AN ECONOMY HIGH-FIDELITY RECEIVER

Practical Wireless 9D

Editor F. J. CAMM

Vol. 20. No. 452 NEW SERIES FEBRUARY, 1944

PREMIER RADIO

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04A	12.26 m.	... 2 6	06A	12.26 m.	... 2 6
04B	22.47 m.	... 2/6	06B	22.47 m.	... 2 6
04C	41.94 m.	... 2/6	06C	41.94 m.	... 2 6
04D	76.170 m.	... 2 6	06D	76.170 m.	... 2/6
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Practical Wireless

and PRACTICAL TELEVISION

EVERY MONTH
Vol. XX. No. 452. FEB., 1944.

Editor F. J. CAMM

COMMENTS OF THE MONTH BY THE EDITOR

More Radio Sets

THE Radio Manufacturers' Association has issued a statement on the supply of radio receivers—a statement which has the approval of the Board of Trade. It affirms that broadcast listening has always been recognised by the Government as a matter of national importance, and it excuses the lack of supplies on the ground that the radio industry is fully engaged on work of the highest priority, and this difficulty had to be overcome in planning the production required to replace worn-out sets and those destroyed by enemy action. The radio industry has been given authority to complete the receivers which were left partly finished when the manufacturers changed over to the production of radiolocation equipment and other war requirements. Seventy-five thousand civilian sets still required completion on September 30th last, and these will be made available as soon as possible.

In view of the inadequacy of this quantity to meet present demands, arrangements have been made to import a substantial number of sets from America, and 10,000 have already arrived in this country. The imported sets are of widely varying types and the work of testing and repairing when necessary to ensure suitability for the British market is in hand. It is anticipated that the majority of these sets, and also the 75,000 British sets, will be on the market early in 1944.

Replacement Sets

FOR 1944, arrangements are well advanced for the production of wartime receivers in this country. There is a great and ever-growing need for replacement sets and parts, and the production of these is being carried out with the full approval of the Government.

The sets will be made to a standard design by various manufacturers, but will not be sold under the trade names of their makers. They will be sets for A.C. mains and battery operation, and distribution will be through normal trade channels, with preference to those areas most urgently in need of sets, but substantial quantities are not likely to be available before June, 1944. The prices of these wartime sets and the imported sets will be covered by maximum price orders.

The annual peacetime output of the radio industry was in the neighbourhood of 1,250,000 sets. Few have been made since the war began, and the numbers now planned will not provide for the replacement of those sets which are still in good working order. They are intended for members of the public without means of listening, and existing sets should receive careful treatment to keep them in good working order. Whilst it is pleasing news, we do not favour the marketing of receivers on the pool system. It smacks too much of a people's set, as in Germany. It smacks of State control, which this country does not want, and after the war will not have. We therefore think the R.M.A. should have insisted that manufacturers be allowed to complete their receivers on their own individual lines. Under the present system the public will gain the impression that the only difference between one manufacturer's wares and another lies in the design of the cabinet.

American Radio Production

TOTAL radio production in America, which about a year ago stood at £6,000,000 a month, is now approaching £60,000,000 a month, representing a considerably greater rate of increase than that of total war production. All such production is for the armed Services. In the majority of the military sets being made, receiver and transmitter are associated. A number of radio products are still secrets of war, and new developments have to be met by widened training in operation and maintenance, but are responsible for intensified research and development, usually by private companies, standardisation, purchase, storage and distribution. The war has brought about an increased use of "Walkie Talkies" and "Handy Talkies." During 1941, the last normal year of production, about 13,000,000 domestic broadcast receiving sets were manufactured in America, and in April, 1942, when production ceased in favour of manufacture of military equipment, several million sets remained in the hands of manufacturers and dealers. There are still certain models on hand for purchase, all of them, of course, well over a year old. If automobile sets are included, there are 60,000,000 receiving sets in the United States—about one set for every two inhabitants. Since there are only about 31,000,000 families in the U.S.A., it is apparent that a goodly number of American families own more than one radio with which to listen to the 900 standard broadcast stations almost continuously radiating programmes.

As in this country, so in America, many domestic receiving sets are deteriorating from age and lack of adequate service, the greatest difficulty at the present time being the shortage of valves.

In this country we need an immediate modification of the Board of Trade licensing system, which is operating against the interests of the public. It is grossly unfair that local traders should be allowed power of veto over other traders who may wish to service or sell wireless apparatus.

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

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

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

ROUND THE WORLD OF WIRELESS

Utility Radio Sets

UTILITY radio sets are not likely to be available in large quantities before June this year. They will be made to a standard design by manufacturers for use with A.C. mains and batteries, and will be sold through normal trade channels, with preference to areas where sets are most scarce. About 75,000 U.S. sets are also expected on the market early in the New Year.

Teheran Conference Televised

IT is reported from New York that the National Broadcasting Company sent out from its television station on top of the Empire State Building in New York newsreel scenes of the Teheran conference. Films were flown by the U.S. Army Air Corps from Persia to the United States, and within a few hours of their release were being radiated from New York and relayed to another television station in Philadelphia.

Bari Wireless Station

THE Bari Broadcasting Station, which was recently captured intact by the 8th Army, is the first radio station on the European mainland to fall into British hands. This 20-kW. Marconi transmitter, which was employed as a relay station, was erected in 1932.

Radio Relays

DESPITE the fact that there is now one less exchange, the number of subscribers to radio relay exchanges is still increasing. There are at present 276 exchanges, and the number of subscribers increased by 7,644 during the three months to June 30th, making a total of 455,588 subscribers at that date.

I.E.E. Meeting

THE Institution of Electrical Engineers held a special meeting in the Lecture Theatre of the Institution on November 25th to commemorate the life and work of Nikola Tesla. A lecture, illustrated by examples of Tesla's experimental work, was delivered by Dr. A. P. M. Fleming, C.B.E., M.Sc. Slides were shown illustrating some of Tesla's pioneer work in the early 'eighties, and interesting practical demonstrations were given with various pieces of apparatus, including high-voltage discharges through several feet of vacuum tubes, and the production of four-foot sparks through the atmosphere.

The Men Who Watch

"TO-NIGHT'S TALK." is often a last-minute surprise, depending on the news of the moment. But on December 10th it was given by Air Commodore Finlay Crerar, O.B.E., Commandant of the Royal Observer Corps, and in it he paid tribute to the vigilant men under his command who go out night after night to lonely stations to keep watch and give warning of the approach of enemy aircraft. Theirs is work which may indeed be "news" any moment of any 24 hours, but it is seldom heard of. It is none the less important for that.

In August, 1939, these men—many of them considerably over military age, some far from fighting fit—went out to the fields, hills and mountains; to the Cotswolds of England, the Ochils and Grampians of Scotland, the Welsh Mountains, and the fens of Norfolk, to posts all over Britain which had been carefully sited as possessing the best views and easiest communications. They went, too, to the high roofs of London and cities all over the country and kept constant watch.

"Songs from the Shows"

JOHN WATT, who happens to be one of the B.B.C.'s best broadcasters, as well as being its Director of Variety, returned to the air on December 28th in the Forces programme. "Songs from the Shows," which has not been heard for several years, is coming back. There will be a resident team of singers and the music for this famous and highly popular series will be played by the B.B.C. Revue Orchestra, conducted by Charles Groves, and John Watt will co-produce with Henry Reed as well as introduce. The Revue Orchestra has lately been winning high praise for its able and versatile performance in the weekly "Bandstand."

There are no daily newspapers on Ramsey Island, off the West Coast of Wales, so the only means of getting news is by radio. Outside communication, in case of emergency, is by morse lamp. In the illustration, Mr. A. Griffiths, the farmer in charge on the island, is seen listening to the radio.

203-metre Wavelength

THE B.B.C. would like to draw the attention of listeners to the fact that certain areas in England, Scotland, Wales and Northern Ireland are serviced by low-power transmitters. If, therefore, reception of the Home Service is not satisfactory on 449 or 391 please try tuning in to 203 metres. This means that three different wavelengths are available on the Home Service, 449, 391 and 203 metres.

Red Cross Benefits

ON Armistice Day a letter containing a cheque was sent to "B.B.C. £250 Red Cross Radio Contest, London, W.C.2." This is what it said:

"Dear Sirs,—I have frequently listened in to your broadcast competition, but have never sent in my answers, as I felt that they were bad. I now realise that by not doing so I deprived the Red Cross Fund of whatever I may have been prepared to send with my entries. I have, therefore, decided to send you £250 for your Fund and I now enclose a cheque for this amount. Should you think that this should cause others to follow my example you are at liberty to publish it, provided you preserve my anonymity.—Yours truly, 'VISITOR FROM THE COLONIES.'"

Around the Pantomimes

THIS Christmas, as usual, the B.B.C. took outside broadcasts from a large selection of pantomimes up and down the country. Wartime pantomimes are perhaps a little less exuberant than usual. Many artists are in the Forces; clothes are rationed. Properties are short. There are other difficulties. Despite them all, pantomime goes on. Excerpts from various pantomimes, including "Humpty Dumpty," "Red Riding Hood," "Robinson Crusoe" and "The Sleeping Beauty," have recently been broadcast.

A second Birmingham pantomime will be visited on January 8th. This is "The Babes in the Wood," at the Alexandra Theatre, Birmingham, with Syd and Max Harrison, Eddie Leslie and the Fayre Four Sisters.

The microphone returns to the North on January 12th for a glimpse of a different "Sleeping Beauty," in Liverpool this time, with Beryl Reid, Tessa Deane, Wilfred Pickles and Douglas Byng.

On January 13th there is a broadcast from one of the most popular of all pantomimes, "Cinderella," at His Majesty's, London, where Evelyn Laye is principal boy in a cast which includes Carol Lynne, Tessie O'Shea, George Moon, Burton Brown and Gaston Palmer.

B.B.C. Entertains Wounded Men

SICK and wounded men back from the Middle East were brought by the Red Cross to a B.B.C. studio recently, where they heard a playback of a programme called "Here's Wishing You Well Again," which is broadcast fortnightly in the General Overseas Service and is directed to men in hospitals overseas.

The idea for the party came from the co-producers of the programme—Jill Allgood and Howard Agg—who were anxious to get reactions of wounded men to it so that they could be sure in the future that they were giving these men what they wanted.

Factory, Farm and Forces

THE Northern microphone on Christmas Day visited factory, farm and Forces in a composite programme. In the factory, where some of the maintenance staff were on duty, their fellow workers came to give them a show; dinner-time aboard ship in a Northern port was described, and members of the Land Army were visited as they ate the Christmas dinner they helped to produce. Their programme closed with an exchange of toasts between the factory's managing director, the ship's C.O., and a well-known agriculturist.

Transatlantic Call

THIS Christmas many families were again separated. The B.B.C., in co-operation with the Columbia Broadcasting System, brought some evacuees and Servicemen to the microphone so that they could be reunited with their families over the air.

The programme was a two-way one. Listeners were able to hear children evacuated to the U.S.A. and Canada in conversation with their parents in Britain. Four American soldiers serving over here talked to their families in New York. Canada was represented by four Servicemen in Britain, two from Montreal and two from Ottawa.

Outside Broadcasting

THE Outside Broadcasting Department was exceedingly busy during the Christmas season. There was a broadcast from the Nuffield Centre, London's newest Services Club, on December 21st, when Flanagan and Allen, Tessie O'Shea, George Moon, Burton Brown, other artists from "The Love Racket," appeared in cabaret produced by Frank More O'Ferrall.

On December 23rd came a big concert from a hall where an audience of 2,000 troops were present at "The Services Entertainment," given by their fellow men.

On the afternoon of Christmas Eve came "Christmas Postbag," a special delivery of greetings from men and women in uniform, wherever they were between Iceland and New Zealand. In the early evening Michael Standing was "Standing on the Corner" of a London street asking passers-by for their thoughts on Christmas, and later there was an entertainment from a hall where local people provided a concert for the benefit of American troops stationed in the neighbourhood, for which the Americans provided the band.

At a U.S. Artillery School in China, an American gunnery instructor checking range data with a battery of artillery over a field radio set.

Pantomimes

OTHER outside broadcasts on Christmas Eve were half an hour's pre-view of pantomimes from three Midland theatres and a carillon exchange between Loughborough, in Leicestershire, and Ottawa, in Canada. Loughborough has been a centre of bell-founding since the fourteenth century and its carillon, built as a war memorial, has 47 bells and was the first grand carillon in this country.

On Christmas morning Michael Standing and Gilbert Harding were heard going the rounds with Britain's postmen, Standing in the Borough of London and Harding in the Cambridgeshire village of Grantchester, talked to the happy recipients of letters and parcels and commiserating with those not so fortunate.

Distortion

An Interesting and Important Subject Dealt with in a Concise and Instructive Manner

By J. ROBERTSON GREER

DISTORTION is perhaps best defined as the difference between that which is received by the microphone in the broadcasting or recording studio, and that which emanates from the producing loudspeaker or headphones. There are, however, several kinds of distortion which may be present in greater or lesser degree, and which do not appear to have any effect on the human ear. Thus the problem of "removing" distortion really consists of reducing the objectionable forms of distortion to such a level that they may be neglected.

The principal forms of distortion may be classified under the following headings:

A — Good Selectivity — Narrow A F Range
B — Poor " — Wide " "
C — Good " — Wide " "

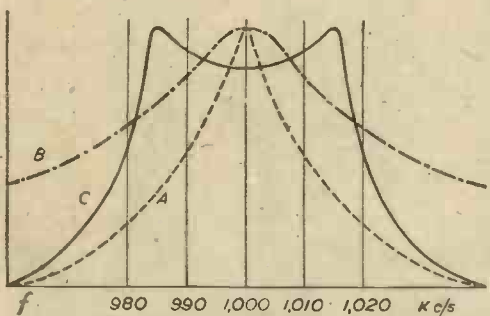


Fig. 1.—Shows the effect of selectivity on L.F. frequency response.

Frequency Distortion

The normal useful range of frequencies is from about 50–10,000 c/s (though for high fidelity it is often taken as 15–15,000 c/s), and, for perfect results, all should equally be reproduced. Frequency distortion implies that one particular frequency, or band of frequencies, is reproduced at a different level from the rest of the acoustic spectrum. There are two main types of frequency distortion. The first implies a lack of balance between the bass, middle and treble registers. This is not really objectionable—fortunately—but if there is a serious lack of bass, the reproduction sounds "tinny," while if the treble is weak—as it too often is in commercial sets—the reproduction is muffled, and consonants, particularly sibilants like "S," become indistinct.

The second type of frequency distortion may be termed "peaky," and can be really unpleasant. It may be likened to a piano in which some notes do not play at all, while others ring forth unpleasantly loud. As may be imagined, a scale played on such an instrument would sound rather erratic. This type of frequency distortion is not generally serious for speech, but for music it may be very conspicuous indeed, particularly with certain instruments such as violins.

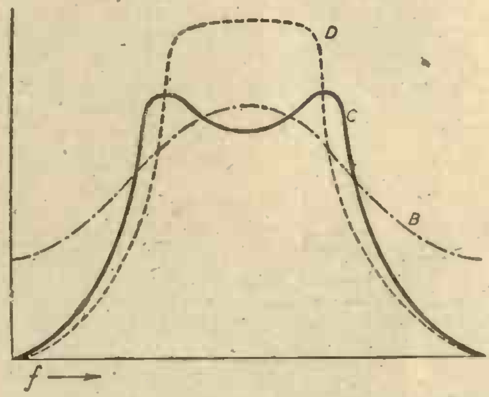


Fig. 2.—If suitable tuning circuits can combine B and C the square topped curve D will result.

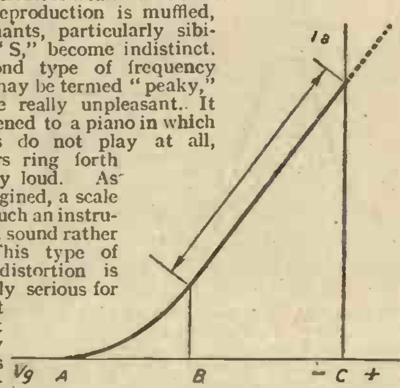


Fig. 4.—A typical anode current grid volt curve.

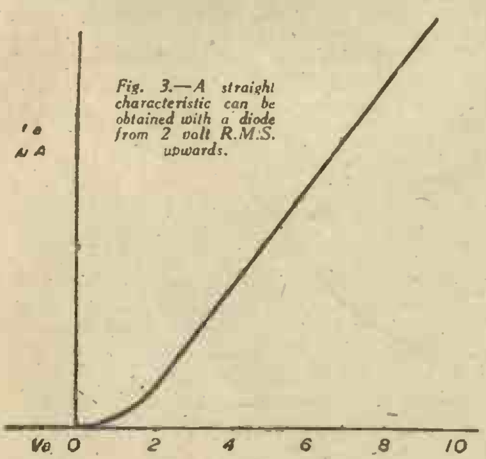


Fig. 3.—A straight characteristic can be obtained with a diode from 2 volt R.M.S. upwards.

Non-linear Distortion (Harmonics and Combination Tones)

A harmonic of a note is a frequency which is an exact multiple of the first, or fundamental, frequency. For instance, if we have a fundamental frequency of 100 c/s, its second harmonic ($f \times 2$) is 200 c/s. its third harmonic ($f \times 3$) is 300 c/s, its seventh harmonic ($f \times 7$) is 700 c/s, and so on. It is these harmonics which give colour or "timbre" to a voice or instrument, and in themselves they are not generally unpleasant.

Combination tones are the result of passing two different frequencies through a non-linear apparatus such as a wrongly biased valve. If two frequencies, f_1 and f_2 of perhaps 400 and 360 c/s respectively, are mixed, combination tones of f_1+f_2 and f_1-f_2 will be produced, i.e., 760 and 40 c/s. As, however, harmonics are also produced by a non-linear amplifier, we will have, in addition, harmonics of each of these four frequencies, and combination tones of the harmonics.

Let us suppose the third is the predominant harmonic: We have fundamentals 400 and 360, combination tones 760 and 40 c/s, plus third harmonics of above: 1,200, 1,080, 2,280 and 120 c/s. Combination tones of harmonics: 3,360, 2,160, 3,480, 1,320, etc.

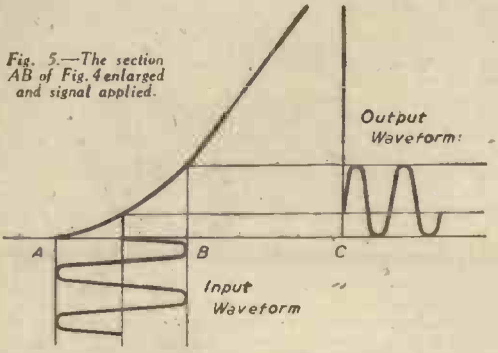


Fig. 5.—The section AB of Fig. 4 enlarged and signal applied.

Clearly, the result will be very different from the two initial frequencies, and may be very unpleasant, as combination tones may be produced by any of the harmonics.

It would appear that it is not the harmonics themselves so much as the various combination tones produced by the harmonics, which are serious, and thus it is the higher order harmonics which produce the most unpleasant effects. In fact, it has been suggested that the percentage of a harmonic should be multiplied by

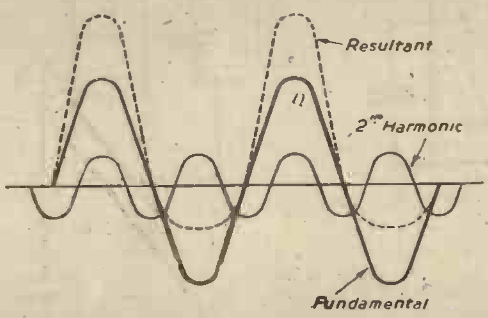


Fig. 7.—Combining a fundamental with its second harmonic produces the broken curve.

its order to get the true value. For example, if the maximum permssible for second harmonic distortion is 5 per cent., the maximum for fourth harmonic is half this, i.e., 2.5 per cent.

Phase Distortion

The ear does not appear to be sensitive to phase distortion: if it were, music would sound different at varying distances from the source. It has, however, very serious effects on television.

Cross-modulation

This implies the unintentional modulation of one frequency by another. At R.F. the signal from one station may modulate that from another, in which case the cure is improved selectivity. With A.F. a sound of fairly high frequency may be modulated by one of lower frequency, a common example being a violin with organ accompaniment. As it most often occurs in the speaker, the best cure (should it be necessary) is to use separate high and low frequency speakers, with a dividing network.

CAUSES OF DISTORTION IN R.F. AMPLIFIERS

Frequency Distortion

As mentioned earlier, if two frequencies are mixed, combination tones consisting of $f_1 - f_2$ and $f_1 + f_2$ occur. This holds, even if the two frequencies are of widely different values; even if one is R.F. and the other A.F. Thus, when an R.F. carrier wave of, say, 1,000 kc/s (300 m.) is modulated by an A.F. signal of 10,000 c/s or 10 kc/s, two other frequencies will be produced, i.e., 1,000 kc/s − 10 kc/s (990 kc/s) and 1,000 kc/s + 10 kc/s (1,010 kc/s). Thus, in order to receive audio frequencies up to 10 kc/s the set must receive not only 1,000 kc/s, but also 990 kc/s and 1,010 kc/s (Fig. 1). If the set has fairly good selectivity, as indicated by the dotted line "A," the higher audio frequencies will be almost entirely suppressed. You have probably come across sets—particularly superhets—where you had to tune them to the edge of a station to make speech clear.

