will match at all points of the receiver dial.

It will be noted that throughout these tests the indications given by the valve voltmeter are only comparative, therefore it is not essential for the instrument to be calibrated, although if it is more definite and useful data may, of course, be obtained. For instance, the actual high frequency developed across coils from a given input may be measured, thereby checking their efficiency. This is done with still the same apparatus, picking up the signals from the oscillator as before. The receiver may be dispensed with if desired and the V.V. connected straight across the coil. Even if the V.V. is uncalibrated, comparative indications may be obtained of two different coils of approximately the same inductance in order to prove which is the most efficient. During tests of this nature it is essential to maintain the output of the oscillator at a constant and unvarying level, and it is advisable to use the same test frequency in each case. This fact will be understood if the actual output of the oscillator is measured. It will be seen to vary somewhat with varying frequencies.

Trimming Circuits with the Oscillator

The "straight" or T.R.F. receiver is comparatively easy to deal with. Referring to the medium waveband, a modulated signal from the oscillator is injected into the receiver under test. This should be done via a screened dummy aerial lead, joining the metal screening to earth on the set and the "hot" lead to aerial. If the receiver is badly out of trim or a new circuit is being lined up, it is wise to make a rough adjustment by ear. In most receivers the tuned circuit associated with the detector stage is by far the most critical to adjust, therefore it should be dealt with first, afterwards working back to the aerial. Having carried out a rough adjustment, an output meter may be connected in order to determine more accurately the exact adjustment of each trimmer.

It is not enough for, say, the second trimmer to be screwed hard down when resonance is obtained. If a receiver is in perfect alignment it should be possible to tune "through" the signal on each trimmer; if not, readjustment of all trimmers will be necessary. For example, if two trimmers appear to be adjusted satisfactorily whilst a third needs to be screwed hard down. then it will be necessary to open the other two so that the third may be balanced with them. The main dial will then require to be adjusted to allow for the capacity change of the trimmers, rocking it slightly either side of the signal whilst again adjusting the trimmers. In difficult cases, another method of dealing with the above trouble is to connect a small condenser of a few micro-microfarads across the trimmer which requires more capacity, after which it (the trimmer) may be eased off. Although it effects a cure, it proves that either the sections of the ganged condenser or the coils are not matched properly unless, of course, some excessive stray capacities exist in the receiver. If the dial is calibrated it should be set to correspond with the frequency of the test signal from the oscillator and adjustment of the trimmers should produce the desired results.

In T.R.F. sets no further trimming is usually necessary on the long waveband, but if it is the foregoing procedure may be adopted.

Trimming the Superhet

Due to the working principles of the superhet, it is necessary to ascertain the correct intermediate frequency of the receiver it is proposed to realign. This is usually given on the service sheet relating to the set, if such is available, otherwise the information must be obtained from the manufacturers. It is possible to find the *approximate* I.F. by juggling with the tuning circuits, but the method is not very satisfactory, especially in view of the fact that in some cases the I.F. may not be the same for all the tuned circuits. This is sometimes done for reasons either of selectivity or audio frequency control of the upper register.

Assuming that the I.F. is known, it is first necessary to tune the I.F. amplifier accurately to this figure. The most convenient method of doing this is to inject a modulated signal from the oscillator—at the correct I.F. —into the signal grid of the frequency changer, having previously disconnected it from the signal circuit by removing the top cap. A 0.5 megohm resistor will probably be required to join between grid and chassis. The oscillator section of the valve is prevented from functioning by the simplest means available—probably by shorting the grid to chassis. The trimmers on the I.F. transformer may then be adjusted for maximum response. As this increases, the input of the oscillator should be reduced in order that further small increases may be noticed. If, as mentioned previously, certain of the I.F. windings are to be tuned to a slightly different frequency, this must be observed, and the oscillator will therefore need to be adjusted as required. In these cases the last winding —that nearest the detector valve—should be dealt with first, afterwards working back to the frequency changer.

With the I.F. amplifier correctly aligned, attention may be turned to the signal circuits. The connections to the input and oscillator sections of the frequency changer valve should be restored to normal and a modulated signal of about 230 metres injected into the aerial and earth of the receiver via a dummy aerial. If the receiver dial is calibrated it should obviously be set to the exact frequency or wavelength of the oscillator. Trimming of the signal circuit may be carried out in a similar manner to that of a T.R.F. set. The oscillator circuit is now the only remaining one to be trimmed, and the frequency of this at resonance should be that of the input signal plus the intermediate frequency. If, therefore, the I.F. amplifier and the signal circuits are adjusted correctly a position will be found on the oscillator trimmer where the circuit comes into alignment. It should be pointed out that in making this adjustment it is possible that two positions of resonance may be found. This is due to the fact that the oscillator may be tuned to the signal frequency *plus* the I.F. or to the signal frequency *minus* the I.F. The correct adjustment of the trimmer is the one which includes the least capacity. In other words, starting with the trimmer fully opened, the first point of resonance is the correct one.

After completing the trimming process, it is wise to check, once again, the signal circuit and that of the oscillator, in order to make sure that all is correct, and the process should be repeated at, at least. one other wavelength—at the upper end of the dial.

Turning to the long waves, it is probable that the only adjustment required is that of a padding condenser which must be adjusted so that the calibrations on the dial are correct. On the other hand, in some receivers, all trimmers are mounted either in the coil cans or near them under the chassis. In this case a complete set of trimmers—except, of course, for the I.F. amplifier—is usually provided for medium *and* long waves, so that adjustments similar to the procedure for medium waves must be carried out for long waves also. It is unlikely that a superhet will suffer from medium wave interference when working on long waves so that the aerial series wave-trap mentioned earlier will probably not be incorporated. It is possible, however, that a trap may be used which is tuned to the I.F. of the receiver so that a particular form of interference is eliminated. Such devices are always shown on the service sheet and should be dealt with accordingly.

In all the foregoing adjustments it is necessary to remember the possibility of the A.V.C. system off-setting any increase in volume brought about by trimming. In a modern superhet, A.V.C. sometimes becomes operative on a very small input, and when trimming it is necessary either to work on a very small oscillator output or to disconnect the A.V.C. system altogether. A simple way of doing this is to short-circuit the A.V.C. diode load resistor or to disconnect the lead to the A.V.C. diode pin. When using an output meter which is not particularly sensitive, it is essential to render the A.V.C. system inoperative.

(To be continued)

The Service Oscillator (June, 1943 issue), used for the tests described in this article.

Radio Examination Papers—28

Output-circuit Matching. The Transitron Oscillator. Standing Waves. Fournier's Analysis. Superhet Fault-finding. By THE EXPERIMENTERS

1. Matching the Loudspeaker

MOST readers are aware of the theoretical need for correct matching between the output stage and the speaker, and are no doubt familiar with the simple formula employed for calculating the correct ratio of step-down transformer required. At the same time, there are probably many who have failed to follow the correct method of matching, and who have perhaps found that reasonably satisfactory results are still obtained. This may have led to the belief that the correct matching, as dictated by theory, is of little consequence in practice.

That would be a fallacy, for although results can certainly be obtained when the matching is incorrect, loss of volume and/or quality of reproduction is inevitable. The object of matching is to ensure that the greatest possible percentage of audio-frequency power in the anode circuit of the output valve, or valves, is used to vibrate the speaker cone. This result can be achieved only if correct matching is employed.

An average impedance for the speech coil of a loudspeaker may be taken as 20 ohms. To take an example, suppose that this were fed directly from a high-impedance source, such as that represented in Fig. 1; this shows choke-capacity coupling. It is evident that the speech coil is in parallel with the anode choke—assuming that the H.T. supply has negligible internal resistance. It is also clear that the speech coil would cut down the anode load to such a low value that there could scarcely be any audio voltage across it.

Now take the other extreme, and suppose that the speech coil had an impedance of 10,000 ohms, whilst the impedance of the anode load were, say, 4,000 ohms at the same frequency. The voltage across the speech coil would be high, but the resistance would be such that the current would be very small. Additionally, a large proportion of the power developed would be expended across the anode load, with little across the speech coil.

Somewhere between these extremes could be found a balance at which the optimum audio power would be transferred to the speaker. The fact that a transformer is normally connected between the output stage and the speech coil does not alter the reasoning, since any load across the secondary is always "reflected" across the primary to a degree dependent upon the turns ratio between the two windings.

Also, when there is a mismatch, reproduction at either the higher or lower end of the audio register is attenuated in respect of reproduction at the other end. It is generally the base that suffers most, since relatively more power is required at low frequencies to produce the same volume level; this is due to the fact that when the cone vibrates more slowly, its amplitude of vibration must be greater in order to produce the same impression of loudness.

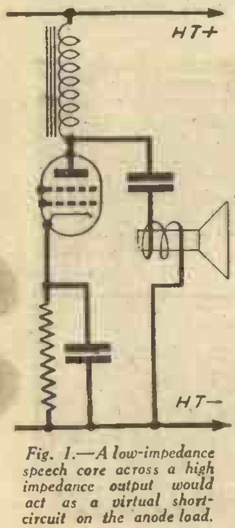


Fig. 1.—A low-impedance speech core across a high impedance output would act as a virtual short-circuit on the anode load.

QUESTIONS

1. *What is the effect of a mis-match between the output stage of a receiver and the loudspeaker?*
2. *Draw a circuit of a transitron oscillator, and state briefly how it operates.*
3. *What is meant by the term "standing waves."*
4. *Explain simply the chief implications of Fournier's Analysis.*
5. *In the absence of proper test equipment, how would you attempt to trace the source of trouble in a superhet which appeared to be completely "dead"?*

2. The Negative Transconductance Oscillator

The title of this reply is rather a "mouthful," but it is the full title of a form of valve oscillator generally referred to as a transitron. A basic transitron circuit is shown in Fig. 2, where it will be seen that a pentode is used in what appears to be a very unusual arrangement. There is only one tuning circuit, and it would not appear that any provision is made for feed-back.