One way, then, is to have very flat tuning ("B" Fig. 1), but a better method is to use band-pass coupling in which two very selective tuned circuits are coupled together. As the coupling is increased a double-humped resonance peak appears, as shown at "C," Figs. 1 and 2. This retains the steep sides of the individual circuits, but provides a broad, flat peak which will reproduce all audio frequencies. If this curve "C" is combined with curve "B" an almost square top "D" is obtained (Fig. 2). Thus, two selective circuits in band-pass, together with a fairly flat single circuit, are desirable.

Non-linear Distortion

This type of distortion is frequently found in the detector stage of a set, and, as its name implies, may be caused through operating on the curved portion of a valve characteristic. The anode bend detector almost inevitably causes distortion. The leaky grid detector

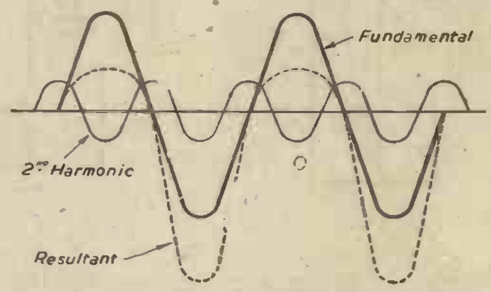


Fig. 8.—When grid current flows it can produce an inverse form of second harmonic distortion.

is normally free of it, but a strong signal will move the operating point on to the curve, and distortion may be very serious.

The diode detector has a straight characteristic from about 2v. R.M.S. upwards, so, provided the signal does not fall below a certain level, this should not cause any trouble (Fig. 3). If, however, the A.C. load on a diode is not substantially equal to the D.C. load, very serious non-linear distortion may take place. Various circuits have been evolved to overcome this, such as

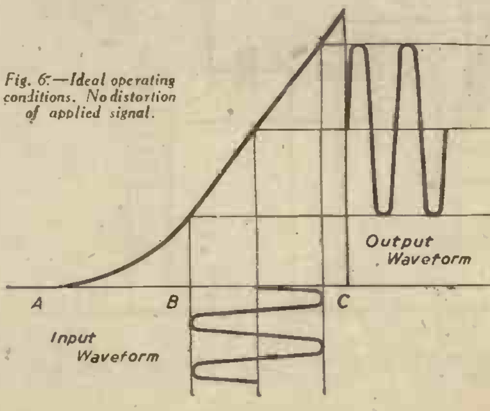


Fig. 6.—Ideal operating conditions. No distortion of applied signal.

the use of two diodes in push-pull, but none has so far become popular. The diode is, nevertheless, much more satisfactory than the triode as a detector.

A.V.C.

Various forms of distortion may arise from the use of A.V.C. (or automatic volume control), and, generally speaking, it is not necessary or desirable for local stations, particularly if high fidelity is aimed at. Although some of the troubles outlined below may be removed, or reduced by careful design, the simple A.V.C. generally employed has many drawbacks.

If the time constant is too short, it may cause non-linear distortion, or at least serious attenuation, of the lower frequencies.

Transients, such as clashing of cymbals, or staccato chords, will be distorted.

A.V.C. is intended to minimise changes of volume due to fading, etc.; unfortunately it also "irons out" variations which are desirable, and increases background noise. It is only necessary to hear an orchestra with and without A.V.C. to realise the profound effect it has on the contrast and vitality of the music.

CAUSES OF DISTORTION IN A.F. AMPLIFIERS

Frequency Distortion

Lack of high notes may be caused by excessive R.F. decoupling condensers in diode or triode detector circuits, or by too large a grid leak which is shunted by the grid/cathode capacitance of the valve in R.C.C. circuits. Similarly a high anode/cathode capacitance in the preceding valve, especially if it is of the high-impedance type working into a high anode load, may cause losses. In R.C.C. circuits a large coupling condenser is often blamed for high-note loss. This is incorrect. A large coupling condenser reduces losses at the low-frequency end of the scale and provides an increased proportion of bass, which may make a lack of treble more noticeable, but to reduce the coupling is merely to make the reproduction thin at both ends.

Lack of bass may be caused, in R.C.C., by an inadequate coupling condenser, or by too low a grid leak value. In transformer-coupled circuits an inadequate primary inductance in the coupling transformer will cause bass losses. As the inductance of an iron-cored solenoid decreases with a heavy current flowing through it, an improvement may sometimes be effected by parallel-feeding the transformer. This, by removing from the primary the direct current which tends to cause saturation of the core, will increase the primary inductance. In choke-capacity-coupling, loss of bass may be experienced due to unsuitable design, or to saturation. The main advantage of this type of coupling is that, as the reactance of a choke rises with frequency, it may in some measure compensate for losses in the upper register caused by the cutting of side-bands, as referred to earlier. It is not, however, to be recommended.

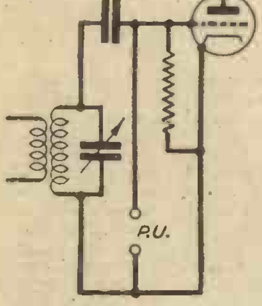


Fig. 10.—A common method of connecting P.U. Not satisfactory.

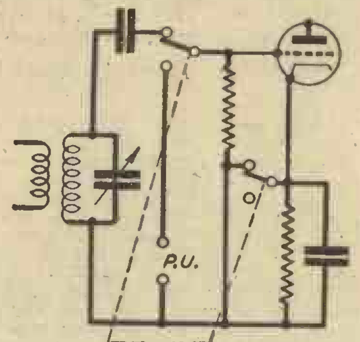


Fig. 11.—A better arrangement and one well worth the extra work involved.

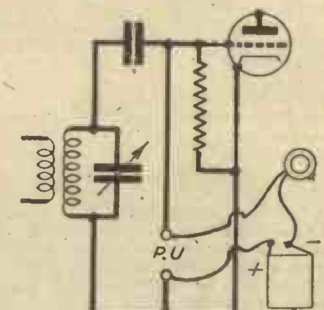


Fig. 12.—Provision of bias by means of an external battery.

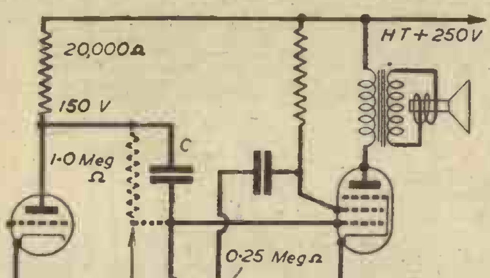


Fig. 9.—Showing the effect of a leaky coupling condenser on its associated valve circuit.

Loss of bass can also occur through inadequate decoupling of cathode bias resistors, causing negative current feedback at lower frequencies.

It might be mentioned in passing that, while negative feedback properly applied may do a great deal to level out the response curve of a set, and reduce distortion, if applied haphazardly it may have some altogether unexpected—and undesired—results.

"Peaky" Reproduction

Due to the large number of turns close together on an A.F. choke or transformer, there is apt to be a fairly large "self-capacitance" between adjacent turns, and thus the winding really consists of an inductance and capacitance in parallel, which, of course, is a tuned circuit, having a resonant frequency. If this resonant frequency is within the audio range—as it frequently is—the amplification will be much greater at that frequency than at any other, and a "peak" will be produced, Hence all chokes and transformers, particularly of the cheaper variety, are liable to produce peaks, and should be avoided if possible.

Non-linear Distortion

In connection with triode detectors we saw that operating on the curved part of a valve characteristic produces distortion. As this is a very fruitful source of trouble, we will consider the point rather more closely. Fig. 4 shows a typical valve characteristic curve. The point "A" is at "cut-off," i.e. zero anode current, AB is the curved portion, and BC the working portion, where "C" is zero grid bias.

Fig. 5 shows the part AB enlarged, and the effect of working on it. It will be seen that the waves are flattened at the bottom. Fig. 7 shows that this effect may also be produced by combining a fundamental with its second harmonic, hence this is known as "second harmonic distortion."

Fig. 6 shows the ideal, working on the straight portion, no distortion present.

Considering the result of working beyond "C" it will be understood that, if the grid is allowed to run positive, it will collect electrons like an anode, and hence current will flow in the grid circuit. It is difficult to show graphically, but it can readily be proved from a mathematical consideration of the conditions, that second harmonic distortion again occurs, this time of an inverse type (Fig. 8). The degree of distortion, however, depends on the D.C. resistance of the grid circuit, and if it is arranged that this resistance is very low, it is possible to avoid serious distortion. This fact is made use of in Class B_2 and AB_2 (push-pull) circuits. Normally, however, it is much safer to use only the section BC, i.e., biasing the valves so that its working point is in the middle of BC, this being the value of bias recommended by the makers.

Clearly, under ordinary conditions, very serious distortion will occur if the valve is overloaded, the signal spreading beyond "B" on the one side and beyond "C" on the other. The only remedy here is to reduce the signal, or use a larger valve.

Anode-bend distortion is due to excessive bias (assuming the valve is not overloaded). This may be caused by too large a bias resistor in a mains set, or excessive G.B. in a battery set. The former is less serious, as the increased bias reduces the anode current, which in turn reduces the bias voltage dropped across the resistor. It may also be caused by the application of a strong signal to a leaky grid detector.

Grid current distortion is caused by inadequate (negative) bias, no bias, or (accidentally) positive bias. This may be the result of too small a bias resistor in a mains set, or by faulty G.B. in a battery set. Again, the former is the less serious, as the change of anode current raises the bias developed across the resistor. A shorted or leaky cathode by-pass condenser may also cause trouble.

A fault which can have very serious results, and one which is sometimes overlooked, is that of a leaky coupling condenser in R.C.C. Consider the case of an Osram ML4 feeding an MKT4 in the conventional circuit shown in Fig. 9. With a bias resistance of 1,000 Ω, the ML4 passes 14 mA anode current at 250 v., and, as a common value of anode load is 20,000 Ω for this valve, the voltage at the anode will be about 150 v. The grid coupling condenser "C" is suspected, but, tested with a multimeter for shorting, appears to be in order. Tested with a megger it is found to have a D.C. or leakage resistance of about 1.0 megohm. This seems high but, as a result of it, a potential divider is formed, and a positive voltage of $150 \times \frac{0.25}{1.0+0.25}$ or 30 volts is applied to the grid. As a negative bias of only 13.5 volts is applied by the bias resistor, the valve has a *positive* bias of 16.5 volts! It need hardly be pointed out that this would cause very serious grid current distortion, and, in addition, the valve would pass excessive current, with very serious consequences. The moral is to use the best condensers available, preferably of the mica or oil-filled variety for this position.

There is one other common cause of distortion with valves, and that occurs when an attempt is made to use a set with a leaky grid detector as a radiogram, with the pick-up connected to the detector (Fig. 10). Either the pick-up is connected to grid and earth and the valve used in its normal unbiased condition, with resultant grid-current distortion, or the detector is permanently biased to be convenient for use with a pick-up, which results in a mixture of leaky-grid and anode-bend detection on radio, and is, if anything, worse. The best method, without altering the detector, is to provide a switch for bias, and, preferably, gang it to the gramo-radio switch (Fig. 11). If the set is a commercial model, it may be more convenient to connect an external battery to provide bias, as in Fig. 12. About 4.5 v. for mains sets and 1.5 v. for battery sets is generally safe.

A Mysterious Rattle

A BUZZING or rattling sound when speech or music is being reproduced is most annoying. The majority of causes of this fault have been described in past issues, but one cropped up recently which caused quite a lot of trouble before it was located and cured.

The receiver, a battery model, buzzed so badly that it was feared the loudspeaker cone was at fault. When this had been inspected, however, it was found to be in order, and the suspension and speech coil was then suspected. This, too, was found to be in perfect order. There were no loose terminals anywhere, nor any lengths of wire which might vibrate. Altogether, the trouble was most perplexing.

Finally, on handling the H.T. battery it was noticed that it had a "loose" feeling; on shaking it something rattled. Here was the cause of the trouble. The battery had evidently had a fall at some time in its life, and the compound with which it was sealed had become broken. This allowed portions of the compound to become lodged between the cells and the cardboard container in such a way that they vibrated with the sound waves from the loudspeaker, thus setting up the annoying buzz.

The cure was in this case to open the container, shake out the offending particles, and reseal. Quite a few H.T. batteries have these loose particles, though it would be only in a few cases that they would cause any trouble. It would be as well, however, to check up on this before undertaking more exhaustive investigations elsewhere. —(W. N.)

PRIZE PROBLEMS

Problem No. 452

IN order to obtain some experience in receiver construction, Williams decided to make a simple one-valver in which he could test home-made components. He made several items, including a dual-range coil of the aerial type with reaction winding. After assembling the parts and switching on, he found that the signals from the local transmitter were quite loud but he could not receive the more distant stations at any strength. When he tried to improve matters by turning up the reaction control the signal strength decreased. He tried reversing the connections to the reaction condenser, but the effect was just the same. What was wrong?

Three books will be awarded for the first three correct solutions opened. Address your solutions to The Editor, PRACTICAL WIRELESS, George Newnes, Ltd., Tower House, Southampton Street, Strand, London, W.C.2. Envelopes must be marked Problem No. 452 in the top left-hand corner, and must be posted to reach these offices not later than the first post on Friday, January 14th, 1944.

Solution to Problem 451

Bradley was not wise enough to verify whether the shaped oscillator section of the ganged condenser had been designed for use in a circuit having an I.F. the same as the I.F. transformers he used. He was unfortunate, the oscillator condenser was not suitable for use with his I.F. components.

The following three readers successfully solved Problem No. 450 and books have accordingly been forwarded to them. H. Cobb, 21, Canning Road, Southport, Lancs.; H. W. Baxter, 44, Audrey Gardens, North Wembley, Middx.; Mrs. Edith Draper, 1, Garibaldi Terrace, Wellingborough, Northants.

Cathode-ray Tubes—2

Degassing. Welding. Assembly. Applying Coatings. Screens. By LAURENCE ARTHUR

(Continued from page 56, January issue.)

DEFLECTOR plates, which are also stamped from ferry, are arranged in two pairs placed exactly at right angles. Positive voltages applied to them singly cause the beam to bend and the spot is deflected. The lower pair are generally known as Y plates (Y^1, Y^2) and the upper pair, nearer the screen, as X plates (X^1, X^2). They take many shapes as shown in Fig. 11. It is essential that they should be symmetrically disposed around the centre line of the tube and completely rigid. Many cathode-ray tubes have an interplate screen between the two pairs of deflector plates. Its purpose is to neutralise the effect that electrostatic charges on one pair of plates would have on the other pair. A typical shape is shown in Fig. 12 and it is internally connected to the anode having the maximum accelerating voltage. At least one notable British tube has a double beam, this being achieved by means of a vertical splitter plate inserted between the final accelerating anode and the lower (Y) deflector plates.

Almost all high vacuum tubes have an internal conducting wall coating (which will be described at a later stage) and this is connected to the final accelerating anode by some form of spring connection. The spring part is made from monel metal or some similar non-magnetic alloy, and ferry is used for the rounded shoe, examples being shown in Fig. 13.

Degreasing and Degassing

All the metal parts become greasy when they are stamped out, and it is necessary to clean them thoroughly before they can be used. They are placed in wire trays which are lowered into a degreasing tank containing trichlorethylene. This effectively dissolves all the grease.

Degassing is another process which is very essential with most of the parts used in cathode-ray tube construction. Metals are porous and can hold large volumes of atmospheric gases, which would have a serious effect on the vacuum of the finished tube and although further outgassing takes place during pumping, it is important to remove as much gas as possible before assembly. The parts are placed in small nickel boats and passed,

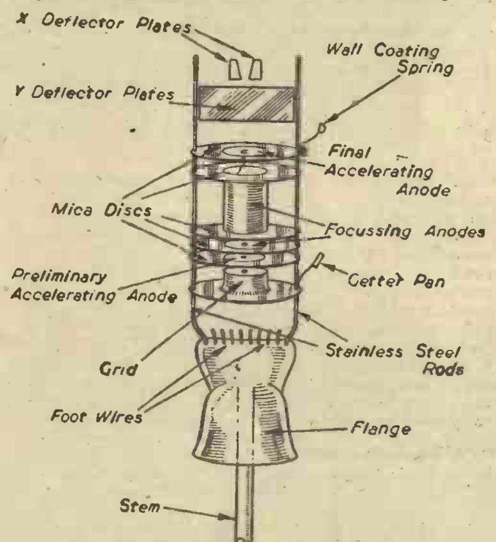


Fig. 14.—Typical small cathode-ray tube assembly.

in an atmosphere of hydrogen, through a degassing furnace heated to 800 deg. Centigrade. Successful degassing can also be done in a vacuum at a similar temperature.

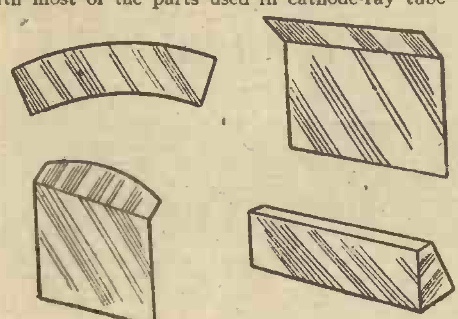
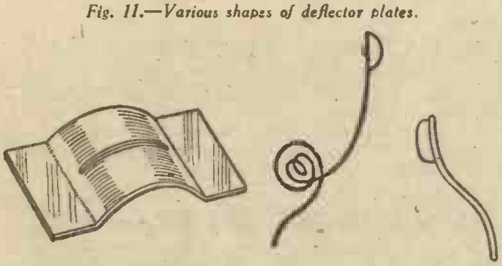


Fig. 11.—Various shapes of deflector plates.



Figs. 12, 13.—Interplate screen and spring connection to wall coating.

Welding Electrodes

In assembly all the metal parts of a cathode-ray tube are electrically welded at one or more points, and a brief description of the process of welding may be interesting. The electric welder used for this work is a bench unit, containing a tapped mains transformer designed to pass a large current at a low voltage between the tips of two copper electrodes when the electrodes are brought together. The electrodes are made from heavy copper rod and the tips are flattened, pointed or bent so that they fit together just where they are needed. In operation the parts to be welded are held on the lower electrode, and the upper electrode brought down by means of a foot-operated treadle. At the point of contact, a heavy current flows and the components are instantaneously and securely welded together. It is very necessary when assembling the parts that the exact distances called for in the design are accurately and consistently maintained, and to ensure this many intricate jigs are used for holding the parts in position until they are welded. Jigs are made from steel, copper or brass and considerable care is taken with their design and manufacture.

Assembly

The mounting or assembly of cathode-ray tubes varies with the type and with the individual manufacturer. Two tubes having a widely differing appearance may have precisely the same test specification and operational use. One leading manufacturer uses quantities of mica for insulating the components and stainless steel rods (non-magnetic) for supporting and connecting them. Another firm uses ceramic rods for supports and wires enclosed in glass tubes for connection purposes. Some assemblies commence at the deflector plates and work downwards, others use the reverse means of construction. Fig. 14 shows a simplified drawing of a typical assembly for a small cathode-ray tube and this is built up from the bottom. Each diaphragm-shaped anode and the grid are secured to circular mica discs by means of a collar electrically welded. This is shown more clearly in Fig. 15; the tubular section of the focusing anode is held in the same way. Each mica disc has several eyeletted

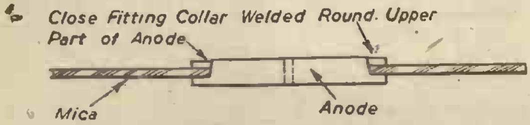


Fig. 15.—Method of securing anode to mica disc.

holes which are welded to the main stainless steel support rods. The whole assembly is quite rigid and jigs have ensured that the separation of electrodes is accurate. Two of the support rods are welded to wires on the foot and then the connections to heater, cathode, grid, accelerating and focusing anodes and deflector plates are welded to the appropriate footwires.

A general idea of a large cathode-ray tube is shown in Fig. 16. Owing to its greater weight and size it is not possible to rely on the footwires to hold it rigid. Instead, a nickel band is clamped round the circular foot. A strip of mica of fine gauze is put round the foot first so that the bolts may be firmly tightened. Four lugs from the foot band are clipped round a thick eyeletted ceramic

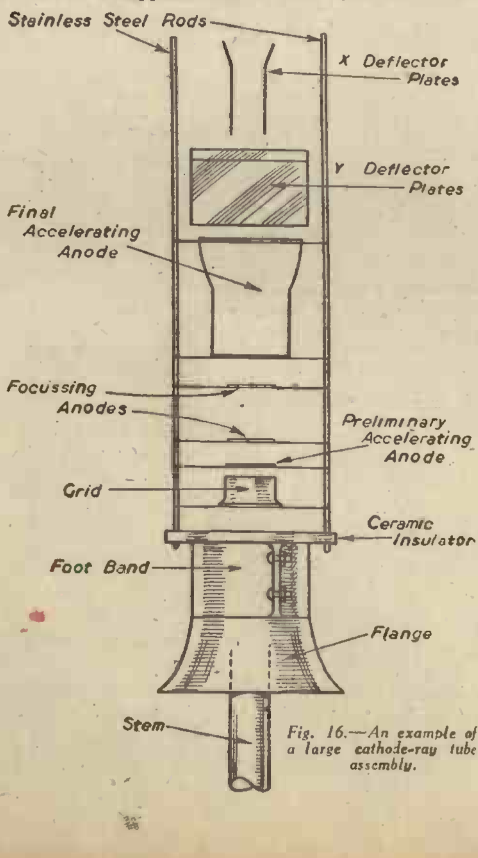


Fig. 16.—An example of a large cathode-ray tube assembly.

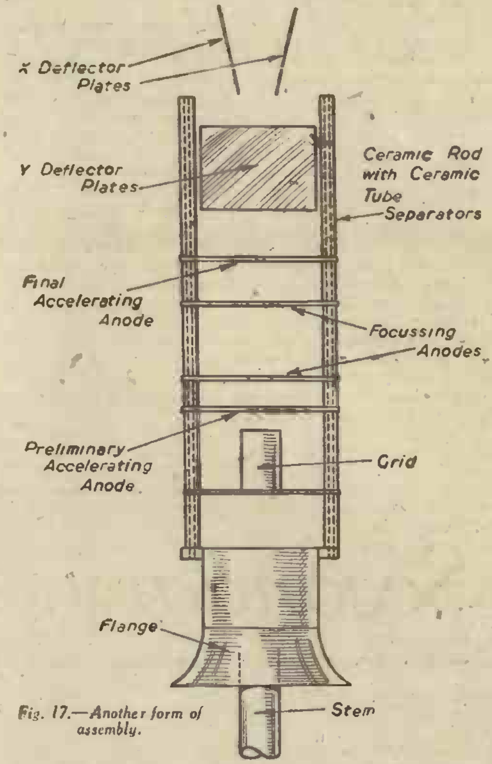


Fig. 17.—Another form of assembly.

disc and the main support rods are welded to the eyelets. A different type is shown in simplified form in Fig. 17. Here four ceramic rods are held in a clamp at the base, and the grid disc and diaphragm anodes which are much larger than those previously described, are slipped over the rods. Separation is achieved by ceramic tubes over the rods, and connections to the various components are made with wires in glass tubing. To ensure that the assembly shall not move with respect to the bulb, and thus cause the spot to move if the finished tube is used in apparatus subject to vibration, means are taken to hold it to the glass. One method is by the use of thick mica "snubbers" mounted in clips alongside the deflector plates in the mica. Another way is to fasten to the mount stiff monel metal springs which engage on four previously made depressions at the top of the neck of the bulb (Fig. 18). When the mount is complete it is subjected to strict inspection. Any mistakes made in the connections to the footwires, loose welds, etc., must be rectified prior to the mount being sealed in the bulb.

The Bulbs

Bulbs are received from separate glass works, and before they can be used they must be checked for dimensions and examined for flaws. Owing to the comparatively large size of the bulbs the glass is much thicker than that found in valves. Because of the need for a flat, or nearly flat, surface at the screen end there are stresses set up which sometimes cause the implosion —or collapsing inwards—of the bulb when a high vacuum is attained during pumping. To prevent this the screen end is much thicker than the walls of the tube. In very large tubes the screen end may be ½in. thick. Before use the glass must be thoroughly cleaned and one method of doing this is to swill the tube out with dilute hydrofluoric acid. As this acid eats into the glass it is flushed away with powerful jets of water, gas-heated ovens being used for drying.

Applying Coatings

The further preparation of the bulb consists in applying the screen and the conducting wall coatings. There are two types of wall coating, one of which, lead sulphide, is applied before screening, and the other, of colloidal graphite, after screening. In the former case the bulb is stood on its screen end and a quantity of carbon tetrachloride poured in. The amount determines where the wall coating begins. On top of the carbon tetrachloride is poured the clear lead sulphide solution up to where the wall coating is required to finish. The two liquids do not mix. After the bulb has been standing for a few hours the lead sulphide becomes deposited as a hard black skin. Fig. 19 shows the final appearance of the process. The liquids are siphoned off for use again. When the bulb has been swilled out with distilled water and baked in a gas-heated oven, it is ready for screening. The second type of wall coating consists of a colloidal solution of graphite which is put on with a specially shaped brush after the screen has been applied. The graphite is toughened with sodium lactate or sodium silicate and the bulb is baked in a gas-heated oven before further operations.

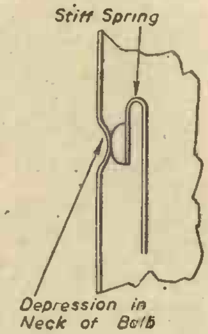


Fig. 18 (above).—Positioning spring.

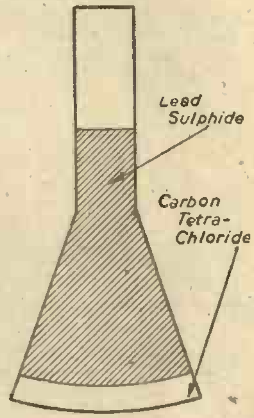


Fig. 19 (right).—Lead sulphide wall coating.

(To be continued.)

Secondary Batteries—6

Further Details of the Charging Room and Its Equipment.

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

(Continued from page 63, January issue.)

THESE two boards provide a total of eight independent charging circuits. Where alkaline batteries are also to be charged a separate compartment should be provided, and a pair of cables looped from board (A) to feed a further panel. Fig. 1 illustrates a typical board having one circuit fitted with a variable resistance and ammeter enabling a variable charging current of 6 to 10 amps to be utilised. Since these boards have no cutout they are for use with bulb and dry rectifiers, and not with motor generator sets, for should the supply fail there is no back feed through that type of rectifier where no cutout is installed.

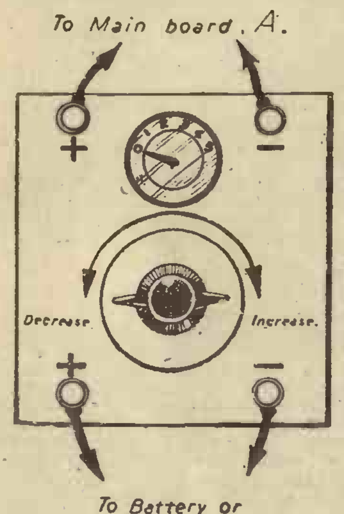


Fig. 1.—A typical single-circuit board.

Such boards need not be elaborate or difficult to make, and, during normal times, the essential fittings could be obtained quite cheaply.

Load Control

Assuming the total D.C. output of the rectifier is 40 amps at 75 volts, this may be allocated to the three boards as follows:

Board A.

No. 1 circuit.	n cells charging at $\frac{1}{2}$ amp.
No. 2 circuit.	n cells charging at 4 amps.
No. 3 circuit.	n cells charging at 6 amps.
No. 4 circuit.	n cells charging at 8 amps.
Total ..	.. 18.5 amps.

Board B.

No. 1 circuit.	n cells charging at 1.5 amps.
No. 2 circuit.	n cells charging at 2 amps.
No. 3 circuit.	n cells charging at 3 amps.
No. 4 circuit.	n cells charging at 5 amps.
Total ..	.. 11.5 amps.

Independent Board for Alkaline

One circuit only. n alkaline cells at 10 amps. Total charging current utilised—40 amps.

The total number of lead acid cells which may be connected in any one series to D.C. supply of 75 volts is $\frac{75}{2.8}$; and that of alkaline is $\frac{75}{1.85}$.

Therefore, with the above arrangement, n cells may be charged simultaneously with charging currents from $\frac{1}{2}$ amp. to 10 amps. The total current must not exceed 40 amps, but where the alkaline circuit is not utilised, extra current is available for the lead acid batteries which, in the above example, is equal to 10 amps. Although the total number of cells connected in series must not exceed that shown above, the charging current may be varied as required, e.g., all batteries may be charged at 1 amp., provided the total current does not exceed the total output of the rectifier. To obtain the total current, add together the charging current of each separate series circuit.

Summary of Equipment for Charging Room—Lead Acid

Quantity of sulphuric acid of 1.270 S.G. and 1.350 S.G. contained in 10 gallon carboys. A quantity of distilled water for topping up cells, or breaking down acid to a lower S.G. as required for various types of batteries. A number of vessels in glass, wood, glazed earthenware or plastic material for mixing electrolyte. A number of one-gallon glass jars to facilitate the handling of electrolyte. Glass or plastic funnels for pouring electrolyte into cells. Rubber tubing for syphoning acid from carboys (a special pump is preferable). A thermometer for measuring temperature of electrolyte. Hydrometers and syringe for measuring S.G. Special bulb syringe for topping up small batteries and extracting small quantities of electrolyte from cells where required. Glass measuring tube for testing the height of electrolyte in cells. Moving coil voltmeter with cadmium stick for testing P.D. of cells during charge and discharge. Voltmeter or cell tester with load as described in Article 3. Box of fine sawdust for dealing with spilt acid and for replenishing that on the bench. Box of bi-carbonate of soda for similar purpose and for dealing with spilt acid on clothing or body. Jar of household ammonia, also utilised for spilt acid on clothing or body. Quantity of pure water, running water from tap is preferable. Quantity of anti-sulphuric enamel for applying to exposed woodwork and metal. Fire extinguishers, buckets of sand and water. Where alkaline batteries are also dealt with, special hydrometers, cell testers, syringes, vessels, etc., must also be obtained. On no account must those used for either lead acid or alkaline be used for the other.

No battery charging station is complete without a workbench and vice, if only for small repairs to plant and batteries. Since special skill is required for replating and the general overhaul of batteries, a separate section will deal with this type of work

Other Accessories

Battery charging is often inefficiently carried out owing to poor battery connections which give rise to intermittent charging. Accidents, including explosions, are also liable to be caused when the connections consist of odd ends of cable twisted round battery terminals and posts. Suitable lugs and spade terminals should always be provided and securely "sweated" to cables of sufficient current carrying capacity. Fig. 2 illustrates the various types of terminals and lugs in use. Types (a) and (b) are used for small batteries of the radio type and are obtainable in a number of sizes. Type (c) is used for larger batteries and has connections made to charging panel terminals. To facilitate connecting and disconnecting it is advisable to cut off a piece of the spade as in (a). Where the terminals of the charging board are "anchored" as in (d) this procedure is essential for charging the leads of the board when other types of batteries are also to be charged. The lugs (e) are used for connecting to the terminal posts of M.T. type batteries. All lugs and tags should be periodically scraped and smeared with pure Vaseline to prevent corrosion. Difficulty is often experienced in removing lugs from the posts of M.T. type batteries. These should not be forced with a screwdriver or similar type of tool as it may cause damage to the battery, Fig. 3 illustrates a suitable drift for this purpose which is simple to make with sheet iron bent and drilled as shown.

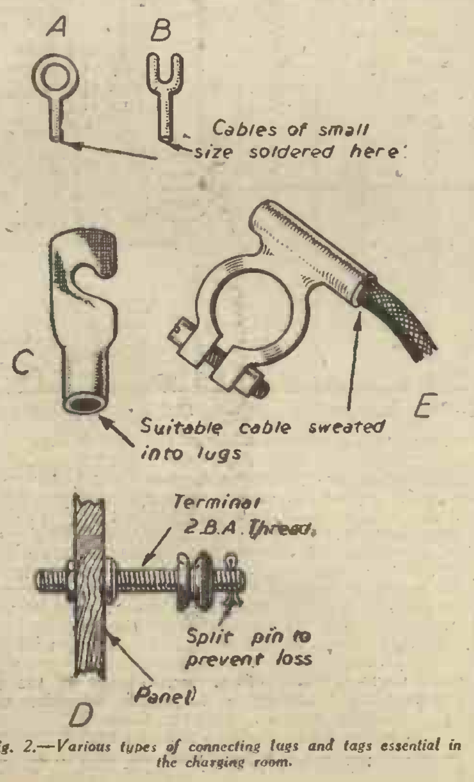


Fig. 2.—Various types of connecting lugs and tags essential in the charging room.

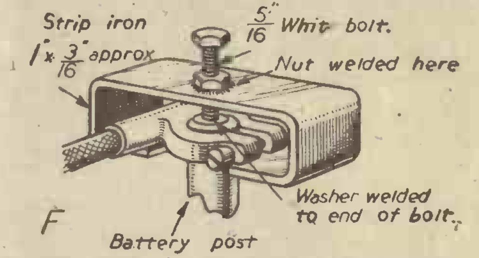


Fig. 3.—A most effective piece of equipment for removing lugs.

When charging batteries it is essential, as pointed out earlier in this series, that the charging current is kept constant. In any event this current must not exceed the maximum permissible charging current for a particular size or type of battery on charge. The temperature, too, must be kept below a safe figure (usually 100 deg. F. in respect of lead acid cells). It is important therefore that the charging station owner or operator is aware of how a specific value of charging current is calculated. The formula given below clearly illustrates this:

Assume the installed plant has a rated output of 75 volts, 6 amps:

It is desired to charge 20 lead acid cells in series at a current of 4 amps.

Total maximum voltage of cells when fully charged $= 20 \times 2.8 = 56$ volts.

Minimum voltage of cells when first connected $= 1.8 \times 20 = 36$ volts.

The charging current passing through a single cell or series of cells depends upon (1) voltage of D.C. supply, and (2) back E.M.F. of cells on charge. This is represented by the following formula.

$$\text{Charging Current} = \frac{\text{Voltage of Supply} - \text{Voltage or P.D. of cells}}{\text{Total internal resis. of cells} + \text{external series resistance.}}$$

Assuming the internal resistance of each cell to be 0.02 ohms, the total resistance of cells in series = Resis. of one × No. of cells $= 0.02 \times 20 = 0.4$ ohms.

When first put on charge the charging current with no external resistance would be $\frac{75-36}{0.02 \times 20} = 97.5$ amps.

Since the current is too high for charging purposes some external resistance must be included.

$$\therefore \text{Total resistance required} = \frac{\text{Voltage of supply} - \text{P.D. of cells}}{\text{Required current}}$$

The required current given above was 6 amps.

(To be continued.)

Low-frequency Amplifier Design—5

This Fifth Article of a Series Deals With Paraphase Amplifiers, and With Negative Feedback

FUNDAMENTALLY, there is little difference between push-pull and paraphase amplification. It may be that the two forms of circuit appear a good deal different when first considered, but it is not difficult to find their points of similarity. As pointed out last month, the object of push-pull is to apply the two half-waves of audio-frequency to a two-valve stage in such a manner that the negative half-cycle is applied to the grid of one valve, at the same time as the positive half-cycle is applied to the other. This means that the two valves are operating at opposite phase.

In paraphase the same principle applies. Instead of employing a centre-tapped transformer to feed the two push-pull valves, however, we use a different method of obtaining phase reversal, or phase inversion, for one of the valves. Fig. 1 shows a simple form of practical circuit. The first valve is a normal L.F. amplifier —it may be the triode section of a double-diode-triode. This is followed by another valve, which is generally known as a phase inverter. It may be regarded as an amplifier, but in point of fact it produces very little gain.

Instead of there being a single load resistance in the anode circuit of the valve, two separate and equal load resistances are used. One is in the anode circuit and the other is in the cathode circuit. These two loads are shown as R_a1 and R_a2 in Fig. 1. Each is equal in value to one-half of the optimum load of the valve. For exemple, if the valve employed had an optimum load of 20,000 ohms (that is, if the optimua output were given with resistor of this value in the anode circuit) the two resistors in question should each have a value of 10,000 ohms when the valve is used for phase inversion.

Phase Splitting

The output from the L.F. amplifier is applied between the grid of the phase inverter and earth. This means that the grid and the earth line are out of phase. In the same manner the cathode and anode of the valve are out of phase. So we include load resistances in the cathode and anode circuit, and feed from the two electrodes to the grids of our push-pull stage. The circuit is, in fact, slightly out of balance due to the inclusion in the cathode lead of a bias resistor, marked R_c, and to the capacity between the cathode and heater of the phase inverter. The effect of the bias resistor is negligible, however, since its value is bound to be low by comparison with that of the load resistor. And the capacity between cathode and heater is so low that its reactance will approach infinity at all except extremely high audio frequencies. In practice therefore, these two unwanted effects can be ignored.

The two push-pull valves are resistance-capacity fed, and the values of grid condensers, C_g, the grid leaks, R_g, and the bias resistor R_c will be determined in exactly the same manner as previously explained in this series when dealing with R.C. coupling. Output from the two push-pull valves is "collected" by the centre-taped speaker transformer, or by means of a tapped choke, exactly as for other forms of push-pull.

Degeneration

It is not necessary to by-pass the bias resistor of the phase inverter, since there is a good deal of degeneration or negative feed-back provided by R_a2, and the slight additional degeneration due to Rc is of no consequence. It is, of course, due to this degeneration (briefly explained in No. 1 of this series) that the phase inverter does not provide any appreciable gain. An excellent type of valve for use as phase inverter is a sharp-cut-off pentode with the screen and anode joined together so that the valve acts as a triode. In any case, it is desirable to use a valve of high amplification factor, and which requires a low value of bias resistor. If a low-μ valve were used the value of the bias resistor might be appreciable in respect of the load resistors; in that case by-passing would be an advantage.

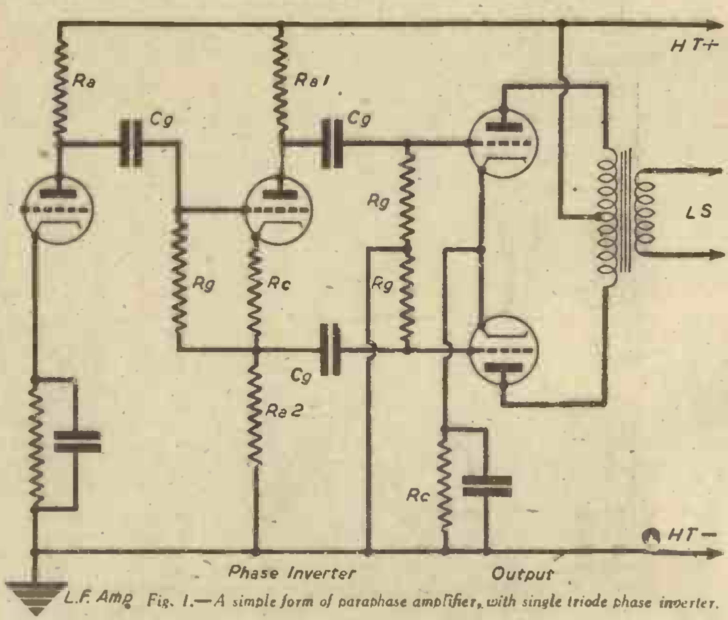


Fig. 1.—A simple form of paraphase amplifier, with single triode phase inverter.

Elimination of P.-P. Transformer

What are the advantages of paraphrase by comparison with transformer-coupled pusb-pull? The most important advantage is the high degree of fidelity which is provided; it has previously been shown that a transformer produces a certain amount of frequency distortion, even when one of the most expensive type is employed. To compensate for the absence of voltage amplification provided by a transformer it becomes necessary to use an additional low-gain valve stage, but two R.C. valve stages are no more costly than a really good transformer. When high-fidelity is the prime requirement, therefore, a paraphase amplifier cannot well be beaten from any point of view.

It is scarcely necessary to consider component values in detail, because the values are all determined in the same manner as they are for other resistance-capacity-coupled stages of the kind previously described.

Two-valve Phase Inverter

Another form of phase inverter (sometimes described as a phase-splitter) is shown in Fig. 2. This is slightly more complicated in form, but has the advantage that all valve cathodes are sensibly at earth potential. Because of this, there is less likelihood of hum being introduced. Referring to Fig. 2, the valve V.1 is a normal L.F. amplifier, and probably the triode of a double-diode triode. V.2 is fed from it through a normal R.C. coupling, and also acts as a "straight" amplifier, feeding into the grid of V.4. The grid of V.3, which is really the phase-splitter, is fed from a tapping on the grid leak of V.4; the position of this tapping is such that the input to V.3 is equal to the input to V.2. In consequence, the output from valves V.2 and V.3, which are of the same type, is identical, but of opposite phase. By making slight adjustment of the tapping point complete "balance" of the circuit may be effected.

The theoretically correct value of that portion of the grid leak marked x can be found by dividing the total resistance of the grid leak by the stage gain of V.2; final adjustment can then be carried out by trial. Valves V.2 and V.3 can be separate, or a double triode may be used. It is hardly necessary to add that the two anode-load resistors marked R_a should each be equal in value to the optimum load of each of the valves used in the phase-splitting stage, since each represents the complete load of one valve.

Thirty-watt Paraphase Amplifier

Fig. 3 shows a complete diagram of a 30-watt amplifier using American valves of types which are now well known on this side of the Atlantic. The circuit closely resembles that shown in Fig. 1, but there are a few refinements, and use is made of high-gain tetrodes and pentodes; the phase-inverter pentode, however, is used as a triode, the screen being tied to the anode. Incidentally, it should be added that this circuit is not original, but is one taken from an American source. The circuit has, however, been used and has proved eminently satisfactory. The only disadvantage, from some points of view, is that an H.T. voltage of between 400 and 450 is required, and the total anode current consumption is in the region of 150 mA, when the two 6L6 valves are operated in class AB_1, as they are in the diagram.

One small refinement is the inclusion of 100,000-ohm stopper resistors in the grid circuits of the push-pull valves. These tend to compensate for any small out-of-balance between the two valves and improve the general stability. Their use has been mentioned in connection with ordinary push-pull.

A more noteworthy feature is the provision of negative voltage feed-back from the anode of V.3 to the screen of V.1. The feed-back voltage is taken from a potentiometer comprising a 1.5 megohm and a 250,000-ohm resistor. This will produce slight out-of-balance, due to the feed-back being taken from only one of the push-pull valves, but the added complication of taking feed-back from both valves is scarcely justified. The .0002-mfd. fixed condenser between the anode of V.1 and earth is not essential, but it tends to prevent parasitic oscillation at very high audio frequencies.