This oscillator depends for its action on the fact that if a suitably high negative potential is applied to the suppressor grid, electrons which have passed the screening grid on their way to the anode will be reflected, and will thus be forced back to the screen. It will be remembered that there is a "hump" in the screen-current, screen voltage characteristic of a screen-grid valve, and that when the valve is operated at a point on the down-grade of the "hump," an increase in screen voltage results in a reduction of screen current. This part of the curve is often referred to as the area of negative resistance.

Further, small increases of suppressor grid voltage allow the passage of more electrons from the screen to the anode. This is equivalent to stating that the screen current is decreased. In other words, the suppressor-screen transconductance is negative in character. Should this negative resistance become equal to the positive resistance of the tuning circuit, oscillation commences. It might be well at this point to remind

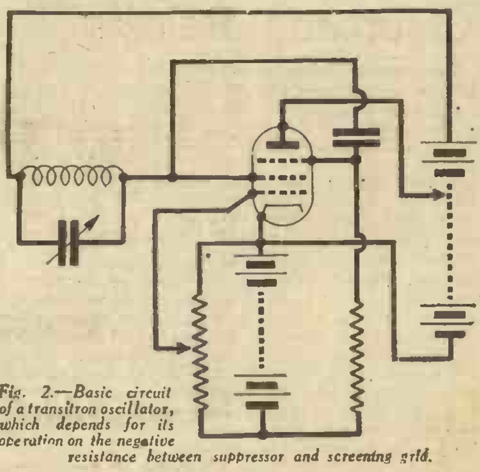


Fig. 2.—Basic circuit of a transitron oscillator, which depends for its operation on the negative resistance between suppressor and screening grid.

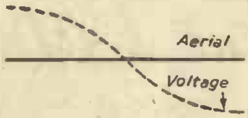


Fig. 3.—Voltage distribution along a half-wave aerial. The broken line represents a standing wave.

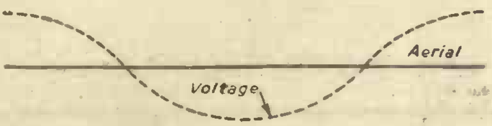


Fig. 4.—Voltage distribution along a full-wave aerial.

some readers that for a valve to produce continuous oscillation in a tuned circuit it is necessary to overcome the resistance of that circuit.

The transitron oscillator has many advantages over oscillators of many other types. One of the most important is its simplicity, but other advantages are the frequency stability achieved and the very wide frequency range over which it will operate. Space does not permit of practical circuit details being given, and the question does not ask for them.

3. Standing Waves

This is a term which is often used, sometimes incorrectly, and which is not an easy one to explain. Its chief application is in connection with aerials, especially those of resonant length, half-wave or full-wave.

It is known that when an aerial acts as a radiator, a wave-form indicating the distribution of voltage, or of current, along the aerial can be drawn. Thus, with a half-wave aerial we get the wave-form shown in Fig. 3; in the case of a full-wave (wavelength long) aerial, we have the voltage wave-form shown in Fig. 4.

Since radiation is assumed to be continuous, and the wave-form remains constant, it may be considered that the wave remains as indicated in Figs. 3 and 4. This very incomplete explanation should give a clue to the derivation and general meaning of the term. To avoid misunderstanding, however, it should be made clear that standing waves are not the sole prerogative of aerials, but may exist about any resonant circuit—even inside a valve used for ultra-short-wave work in certain conditions.

4. Fournier's Analysis

The scientist Fournier devoted a considerable amount of time to the investigation of wave-forms. He was able to show that waves of all shapes are always built up by combining two or more sine waves. Moreover, he proved that, however complicated the wave-form may be, it could be "broken down" into a number of sine waves.

One simple example which will easily be understood by readers is the wave-form of a modulated oscillator. By combining two sine waves of constant amplitude—one an audio frequency, and the other a radio frequency—a resultant wave of constant frequency and varying amplitude is produced.

By Fournier's method, it can be shown that a square wave consists of a greater number of sine waves than does a wave of any other form. Thus, when square waves, or others similar in form, are transmitted an unusually wide band width is required. High-definition television transmission showed us this.

5. Testing a Superhet

It would be logical to start by checking the low-frequency amplifier. If there were provision for connecting a pick-up, this would be easy. If not, touching the grid terminal of each L.F. valve from the output valve backwards would give an indication; there should be some sort of noise in the speaker on each occasion, the noise level rising as the number of valves before the speaker was increased. In most cases a hum would be heard, especially if the other hand were held near the mains transformer, or if the A.C. mains leads (insulated, of course) were grasped. In a battery set there would probably be a mild "plop" when the grids were touched.

Having decided that the L.F. portion was, at least, providing some amplification the I.F. stages should be checked. This could be done by connecting the aerial to the "H.T." terminal of each I.F. transformer in turn, starting with that nearest to the detector. An actual signal may not be heard, since the I.F. would perhaps not be tuned to one, but some sort of "hiss" or mush should be picked up.

If that were so, only the frequency-changer and H.F. amplifier, if fitted, would remain to be tested. The H.F. amplifier could be cut out by connecting the aerial to its anode terminal; if this valve were responsible for the lack of signals, normal reception should be obtained with the valve out of circuit. But if this test failed to produce signals it would be fairly clear that the frequency-changer stage was at fault. Coils, power supplies and connections should be checked, but the fault would probably be traceable to the valve itself.

Overseas Relays

THE Engineering Division of the B.B.C. recently made a technical report on "Overseas Relays" during the year ended on December 31. By way of explanation, an overseas relay means the re-broadcasting overseas of anything the B.B.C. puts out or the re-broadcasting over here of programmes coming from other countries. This report shows that in both cases there has been a very large increase. For instance, during the past year there have been nearly 9,000 "incoming relays" (8,924)—nearly three times as many as in the preceding year (3,217).

Of outgoing relays there has also been an increase, though not as large as that in the incoming relays—a rise from 2,170 in 1942 to 2,452 in 1943. The considerable isparity in increase between outgoing and incoming is largely due to the expansion of the "America Calling Europe" programmes. In short, the B.B.C. has put all its technical facilities at the disposal of the United States for re-broadcasting to the people of the Occupied Countries whatever our Ally has to say.

Turning back again to the outgoing relays, these do not include the very large number of programmes, over 181,000 station quarter-hour periods, which are re-broadcast by radio organisations overseas from B.B.C. short-wave transmissions. Nor, of course, do any of these figures refer to programmes taken solely for monitoring or other B.B.C. information purposes.

Before the publication of this report, few people realised to what extent this sphere of the B.B.C.'s activities has grown, or the great amount of work involved to maintain a highly efficient service. For those people abroad, and in particular those in the occupied countries, the Overseas Relays provide a vital source of authentic news and entertainment.

Elementary Electricity and Radio—15

Direction-finding. The Loop Aerial. Sensing. Errors. By J. J. WILLIAMSON

(Continued from page 160, March issue.)

IN order to discover the direction from which a signal is being radiated it is necessary to have an aerial system possessing definite directional properties.

Polar Diagrams

To facilitate the investigation of the directional properties of an aerial, a polar diagram may be used. The polar diagram shows the intensity of the received signal in suitable units (usually microvolts per metre μV p.m.) for any direction around the aerial. Fig. 96 (A) shows the horizontal polar diagram of a straight aerial; notice that the signal strength is shown on a scale formed by concentric circles, the centre being zero and also representing the aerial position, direction being indicated in degrees around the aerial. It indicates that if we move a transmitter, which is radiating a signal of constant strength along a path equidistant from the receiver's aerial we shall receive the same signal strength no matter from what direction the radiation is transmitted; i.e., a straight aerial possesses no directional properties. Fig. 96 (B) shows the waveforms and vectors for the straight aerial.

The Loop Aerial

If we have a symmetrical aerial of one of the types shown in Fig. 97 we shall find that its polar diagram indicates a bi-directional response, i.e., when the loop is "edge-on" to the transmitter maximum signal voltages occur across the loop terminals, the "flat-on" position giving minimum signals. Consider the wave-front to be approaching "edge-on" to the loop in Fig. 98 from a transmitter *X*. Wire number one is struck and a fraction of a second later wire number two receives the radiation, thus the wires have voltages induced in them, but the second wire has its voltage lagging on the first. These voltages are, of course, at radio frequency but for analytical purposes let us consider the first half cycle of voltage to be induced in the wires. It can be seen that V_1 and V_2 act against one another around the loop (are out-of-phase), but because voltage number two occurred after V_1, they are not *exactly* out-of-phase (180 deg.) and therefore do not cancel completely, thus a signal will be received across the loop terminals (V_R) which is the sum of V_1 and V_2. Fig. 98 (B) and (C) show the waveforms and vectors of this process.

If the transmitter is situated at Y (Fig. 98 (A)) then wire number two is struck *first*, resulting in a complete reversal of V_R as shown by the waveforms and vectors of Fig. 98 (D) and (E). This reversal of phase due to reversal of direction is very important, as we shall see under the heading of "sensing."

Fig. 99 shows the loop in the "flat-on" position, both wires number one and two are struck *at the same time*, resulting in complete cancellation of V_1 and V_2 causing

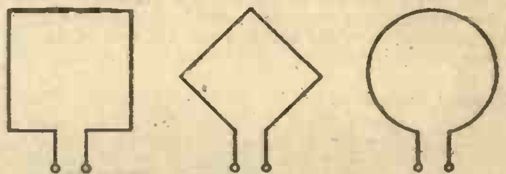


Fig. 97.—Types of loop aerial.