Before leaving the subject of paraphase amplification, it should be stated that, although triodes are indicated in Figs. 1 and 2, tetrodes and pentodes may equally well be employed. In general, it is most economical of valves and current supply to employ tetrodes in the output stage, with a high-mu triode or sharp-cut-off pentode with screen grid tied to the anode, as phase-inverter. The valve which precedes the phase-inverter may be of any type which will give sufficient output fully to load the push-pull stage; this assumes that the phase-inverter stage will not produce any gain, whereas in practice one may expect an overall gain up to about 1.5 to 1.

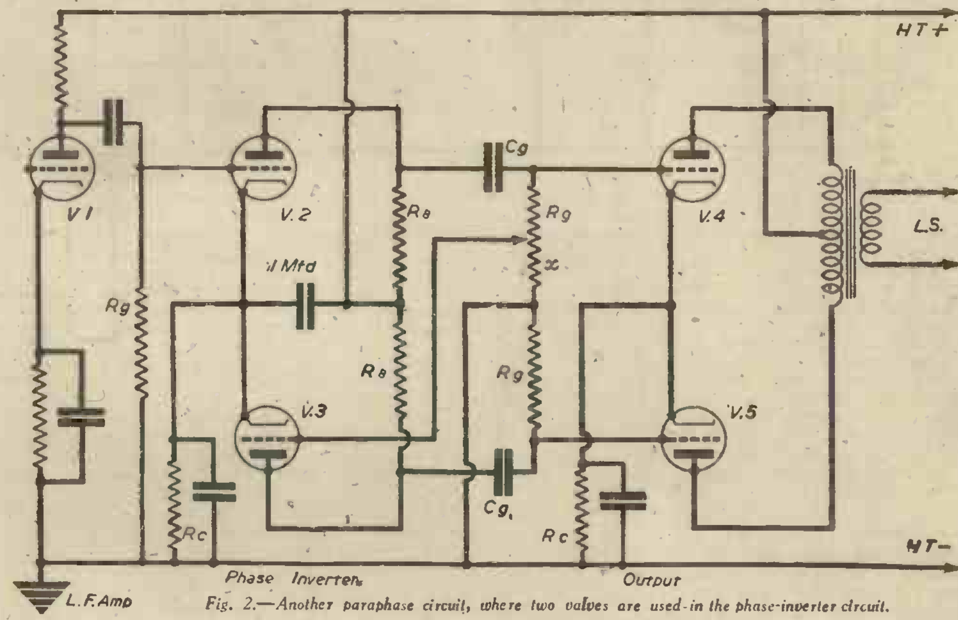


Fig. 2.—Another paraphase circuit, where two valves are used in the phase-inverter circuit.

Negative Feed-back

A good deal of reference has been made in this article to the use of degeneration or negative feed-back. This subject was treated to a minor degree in the first article of this series. There, however, reference was made principally to current feed-back. This is obtained in the simplest form by omitting the usual by-pass condenser in parallel with the cathode bias resistor. If the degree of degeneration obtained by that means is too great, it is possible to use two bias resistors in series to provide the necessary voltage drop, and to by-pass only one of them. Alternatively, a variable or pre-set resistor may be used, connecting the by-pass condenser (an electrolytic of 25 mfd. is desirable) between the slider and one end of the resistance element.

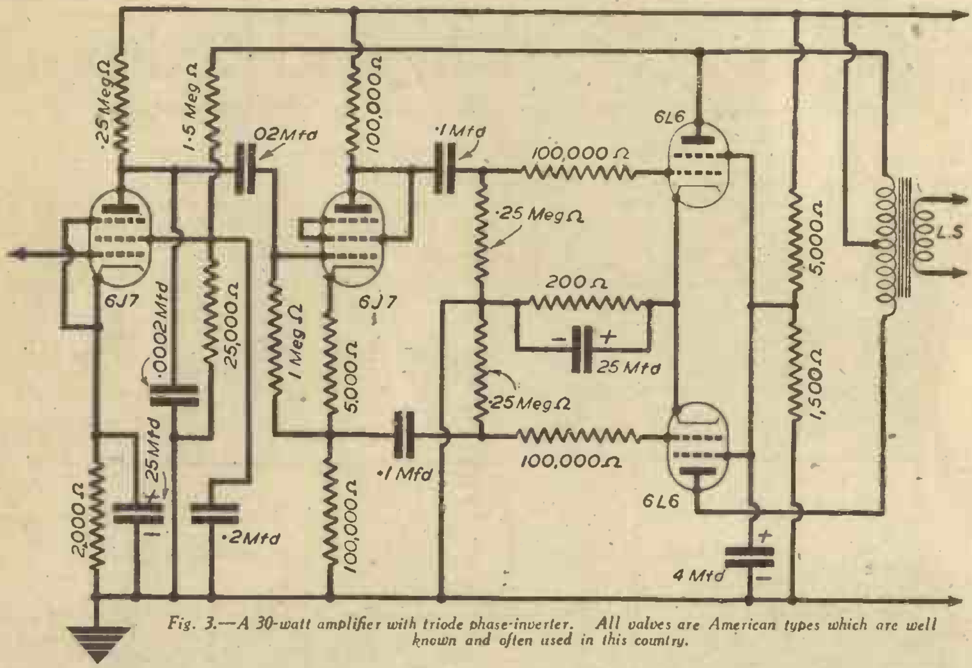


Fig. 3.—A 30-watt amplifier with triode phase-inverter. All valves are American types which are well known and often used in this country.

In voltage feed-back the usual method is to feed back from the anode of the output valve to the grid of the same valve a voltage which is out of phase. This is automatically done, since there is always phase reversal through a valve amplifier; when the grid goes negative the anode goes positive, and vice versa. It is not always desirable to feed back the full inverse potential, and the arrangement shown in Fig. 4 may be used. Here it will be seen that a potentiometer is connected across the output, with a condenser in series, and feedback to the grid circuit is taken from the tapping on this potentiometer. It will be seen that the system of degeneration shown in Fig. 3 resembles that indicated in simpler form in Fig. 4. Another negative feed-back circuit is given in Fig. 5. In this case the lower "limb" of the potentiometer is made up of the grid condenser and leak in series.

Advantages of Degeneration

The use of negative feed-back has a number of valuable advantages in amplifiers required for high-fidelity reproduction, and one main disadvantage. An advantage is that it prevents the amplifier from falling into self-oscillation, as it may do at certain frequencies. Another and more important advantage is that it tends to make the amplifier independent of variations in output load. That is, if the load changes the degeneration automatically applies a "corrective balance." This is very valuable when using an output transformer, the impedance of which necessarily varies over the audio-frequency range. It also makes possible the connection of additional speakers without the need for altering the output coupling. In short, it causes the valve to behave in most respects as though it were of very low impedance, with the result that the regulation is very good.

The chief disadvantage is that degeneration, as the name would suggest, reduces to a degree, depending upon the proportion of the output voltage fed back, the effective amplification or gain. This can be offset to some extent by using a pentode or tetrode output valve, and by applying the lowest satisfactory amount of feed-back.

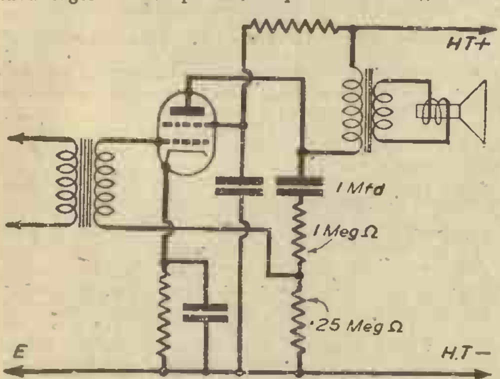


Fig. 4.—Voltage negative feed-back in its simplest form. A portion of the audio output voltage from the anode circuit is fed back to the grid. The valves are not necessarily those which would be used in practice.

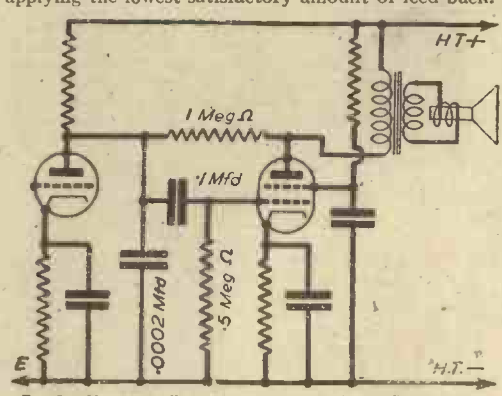


Fig. 5.—Voltage feedback in more practical form. Representative values are assigned to the components associated with the degenerative circuit.

Elementary Electricity and Radio—13

The Ionosphere. Skip Distance. Fading. By J. J. WILLIAMSON

(*Continued from page 59, January issue.*)

FIG. 80 (A) and (B) illustrates the effect of altering the height of a $\lambda/2$ dipole above the earth.

Aerial Arrays

When two or more aerials are arranged to give directional radiation, then the combination is known as an aerial array.

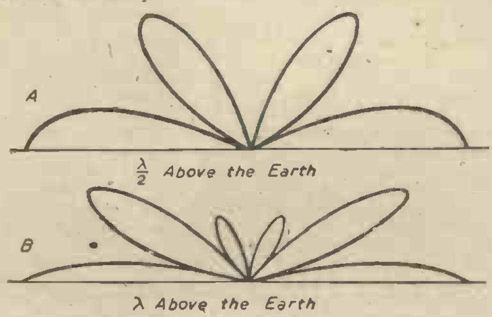


Fig. 80.—Vertical polar diagrams of $\lambda/2$ aerial.

If the array radiates energy in a direction that is in line with the aerials or elements that make up the array, and that radiation is in a horizontal plane, the array is said to be of the "*end-fire*" type. If radiation is in the horizontal plane but "broadside-on" to the line of aerials making up the array, then the system would be called a "*broadside*" array.

Fig. 81 (A) depicts two vertical aerials spaced $\lambda/2$ apart; they are fed with energy in such a manner that radiation from both will be in phase. It follows that radiation along a line drawn through the aerials will cancel, maximum radiation occurring in the broadside direction. Note the polar diagram—Fig. 81 (A). This combination, therefore, is a simple "broadside" array.

If the two aerials are now placed $\lambda/4$ apart and fed with energy in such a manner that one aerial radiates 90 deg. ($\lambda/4$) behind or ahead of the other, then we have a simple "end-fire" array—Fig. 81 (B).

Several combinations of aerials and their polar diagrams are shown in Fig. 82, (A) represents four $\lambda/2$ dipoles in free space, these dipoles are placed end to end, as shown, and are said to be *co-linear*: (B) shows a V-aerial each leg of which is fed with antiphase (180 deg. out-of-phase) energy; (C) shows a "fishbone" aerial array's polar diagram, the spacing of aerials along the non-resonant feeder gives the required phasing to them; forming the directional characteristics shown.

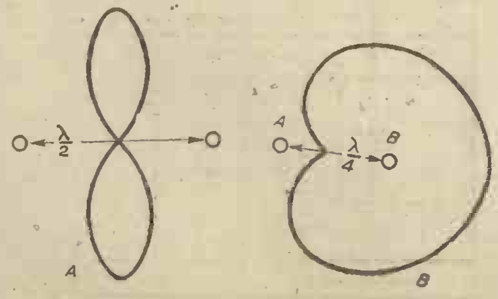


Fig. 81.—Simple "end-fire" array.

Reflectors

A reflector consists of a wire placed behind and in line with the actual aerial; it is not connected to a source of R.F. energy but relies upon its proximity to the energised aerial to receive energy by induction which it re-radiates. The distance between the energised aerial and the reflector in terms of the wavelength will govern the manner in which the two radiations—one from the energised aerial and one from the reflector—add, and hence the resultant radiation pattern and the directional properties of the system. A reflector could have been used in the place of aerial "A" in Fig. 81 (B) with similar results.

"Beaming" of the radiation from an aerial array is usually achieved by the use of reflectors placed behind the elements (separate aerials of the array) of the array. Band-pass characteristics of an aerial array—to enable the carrier and sidebands necessary for radio-telephony to be broadcast with equal efficiency—may be obtained by making the length of the reflectors slightly different to that of the directly energised elements.

Wave Propagation

When a signal is transmitted the radiation produced may be propagated in all directions, the intensity in any one direction depending upon the directional properties

Fig. 82.—Horizontal polar diagram of a "fish-bone" array.

of the aerial system. For analytical purposes we may divide the radiation produced into two categories, e.g., the ground-wave and the sky-wave.

The Ground-wave

The passage of a radio-wave over the surface of the earth causes extraction of energy from the wave, the manner in which the earth acts, i.e., as a conductance or a capacitance, depending upon the frequency of the wave and the nature of the earth, i.e., sea, sand, good soil, etc.

Normal soil acts as a conductance for frequencies below approximately 1,500 kc/s., but for frequencies higher than this the earth is mainly capacitive.

The *higher* the frequency the *greater* is the loss of energy from the wave; whilst for frequencies below 1,500 kc/s. losses *increase* with a *decrease* of conductivity. For frequencies above 1,500 kc/s. losses *increase* with a *decrease* of the soil's dielectric constant. From these facts we can deduce that for long distances and strong signals the lower the frequency the better; that for frequencies *below* 1,500 kc/s. better results would be obtained over sea than land, or over good soil rather than dry sand, etc., also, that for frequencies *above* 1,500 kc/s. the higher the dielectric constant over which the wave is travelling, the better will be the results.

The field strength of a signal travelling over the surface of the earth, according to Sommerfeld, is—

$$e=\frac{kA}{d}$$

where d is the distance from the transmitter, A the effect of the losses in the earth and k is concerned with the field strength radiated horizontally from the transmitting aerial. For high frequencies d is replaced with d^2, i.e., attenuation is very much greater for high frequencies.

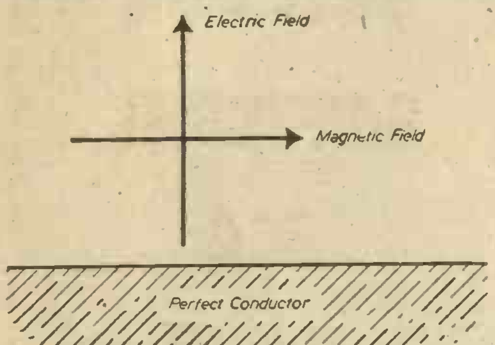


Fig. 83.—Normal polarisation of a radio wave.

Polarisation of the Wave

The term "polarisation" of a wave refers to the plane of action of either its electric or magnetic field with respect to the surface of the earth. It has now become common practice to refer to the electric field when speaking of a wave's polarisation, i.e., a vertically polarised wave having its *electric* field vertical—this type of polarisation is normal.

As shown by Fig. 83, it is impossible for an electric field to exist horizontal or a magnet field vertical to a perfect conductor, such conditions resulting in immediate dissipation of the energy contained within the fields, thus, vertical polarisation (electric fields vertical, magnet fields horizontal) is normal.

The passage of a radio wave over a poor conductor causes a "dragging" at the "foot" of the wave, resulting in a tilt being given to the wave-front, this tilt can be shown to have a horizontal electric-field component, thereby causing energy loss.

Ground-wave Propagation Characteristics

The characteristics of propagation for ground waves of different frequencies may be summarised as follows:

For frequencies below 600 kc/s. very great distances may be covered because of the small attenuation experienced by the ground wave.

From 600 kc/s. to 1,500 kc/s., several hundreds of miles may be covered, giving good quality radio-telephony and good constant signal strength; for these reasons the 600–1,500 kc/s. band is utilised as the broadcast band.

The 1,500–30,000 kc/s. band suffers much greater attenuation, being suitable for transmission for a few miles only.

Frequencies above 30,000 kc/s. appear to have their range limited to approximately optical distances and may be compared in some respects with light rays.

The Ionosphere

Situated many miles above the surface of the earth are layers of ionised gas. The approximate heights of these layers are shown in Fig. 84. For purposes of classification these layers are termed the E, F, and F_2 layers, respectively, as their heights increase. The E layer is also known as the Kennelly-Heaviside layer, after the two scientists who discovered its presence independently and simultaneously. The Appleton layer, again named after its discoverer, comes into existence during the night, due to the fading out of the F_1 layer and the descent of the F_2 layer. The Appleton layer is also known as the F layer.

The gases forming these layers are ionised by ultra-violet rays from the sun, with the exception of the F_2 layer, which, although it has daily and seasonal variations and thus must be effected by the sun, shows itself to be largely affected by other influences, i.e., cosmic radiation. The term layer refers to the region of *maximum electron density* in the gas concerned.

As the height of a layer increases and the rarity of the atmosphere decreases the proximity of atomic particles becomes less with the result that less recombination of those particles (deionisation) is possible. For the reasons just stated the E layer shows great variations in electron density although the region of maximum electron density keeps at about the same height when night falls. The height of the F_1 layer shows small variation whilst its electron density follows similar variations to the E layer. The F_2 layer's height descends at nightfall, but its *electron* density is very erratic in variation. See Fig. 85 (a) and (b) for variations of layer height and density with the time of the day. The electron density of the layers increase with height—as would be expected.

It has been noticed that ionospheric variations follow 27.3 day and 11 year periods; 27.3 days is the period of rotation of the sun, whilst 11 years mark the period of sun-spot activity. Also, the appearance of sun-spots is usually accompanied with ionospheric

(*Continued on page 107.*)

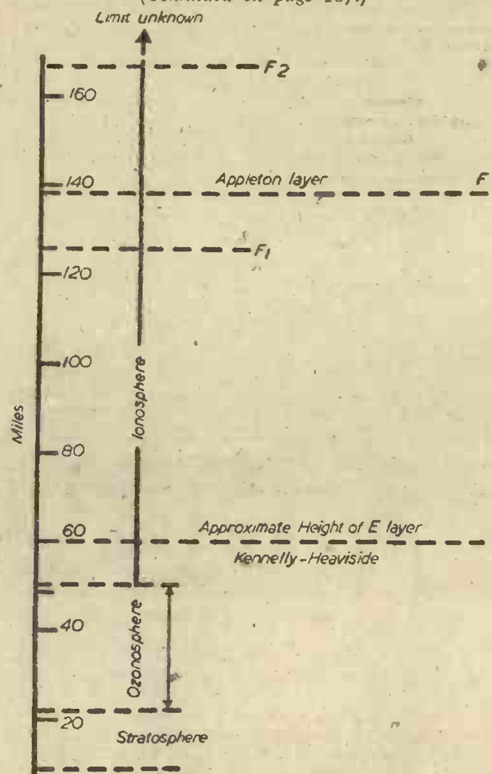


Fig. 84.—Scale showing approximate layers of spheres.

storms resulting in the dislocation of short-wave radio services, etc. These facts definitely link up ionospheric variations with influences from the sun.

The Effect of the Ionosphere upon Radio Waves

In just the same way that a ray of light is bent (refracted) when it passes into a medium of different

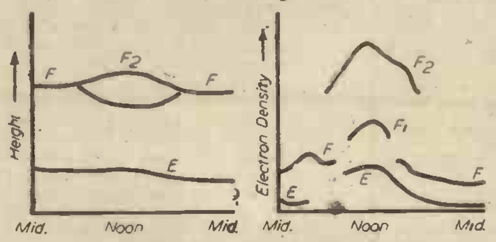


Fig. 85.—Variations of layer height and density.

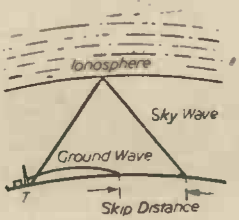


Fig. 86.—Denotes "skip distance."

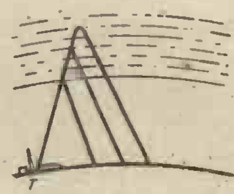


Fig. 87.—Variation of skip distance with frequency and/or electron density.

density, a radio wave is bent in entering the regions of ionised gas. As in the case of light, if the wave enters the ionised layer at right angles no bending occurs. The angle at which the wave enters the layer is equal to the angle at which it leaves it. Referring to Fig. 86 it can be seen that there is a distance between the end of the range of the ground wave and the point where the refracted wave returns to earth wherein no signals may be received; this distance is known as the "skip distance."

Factors Affecting Skip Distance

Alteration of the electron density of the ionised layers will change the depth to which a radio wave will penetrate before complete bending occurs. Thus, as shown in Fig. 87, the skip distance will vary with electron-density of the layer concerned.

The higher the frequency the greater is the penetration of the wave into the ionised region, the skip distance therefore increases as the frequency is increased until complete penetration occurs when the next higher layer, being of higher electron-density, again refracts the wave to earth.

Also, alteration of the angle of radiation of the wave obviously affects skip distance as shown in Fig. 88.

Variations of layer height affects skip distance as shown by Fig. 89.

The manner in which a knowledge of factors affecting skip distances may be utilised is illustrated in the case of maintaining communication with a moving ship. As shown in Fig. 90, as the ship moves on the frequency used may be increased causing the skip distance to keep pace with the ship.

Variations in layer heights and densities may be compensated for by adjustment of the frequency used, i.e., one frequency for day operation and one for night, etc.

Fading

Fading or variation of the received signal strength may be caused by any of the factors that affect the skip distance, i.e., layer height, density, etc. Fading due to variations of layer height or density is most noticeable at sunset and sunrise, at which time ionospheric changes are greatest at that part of the world.

A second type of fading occurs when the receiver is within the range of both ground and sky waves. As shown in Fig. 91, the two waves may combine in such a manner as to be additive or subtractive depending upon their relative phase. Slight alterations in the length of

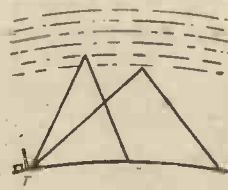


Fig. 88.—Effect of angle of propagation on skip distance.

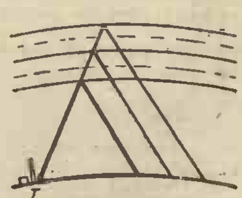


Fig. 89.—Layer height affects skip distance.

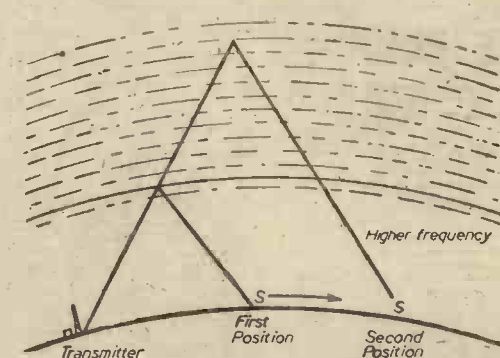


Fig. 90.—Showing how, by increasing frequency, communication can be maintained with a moving vessel.

the path of the sky-wave due to variations in layer density or height will cause the relative phase of the two waves to change, thereby causing variation of signal strength.

(To be continued.)

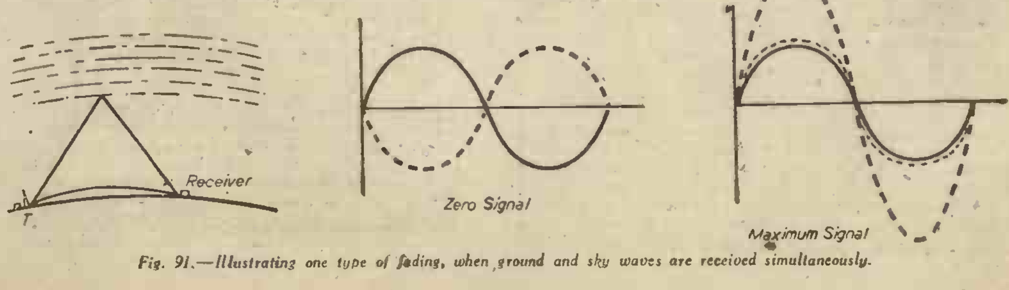
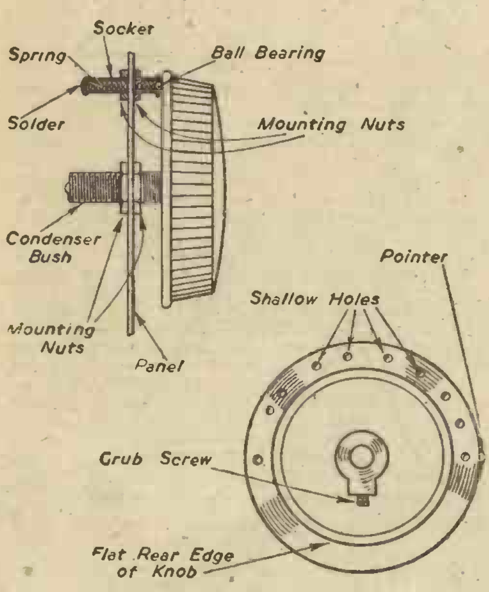


Fig. 91.—Illustrating one type of fading, when ground and sky waves are received simultaneously.

Practical Hints

Band-spread Tuning

THIS is a simple, smooth and efficient way of arranging for definite stops when a bandsetter condenser is used. The sketch should make the method quite clear. The socket is an aerial socket with one end sealed with solder. Inside is a spring such as is used in a cigarette lighter, and a small ball bearing. The rear face of a knob with a flat surface is drilled with shallow holes in the desired positions. If the knob has a pointer it can point to numbers marked on the panel. When the knob is to be mounted the set should be turned on its back, and the ball bearing balanced on the spring until it is forced into the socket by the knob. The socket is completely hidden by the knob and does not detract from the appearance of the panel.—WM. J. GRAHAM (Douglas, Lanark).



fficient way of providing definite stops for a band-spread tuning knob.

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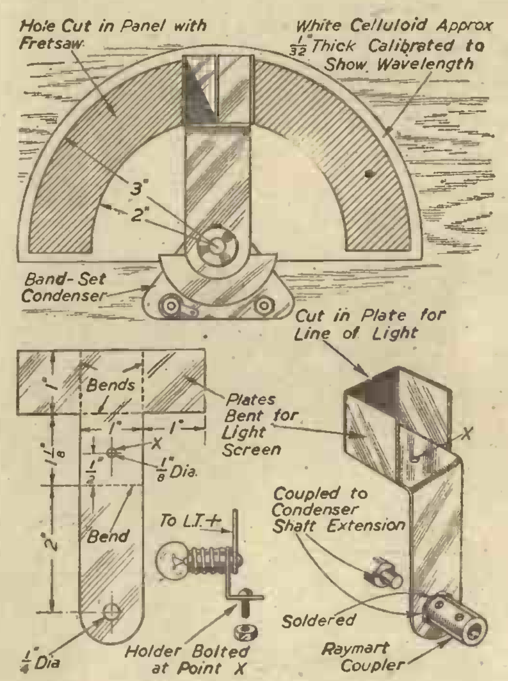
All hints must be accompanied by the coupon cut from page iii of cover.

Correct Ganging

IT is often found that accurate ganging at all points on the tuning scale cannot be obtained when cheap coils of doubtful make are used. This is generally due to the coils not having the same inductance, and the addition of a few turns to a canned coil is usually a somewhat difficult task. The best method of overcoming a defect of this type is to fit a small variable trimmer condenser across the aerial tuning condenser—the fixed vanes of the trimmer to the fixed vanes of the tuning condenser and the moving vanes of the former to the moving vanes of the latter. This extra condenser can be mounted on the chassis with its spindle protruding through the front panel so that it can be operated in conjunction with the main tuning control. An alternative method is to substitute a tuning drive having a variable concentric trimmer attached for the straight drive in use. This type of drive-trimmer combination is very useful when it is particularly desired not to interfere with the disposition of the controls already in use. The use of an extra trimmer is sometimes advantageous even when reasonably well matched coils are employed, as operation of the extra condenser often helps to cut out an interfering station, either by bringing the two tuned circuits exactly into step or, in some cases, by slightly detuning the circuit to which the trimmer is attached.—R. W. (Purley).

S.W. Indicator Dial

IN a short-waver that I built recently I did not have a suitable dial at hand for the bandset condenser, so I rigged up the following indicator, which I found very satisfactory for the purpose. As I had a plywood panel it was easy to cut the hole out with a fretsaw on which the celluloid scale is fixed. The arrangement is most suitable for the standard Raymart condensers, as the indicator is attached to the extension of the shaft which is usually used for ganging purposes. The dimensions given in the sketch are the ones I used for the VC160X condenser that I was using for bandset, although certain modifications can make it suitable for other types.—R. JONES (Stirchley).



Method of arranging a dial for a band-set condenser.

ON YOUR WAVELENGTH

By THERMION

From the Start ?

APROPOS my remarks concerning the coming of age of the B.B.C., a wag reminds me that my simile breaks down in that the average individual has to wait 21 years before he can do as he likes, whereas the B.B.C. has been doing as it likes from the start. I suppose so.

B.E.R.B.

THESE initials stand for the British Electrical Research Board proposed by the Institution of Electrical Engineers in a recent report. The British Institution of Radio Engineers has made proposals on somewhat similar lines with regard to radio engineering.

Sir William Larke at a meeting of the Royal Society of Arts (February 1st, 1943) stated that through industrial research alone can we regain even in part our position as premier exporting nation of the world. Lord McGowan emphasised the same point in the House of Lords (July 15th, 1943) and at the last annual meeting of Imperial Chemical Industries. Mr. Oliver Lyttelton, Minister of Production, in a recent speech about the future of British industry declared: "It is towards the creation of demand and to the use of inventions that the economic thought of our specialists must be directed." Mr. Samuel Courtauld has advised members of the Rayon Federation that their research should be increased. He pointed out that all the big textile manufacturing nations of the world spend far more thereon proportionately than we do. He urged that State expenditure on research should be launched on a "revolutionary" scale and that there should be some remission of the present fiscal burdens on private research. Sir Harold Hartley, in a pamphlet just published, has written, "It is impossible to avoid the conclusion that if this country is to maintain its position in the world markets, our industries must greatly increase their attention to research as soon as the progress of the war makes it possible. There is danger in delay; markets once lost are not easily regained, and industrialists must take active steps now to organise this aspect of their post-war activities."

Colleges and Institutes

CONSIDERATIONS should be given to the possibility of converting more colleges into institutes of technology on American lines, with more full-time work and chairs in various branches of applied science. It is in such places, as well as the universities, that the urgently needed chair of radio engineering might be founded. We have more than doubled the output of engineers and physicists. The implementation of any thoroughgoing post-war reorganisation of research and technological development will require an equal or even greater expansion in trained personnel. Our universities will, therefore, need to handle ultimately something like two to three times the 1938/39 number of science and technology students, plus the further increase for developments foreshadowed in connection with science teaching in schools. In the year before the war, there were in all 50,000 full-time students in the universities of this country, of whom under 13,000 were studying science and technology. These were accommodated in 16 universities and four recognised university colleges.

Radio Engineering

RADIO engineering started as an amateur movement and has never grown out of it. One has only to inspect the inside of a wireless receiver to perceive that it is amateur work. It is true that engineers have come to the rescue with press tools and plastics, but they do not understand radio engineering, and, therefore, must slavishly follow the comic shape which amateurs give to wireless apparatus. Take another look inside a commercial receiver. Look at the array of comic shapes of condensers, the irregularity of valve shapes, the tangles of resistances. It looks more like a Heath Robinson cartoon. The shapes of components should conform to some geometrical layout. Sets have all the appearance of having been assembled from components made by a large number of individual manufacturers, each of whom has independently designed his component without reference to other designers, or the design in which the components are being incorporated. That is why wireless sets are so large. They need be no larger than one-third of the present size. America, where radio design is ahead of ours, has produced small and efficient receivers, which look like dwarfs compared with our smallest. Yet they have more valves and can handle, in some cases at least, larger outputs than ours. I foresee the time when each manufacturer will design his receivers from start to finish. He will design the components so that they blend into a harmonious whole, pleasing to the eye.

Our Roll of Merit

Readers on Active Service—Thirty-eighth List.

C. L. Hodgetts (Sgt., R.A.F.).
D. Cawdell (L.A.C., R.A.F.).
A. K. Jackson (Sgt., R.A.F.).
E. N. Hunt (Sgm., R.A.F.).
S. W. Green (Gnr., Home Forces).
D. Pennington (Cfn., R.E.M.E.).
J. C. Parsons (F./O., R.A.F.).
R. Taylor (A.C.1, R.A.F.).
R. Street (A.C.2, R.A.F.).

WHAT IS COMING? WHO CAN SAY?

(May be sung to the tune of "In the Gloaming.")

In the better Britain coming,
  Will the B.B.C. reform?
Will it cease to give us programmes
  Which were better never born?
In the better Britain coming,
  Will the crooner be unknown?
Loathsome noise from Tin-Pan Alley
  Will the B.B.C. disown?

In the better Britain coming,
  Will the B.B.C. display
Wish to help our own composers
  And assist them on their way?
Or in better Britain coming,
  Will the B.B.C. remain
True to all its old traditions,
  And for ever be the same?

Only time can give the answer
  To the questions here we see.
Best solution? Frame new Charter
  Representing you and me
Then when those who pay the piper
  Shall at last decide the tune,
Will the programmes fill their function
  As an "all-round" daily boon?

"TORCH."

An Economy High

Home-made Coils. Two H.F. Stages. Infinite Imp

Features of this A.C. Operated Re

As the broadcast receiver I was using was gradually losing its efficiency and disintegrating—in spite of repeated efforts to keep it going—I thought it time to design and construct one as, at that time, new receivers were very difficult to get. While considering what circuit to use and where components were to come from, the old set finally gave out after about 8-10 years' service. This helped considerably as the chassis and power pack could be used as well as a number of components. The valves, tuning condenser and coils could not be put into service again owing to

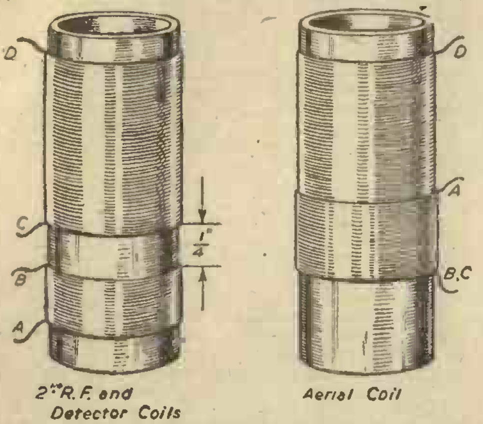


Fig. 2.—Shows the location of the windings for the aerial and H.F. coils.

defects due to their age, etc. The I.F. transformers were of some incredibly low frequency (and Q) and so they were thrown out. The primary consideration was to obtain quality of reproduction (a feature the old set never possessed) plus a reasonable degree of sensitivity.

It was decided to use two stages of R.F. amplification, followed by a detector and two stages of A.F. in the form of a quality amplifier. The R.F. stages are quite straightforward, transformer coupling being used in both cases. The valves are 6K7's, which are variable mu R.F. pentodes, but any of the other valves mentioned for V1 and V2 would do as their characteristics are more or less similar. An R.F. gain control uses a variable cathode bias resistor of 20,000 ohms in series with a fixed bias resistor of 300 ohms to each valve, the cathodes being by-passed to earth by a .1 mfd. condenser. It was found, on testing the set, that on very loud signals the 20,000 ohms was not sufficient to cut-off the valves when required, so a 50,000 ohm was connected between H.T. positive and the common lead connecting the two cathodes together. This lead goes to the variable 20,000 ohm resistor. As the resistance is increased—thus increasing the bias—an increasing positive potential is applied to the cathode, so assisting in cutting the valves off. Fig. 1.

It was also found that screen resistances and anode decoupling resistances as well as various by-pass condensers were not at all critical. Screen resistances can be between 50,000 ohms and 150,000 ohms, anode decoupling resistances between 3,000 and 10,000 ohms, and the screen and anode decoupling condensers can vary between .01 and .25 mfd.

Coils

As no coils were to hand and as the existing coils of the old receiver were not suitable, it was decided to wind some. The formers of the original coil assembly were stripped and rewound for 200-500 metres, the long-wave band being omitted as there is little of interest to be found there. The formers are about ⅞in. diameter paxolin and about 3in. long, and fitted on to a paxolin base which, in turn, is fixed to the shield base. The switching gear was removed and the formers taken off their bases. It was found that 110 turns of 32 S.W.G.

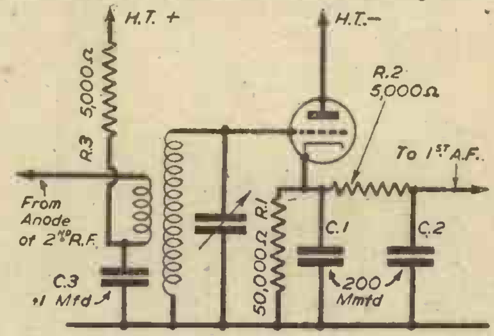


Fig. 3.—The infinite impedance detector circuit which is used in the receiver.

enamelled silk covered wire were needed to tune over the broadcast range with a variable condenser of about 450 mmfd. maximum capacity. The primary turns are about a third the number of the secondary, wound on the earthy end of the coil and spaced about ¼in. from it. The aerial coil contains the same number of turns wound *over* the earthy end of secondary. See Fig. 2. In the aerial coil, the aerial is connected to A. B and C

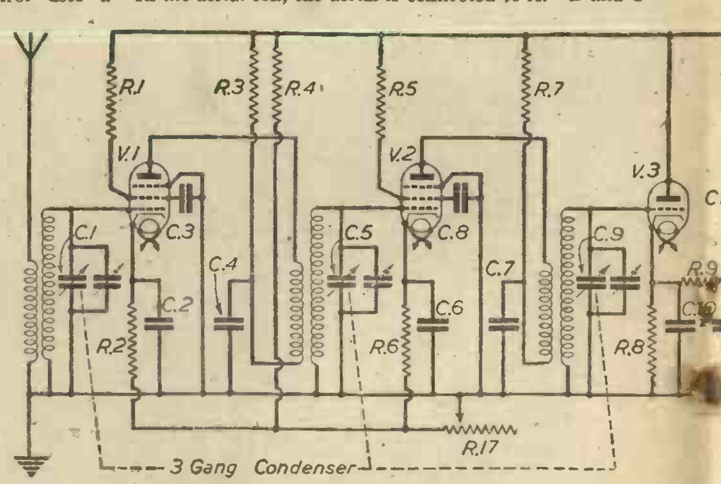


Fig. 1.—The theoretical layout of the complete receiver, showing the pre-de

-fidelity Receiver

edance Detector and Negative Feedback are the ver, Described by D. R. HOOPER

are connected to earth, and D to the 1st R.F. grid. In the 2nd R.F. and detector coils, A is connected to anode of the previous stage, B to H.T. via the 5,000 ohm resistance, C to earth and D to grid. The primary is wound with 38 S.W.G. D.S.C. wire. The leads are brought down inside the former and made fast to tags on the paxolin base, and flexible leads brought through

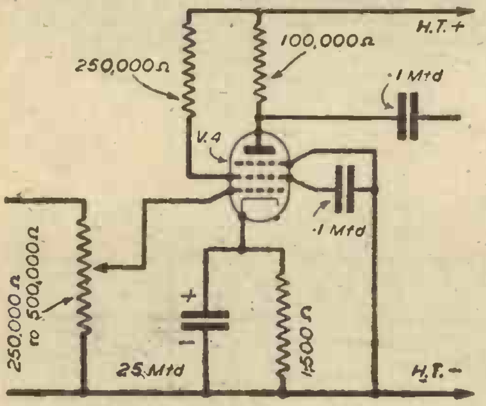


Fig. 4.—If a 6J7 is used for V4, the wiring must be arranged as shown here.

the holes provided in the base to the underside of the chassis. It might be interesting to note that these coils have a Q of 170.

Actually any coils of reasonable quality would do for this set. Coils such as the Wearite midget type for communication receivers would be ideal provided they can be kept well screened from each other. Using these coils on a similar set I built later I found that the primary was tightly coupled to the secondary, causing instability in the R.F. stages. This trouble was overcome by pruning the primary coils (type PA2) of 70 turns. Coupling still seemed rather on the tight side but was satisfactory with a very short aerial.

Detector

The detector stage proved to be a stumbling block. It is known that the leaky-grid detector cannot handle large inputs without putting a fairly heavy load on the

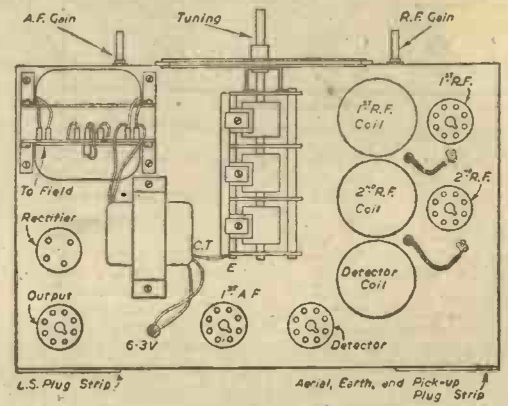
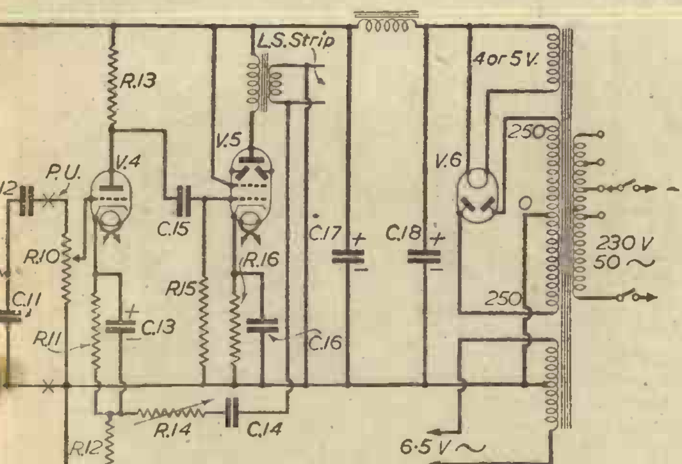


Fig. 5.—Plan view of the chassis showing additional 6.3v. transformer.

tuned circuit. The anode bend detector can handle quite large inputs of power without undue distortion but is not so sensitive, and also loads the tuned circuit. The diode, of course, gives no gain, can handle large inputs, but loads the circuit to a lesser degree.

With two R.F. stages there is more than enough gain so there is no need of further amplification at the detector stage. Leaky-grid detection was not tried. Anode bend proved good except on loud signals, so the diode was tried with good results. The writer then tried the cathode follower or infinite impedance detector, as this type of rectifier has little or no damping effect on the tuned circuit. It can handle very high modulation percentages without distortion. In other words, what is put in on to the grid is faithfully reproduced on the cathode. This system was eventually adopted. The A.F. signal is taken from the cathode, the cathode load being 50,000 ohms, and the R.F. component is filtered out by the network C1, R2, C2. Fig. 3. This is then passed on to the first A.F. stage V4 and then on to the output stage V5.