V_R to become zero as shown on the right by means of waveforms and vectors.

Summarising, the voltage across the terminals of the loop (V_R) will pass through two maxima (edge-on) and two minima (flat-on) as the loop is rotated or a constant strength equidistant transmitter is moved around the loop. V_R will follow a cosine law, i.e.,

$$V_R = V_m \cos \theta$$

where V_m is the voltage across the loop in the (edge-on) maxima positions and θ is the angle between the axis of the loop and a line running through the loop centre and the transmitter, Fig. 100 (A). This relationship gives the "figure-of-eight" polar diagram of Fig. 100 (B).

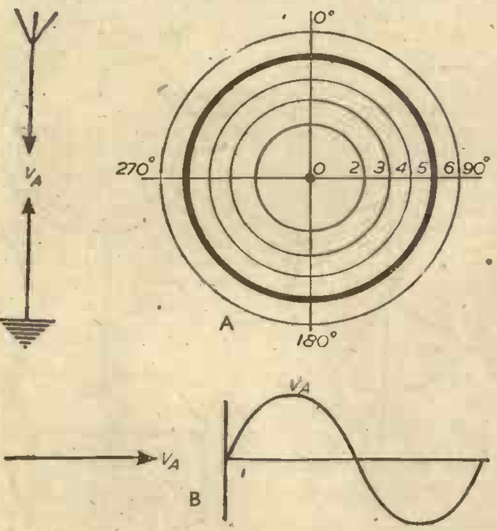


Fig. 96.—Polar diagram, vector and waveform of a straight aerial.

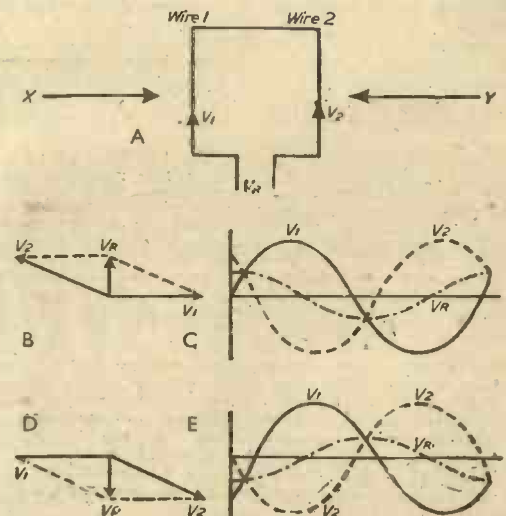


Fig. 98.—Vectors and waveforms of loop aerial when considering two directions.

Practical Application of the Figure-of-eight Response

We must now decide which of the two directional characteristics of the loop will give the greatest discrimination of signal strength per degree when the loop is to be used for aural direction-finding. There will obviously be the minima positions, see Fig. 100 (C). A scale having 60 deg. may now be fitted to the loop in such a way that 0 deg. or 180 deg. are read when the loop is "flat-on" to a station situated along the axis of the loop, Fig. 101.

To use the loop, pick up the required station upon the receiver, turn the loop for weakest signal strength. The scale reading now gives the number of degrees between the axis of the loop and a line running through the transmitter and the loop's centre, as shown in Fig. 102. Notice that *two* readings may be obtained, θ and θ', being separated by 180 deg.; therefore we cannot tell if the transmitter is situated in direction T or T_1.

"Fixing" the Position of a Transmitter

This may be done with the use of two or more loops conveniently situated. Fig. 103 (a) shows that the use of two loops gives the position of the transmitter except when it is situated on a line between the two direction-finding stations. The use of three loops—Fig. 103 (b)—will give the position of the transmitter in any situation.

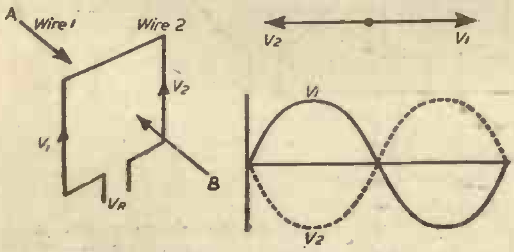


Fig. 99.—Effects produced when the loop is "flat-on" to the wavefront.

It is inconceivable that the accuracy of the loops will be so great that lines drawn through their minimum axes will all cross at the same point, thus we obtain a triangle at the junction known as the "triangle of error" or the "cocked-hat"; the transmitter is within this triangle.

"Sensing"

If it is necessary to discover the true direction of a transmitter from a D.F. station using a loop one of the two readings must be eliminated. This elimination of the incorrect scale reading is known as "sensing" the signal.

The only difference between the two loop positions giving a *maximum* signal is that the resultant loop voltage V_R has its phase reversed with loop reversal. This fact must be used in "sensing."

The Cardiod (Heart)-Shaped Diagram

If we couple a straight and a loop aerial to a receiver together we shall obtain the directional properties shown in Fig. 104. This polar diagram is easily deduced by placing the straight aerial and loop aerial polar diagrams over one another and adding them directly. This may be done if we assume that the loop and straight aerial voltages are either exactly in or out of phase, i.e., vectors in phase or 180 deg. out of phase may be added numerically. The cardiod shows a unidirectional response, giving one maximum and one minumum position and therefore is suitable for sensing.

Practical Use of the Cardiod Polar Diagram for Sensing

Reference to Fig. 104 shows that if we are to use the minimum of the cardiod polar diagram for sensing, then the loop must be in the "edge-on" position. It is not

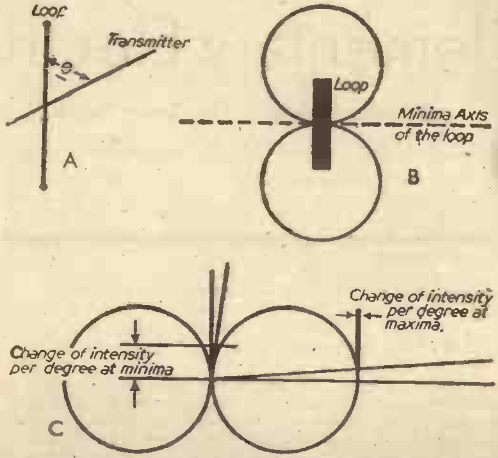


Fig. 100.—"Figure-of-eight" diagram of loop aerial and choice of maxima or minima for greatest discrimination.

practicable to use the cardiod response directly because of the uncertainty of obtaining a pure cardiod response under all conditions, therefore we must adopt the following procedure.

(1) Obtain the minimum signal with the loop aerial alone.

(2) Switch in the straight aerial to convert the figure-of-eight response to the cardiod response.

(3) Turn the loop 90 deg. from the reading obtained when using the loop alone. The loop will now be "edge-on" to the transmitter.

(4) Reverse either the loop or its connections and discover which of the two positions (normal or reversed) gives the weakest signal. If weakest signal strength is obtained on normal then the bearing obtained when the loop was used alone is correct, but, if the weakest signal occurs with reversed connections or loop then the first reading obtained was the reciprocal of the bearing and 180 deg. must be added or subtracted. D.F. loops are usually fitted with a "sensing" scale (often in red), which is displaced 90 deg. from the "bearing" scale—

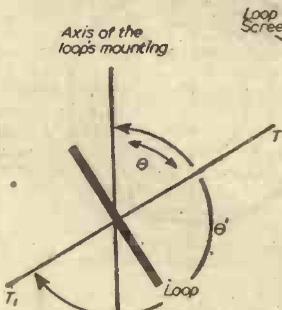


Fig. 102.—Use of loop's properties.

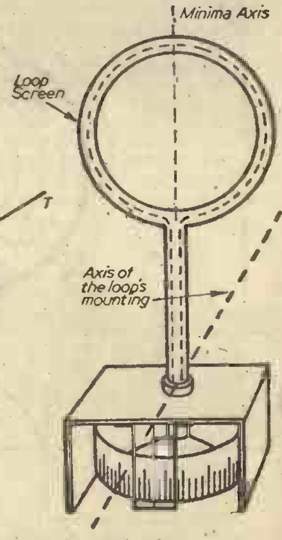


Fig. 101.—Practical application of the loop.

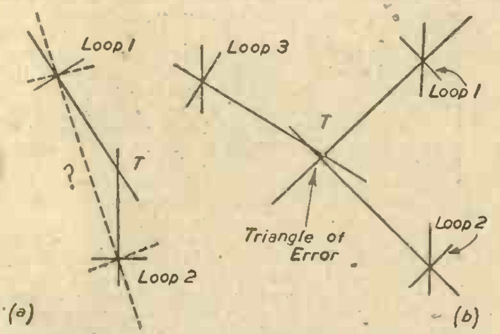


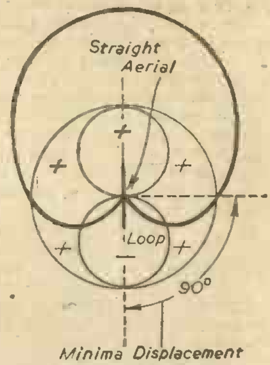
Fig. 103.—Fixing the position of a transmitter by two and three loops.

because of the 90 deg. difference between the minima of the figure-of-eight and cardiod polar diagrams. The reversal of loop or connections for comparison of cardiod maximum and minimum being achieved by means of a reversing switch, marked "reciprocal"—reversed connection, and "bearing"—correct connection.

Variations of the Cardiod Response

The cardiod diagram of Fig. 104 was derived from frame and straight aerial voltages of equal amplitude and having correct phase relationships, but these

Fig. 104. — Formation of cardiod diagram derived from frame and straight ' aerial voltages.



conditions necessary for efficient direction-finding must be carefully planned if ambiguity is to be avoided.

Fig. 104 (A) shows the effect obtained when the straight aerial's voltages are *larger* than those of the loop aerial. Notice that a very poor minimum exists, introducing great difficulty in the comparison of signal strength for sensing purposes.

Fig. 104 (B) shows the effect obtained when the straight aerial voltages are *smaller* than those of the loop aerial; two minima are now producing, making the response useless for sensing.

(To be continued)

Detection

Component Values. Super Regeneration. Quench Frequency. By S. A. KNIGHT

(Continued from page 140, March issue)

Choice of Leak and Condenser

IN choosing suitable values for the grid leak and condenser, several opposing factors must be borne in mind:

(a) The leak must be high, since the audio grid fluctuations are set up by the audio component of grid current passing through the resistance. The greater the resistance, the greater are the grid p.d. fluctuations caused by a given current.

(b) The grid condenser should be small, such that its reactance $1/\omega C$ to the audio frequency is at least as large as the grid leak resistance. The condenser shunts the leak, and it is necessary to keep this parallel reactance as high as possible to the A.F. If the impedance of the whole parallel circuit is low the results set out in (a) above are impossible to obtain, i.e., A.F. fluctuations of grid current will not produce large fluctuations of grid potential.

(c) Consider the simple equivalent circuit of a grid detector, as shown in Fig. 5. From this it will be seen that it is necessary for the $1/\omega C$ of the grid condenser C to be small to radio frequencies when compared with the grid filament path of the valve itself. It will be seen that the total impedance between these two electrodes is composed of the impedances R, the leak, Rgf the grid-filament resistance of the valve and Cgf the grid filament interelectrode capacity. These are all in parallel, and if their joint impedance is given by Zj, then it is quite obvious that the applied p.d. e caused by the signal divides in some ratio across C and Zj such that $C+Zj=e$ (vectorially).

If the reactance of C is small compared with Zj, then the drop in C is also small compared with the p.d. across the filament and grid, i.e., nearly the whole of the incoming signal is applied to the grid and filament. This, therefore, points to a grid condenser with a small reactance, that is a condenser of a large value. Which is contrary to condition (b) set out previously.

(d) The time constant of a condenser in parallel with a resistance is given by:

$$q/C+R.\ dq/dt=o$$

where q/C is the p.d. between the plates and R. dq/dt is the p.d. across the resistance at some instant after the resistance has been applied.

The equation $q/C+R.\ dq/dt=o$ is an elementary differential, and its solution is given by:

$$q=Qe^{-t/CR}$$

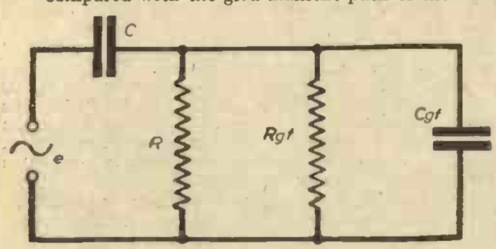


Fig. 5.—Simple equivalent circuit of the grid detector shown in Fig. 4 (March issue).

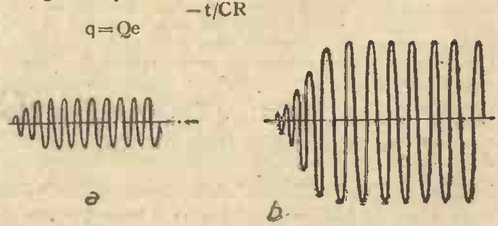


Fig. 6.—Induced and free oscillations respectively in a super regenerative receiver.

Thus, as readers know, in a time CR seconds the condenser charge falls from its initial value, Q to Q/e; that is, 0.632 of its charge in CR seconds. Now, in the grid detector, the time constant of the leak and the condenser must be low, since the excess charge which is left on the condenser when the signal fluctuations fall away must leak away through the resistance as rapidly as possible. This is in order that the grid potential can follow as faithfully as possible all the rapid changes of the audio frequency contained in the arriving signal.

If the true constant is too high the grid potential fluctuations are smoothed out, and distortion of a kind occurs. This condition calls for low values of the condenser and leak.

Considering the four conditions just outlined, it becomes clear that the grid leak should be as high as possible consistent with a small CR value when combined with the condenser, while the condenser should be so arranged that its reactance to R.F. is small and its reactance to audio frequencies is large. Good all-round values are generally of .0001 μF for the condenser and 1 to 2 MΩ for the leak.

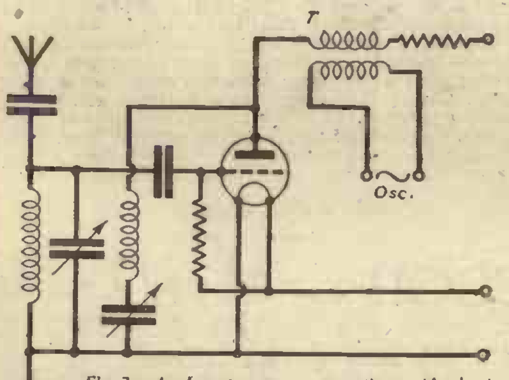


Fig. 7.—An elementary super regenerative receiver showing how the quench frequency is injected into the anode circuit

Super Regeneration

This receiver could perhaps come more favourably under the heading of R.F. amplification, but the principle of its working is not clear to a lot of people, and it is therefore being included with this survey of simple detectors.

The sensitivity of the super regenerative circuit is its most important feature, this far outweighing the sensitivity of any other arrangement not employing R.F. amplification. For a clear understanding of its working it is assumed that the reader has a knowledge of reaction as applied to ordinary detectors and the meaning of sustained oscillations in a valve circuit—This was covered in the article on "Oscillators," and should be referred to if any doubt exists.

Suppose that a simple detector employing conventional reaction is set right on the verge of oscillation, and that a signal arrives at the aerial. An A.C. current flows in the grid tuned circuit and an alternating p.d. appears across the grid coil. This signal upsets the stability of the receiver and it is shocked into oscillation. This oscillation commences to grow at the frequency of the tuned circuit ($\frac{1}{2}\pi\sqrt{LC}$) and continues to build up until limited in growth by various circuit factors. The tuned circuit current then has two components, the normal current induced by the signal e.m.f. (Fig. 6a), and an oscillatory current of increasing amplitude (Fig. 6b) which is actually the sum of the induced and the free oscillations.

With a receiver in an unstable condition the effect of a signal is much greater than would be the case were the circuit normally stable; the current builds up to a far bigger value and the arrangement acts similarly to an amplifier. In a stable receiver, however, the current ceases when the signal ceases; in the unstable condition the valve will generate oscillations indefinitely at the natural frequency of its tuned circuit.

The main point to be grasped at this stage is, however, that a receiver which is on the brink of unstability or oscillating weakly will respond instantly to any signal however feeble.

The super-regenerative receiver makes use of this fact in its operation. Consider Fig. 7, where a normal detector is shown, using reaction, but in the anode lead has connected some form of oscillator coupled by the transformer T. This oscillator has a frequency above the audio range, say, 25,000 c.p.s., and when in operation causes the valve anode potential to fluctuate at this frequency between (V+E) volts and (V−E) volts, where V is the value of the applied H.T. and E is the maximum value of the e.m.f. induced in the secondary of transformer T by the oscillator. If the reaction of the detector is now so adjusted such that at anode potentials above V volts the set is unstable, while at anode potentials below V volts the set is stable, the arrival of a signal at the aerial will cause the receiver to behave in this way:

During the period when the anode potential is above V volts (1/50,000th of a second) and the circuit is consequently stable, an ordinary A.C. current will flow in the grid circuit, its frequency being that of the incoming signal; this is the induced oscillation. During the next 1/50,000th of a second when the anode potential is above V in value and the circuit becomes unstable, a large free oscillation builds up in the grid circuit and the total current then flowing consists of the sum of the induced and the free oscillations.

Quench Period and Frequency

This period of instability is followed up by a period of stability, wherein the induced oscillations continue to flow, but the free oscillation is damped out. This damping out is referred to as the quench period. This process continues as long as the signal is arriving.

Since, then, a large oscillatory p.d. is applied to the grid of the valve during unstable periods each of these periods is accompanied by a sudden fall in the mean value of the anode current. This is best seen by considering a signal consisting of interrupted continuous waves, a morse transmission. Suppose a particular train of waves lasts for 1/500th of a second, then 50 sharp falls of mean anode current occur during this time. The individual decreases are inaudible, because the quench frequency, here 25,000 c.p.s., is inaudible, but the effect over the complete train is a large decrease in anode current, larger than would occur in any other normal receiver.

When the train ends the grid current should fall to zero, but in practice it does not do so. Oscillation continues feebly even during a no-signal period and accounts for the inevitable background noise or "rushing" peculiar to super-regenerative circuits.

The choice of the quench frequency depends on several factors. It should be low, since the longer the period for a free oscillation to build up the greater is its amplitude, the larger the mean decrease of the anode current and consequently the more sensitive is the receiver. The quench frequency should not be too low, however, or it will become audible and a high pitched whistle will be heard as a background to the received signal.

When the receiver is picking up normal modulated signals the mean value of the anode current rises and falls in amplitude very nearly the same as the signal itself, because the oscillations that build up during the unstable periods are at a maximum when the signal is a maximum and a minimum when the signal is a minimum, that is, the amplitude of the free oscillations vary with the amplitude of the incoming signal.

While the super-regenerative receiver is not very selective, and considerable background mush is a great disadvantage, it must be said that for sensitivity there is no other detector, without R.F. amplification, that can equal it.

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NEW LONGTON
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The B.B.C.'s Twenty-first Birthday

Important Dates in the Progress of the B.B.C. Between 1937 and 1939

(Concluded from page 167, March issue.)