...ector volume control arrangements and the negative feed-back system.

L.F. Stages

In these two stages the component values are not very critical; the anode load of the 1st A.F. can be anything between 50,000 ohms and 150,000 ohms, the grid coupling condenser between .01 and .1 mfd., the cathode resistance can be between 700 ohms and 1,500 ohms and the by-pass condenser between 10 and 50 mfd. The grid condenser of the output stage can be between .05 and .25 mfd. and the cathode by-pass between 20 and 50 mfd. The grid leak can be between 300,000 and 750,000 ohms.

The usual type of "tone control" is normally a condenser of about .01 mfd. in series with a variable resistance between

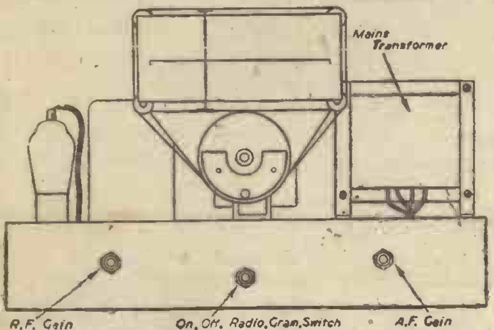


Fig. 6.—Front view of chassis showing location of panel controls.

anode and earth. All this does is to cut off the upper response so giving the receiver a "mellow" quality. In place of this the writer used negative feedback.

Negative Feedback

Negative feedback or degeneration causes a reduction in gain but as there is plenty in hand this does not matter, and is amply made up for by reduction in distortion which is always present to a greater or smaller degree in every amplifier. The general principle of negative feedback is to take a portion of the output voltage and feed it back 180 deg. out of phase with the input voltage.

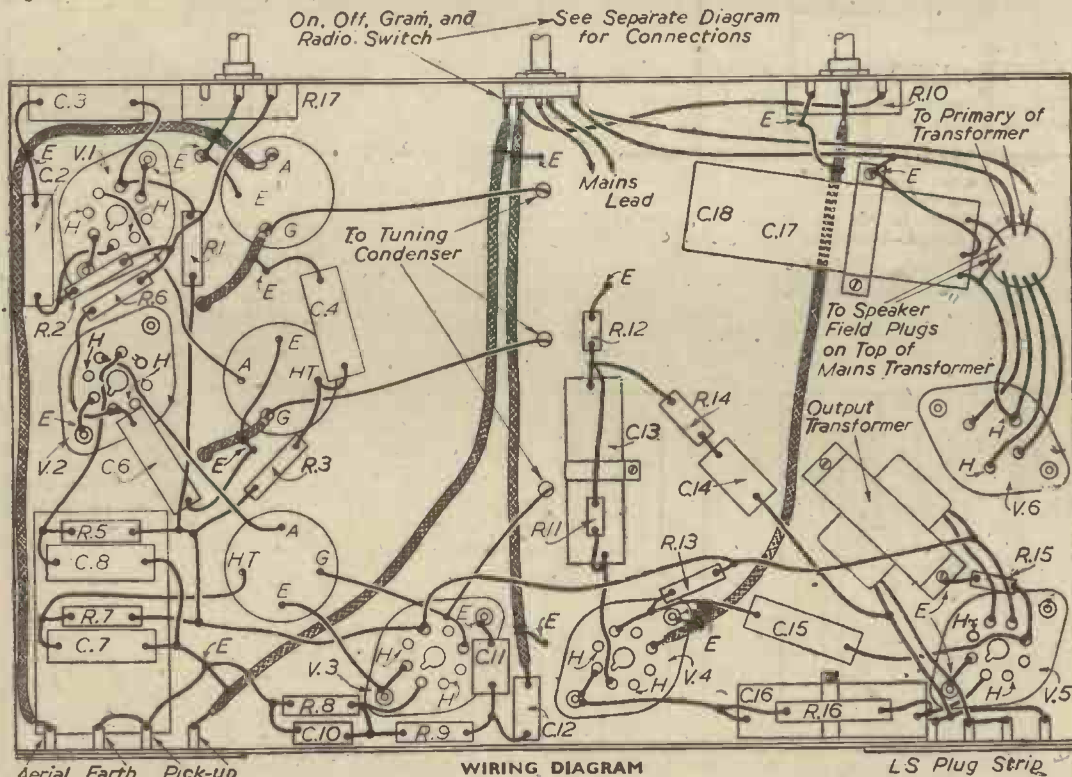
In order to eliminate a fourth variable control, the writer found that 100,000 ohms gave, in his estimation, the correct amount of feedback for good quality, so a fixed resistance of that value was used in place of the variable resistance.

Provision is made for pick-up which is switched in parallel with the A.F. gain control on V4. In the writer's receiver a 6J7 is used as the first A.F. owing to low output from the pick-up and also because it gives greater "punch," although there is plenty of gain in hand using a triode first A.F. See Fig. 4.

With regard to the output stage, a 6F6, 6V6, KT63 and 42 can be used with a bias resistor of 350 ohms. If a 6L6 or KT66 is used it is as well to reduce this to about 200 ohms, although it is improbable that distortion would be present even if 350 ohms were used.

Referring again to the detector and first A.F., if a 6F8 is available this can be used in place of two separate valves. Actually a 6F8 is two triodes—similar to 6J5's—with separate cathodes in one envelope.

The power supply calls for very little comment. The writer, not having any 4-volt valves of a suitable type available, used 6.3 volt, and a transformer giving this was fixed near the H.T. transformer on the top of the chassis. The layout of the chassis and panel is shown in Figs. 5 and 6. The smoothing circuit is conventional, using the field winding of the speaker as a choke. If the speaker available is a P.M.



WIRING DIAGRAM

The points H denote connections for heater wiring which has been omitted for clarity. V1 and V2: 6K7, 6D6, 78, KTW 63 (Osram) or 6SK7; V3: 6J5, 6C5, L63 (Osram), 6F5 or 6SF5; V4: 6J5, 6C5, L63 (Osram), 6J7 or 6SJ7; V5: 6V6, 6F6, 42, KT63 (Osram), 6L6 or KT66; V6: any full-wave rectifier capable of delivering 120 mA's at 250 volts with 4-volt heater, or 5Z4 or 80 with 5-volt heater.

R1, 100,000 ohms; R2, 300 ohms; R3, 50,000 ohms; R4, 5,000 ohms; R5, 100,000 ohms; R6, 300 ohms; R7, 5,000 ohms; R8, 50,000 ohms; R9, 5,000 ohms; R10, 250,000 ohms potentiometer; R11, 1,000 ohms; R12, 100 ohms; R13, 100,000 ohms; R14, 200,000 ohms; R15, 500,000 ohms; R16, 350 ohms; R17, 20,000 ohms potentiometer.

C1, C5 and C9: .0005 mfd. and 30 mmfd. trimmer per section; C2, C3, C4, C6, C7, C8, C15: .1 mfd.; C10, C11: 200 mmfd.; C12: .01 mfd.; C13 and C16: 25 mfd.; C14: .05 mfd.; C17, C18: 8 mfd.

a 10-20 H. choke should be used. If the speaker is of the energised type and the field winding is high impedance a mains transformer of about 300 volts output should be used to allow for the drop in volts when on load.

Lining up procedure is similar to any other TRF receiver. The writer found the circuit pretty well foolproof, and so long as common sense is used in the layout, the receiver should work when first switched on. Keep the coils well screened and leads fairly short. Quite large tolerances have been allowed in the resistance wattage, and condensers should be of 350-volt D.C. working or more, except, of course, the A.F. cathode by-pass condensers.

On test the receiver seems comparable, as regards sensitivity, with a superhet, and selectivity is good. All B.B.C. stations are received at more than ample strength, as are many European stations. The quality of reproduction is a great deal better than what one may term the "average 4 or 5 valve receiver."

The writer considers that this set fulfils the requirements of a sensitive quality receiver that can be built from comparatively few components, many of which can be found in the junk-box or easily bought, thus making it ideal for wartime construction.

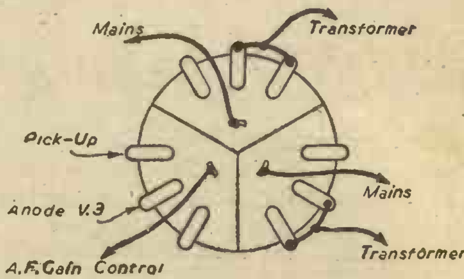


Fig. 7.—Rear view of switch and associated connections. Three single-pole double-throw sections are needed.

Resistor Colour Code

R.M.A. Recommended Standard for Colour Coding for Resistors

THE details given below form the standard method of indicating resistance and tolerance values as published by the Radio Manufacturers' Association.

1. General

The nominal resistance values of fixed resistors and the tolerance on these values, expressed in ohms, may be indicated thereon either by numerical marking or by means of colours or by a combination of both methods.

2. Standard Colours

When colours are so used, they shall have the significance shown in the table, and shall as closely as possible conform to the shade therein specified by reference to British Standard Specification No.381C—1931.

Colour.	Shade.	Significant figures.	Decimal multiplier.	Tolerance.
Black	—	0	1	—
Brown	No. 13	1	10	—
Red	No. 38	2	100	—
Orange	No. 57	3	1,000	—
Yellow	No. 55	4	10,000	—
Green	No. 26	5	100,000	—
Blue	No. 5	6	1,000,000	—
Violet	*	7	10,000,000	—
Grey	No. 31	8	100,000,000	—
White	—	9	1,000,000,000	—
Gold (metallic)	*	—	0.1	5%
Silver (metallic)	*	—	0.01	20%
No additional colour	—	—	—	10%

*No suitable shade is included in the B.S. Specification. The violet shall be a *dark* violet.

3. Methods of Marking

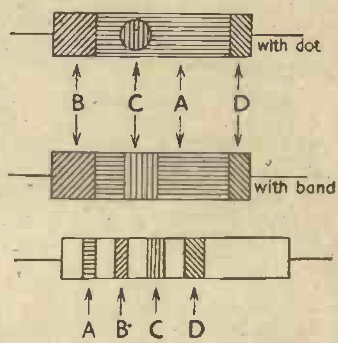
Two alternative methods of marking shall be standard:
(i) The body, end and dot (or band) method.
(ii) The four band method.

Colour A.—(Body colour or first band colour) shall indicate the first significant figure of the resistance.

Colour B.—(End colour or second band colour) shall indicate the second significant figure of the resistance.

Colour C.—(Dot or band colour on body, or third band colour) shall indicate the decimal multiplier applicable to the two significant figures to give the resistance value.

Colour D.—(Narrow end colour or fourth band colour) shall indicate the percentage tolerance.



The R.M.A. standard system of colour marking of resistors.

Note.—The four colour bands of method (ii) may touch each other or be slightly separated as desired.

Note.—A band or dot of colour to designate the *tolerance* only of the resistance value may be applied if desired to a resistor that has the value of its resistance indicated by a numerical marking.

A REQUEST

READERS are requested to bear in mind that, owing to our depleted technical staff, we cannot undertake to offer advice concerning the modification of receivers and other apparatus described in this journal *to suit individual requirements.*

Our Query Service receives many letters asking how to modify, say, a published design of a three-valver as a two- or four-valver. Such requests, at the present time, are unreasonable, as reference to previous issues of PRACTICAL WIRELESS will reveal numerous designs of receivers, etc., from which it should be possible to select one to suit most requirements.

Radio Examination Papers—26

Automatic and Self-bias, Tracing the Cause of Mains Hum, the Electron-coupled Oscillator, Matching of Tuning Coils, Superhet Interference and a Practical Problem Form the Subjects of This Month's Questions to Which THE EXPERIMENTERS Give Appropriate Answers

A Self-bias and Auto-bias

ALTHOUGH these two terms are often confused, they refer to entirely different systems; perhaps the names could have been better chosen. In the case of self-bias the bias voltage applied to the grid of the valve varies in magnitude according to the amplitude of the H.F. or signal voltage appearing at the grid. With auto-bias, the bias voltage applied to the grid remains steady, and is governed by the amount of cathode current passed by the valve, or, in the case of a battery set, by the total cathode current taken by all the valves in the receiver.

The simplest example of self-bias is to be found in the leaky-grid detector, where the bias voltage is that developed across the grid leak. The actual voltage is normally very small, but it varies with the amplitude of the modulated signal applied to the grid of the valve. As the action of leaky-grid detection has been explained earlier in this series it is not proposed to deal with it again now.

Another important application of self-bias is with oscillator valves—either in a transmitter or a superhet receiver. If the grid leak were omitted from the circuit the grid of the valve would tend to become increasingly negative until oscillation ceased. The grid leak allows the grid condenser slowly to discharge, and so brings about a "balance," with the result that a bias voltage appropriate to the amplitude of oscillation is applied, thus the amplitude of oscillation becomes stabilised. The circuit of the oscillator section of a triode-hexode frequency changer is shown in Fig. 1.

QUESTIONS

1. *Explain the difference between "self-bias" and "auto-bias."*
2. *If an A.C./D.C. receiver reproduced a pronounced mains hum after having operated satisfactorily for a long period, what faults would you suspect?*
3. *Draw simplified circuits to show the similarity between Hartley, Colpitts and electron-coupled oscillators. State why the last-mentioned is so named.*
4. *How would you identify the different battery leads of an unfamiliar receiver, when about to connect H.T., L.T. and G.B. batteries without removing the chassis from the cabinet?*
5. *Why is it that with certain types of simple superhet it is possible to receive the same transmission at two different settings of the tuning condenser, particularly on the short-wave ranges? Explain also a possible reason for a heterodyne whistle being heard as an accompaniment to signals received at all settings of the tuning condenser.*
6. *Describe two methods of slightly modifying the inductance of a tuning coil to permit of accurate matching with ganged tuning circuits.*

With auto-bias, a resistor is included in the cathode lead of an indirectly-heated valve, so that all the H.T. current to the valve must pass through it. As a result, a voltage is developed across the resistor, its magnitude being governed by Ohm's Law. The end of the resistor connected to the cathode becomes positive in respect of the "earthy" end, so that the cathode is made positive in respect of the earth line—to which the grid circuit is returned. It follows, therefore, that the grid is made negative in respect of the cathode. Fig. 2 will make this point clear.

When using directly-heated valves, the auto-bias resistor is wired in series between H.T.— and L.T. — By returning the grids of biased valves to H.T.—they are given a negative potential in respect of their filaments. The voltage drop across the resistor is equal to the product of the resistance in ohms and the H.T. current in amps.

2. Tracing Mains Hum

Since the receiver in question had previously operated in a hum-free manner, the cause of trouble could not be attributed to unsuitable design. It is possible that the hum may result from the use of an unusually bad mains supply, but that would be unlikely; such a cause would not normally continue for any length of time, and therefore would not prove very troublesome.

It is logical to assume that one or more of the components would have developed a fault. Breakdown of insulation between the two smoothing-choke terminals would give the trouble, but would not be likely. If that were the cause of trouble, short-circuiting the choke should have little or no effect. A high-resistance leak between the choke windings and the core could also

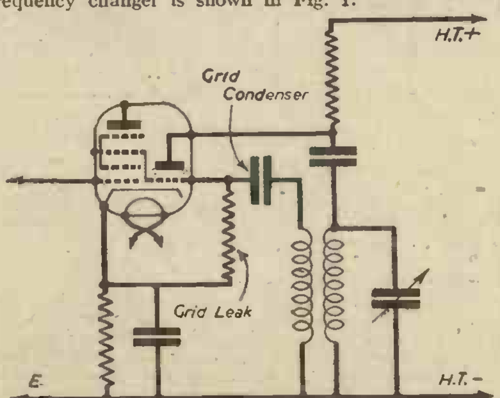


Fig. 1.—A triode-hexode frequency-changer, showing the grid leak and condenser connections to the triode oscillator section. These components provide self-bias for the oscillator.

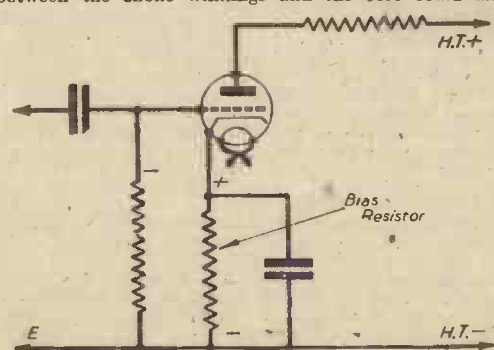


Fig. 2.—Auto-bias obtained by the voltage drop across the cathode resistor of an indirectly-heated valve.

produce hum, but in that case there would probably also be various crackles or "scratchy" noises. Again, this is not a very likely cause.

The fault would most probably be due to failure of one of the electrolytic smoothing condensers. One may expect to find a condenser open-circuited. A test would probably be made by connecting another, good, condenser across each of the electrolytics (or sections of a multiple electrolytic) in turn. Such a method of test might be misleading, however, due to the fact that the hum may not be affected to any appreciable extent when the new condenser was in parallel with the defective one. The only reliable method of testing, when this fault is suspected, is to disconnect one side of each smoothing condenser in turn, and then to connect the new condenser in its place.

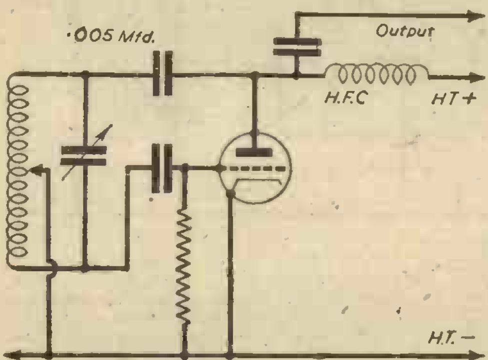


Fig. 3.—Hartley oscillator circuit. Compare this with Fig. 4.

It will often be found that the hum is immediately reduced in volume merely by disconnecting the faulty smoothing condenser. This is probably because the condenser develops a high internal resistance, across which a hum voltage tends to build up. A fault of this nature generally comes rather as a surprise when it is first encountered.

3. Oscillator Circuits

Hartley, Colpitts and electron-coupled oscillators are shown in Figs. 3, 4 and 5. The Hartley is best known, and it will be seen that the tuned circuit is wired between the grid and anode of the valve, while an earth lead is taken to a tapping of the coil. A condenser is placed between the anode and one end of the coil merely to prevent short-circuit of the H.T.; it has no effect on H.F.

In the Colpitts circuit the tuning circuit is similarly wired, but the earthed tapping is replaced by an "artificial" tapping obtained at the junction of two fixed condensers wired in series across the tuned circuit. These condensers may, in fact, form part of the tuning circuit.

In the electron-coupled circuit, use is made of a pentode or tetrode valve (a tetrode is shown in Fig. 5), and the tuning circuit is connected between grid and earth. The cathode, instead of being returned to the earth line, is connected to a tapping on the tuning coil. Now how is this comparable with the other two circuits discussed? It will be seen that the screening grid is by-passed to earth through a fairly large-capacity condenser, in addition to being connected to H.T.+. Thus, it is connected to the earthy end of the tuning coil. It acts in the same manner as does the anode in the Hartley circuit, so the similarity between the electron-coupled, Hartley and Colpitts oscillators can be seen.

But since the output from the oscillator is taken from the anode, some form of coupling to what is virtually the triode oscillator is essential. This coupling is provided by the electron stream passing through to the anode through the screening grid. Hence the name.

4. Identification of Battery Leads

It is clear that the first requirement is to identify the L.T. leads, since once they are connected to the accumulator or L.T. battery there is little danger of burning out the filaments by applying the H.T. voltage to them! The L.T. leads can be found fairly easily by connecting a flash-lamp bulb to the filament sockets of one of the valve holders, switching on the set by means of the on-off switch, and finding which pair of leads causes the bulb to light. Of course, with some battery valves it is possible to see the filament glowing a dull red when it is connected to the L.T. supply, in which case the bulb is not necessary.

The H.T.— lead can next be found by connecting one side of the flash-lamp bulb to the L.T.+ and connecting each of the "spare" leads to the other side of the bulb, one at a time. When the H.T.— lead is found the bulb should light, since L.T.— and H.T.— are generally connected together. It may be found that two different leads produce this result, when it will be known that one is H.T.— and the other is G.B.+; since both are joined together it will not matter which way round they are connected to the batteries. In making this test it should be remembered that the L.T. leads may have been reversed, or that in the particular set under consideration H.T.— is connected to L.T.+. This simply means that if the bulb fails to light, the connection to it should be transferred to L.T.—.

If there are no G.B. leads (due to the use of auto-bias) the next tests are simple, since it is necessary only to connect a lead to a low-voltage tapping on the H.T. battery and see if a click is heard in the speaker; if so, the lead is the main H.T. positive. Any single remaining lead is probably a lower-voltage H.T.+ connector, and can safely be tried in the 60-volt socket. The most suitable voltage tapping can later be found when the set is in operation.

When there are two G.B.— leads, start by putting both in sockets near the maximum-bias end of the battery. Reproduction will probably be badly distorted, and one lead in turn should be moved to different voltage points—remembering to switch off the set before taking any G.B. plug out of its socket.

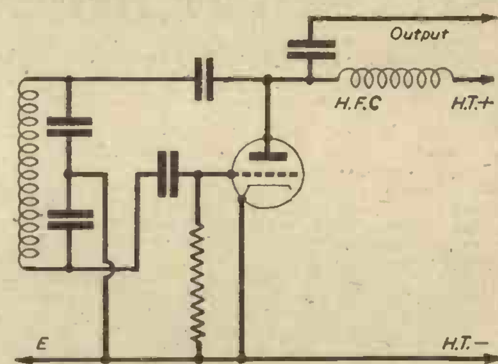


Fig. 4.—The Colpitts circuit uses an "artificial" tap to earth instead of the "electrical" tap in the Hartley circuit.