January, 1937
1. New Royal Charter and Licence came into force for ten years.

February, 1937
1. Medium-power transmitter opened at Penmon (Anglesey).

May, 1937
12. Broadcast ceremony of Coronation of Their Majesties King George VI and Queen Elizabeth ; First outside broadcast of television—procession televised. Also first broadcast by George VI as King.
15. Relay of part of King Christian's Silver Jubilee celebrations from Copenhagen.

July, 1937
4. West of England and Wales stations separated.
6. Visit of Duchess of Kent to Broadcasting House.
12. Visit of Duke of Kent to B.B.C. House, Gateshead.
20. Death of Marconi.

August, 1937
31. Broadcast of Farr-Louis fight direct from Yankee stadium.

September, 1937
25. Last performance of B.B.C. Dance Orchestra under Henry Hall.

October, 1937
19. Stagshaw transmitting station opened.

December, 1937
25. First Christmas broadcast by King George VI.

January, 1938
3. Arabic Service started.

March, 1938
15. Daily news service in Spanish and Portuguese inaugurated.
—. Telephone Enquiry Unit formed.

July, 1938
19. Opening of Malayan station.

September, 1938
27. First broadcast by Queen Elizabeth when she launched the *Queen Elizabeth.*
Broadcast by Mr. Chamberlain on his return from Munich.
Foreign news bulletins in German, Italian and French were introduced for the first time, being broadcast in Regional programmes.

November, 1938
16. Priestley's "When We Are Married" televised from theatre. First one to be televised direct from a theatre.

December, 1938
9. Opening of Broadcasting House, Aberdeen.

February, 1939
23. Boon-Danahar fight at Harringay. First time promoters were permitted to sanction reproduction of television broadcast in places of public entertainment.

March, 1939
21. Television transmission of arrival of President Lebrun at Victoria Station.

April, 1939
16. Relay from Cairo of playing of trumpets found in Tutankhamen's tomb.

May, 1939
—. "Programme Engineering" unit created within Engineering Division to take charge of balance and control.

June, 1939
14. Two new transmitting stations opened in West Country (Start Point and Clevedon).
26. World's first television party held in Broadcasting House Concert Hall for listeners and television staff.

September, 1939
1. First appearance (at 8.15 p.m.) of B.B.C. Home Service. Television service closed down.
3. Broadcast of first of 17 instalments of "Let the People Sing" (Priestley). First time an unpublished novel had been broadcast.
Broadcast by Prime Minister on outbreak of war.
Broadcast by the King on the outbreak of war.

Television

The B.B.C.'s television station at Alexandra Palace transmitted test programmes for the first time in August, 1936, coinciding with the radio exhibition at Olympia. There were two systems in use at the time, but on February 5th, 1937, the Postmaster-General announced that the Television Advisory Committee recommended the termination of the experimental period and the adoption of a single set of standards for transmissions. These—known as the London Television Standards—provided for a picture composed of 405 lines, interlaced with a frequency of 50 frames a second. These were the standards employed in the Marconi-E.M.I. system, then in use.

When the service closed down in September, 1939, there were more than 20,000 viewers, an increase of 100 per cent. during the year. People were beginning to realise that they could have television in their homes for a few shillings a week and the increase believed to be imminent in September, 1939, would probably have been out of all proportion to previous rises. It was estimated that by Christmas, 1939, television would be seen and enjoyed in 80,000 homes.

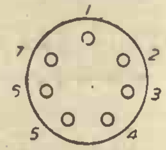
Valve Data Sheets

OSRAM

BASE CONNECTIONS—(*Continued*).

Valve Type	Pin Number 1	2	3	4	5	6	7	Top Cap
MX40 X42 X30 X32	Ao	Go	Gs	H	H	C (M)	A	Gc
X21 X22	Ao	Go	Gs	F	F	M	A	Gc
X23 X24	Ao	Go	Gs	F	F	M	A	Gc
X41 X31	Ao	Go	Gs	H	H	C (M)	A	Gc
H30 H42	M	—	—	H	H	C	A	Gc
DN41	D1	A	D2	H	H	C	Gs	Gc
QP21	G1	G2	A2	F	F	Gs	A1	—
U30	H cent.	A1	C1	H	H	C2	A2	—

Key : F Filament
H Heater
C Cathode
Gc Control Grid
Go Oscillator Grid
Gs Screen Grid
A Anode
Ao Oscillator Anode
M Metallising
D Diode Anode

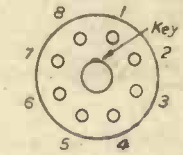


View from underside of base.
7-pin base.

BASE CONNECTIONS—(*Continued*).

Valve Type	Pin Number 1	2	3	4	5	6	7	8	Top Cap
H63	—	H	X	A	X	X	H	C	Gc
L63	—	H	A	X	Go	X	H	C	—
KTW63 KTZ63 Z63	—	H	A	Gs	—	X	H	C	Gc
KTW61	—	H	A	Gs	Ge	X	H	C	Gc
KTW73 KTZ73	—	H	A	Gs	—	X	H	C	Gc
Z62	—	H	A	Gs	Ge	X	H	C	Gc
D63	M	H	D2	C2	D1	X	H	C1	—
DH63 DL63 DH73	—	H	A	D1	D2	X	H	C	Gc
BL62	—	H	A2	C2	G1	A1	H	C1	G2

Key : H Heater
C Cathode
A Anode
Gc Control Grid
Gs Screen Grid.
Ge Suppressor Shields
D Diode Anode
X Pin omitted

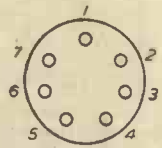


View from underside of base.
" Octal " Base.

BASE CONNECTIONS—(*Continued*).

Valve Type	Pin Number 1	2	3	4	5	6	7	Top Cap
VMP4 VMP4G MSP4 MSP41 W30 W31	M	Gc	Ge omitted in tetrodes	H	H	C	Gs	A
VP21 Z21 W21	M	Gc	Ge	F	F	—	Gs	A
W42 KTZ41	—	A	Ge	H	H	C	Gs	Gc
MHD4 DH42 DH30	D1	M	D2	H	H	C	A	Gc
MPT4 MKT4 N41 KT41 N42 KT42 N30G KT30	—	Gc	Gs	H	H	C (Ge)	A	—
N43	—	—	Gs	H	H	C (Ge)	A	Gc
N31 KT31	H c'tre	—	Gs	H	H	C (Ge)	A	Gc
KT44	—	Gc	—	H	H	C	Gs	A

Key : F Filament
H Heater
C Cathode
A Anode
Gc Control Grid
Gs Screen Grid
Ge Suppressor Grid
M Metallising
D Diode Anode

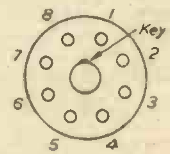


View from underside of base.
7-pin base.

BASE CONNECTIONS—(*Continued*).

Valve Type	Pin Number 1	2	3	4	5	6	7	8	Top Cap
X63 X73	—	H	A	Gs	Go	Ao	H	C	Gc
X64	—	H	A	Gs	Go	X	H	C	Gc
X62 X65 X75	—	H	A	Gs	Go	Ao	H	C	Gc
KT61 KT63 KT66 KT72 KT73 KT32 KT33	—	H	A	Gs	Go	X	H	C	—
KT33C	H Cent.	H	A	Gs	Gc	X	H	C	—

Key : H Heater
C Cathode
A Anode
Gc Control Grid
Go Oscillator Grid
Gs Screen Grid
Ao Oscillator Anode
X Pin omitted



View from underside of base.
" Octal " Base.

Valve Data Sheets

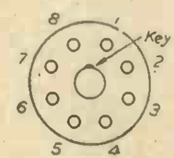
OSRAM

77

BASE CONNECTIONS—(*Continued*).

Valve Type	Pin Number								Top Cap
	1	2	3	4	5	6	7	8	
U50 U52	—	F	X	A1	X	A2	X	F	—
U70	—	H	A1	X	A2	X	H	C	—
U31 U71	—	H	X	X	A	X	H	C	—
U134	—	H	A1	C1	A2	X	H	C2	—
Y63 Y64 Y73	—	H	A	T	Go	X	H	C	—

Key :
- F Filament
- H Heater
- C Cathode
- A Anode
- Gc Control Grid
- T Target
- X Pin omitted



View from underside of base. "Octal" Base.

78

GLOSSARY OF VALVE TERMS

Cathode.—The source of electrons in a thermionic valve. In battery and certain types of mains operated valves, it is synonymous with filament, in which case the valve is said to be directly heated. In other types, the cathode surrounds the filament or heater, and they are, therefore, referred to as indirectly heated valves.

Grid.—A wire mesh or grid located between the cathode and the anode, its purpose being to control the electron stream between those two electrodes.

Anode.—This electrode is also known as the plate. It collects the electrons emitted by the cathode.

Screening Grid.—A grid which is placed between the control grid and the anode to minimise inter-electrode capacity and thus prevent feed-back and, likewise, instability due to inter-electrode capacity coupling.

Suppressor Grid.—This is the name given to yet another grid electrode which is interposed between the screening-grid and the anode. Its object is to eliminate the harmful effects of secondary emission it is usually connected to the cathode of the valve.

Diode.—A thermionic valve incorporating two electrodes, the cathode and anode. It forms the simplest type of valve and is used for the rectification of alternating current.

79

Glossary of Valve Terms—(*Continued*)

Triode.—If a grid is fitted to a diode, the valve then possesses three electrodes and is known as a triode.

Tetrode.—The name given to a four electrode or screen-grid valve, which consists of a cathode, control-grid, screening-grid and anode.