The method outlined assumes that a meter is not available. If a multi-range meter is to hand, the leads can readily be identified by testing between each and the anode and grid sockets of the valve holders, with the meter set to read high resistance values.

5. Double Tuning with Superhet

It is known that superhet reception is obtained when the oscillator frequency is 465 kc/s (assuming that to be the intermediate frequency) above or below the signal frequency. Provided that the signal-frequency tuning circuits are very selective, and especially if a pre-selector stage is provided, they will respond to only one frequency. So if a ganged tuning condenser is used any given station can be received at only one setting of the condenser.

On short waves, however, tuning is relatively fairly flat with the average inexpensive superhet, and therefore if the input tuning circuit is tuned to, say, 20,000 kc/s and the oscillator to 20,465 kc/s, signals on 20,930 kc/s may reasonably be expected to "break through." In such conditions, a signal on 20,465 kc/s may well be heard when the oscillator is tuned to either 20,000 or 20,930 kc/s. Hence the double tuning.

Referring to the second part of the question, if the I.F. were 465 kc/s and a strong signal on 466 or 464 kc/s were able to pass through to the I.F. stages, a 1,000-cycle heterodyne note or whistle would be heard whenever a signal at any frequency within the tuning range were picked up. The spurious signal at near —I.F. might reach the I.F. stages due to break-through or to pick-up by unscreened leads in the I.F. circuits.

6. Matching Tuning Coils

One system of matching coil inductances, and used by coil manufacturers, is simply to move a few of the end turns on the coil a fraction of an inch away from the others, so reducing the inductance. On a plain cylindrical former this is easily done before the application of varnish or dope to secure the windings.

With rigid self-supporting short-wave coils the same result is achieved by slightly increasing the spacing between the end turn and the second turn. When fairly heavy-gauge wire is used and the coil is wound on a former, the end of the winding may be passed through a hole in the former and led out at a diametrically opposite hole after forming a half-turn or loop in it. Inductance can then be varied by rotating this half-turn so that it is parallel to or at right-angles to the main winding.

Another method is to make a ring of stiff wire in the form of a closed loop and mount this in the end of the coil so that it can be rotated within the former. Although not in any way connected to the winding, the closed loop will affect the inductance, causing a reduction in value when its plane is at right-angles to the axis of the coil.

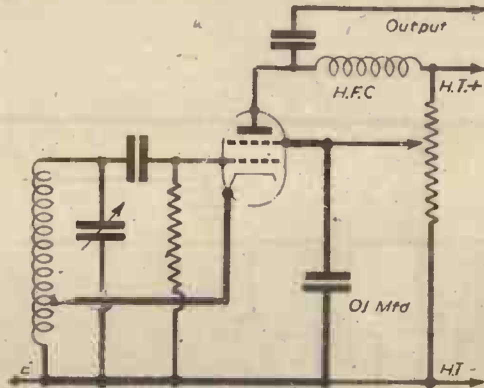


Fig. 5.—An electron-coupled oscillator circuit. Heavy lines help to show its similarity to the Hartley circuit.

It should be understood that all three methods explained bring about only minute changes in inductance, and are of value only after the best possible match has been obtained by adding or subtracting turns and half-turns to and from the winding. Additionally, the methods are mainly of use with short-wave coils.

An Economical One-valver

A Medium-wave Receiver Capable of Putting Up a Good Performance With Minimum Power Consumption. By P. D. THOMAS

THE chief feature of this receiver, apart from its efficiency, is its economy of operation. Using a 6J7 metal valve, which is a 6.3-volt type, it derives its power from a filament transformer and a 9-volt G.B. battery for H.T. A small filament transformer consumes very little power, and as the H.T. current is less than 1 mA, the running costs are almost negligible.

Sensitivity is as good as that of most 0-v-0 receivers, and the controls are easy to handle. In most localities the receiver will give comfortable 'phone signals from Home and Forces transmissions with a 20ft. indoor aerial; but to do it justice it is better to use an outdoor aerial and earth, when the performance will greatly be improved. Plenty of continental stations will be audible after dark, as well as other B.B.C. transmissions.

The Circuit

This is shown in Fig. 1. There are two aerial tappings, one at the 40th turn, and the other at the top of the grid coil. A short flex, run from the aerial condenser, terminates in a crocodile clip which makes this connection direct to the coil. The tapping can therefore easily be adjusted when necessary. The tuning condenser is an ordinary .0005 mfd. type.

Leaky-grid detection is used, with a condenser of .0003 mfd. and a leak of 2 megohms. The control grid (top cap) is used for detection; the screen and suppressor are connected together and to H.T.+9v.

A .0003 mfd. differential condenser controls the reaction; this makes the adjustment rather smoother than with an ordinary variable condenser. Any *good* H.F. choke can be used.

Construction

The panel and chassis can be made of metal or thin plywood, whichever is available. A suitable size is 8in. by 6½in. for the panel, and 8in. by 5in. for the chassis, the latter being supported on runners of ⅜in. wood, measuring 5in. by 2½in. These sizes, however, can and should be increased or decreased to suit the particular components used (Fig. 2).

A pointer knob and dial plate are the simplest form of tuning control; but a slow-motion dial can obviously be used if this is available.

The controls are: top, tuning; left-hand knob, reaction; centre, on-off switch; and right-hand knob, aerial series condenser.

Connections to aerial, earth, 'phones and 9-volt battery are best made by mounting six sockets or terminals on a strip of paxolin or ebonite across the back of the runners. If the chassis is made of plywood, however, these can be mounted in a row along the rear edge.

There is not much drilling to be done; one large hole (⅞in. or 1in. diameter) for the valve, four holes, about ⅜in. diameter, on the panel, and a few ⅛in. mounting holes are all that are necessary. As actual dimensions and positions will vary with different components, no detailed particulars can be given.

The coil is quite simple to make (Fig. 3). The materials required are: 3in. or 4in. of 1½in. former, and about ¼ oz.

each of 26 and 34 S.W.G. enamelled or silk-covered wire or approximate sizes. The grid coil has 65 turns of 26 S.W.G., tapped at 40 turns, where a small loop is made with the bared wire, on to which the aerial tap is clipped. A similar loop is made at the upper end of the winding. The reaction coil has 40 turns of 34 S.W.G., spaced ¼in. away from the grid coil. All turns are close wound, and in the same direction.

General

The valve used in the writer's receiver is an American type 6J7, but 6J7G, 6J7GT or 6W7G can be used without making any change to the receiver. If it can be obtained, the 6W7G is a particularly suitable type, as the heater current is only .15 amp. as against .3 amp. for the 6J7. A 6L6 or 77 can be used if the octal socket is replaced by an American six-pin wafer valveholder.

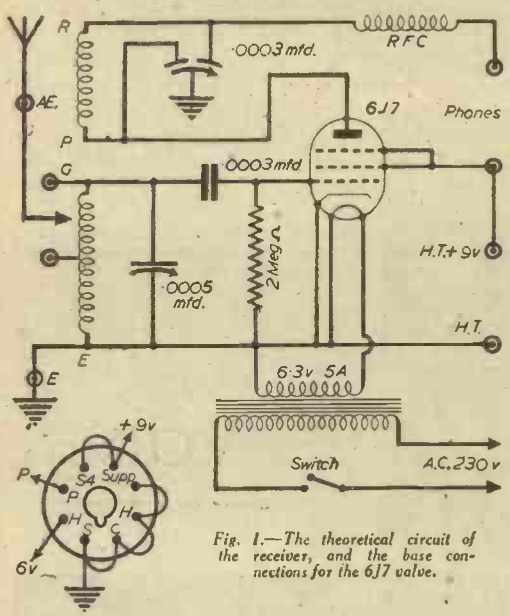


Fig. 1.—The theoretical circuit of the receiver, and the base connections for the 6J7 valve.

If a proper filament transformer is not available, a bell transformer with the secondary re-wound to give 6 volts can be used; but this voltage should be checked with an accurate A.C. voltmeter, since it must not exceed 6.5 volts, or the valve will be damaged.

Should a transformer of any kind be unobtainable, the heater can be supplied by a 6-volt accumulator, or even dry batteries. In this case, a flex, connected to the heater pins and brought out through the back of the chassis, will make suitable connections, the switch being inserted in series with one of these leads.

The aerial series condenser can either be .0001 mfd. or .0003 mfd., but the former value, which was used in the original, is recommended. The on-off switch must be a type rated for use in mains circuits, but otherwise the kind is immaterial.

Operation

When the construction and wiring are complete, connect up the H.T. battery (9 volts), aerial, earth and 'phones, and plug in the mains lead and switch on. Set the right-hand knob (aerial condenser) about half-way out; now turn the reaction knob clockwise. If all the connections have been made correctly, a slight "plop," and possibly a whistle, will be heard, showing that the valve is oscillating. If the reaction is found to increase anti-clockwise, the connections to the two sets of fixed plates must be reversed.

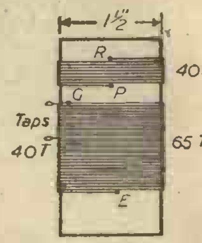


Fig. 3.—Details of the coil.

A little experiment with the aerial tappings and setting of the aerial condenser will enable the maximum results with any aerial to be obtained.

Don't forget that the valve will take about 10 seconds to warm up.

COMPONENTS

One Tuning condenser, .0005 mfd.
One Differential reaction condenser, .0003 mfd.
One Midget variable condenser, .0001 mfd.
One Mica fixed condenser, .0003 mfd.
One Grid-leak, 2 megohms.
One H.F. choke.
One 6.3v. .5a. filament transformer.
One On-off switch.
One 6J7 valve.
One American Octal valveholder.
One Chassis and panel.
Six Sockets or terminals.
Two Knobs.
One Pointer knob and dial.
One Crocodile clip.
One Metal valve cap.
Wire, sundries, etc.

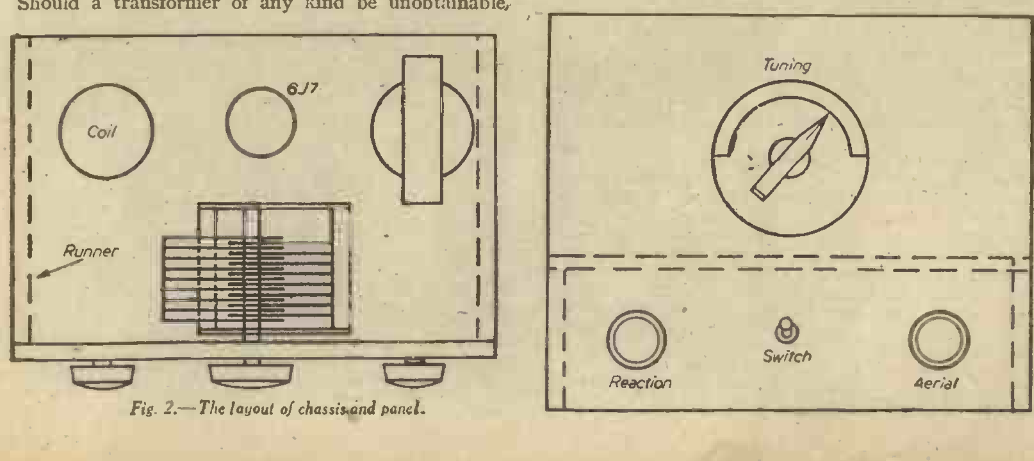


Fig. 2.—The layout of chassis and panel.

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

A Further List of Important Dates in the History of the B.B.C.

(Continued from page 74, January issue)

January, 1927

1. Royal Charter for the incorporation of the British Broadcasting Corporation and Licence and Agreement between the Postmaster-General and the British Broadcasting Corporation.
   Receiving licences first issued to blind persons without charge.
3. Inauguration of evening "Foundations of Music" series. (Discontinued June 26th, 1936.)

February, 1927

21. First broadcast by H.R.H. the late Duke of Kent.

March, 1927

25. First racing running commentary: the Grand National from Aintree. (Commentary by Meyrick Good and G. F. Allison.)

Savoy Hill. Home of the B.B.C. 1926.

April, 1927

2. First broadcast of Oxford and Cambridge boat race.
23. First broadcast from Wembley Stadium: Running Commentary on Cup Final.

May, 1927

21. First running commentary from Olympia on the Royal Tournament.

June, 1927

4. First running commentary on the "Trooping of the Colour."

July, 1927

2. First running Commentary on the Royal Air Force Display from Hendon.
24. Memorial Service and ceremony at opening of New Menin Gate, relayed from Ypres.

August, 1927

13. First B.B.C. Promenade Concert from the Queen's Hall. (Conductor: Sir Henry Wood.)
21. Opening of Daventry experimental transmitter 5GB for alternative programmes.

September, 1927

4. First programme from Sydney, Australia. (No details available.)

November, 1927

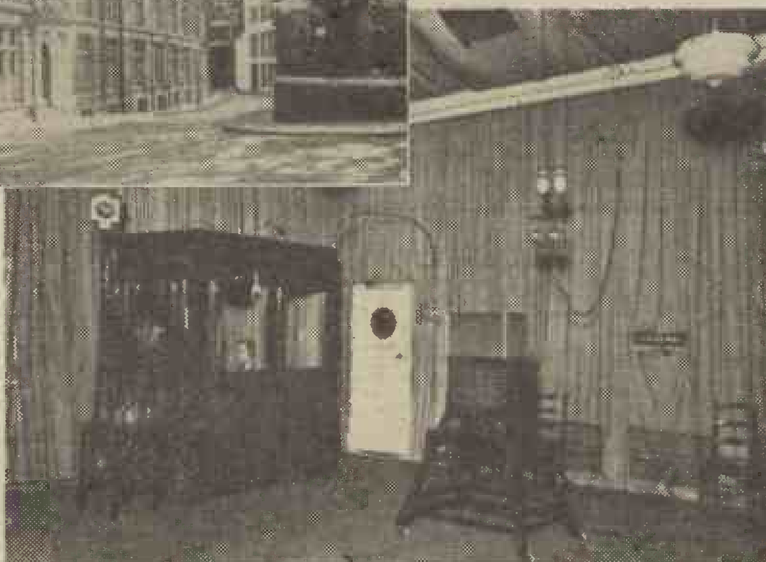
11. Chelmsford experimental short-wave station 5SW opened; experimental broadcasts to the Empire.
— Central Council for Broadcast Adult Education formed at end of 1927.
— Committee of independent experts appointed at beginning of 1927 to advise the British Broadcasting Corporation on Regional high-power distribution.

January, 1928

2. Inauguration of week-day Religious Services from Daventry. (January 12th: Taken in London programme as well.)

March, 1928

5. Ban on broadcasting of controversy removed by the Postmaster-General.
12. Jack Payne and the B.B.C. Dance Orchestra gave first broadcast.



March, 1928. No. 1 Studio of the B.B.C. at Savoy Hill.

May, 1928
20. Inauguration of Sunday afternoon Bach Church Cantata series.

August, 1928
10. Eye-witness account of Menin Gate broadcast. (British Legion pilgrimage.)

1928.
—. The B.B.C. completed arrangements for the building of new headquarters in London to replace Savoy Hill.

October, 1928.
15. Sir James Barrie's first broadcast (from Jedburgh where he received the Freedom of the city).
30. Inauguration of experimental transmission of still pictures by the Fultograph process from Daventry.

November, 1928.
21. First announcement broadcast of the illness of H.M. King George V. Thereafter medical bulletins of official statements were broadcast whenever issued.

December, 1928.
12. First broadcast by H.M. Queen Mary.
—. National Wireless Chorus formed.

January, 1929.
16. First issue of *The Listener* published.

October, 1929.
21. Brookmans Park transmitter took over from Oxford Street. London Regional Station opened.

November, 1929.
14. Birthday programme by members of the B.B.C. staff.

January, 1930.
21. World broadcast of the opening of the Naval Conference by H.M. the King in the House of Lords.

April, 1930.
18. Relay of Bach's St. Matthew Passion from the Thomaskirche, Leipzig.
23. Shakespeare Birthday celebrations broadcast from Stratford-on-Avon.

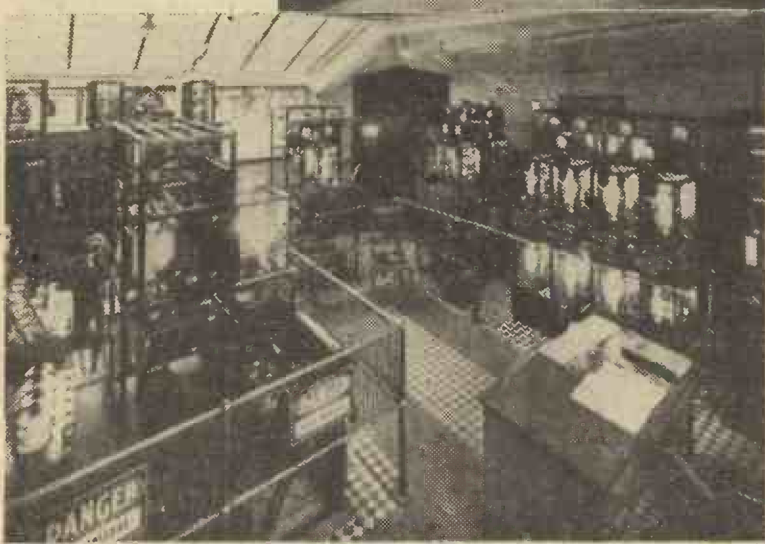
May, 1930.
31. Opening of Bristol Air Port by H.R.H. Prince George.

June, 1930.
—. Supplemental Agreement between the Postmaster-General and the British Broadcasting Corporation.

July, 1930.
8. Opening of India House by H.M. King George V.

August, 1930.
4. Broadcast of arrival of Miss Amy Johnson at Croydon.
16. Arrival of R100 at Cardington from Canada broadcast.

Control Room (2LO) prior to 1931, showing the Simultaneous Broadcasting Board and Control Desk in background.



B.B.C. transmitter on the roof of Selfridge's building in Oxford Street, London (1925 to 1929).

September, 1930
8. Broadcast by W. B. Yeats of some of his poetry.
23. General Smuts opened the Faraday Centenary Exhibition.

October, 1930
22. First broadcast from Queen's Hall of B.B.C. Symphony Orchestra with 114 players in new season's symphony concerts.

February, 1931
23. Memorial concert of Peter Warlock's music broadcast.

(*Continued on page* 123)

A Matter of Solution

An Imaginary Conversation Between L. H. Gibson and Mr. Robinson, Whose Troubles Were Described in Problem No. 448

"AH, yes, Mr. Robinson. You say you get unsatisfactory reproduction, inferior quality and gain.

"Well, now, let me see. Let's just run over a few points first, shall we?

"Firstly, your L.T. battery. You say it is fully charged. All right then, that clears point one satisfactorily. Unless, of course, there is a circuit leak somewhere which you may have overlooked.

"You've checked that! And there appears to be none at all. All right, Mr. Robinson, that does clear point one.

"Secondly, you *did* say that your grid bias battery was all right? You checked that too.

"Right-ho, Mr. Robinson. I assume, of course, that you have a reliable voltmeter? You have a good and expensive one of high ohms-per-volt value! Good then, that clears point two.

"Now your H.T. battery. Is that above suspicion? It's a new one! Well, of course, you know, you can buy a *new* battery which appears to be good; but—oh, you checked it on load, did you? Was there any difference in voltage than when off load? Just a volt or two, very little. O.K., well, that appears to clear up point three, and we are satisfied that the potential supply is satisfactory. Right, Mr. Robinson, let us check and consider your other information.

"You say that the loudspeaker you are using is of the balanced armature type, giving a load of 2,000 ohms, and is connected direct in the output circuit, and you checked the current, you say? Eighteen milliamps! Rather high, don't you think, for one valve? When you consider that the other two valves are probably consuming, shall I say, three to five milliamps, which, in comparison, seems quite small, don't you think?

"Did you check the volts applied to the plate of your output valve, Mr. Robinson? No! Well, let us calculate a little. Your load by the loudspeaker is 2,000 ohms and the current is 18 milliamps.

"Now, as you probably know, the potential across any circuit section is the product of its resistance and D.C. current. Right. So by ohms law, the potential across the speaker is:

$$E = I \times R = \frac{18}{1{,}000} \times 2{,}000 = 36 \text{ volts.}$$

"Therefore you see, there is a voltage-drop of 36 volts across the speaker coil, leaving only 120 v. − 36 v. = 84 v. on the plate of the valve. That is a little low, you know, and the load caused by that valve is liable to cause the other valve voltages to be lower than what they should be for proper functioning. However, for the moment we will assume that they are all right.

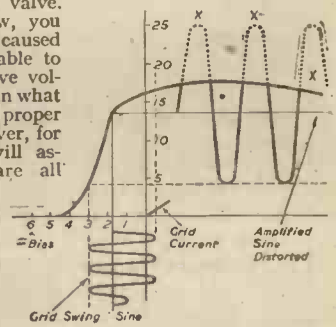


Fig. 2.—Depicts the conditions under which the valve was operating.

"Now, this is where we can help matters by consulting a characteristic curve, or a number of such curves, Mr. Robinson.

"These curves are only rough and approximate, but they will do to serve our purpose.