Pentode.—This is a five electrode valve, or a tetrode to which has been added a suppressor-grid.

Pentagrid or Heptode.—A valve possessing five grids or seven electrodes, i.e., five grids plus a cathode and an anode.

Triode-pentode.—When two separate electrode assemblies, forming a triode and a pentode, are contained within one bulb, the valve is known as a triode-pentode.

Triode-hexode.—Similar to the above, but in place of the pentode section a hexode is incorporated and the grid of the triode section is connected internally to the third of the four grids of the hexode.

Octode.—As the name implies, a valve of this type has eight electrodes, namely, six grids, a cathode and an anode.

Double Diode.—Two diodes contained in one bulb. The most common arrangement consists of two anodes and a single cathode, but some types have a separate cathode for each anode.

80

Glossary of Valve Terms—(*Continued*)

Double Diode Triode.—As the name implies, a valve of this type embodies two diodes and a triode section, the cathode being common to all.

Double Diode Pentode.—The same as above, with the exception that the triode section is replaced by a pentode assembly.

Class B.—A Class B valve consists of two high amplification triode sections designed for use in the output stage of a receiver or amplifier operating under Class B push-pull conditions.

Q.P.P.—Similar to above but pentodes are used in place of the triode sections.

Power Valve.—A triode having a low impedance and characteristics which make it suitable for handling large input signals, e.g., in the output stage of an L.F. circuit.

Super-power Valve.—Same as above but designed to handle even greater inputs.

Half-wave Rectifier.—A diode used for the rectification of alternating voltages using the half-wave system.

Full-wave Rectifier.—Two diodes in one bulb, normally employed to secure full-wave rectification of alternating voltages.

Impressions on the Wax

Review of the Latest Gramophone Records

H.M.V.

TO the list of recordings of British music made under the auspices of the British Council, H.M.V. have added the first recording of Sir Arnold Bax's "Third Symphony," performed by the newly constituted Hallé Orchestra, under the baton of John Barbirolli.

The recordings are outstanding in many respects, first of which is the composition and its composer. Sir Arnold Bax, who is the Master of the King's Music, is an Englishman, but often mistaken for an Irishman, due, no doubt, to the fact that he spent much of his early life in Dublin, Donegal and western parts of Ireland. He also wrote under the pseudonym of Dermot O'Byrne, sharing his activities between music and letters. He has eight symphonies to his credit, and has spent 40 of his 60 years creating works in almost every branch of composition.

Second, great credit is due to the conductor, John Barbirolli—youngest of our classical conductors—for his genius in obtaining perfect discipline and interpretation from an orchestra composed almost entirely of students. The string section is remarkably fine, and there is no doubt that this newly constituted Hallé Orchestra has a great future. These remarks would not be complete without a word of praise for those responsible for the recordings, as they form an outstanding example of technical progress in that sphere.

The recordings are on six records—12 parts—*H.M.V. C*3380-85.

The 10in. H.M.V.s I have selected this month are for dancing folks, with one exception, and that is *H.M.V. BD*1070 on which "Hutch" has recorded "My Heart Tells Me" and "Hold Back the Dawn," two numbers which "Hutch" puts over in his best style.

"Star Dust" linked with "I'm Gettin' Sentimental Over You," are two good tunes, nicely played by Ivy Benson and Her Girls Band and featuring Ivy on the saxophone. The number is *H.M.V. BD*1071.

My next record reminds one of the loss to the world of that great comedian of jazz, Thomas "Fats" Waller, as it represents one of his best contributions to the H.M.V. lists. The record is *BD*1073, "Imagine My Surprise" and "Your Socks Don't Match"—both foxtrots—and "Fats," naturally, takes the vocals and does some amazing things with the score on the piano.

Joe Loss and his Orchestra, on *H.M.V. BD*5830, have recorded two good tunes in "In Pinetop's Footsteps" and "Fan It."

Eric Winstone and his Band have selected "Tenement Symphony," which is a feature in the Marx Brothers film, *The Big Store*. For this recording, a specially augmented combination of six brass, four saxophones, four rhythm, a strong string section and a vocalist was used in an arrangement by Stanley Black. A good record, the number being *H.M.V. BD*5832.

Columbia

A LARGE proportion of Grieg's compositions took the form of short pieces for the piano, and except for those who play them at home, they have not gained the popularity of such works as his "Peer Gynt Suite" and his "Piano Concerto," or some of his songs. The lack of popularity of the shorter works is due, no doubt, to the fact that they were too brief for inclusion in recital programmes, which is rather a pity, as they are beautiful works, rich in Norwegian folk music. In this class we have Grieg's "Lyric Pieces," of which Grieg composed 10 sets, and this month Columbia has released four of these. 1. Shepherd's Boy; 2. Norwegian Rustic Dance; 3. Nocturne, and 4. March of the Dwarfs. The first two are on *Columbia DX*1142 and the second two on *Columbia DX* 1143—"Lyric Suite, Grieg, Op. 54."

These delightful works are played by the Liverpool Philharmonic Orchestra, conducted by Basil Cameron, and their performance is superb.

Handel was particularly fond of an instrument which we call to-day the oboe, and proof of this, and his great understanding of the instrument, will be found in his "Concerto Grosso in G Minor," which has been recorded on *Columbia DX*1144, by Leon Goosens, oboe, with the Liverpool Philharmonic Orchestra, conducted by Basil Cameron.

The slow movements have some delightful melodies, while the allegro sections are full of life, in fact, almost boisterous. The work calls for great understanding and technique from the soloist, but Leon Goosens exhibits complete mastery of his part and a thorough appreciation of the composer's love of the oboe.

To open my selection of the Columbia 10in. records, I have chosen *Columbia DB*2133, as it is a fine recording of "Suite Espagnole" (3 and 4), namely, "Cadiz" (Saeta) and "Asturias" (Legenda), by those two gifted and popular artists at the piano, Rawicz and Landauer.

Carroll Gibbons and the Savoy Hotel Orpheans have taken two good pieces out of the film "Thank Your Lucky Stars" for their contribution this month. They are "How Sweet You Are" and "They're Either Too Young Or Too Old," and on *Columbia FB*2993.

Victor Silvester is present in force again in the current list, as he has two records, one by his Ballroom Orchestra and the other by his Jive Band. The former play "The Wishing Waltz" and "Always" in, of course, strict dance tempo, and a very nice style. The jive record consists of "I'm Comin' Virginia" and "Poor Butterfly." *Columbia FB*2994 and *FB*2996 respectively.

Monte Rey—with orchestra—has made a good recording out of "Kiss Me" and "Serenade To A Dream," on *Columbia FB*2990. Hawaiian enthusiasts will welcome Felix Mendelssohn's latest record—*Columbia FB*2991—on which he has recorded with his Hawaiian Serenaders "To-night" (Beguine) and "In The Still Of The Night" (Beguine).

Parlophone

RICHARD TAUBER has selected two songs which enable him to make full use of his rich tenor voice and technique, and I am sure they will have a wide appeal. I am referring to "Down In The Forest" (Simpson—Landon Ronald) and "Passing By" (Herrick—Edward Purcell) on *Parlophone RO*20527. A fine record which I recommend for your library of vocals. The Organ, The Dance Band and Me, entertain one with "Happy Days, Happy Months, Happy Years," which they link with "The Dear Little Isle I Love," foxtrot and waltz respectively. *Parlophone F*2007.

"For The First Time"—foxtrot—and "The Rhythm Of The Jeep"—quickstep—are played by No. 1 Balloon Centre Dance Orchestra on *Parlophone F*2006. These are two good tunes well orchestrated and presented.

Geraldo's latest record consists of "Paper Doll," a number which has achieved amazing popularity in the U.S.A., and which is rapidly becoming very much in request over here, though, of course, one should not take the words too seriously. Coupled with "Paper Doll"—on *Parlophone F*2005—is "Thanks for The Dream" a rumba foxtrot.

For Nos. 7 and 8 of the 1944 Super Rhythm-style Series, Jimmie Lunceford and his Orchestra have recorded—on *Parlophone R*2928—"White Heat" and "Lunceford Special" two numbers which should appeal to super-rhythm enthusiasts.

Regal

THERE is a good *Regal* record of George Formby released this month, its number being *MR*3723, and on it George has recorded—in his bright and breezy style—"Serves You Right" and "Swim, Little Fish."

Finally, on *Regal MR*3725, the Stage Coach Players play for us "I Left My Heart At The Stage Door Canteen" and "This Is The Army Mr. Jones."

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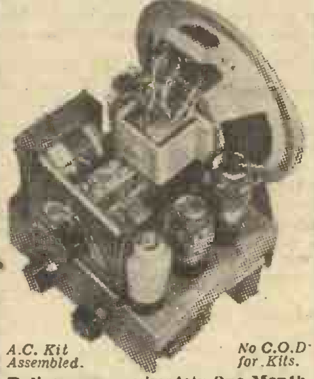

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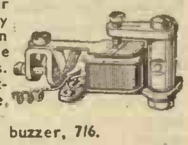

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Open to Discussion

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).

B.B.C. Transmissions

SIR,—May I be permitted to reply to the letter from Mr. D. J. Burton in your March issue?

The fact that "mush areas" exist in these very small islands is tantamount to an admission of failure on the part of the B.B.C., and this, as is usual these days, is blamed on the war.

The B.B.C. has received from time to time enormous "boosts" in the press, including their own periodicals, and their multitudinous activities have been publicised stressing the number of transmissions put out in various languages to almost unknown destinations, while right on their own doorstep there are numbers of *paying* listeners who are not able to receive the transmission at all after dark, and sometimes in daylight, too.

It is a good thing for the country that *essential* public services are still delivering the goods as required, both in quantity and quality.

Regarding Mr. Burton's last paragraph, we here, with cinemas six miles away, and bus queues to contend with, are only too pleased to hear a good concert delivered at first-class quality and power from the Continent in preference to a distorted jumble of hideous noises from the B.B.C.—C. FIELD (St. Asaph).

Radio Society of Great Britain

SIR,—I give below a report of the first meeting of the above society to be held in Reading for many years.

The Radio Society of Great Britain, Reading Branch, District 7, held their inaugural meeting on Saturday, January 22nd, 1944, at The Comrades Club, Reading. The meeting was convened by the town representative, and was presided over by the District No. 7 representative, W. E. Russell (G5WP). Amongst those present were 2BTY, G2YI, 2DIO, 3BN and Dr. Moss.

Apologies were received from many members who were unable to attend owing to Service demands.

The gathering was not limited to members only, and a well-represented company of radio enthusiasts ranged from the amateur to the research expert.

Subjects discussed included Valve Voltmeters, Cathode-ray Tubes, Absorption Meters and Short Wave Radio Communication.

It was decided to hold monthly meetings, and all interested are invited to get in touch with the undersigned at 9, Holybrook Road, Reading.—R. G. NASH (Reading).

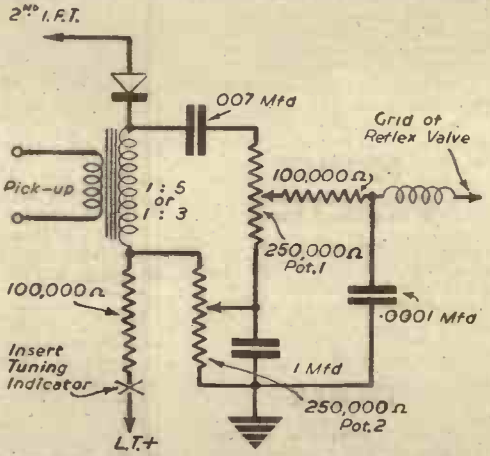
Communications-type Three-valver

SIR,—Since forwarding to you my article entitled "A Battery-operated 'Communications Type' Three-valver," I have been making some further experiments on the A.V.C. circuit which have resulted in improved performance.

With the original circuit it was often necessary to juggle with the reaction, volume and series aerial controls in order to obtain a perfectly controlled signal, as pointed out towards the end of the article. As two of these three controls affect the tuning, this was a disadvantage. The revised A.V.C. circuit contains a variable control instead of an on-off switch and enables the desired A.V.C. effect for every type of fading to be obtained much more quickly and conveniently. Incidentally, the circuit enables a pick-up to be left permanently in circuit without a switch.

The extra components required are one L.F. transformer—the small parallel feed type is very suitable—one 250,000 ohm pot., one 1 mfd. condenser, and one half-watt 100,000 ohm resistance. All the other components shown in the accompanying diagram form part of the original circuit. Pot. 1 is the original volume control and Pot. 2 the new A.V.C. control. The circuit is arranged so that the Westector has a bias of 1 volt (on a 1.4-volt valve circuit) while the reflex valve has zero bias with the A.V.C. control at zero. As A.V.C. is brought into action a positive bias is applied to the reflex valve, but this is cancelled out by the A.V.C. voltage as soon as a carrier is tuned in. The L.F. load for the Westector is the secondary of the L.F. transformer plus some resistance in series at all positions of the A.V.C. control except the full-on position. The A.V.C. load is the 100,000 ohms resistance with Pot. 2 in parallel.

Anyone who is fortunate enough to own a meter with



Improving the A.V.C. circuit of a three-valver (see D. B. Hall's letter).

a maximum reading of 100 microamps can insert it at the point marked X. This should make a very neat tuning indicator giving a direct reading of the total D.C. voltage available for A.V.C—full scale being 10 volts.—D. B. HALL (Mkushi, N. Rhodesia).

Radio Engineering: U.S. Expeditionary Forces Station

SIR,—In these times we hear quite a deal about radio engineering, but is it not time we stopped fooling ourselves? What, after all, is radio engineering?

The main principles of radio engineering are surely those of physics. For those who would say "And what about electricity?" I reply, "And is not electricity physical?" So shall we reduce radio engineering (such a nice high sounding term!) to applied physics. The sceptical remark that physics, whether applied or not, covers a multitude of sins invites the apt reply, "But radio engineering does not cover them even!"

Some will probably contend that, after all, what was Marconi if not a radio engineer. I prefer not to argue about Marconi; much has already been written on the merits of his claims to fame, and I will cite Hertz and Clerk-Maxwell, Fleming and de Forest. So these are to be known as radio engineers! But what are they? They are forerunners, pioneers, leading lights, "stars," if you like, in the sphere of radio. But who would call them radio engineers? Yet few there are who can or could outshine them in this sphere.

Let us cast aside all pretence; these brilliant figures were physicists—the physicists of their time. Those who have followed after have applied their work, and are merely developing physical principles.

Applied physics, then, or if we *must* differentiate—applied radio physics.

I believe many would like to append the word "engineering" to every particular sphere of application. Perhaps meal-time is, after all, only the test of successful "dietetic engineering." May the very terms they invent swallow them up!

And now for some information:

On 214 metres—the "American Expeditionary Forces Station in the European Theatre of Operations"—audible in the West Country at quite good programme strength in the evening until 10.30 p.m. when it closes down. I have not heard it regularly but it is worth listening for (there is trouble with "sideband splash" at times).

On medium waves between Cologne and the B.B.C. transmitter (North Regional) now radiating the Home Service programme: the "American Expeditionary Forces Station in the Mediterranean Theatre of Operations" closes down at 10.30 p.m.—strength and quality of reception depends on local and weather conditions.—"Osc" (Abbey Wood).

B.O.T. Licences

SIR,—The letters published from time to time show the urgent need for an organisation of radio technicians to fight for just treatment and to marshal their case for representation.

Licences for trading after the war will become extremely difficult to obtain, and if we have no organisation to see our case through it is certain that we shall be under the gravest disadvantage, whilst other sections of the trade—traders who have many branches with a few skilled technicians, will be in an advantageous position.

Several of my friends and fellow radio engineers feel this way, and are forming a committee to do something about it. If any person who is interested will please contact me, this proposed committee will formulate procedure and get the project under way.

We are marshalling support and envisage holding a meeting in central London at an early date.—J. LEVITT, 195, High Street, Sutton, Surrey.

S.W. Broadcasts

SIR,—Those who have written to PRACTICAL WIRELESS about the Free Jugoslav station may be interested to know its exact location. It is in Tiflis, Georgia, South Russia, as may be suspected by the type of news it broadcasts. Here are some items about other short-wave stations. Leopoldville gives programmes in English at 12.00 and 14.00 hrs. on 19.33 metres and at 16.30 hrs. on 30.66 metres. The A.B.C. have opened two new transmitters for their Asia service, VLG Melbourne 31.32 metres, and VLI4 Sydney 41.45 metres. They give an English programme from 15.15 to 15.45. VLG is the better signal. The World Wide Broadcasting Foundation, Boston, have opened a new transmitter, WRUA on 25.45 metres, 11.79 mc/s. till 18.30 and on the 26-metre band, 11.145 mc/s., from 18.45. The CBS have opened two new transmitters, WOOC on 19.75 metres and 31.09, and WOOW on 25.27 metres. United Nations Radio operates on 31.45 metres during the afternoon. The "Voice of America" gives the news at 16.00 hrs. in basic English, consisting of not more than 850 words. Rio de Janeiro operates on 30.86 metres in the evenings but I do not know the call sign. All times B.S.T.—S. HUDSON (Cambridge).

Cementing Valve Bases

SIR,—With reference to your reply in the February issue of PRACTICAL WIRELESS to C. P. (York) regarding "Repairing a Valve," I submit the following "recipe," which I have found to be most effective in joining metal, etc., to glass. It was given to me by a local radio service man, and he showed me numerous repairs to loose valve bases such as your querist has encountered.

Mix a small quantity of plaster of paris with Certofix glue, to a thick workable paste. Lift the glass bulb a little, and place cement all round the base and press glass well on to cement. This sets hard in a day and no further trouble will be encountered. The surplus cement which oozes out as bulb is pressed in should be trimmed off before it has set. Otherwise it will have to be *chipped* off! The quantity of plaster of paris for this job will only need about two or three teaspoonfuls, and the "dental" plaster, obtainable at any chemist, is the best.

The cement is only placed *around* the *edge* of base and, of course, should not fill the whole cavity. The valve can be put into use immediately, care being taken that the tube has bedded down well.—R. ERIC OWEN (Weston-super-Mare).

Midget One-valver

SIR,—We recently constructed the "Midget One Valve" set described in the October issue of PRACTICAL WIRELESS, and excellent results have been achieved. Using a 6ft. indoor aerial, the Home, Forces and Overseas programmes were received, exceptional reception being obtained on Home and Overseas.

The valve used was Cossor 220 O.T., the original being unobtainable in these parts.

It was found that an earth improved the performance considerably, and that a counterpoise earth also gave improved results.—H. GARDNER and D. H. BIRD (Orkney Islands).

SIR,—I was interested in F. G. Rayer's letter in the December issue of PRACTICAL WIRELESS, *re* the Midget One-valver of the October issue. I made it up from old parts, and added above the plug in valve base a .0003 max.-.000025 min. pre-set condenser and found with 12 volts H.T. and an attic aerial of 40ft. that the set brings in at very good strength the Home, European and Forces programmes, and is very selective. On nine volts the Home Service is very good and works well with a great deal louder signal with an earth wire attached to L.T. minus. On nine volts it does not oscillate very well, but on 18 volts it gives good signals on two sets of 2,000Ω 'phones.

It is a splendid stand-by if one has large H.T. batteries run down, and which are not always obtainable in these country districts.—A. W. JAMES (Wokingham).

SIR,—I recently constructed the 0-v-1 RX described by F. G. Rayer several months ago, but with two alterations. I am using four-pin coils, and have connected the grid leak to the sliding contact of a potentiometer across the L.T. I can make reaction as smooth as I desire by moving the sliding arm round to L.T. negative.

This RX works very well indeed and gives good loudspeaker strength on many signals; the valves are PM2HL det. and PM22A output.

On Saturday, November 27th, at 13.15 B.S.T., I heard VWY2, Poona, closing down and asking for reports of reception. The transmission was on 16.7 m. approximate. I can only give the wavelength approximately as I have not yet been able to calibrate my set properly.

Allied Force H.Q. in North Africa usually transmits despatches to Press Agencies in New York and London and occasionally material for B.B.C. recordings, on Sundays at about 13.00 on 18.6 m. approximate. It usually announces that it will be on the air later in the afternoon.

On December 12th A.F.H.Q. was in contact with the B.B.C. and also GBB2; I heard the replies from them very faintly.

Leopoldville, 16.88 m., gives a programme in English from 12.00 to 12.30 B.S.T.; Boston now uses call-signs WRUL, WRUW, WRUS (or X?) and WRUA.—P. GOLLEDGE (Rayleigh).

Replies to Queries

Mains Smoothing

"I have modified my set which is an A.C. model. There is a rather small choke in the H.T. lead which was previously suitable, but I have modified the output stage with much greater current. The rectifier will supply the extra, but the problem will be smoothing. I do not want to alter the dropping resistances in previous stages and wonder what is the best plan for me in this case."—V. S. (Bristol).

THE best plan would no doubt be to obtain a new choke and use this for smoothing only the output stage. In this way you would not need a very substantial component (compared with substituting your present choke for all stages) and, furthermore, additional smoothing will be provided for the stage owing to the smaller current which will flow through it. Thus there will be two chokes in your circuit, the smaller feeding the early stages, and the other taking only the output stage. A 4 mfd. condenser should, of course, be joined across the receiver side of the choke in the usual manner.

Condenser Damage

"I have just built a short-wave one-valver, but find that as the condenser is turned there are loud bangs and clicks, and on looking I see that the vanes are all touching. Should this be so, or have I been sold a dud condenser? I might mention that this is my first constructional attempt."—W. B. (Bognor).

YOU have probably fallen into a common trap which meets the beginner. The hole you drilled in the panel for the condenser was probably slightly on the small side, and instead of enlarging the hole you probably forced the condenser through and the pressure on the end plate has forced the supporting strips outwards and thus distorted the entire condenser framework. Always make certain that fixing holes provide sufficient clearance to enable components to be mounted without forcing.

S.W. H.F. Choke

"Could you give me an idea what inductance I should need for a short-wave choke to use in a set designed to cover from about 5 to 70 or 80 metres? I thought a former about 1in. in diameter would be suitable as I have a paxolin former of that size available."—P. G. (Raynes Park).

AN inductance of 170 to 180 μH would be satisfactory, and 100 turns of 26 or 28 enamelled wire close wound would give you a suitable inductance value. If you require a rather high degree of efficiency we would suggest that you split the winding into, say, five sections, each separated by about ½in.

Speaker Position

"I am rather disappointed by the results given by my new speaker. This has been stated to be a very good model and I know my set is good as it is designed for quality. The reproduction is not, however, satisfactory for the price I have paid, and I wonder if you can give me any advice in the way of improving it."—R. H. (Blackpool).

WHILST your set may be quite good from the theoretical point of view and the speaker may also be good theoretically, there may be several points resulting in the inferior results. Firstly, there may be need for some form of tone correction to cut out resonances. Secondly, you may not be correctly matching the speaker to the set. Thirdly, the results may be seriously affected by the acoustics of the room. If you placed the set and speaker in a modern recording studio, for instance, it would perhaps sound excellent, but the furnishings of your room may be having a marked effect on the high notes, or lack of furnishings, bare floors, etc., may be hardening the tone. Therefore, you should attend to these points before making any attempt to modify either set or speaker.

Bias Problem

"I have a standard transformer-coupled output stage and am in a difficulty regarding bias. When the plug is removed from the battery the performance is all that is desired, but as soon as the plug is put back reception is weak and poor. I have tried a new battery, replacement of the valve and secondary winding for break, but I cannot find any such fault as exhausted bias battery, weak valve or short. I should be glad if you could help me."—B. B. (Balham).

THE fact that the insertion of the plug affects results proves that the grid circuit (transformer flex lead and plug) is complete, and therefore the trouble is most likely due to the fact that the minimum bias you can apply is too much for the valve. This could be due to a low H.T. voltage, or the use of the wrong type of valve. In some cases it has been found, however, that G.B. batteries are marked with wrong polarity and we therefore suggest that you try reversing the particular batteries you are using. A negative potential must be applied to the grid.

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.

Aerial Coupling Coil

"I have been making one or two coils lately and am rather puzzled by the effects of the primary or aerial winding. Although I have used the same number of turns I have found that signal strength is varied by the spacing of the winding and I should like to know whether this is usual, or whether I have done anything wrong in the winding. (A sketch of the coil was attached.)"—C. P. (Harrow).

THE number of turns on a primary winding is not the sole factor in an H.F. transformer. For highest efficiency the primary should be coupled *inductively* to the secondary and any capacity coupling which exists will affect efficiency. Unfortunately it is not possible entirely to avoid capacity coupling, but you will find if you use a very fine wire primary, wound in such a way that turns of wire make a slight angle with the secondary turns, and with a fair spacing between the two windings, selectivity would be much higher than if you use a thick wire primary wound exactly parallel to the secondary. A good plan for experimental purposes is to make a former for the secondary sufficiently large to permit another former to be inserted inside it, and to provide two-pin and socket connections inside the coil. You could then wind different types of primary and insert them in the secondary in order to see the effects of the different windings.

REPLIES IN BRIEF

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

R. A. N. (Belfast). No, it will not be possible to use the output transformer for the input component. Some of our advertisers might be able to assist you.

R. H. R. (N.12). There are several American radio publications, but during existing conditions the supply in this country is naturally restricted.

P. McM. (Shotts). We do not think that the set would work as a portable in the sense of having its own self-contained aerial, therefore we advise you to use, say, a 20 or 30ft. length of thin insulated wire as a throw-out type of aerial.

P. R. B. (N.W.11). The trouble is evidently due to L.F. instability. We advise decoupling of the preceding anode circuit or a small by-pass condenser between output anode and common negative line. Check bias circuit of the 25A6Q; if that is perfect, the effect mentioned may, if only slight, be due to the characteristics of the valve.

T. P. D. (Blackburn). We are unable to assist as the issue you require is out of print. The speaker could be rewound if you care to get in touch with one of the firms who specialise in such work. It is not an expensive matter.

D. N. A. (Hammersmith). The subject is far too comprehensive to be dealt with as a query. To secure constant speed, the motors are usually of the induction type.

W. R. W. (Steyning). We cannot undertake to supply diagrams to suit individual requirements. Equipment for Home Recording purposes is in very short supply, and a permit is necessary before purchases can be made.

E. S. (Dagenham). You need not be concerned with the H.T. consumption in the case in question, it being sufficient to calculate the voltage drop produced by a given resistor when carrying the filament current of the receiver. Divide the voltage to be dropped by the filament current.

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The "Pyramid" One-valver (HF Pen) .. .. .. — PW93*

Two-valve : Blueprint, 1s.
The Signet Two (D & L F) .. — PW76*

Three-valve : Blueprints, 1s. each.
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 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
The "Colt" All-Wave Three (D, 2 LF (RC & Trans)) .. — PW72*
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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) .. — PW87
The "Hurricane" All-Wave Three (SGD, (Pen), Pen) .. — PW89
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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
"Acme" All-Wave 4 (HF Pen, D (Pen), LF, Cl. B) .. — PW83
The "Admiral" Four (HF Pen, HF Pen, D, Pen (RC)) — PW90*

Mains Operated

Two-valve : Blueprints, 1s. each.
A.C. Twin (D (Pen), Pen) .. — PW18*
Selectone A.C. Radiogram Two (D, Pow) .. .. — PW19*

Three-valve : Blueprints, 1s. each.
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D.C. Ace (SG, D, Pen) .. — PW25*
A.C. Three (SG, D, Pen) — PW29
A.C. Leader (HF Pen, D, Pow) .. — PW35C*
D.C. Premier (HF Pen, D, Pen) .. — PW35B*
Unique (HF Pen, D (Pen), Pen) .. — PW36A
F. J. Camm's A.C. All-Wave Silver Souvenir Three (HF Pen, D, Pen) — PW50*
"All-Wave" A.C. Three (D, 2 LF (RC)) .. — PW54*
A.C. 1936 Sonotone (HF Pen, HF Pen, Westector, Pen) .. — PW56
Mains Record All-Wave 3 (HF Pen, D, Pen) .. — PW70*

Four-valve : Blueprints 1s. each.
A.C. Fury Four (SG, SG, D, Pen) — PW20*
A.C. Fury Four Super (SG, SG, D, Pen) .. — PW34D
A.C. Hall-Mark (HF Pen, D, Push-Pull) .. — PW45*
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F. J. Camm's "Limit" All-Wave Four (HF Pen, D, LF, P) .. — PW67*

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The index letters which precede the Blueprint Number indicates the periodical in which the description appears: Thus P.W. refers to PRACTICAL WIRELESS, A.W. to *Amateur Wireless*, W.M. to *Wireless Magazine*.

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