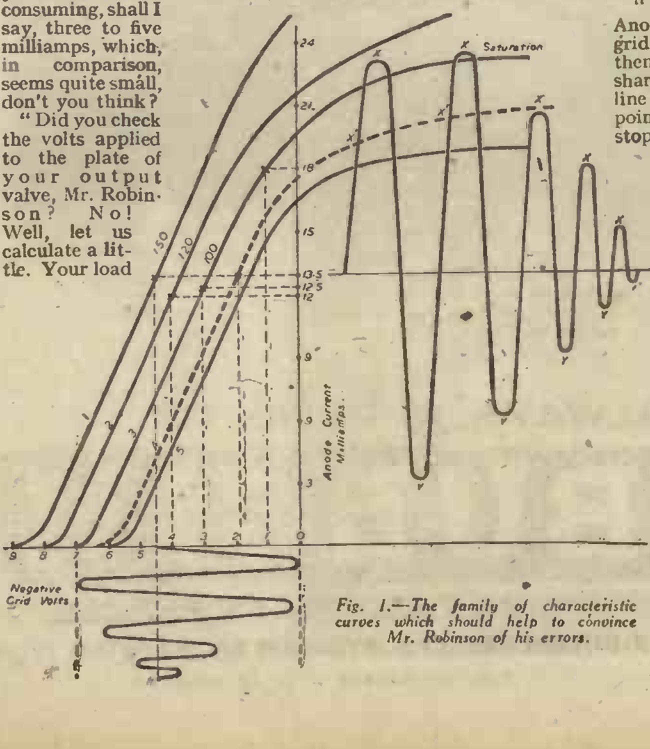


Fig. 1.—The family of characteristic curves which should help to convince Mr. Robinson of his errors.

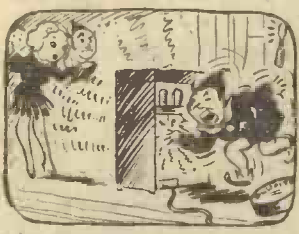
"Let us take first of all, curve 1, Fig. 1. Anode volts 150. You can see that, at 9 volts grid bias negative, there is no anode current, then it rises slowly at 8 volts, then rather sharply from 7½ volts and maintains a straight line in equal bias volts afterwards. There is a point, of course, where this state of affairs stops slowly and bends over to the right, to saturation point. That means that any increase of bias positive value does not necessarily *increase* the anode current, but actually tends to decrease it slowly.

"For good, satisfactory results, we need to be at the *centre-point* of the *straight* portion, or linear section, of the curve. The reason is this; if you glance at the sine wave I have drawn vertically, you will see that peaks x and y are faithfully produced, that is, when the swings of the original sine curve are applied to the grid, and shown amplified.

"If, however, the anode volts are *less* than what they should really be, say, as in your case, 84, shown as curve 4, the top peaks X are cut off, as shown at X[1]. This, of course, Mr. Robinson, is not the state of affairs we want, is it? That is, if we maintain the same anode current, which corresponds here to a bias potential of 1.9 volts.

"Now, if we wish to arrange our voltages when amplified within the limits of the curve we must make a few alterations. Either to increase the voltage on the plate to something over 100 volts, where the small amount of X peak cut-off

(Continued on page 123.)



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It's never behaved in that way ! "
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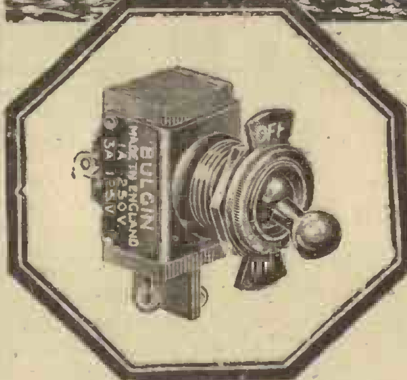

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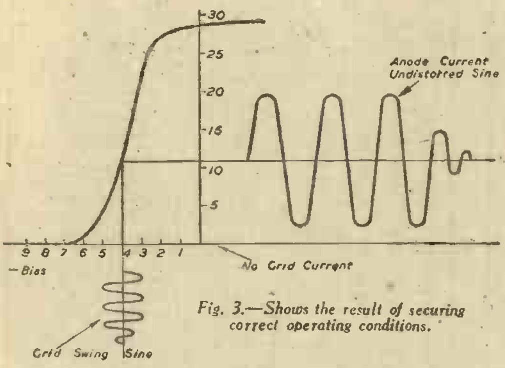


Fig. 3.—Shows the result of securing correct operating conditions.

will pass unnoticed, or to bring our grid-amplified swings more to the central point of the straight line of curve, by increasing our bias volts from 1.9 volts to 3 volts, which will just bring the amplified voltage swings to the ends of the straight, or linear sections.

"Such large variations of anode current are actually not the case in practice with an ordinary battery set like yours, Mr. Robinson, but it's probable that your first L.F. valve is causing too big a grid swing on the second L.F., and causing it to overload, that is, the grid swing potentials are too large to be handled by the second valve curve without cutting off the peaks X and Y.

"The suggestions for you, Mr. Robinson, are to increase your H.T. supply, and also increase the negative bias on the output valve grid, which will reduce your anode current appreciably also. Assuming that you are using transformer coupling, be sure that you are using correct bias voltage on your first L.F. valve grid, otherwise, you will be producing distortion of the amplified wave-form, which, when passed through the transformer, will be amplified again by the second L.F., and likewise accentuate, or show up, the distortion even more.

"Well, Mr. Robinson, I rather think your trouble is due to too small a voltage on your second L.F. and not sufficient negative bias; the latter will account for heavy anode current, and the former for the distortion or a combination of both actions in each case. These are the conditions you have, Mr. Robinson, as shown in Fig. 2, and what you really require is shown by Fig. 3. O.K., Mr. Robinson? If it still overloads, or distorts with the volume control all out (viz., minimum volume), then try reducing your input to the first valve by fitting a small preset condenser in the aerial circuit, and adjust the bias on the first L.F. valve.

"If you still have trouble, Mr. Robinson, scrap the circuit and rebuild it, but this time purchase 'Practical Wireless Tested Circuits, price 6s. 6d. or 'Practical Wireless Service Manual,' price 8s. 6d. published by George Newnes, Ltd. You will be more satisfied, and you will learn a lot more. I did.

"Well, good-bye, Mr. Robinson. I wish you success with your receiver."

THE B.B.C.'S TWENTY-FIRST BIRTHDAY

(Continued from page 119)

May, 1931

17. North Regional station at Moorside Edge opened.

June, 1931

21. First appearance of B.B.C. Bach Orchestra, conductor, Stanford Robinson.
24. Manuel de Falla conducted a concert of his own works.
28. First broadcast by B.B.C. Light Orchestra, conductor, Percy Pitt.

July, 1931

3. First broadcast by B.B.C. Studio Orchestra, conductor, Constant Lambert.
12. First broadcast by B.B.C. Studio Symphony Orchestra, conductor, Percy Pitt.
27. First broadcast by B.B.C. Theatre Orchestra, conductor, Leslie Woodgate.

August, 1931

19. Two acts of "Tristan and Isolde" relayed from the festival at Bayreuth.

October, 1931

1. First of series of weekly evening services from St. Michael's, Chester Square (conducted by Rev. W. H. Elliott).

November, 1931

19. Weekly bulletin at 7.20 p.m. on Thursdays relating to Service re-unions and later to Government and other Public Services instituted.

December, 1931

18. First appearance of the B.B.C. Chamber Orchestra, conductor, Constant Lambert.

February, 1932

15. First broadcast by B.B.C. Wind Orchestra, conductor, Percy Pitt.

March, 1932

15. New B.B.C. Dance Orchestra under Henry Hall to replace that directed by Jack Payne.
26. First of "Music-Hall" series presented by J. E. Sharman and John Watt.

April, 1932

4. First of series of talks interchanged between the B.B.C. and CBS.

May, 1932

15. B.B.C. move to Portland Place. Broadcasting House becomes headquarters of the B.B.C.
23. Talk by Amelia Earhart on her record trans-Atlantic flight.

June, 1932

12. Scottish Regional station opened at Westerglen.
19. First broadcast service from All Soul's, Langham Place.

July, 1932

7. King and Queen visit new London H.Q.'s of the B.B.C.

August, 1932

22. Television programme transmitted by Baird process taken over by the B.B.C. from Baird Television Co., Ltd.

November, 1932

11. *World Radio* published its first Empire edition.

December, 1932

19. Inauguration of Empire broadcasting service from Daventry.
25. First "Round the Empire" Christmas Day programme. Broadcast message from H.M. King George V.

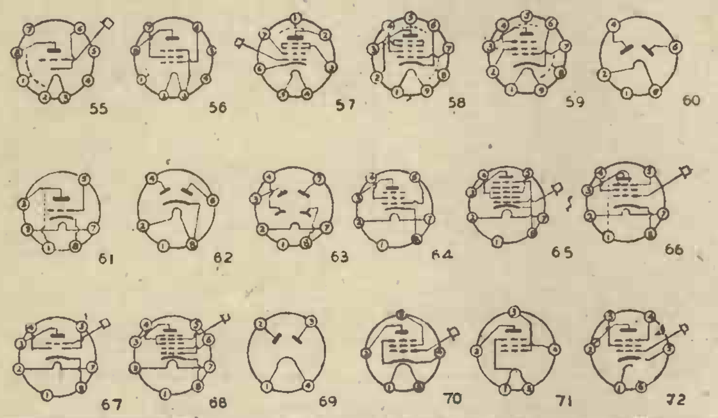
—. Festival of Elgar Celebration concerts.

(To be continued.)

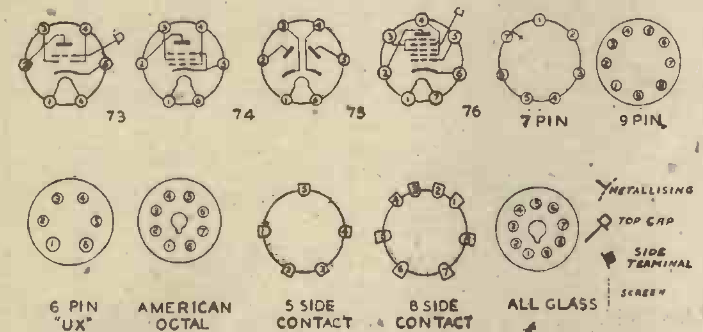
Valve Data Sheets

MULLARD

57



58



The valve bases are viewed from the free end of the pins, or the underside of the valveholder.

The reference numbers are those quoted in the " Base " columns on the Data Sheets which give the characteristics and operating data, etc.

OSRAM

59

H.F. PENTODES AND TETRODES
(2-VOLT BATTERY DIRECTLY HEATED TYPES)

Type	Description	Filament Volts	Filament Current amps.	Type of Base	Anode Volts max.	Screen Volts max.	Mutu'l Con-duct-ance mA/volt	As amplifier under conditions of max. anode and screen volts: Appr'x Grid Bias Volts	Av'ge Anode Curr't mA.	Av'ge Screen Curr't mA.
S23	Short Grid Base Tetrode ..	2	0.1	4-pin	150	70	1.1	—1.5	1.3	0.6
VS24 (o)	Variable-mu Tetrode	2	0.15	4-pin	150	75	1.5	0	4.5	0.5
VP21	Variable-mu Pentode	2	0.1	7-pin	150	60	1.1	0	2.8	0.7
W21	Variable-mu Pentode	2	0.1	4-pin or 7-pin	150	150	1.4	0	3.6	1.2
Z21	Short Grid Base Pentode ..	2	0.1	4-pin or 7-pin	150	150	1.7	—0.5	1.7	0.6
S12 (o)	Miniature Tetrode for "Deaf Aid," etc.	2	0.06	midget 4-pin	100	30	0.7	0	2.5	0.4

(o) = Obsolete.

60

SHORT GRID BASE H.F. PENTODES AND TETRODES WITH PENTODE CHARACTERISTICS
(WITH INDIRECTLY HEATED CATHODE)

Type	Filament Volts	Filament Current amps.	Type of Base	Anode Volts max.	Screen Volts max.	Mutual Conductance mA/volt (working point)	As amplifier under conditions of max. anode and screen volts: Approx. Grid Bias Volts	Bias Resist. Ohms	Average Anode Current mA.	Average Screen Current mA.	Connected as Triode: Amplification Factor	Impedance Ohms
MSP4	4	1.0	7-pin (also 5-pin)	250	100	2.4	—1.75	400	3.3	1.0	—	—
KTZ41	4	1.5	7-pin	250	250	7.5 12.0	—2.5 —1.5	244 65	8.0 18.0	2.25 5.25	80	6,250
Z62* (o)	6.3	0.45	Octal	300	150	7.5	—2	160	10.0	2.3	—	—
Z63 } KTZ63 }	6.3	0.2	Octal	250	125	1.23	—3	1,200	2.0	0.5	21	10,500
KTZ73 (o)	6†	0.16	Octal	250	100	1.5	—3	1,000	2.0	0.25	—	—

* Short seal type, suitable for ultra-short wave amplifiers. † Suitable for use with 6.3 v. transformer, or 6 volt accumulator, or series operation at 0.16 amp. (o) Obsolete.

Valve Data Sheets

OSRAM

61

"VARIABLE-MU" PENTODES AND TETRODES WITH PENTODE CHARACTERISTICS (WITH INDIRECTLY HEATED CATHODE)

Type	Filament Volts	Filament Current amps.	Type of Base	Anode Volts max.	Screen Volts max.	Mutual Conductance mA/volt at working point	As amplifier under conditions of max. anode and screen volts. Min. Grid Bias Volts	Bias Resist. Ohms	Average Anode Current mA.	Average Screen Current mA.
VMP4G	4	1.0	7-pin	250	100	2.7	—2	150	8.0	5.0
W42 (o)	4	0.6	7-pin	250	125	1.5	—3	300	7.6	1.9
KTW63	6.3	0.3	Octal	250	125	1.5	—3	300	7.6	1.5
KTW61	6.3	0.3	Octal	250	80	2.9	—3	300	8.0	2.3
KTW73 (x)	6†	0.16	Octal	250	100	1.7	—3	300	6.5	1.3

† Suitable for use with 6.3 v. transformer or 6 volt accumulator, or series operation at 0.16 amp.
(o) Obsolete. (x) Not available.

63

DIODES AND DIODE-TRIODES

Type	Filament Volts	Filament Current amps.	D (directly) or I (indirectly) heated	Type of Base	Anode Volts max.	Amplification Factor	Impedance Ohms	Mutual Conductance mA/volt	As amplifier under conditions of max. anode volts. Approx. Grid Bias Ohms	Bias Resist. Ohms	Average Anode Current mA	Optimum Load Ohms
HD23 (o)	2	0.15	D	5-pin	150	40	28,600	1.4	—1.5	—	1.7	150,000
HD24	2	0.1	D	5-pin	150	40	28,600	1.4	—1.5	—	1.7	150,000
D41	4	0.3	I	5-pin	Double diode							—
D42, D43 (o)	4	0.6	I	4-pin	Single diode (low impedance)						15 max.	—
D63	6.3	0.3	I	Octal	Double diode (separate cathodes)—						2 max. per diode	—
MHD4	4	1.0	I	7-pin	250	40	18,200	2.2	—4	1,000	4.0	30,000
DH63	6.3	0.3	I	Octal	250	70	58,000	1.2	—3	2,000	1.1	250,000
DL63	6.3	0.3	I	Octal	250	36	22,500	1.6	—3	1,500	4.2	50,000
DH73 (x)	6†	0.16	I	Octal	250	44	22,000	2.0	—3	1,000	4.5	100,000

† Suitable for use with 6.3 v. transformer, or 6-volt accumulator, or series operation at 0.16 amp.
(o) Obsolete. (x) Not available.

62

FREQUENCY CHANGERS

Type	Description	Filament Volts	Filament Current amps.	D (directly) or I (indirectly heated)	Type of Base	Conversion Conductance micromhos	Anode Volts max.	Scr'n Volts max.	Oscillator Anode Volts max	Under conditions of max. anode, screen and osc. anode Volts: Total Cathode Current mA	Control Grid Volts	Oscillator Resistance Peak Volts	Bias Resistance Ohms	Conversion Impedance megohms
X22	Heptode ..	2	0.15	D	7-pin	350	150	70	150	9.0	0	20	—	0.65
X23 (o)	Triode-Hexode	2	0.3	D	7-pin	250	150	60	through 20,000	4.5	—1.5	6	—	0.016
X24	Triode-Hexode	2	0.2	D	7-pin	250	150	60	ohms.	4.5	—1.5	6	—	0.016
MX40	Heptode ..	4	1.0	I	7-pin	500	250	100	250	5.85	—3	10	500	0.5
X41	Triode-Hexode	4	1.0	I	7-pin	640	250	80	through	8.5	—1.5	12	300	0.75
X63	Heptode ..	6.3	0.3	I	Octal	500	250	100	10,000	9.5	—3	25	300	0.31
X65	Triode-Hexode	6.3	0.3	I	Octal	225	250	100	to	11.0	—3	10	300	2.5
X73 (x)	Heptode ..	6†	0.16	I	Octal	500	250	80	40,000	8.0	—3	10	350	0.4
X75 (x)	Triode-Hexode	15	0.16	I	Octal	225	250	100	ohms.	11.0	—3	10	300	2.5

† Suitable for use with 6.3 v. transformer, or 6 volt accumulator or series operation at 0.16 amp.
(o) Obsolete. (x) Not available.

64

TRIODES

Type	Filament Volts	Filament Current amps	D (directly) or I (indirectly heated)	Type of Base	Anode Volts max.	Amplification Factor	Impedance Ohms	Mutu'l Conduc'ce mA/volt	As amplifier under conditions of max. anode volts: Appr'x Grid Bias Volts	Bias Resist. Ohms	Av'ge Anode Current mA	Optimum Load Ohms	Power output (single valve) watts
HL2	2	0.1	D	4-pin	150	—	18,000	1.5	—3	—	1.75	—	—
HL21† (o)	2	0.1	D	4-pin	150	—	18,000	1.5	—3	—	1.75	—	—
L21 (o)	2	0.1	D	4-pin	150	16	8,900	1.8	—6	—	2.2	—	—
LP2	2	0.2	D	4-pin	150	15	4,170	3.6	—6	—	5.6	—	0.1
P2 (o)	2	0.2	D	4-pin	150	7.5	2,150	3.5	—12	—	14.0	—	0.2
H12* (o)	2	0.06	D	midget	100	26	21,600	1.2	—1.5	—	0.6	250,000	—
L12* (o)	2	0.06	D	4-pin	45	4.8	6,000	0.8	—4.5	—	1.9	12,000	0.012
MH4	4	1.0	I	5-pin	250	40	11,100	3.6	—4	750	5.0	50,000	—
MHL4	4	1.0	I	5-pin	250	20	8,000	2.5	—8	1,000	8.0	20,000	—

† Small bulb. Anti-microphonic. * Miniature Triodes for "Deaf Aid," etc.
(o) Obsolete.

Impressions on the Wax

Review of the Latest Gramophone Records

H.M.V.

THIS month, H.M.V. release three records—*DB*5959-61—of Koussevitsky conducting the Boston Symphony Orchestra playing one of Mozart's lesser known works, the "Symphony No. 34 in C Major, K. 338."

It is in five parts, and as in the much earlier "Prague" symphony, Mozart does not bother with the more customary preambles, but dashes into his particular enchanting themes. The slow movement is delicate music for strings alone; the finale introduces an exciting atmosphere of jubilation as the symphony sweeps to its conclusion against a background of fanfares from the oboes. Koussevitsky, together with the Boston Symphony Orchestra, give us a perfect performance.

The "Triumphal March," by Grieg, is fairly well known, it being one of three pieces he wrote for Bjornson's "Sigurd Jorsalfar" (Sigurd the Crusader). The other two compositions are not so familiar, therefore, they are, so to speak, all the more welcome, especially when they are performed by the Indianapolis Symphony Orchestra, conducted by Fabien Sevitzky; they are: "Prelude (In the King's Hall)" and "Intermezzo (Borghild's Dream)." The full title of the record is "Incidental Music, 'Sigurd Jorsalfar,' Op. 56 (Grieg)," and the number of the record is *H.M.V. C*3373.

A wonderful combination is that formed by Webster Booth, the Liverpool Philharmonic Orchestra and Dr. Malcolm Sargent, on *H.M.V. C*3372.

Webster Booth sings—in English—"Mine Be Her Burden" and "Speak For Me Lady," two arias from Mozart's "Don Giovanni." The second one is a difficult test for any tenor, but in this case, it only gives further proof of Webster Booth's great qualities as a singer.

My last 12in. H.M.V. record for this month is one which is ideal for dancing—especially in the case of a party—is *C*3371, its title being "Paul Jones," two parts. It introduces nine popular modern tunes, the link tune being "A Life On The Ocean Wave," and they are played in fine style by the New Mayfair Dance Orchestra.

"Something in the Air" is one of the hit shows now on in London. It is drawing large audiences, and the critics have nothing but praise for the two brilliant stars, Cicely Courtneidge and Jack Hulbert, whose charm, talent and sheer *joie de vivre* act as a most stimulating and very enjoyable tonic. It is not possible for all of us to see the show in person, therefore, the next best thing is to hear the *H.M.V.* record *B*9353—"Something in the Air-s," linked with "It's Going to Take a Lot of Getting Used To." The first recording is by Cicely Courtneidge and Jack Hulbert, and the second by Jack alone.

Another show which has been well to the fore is Irving Berlin's "This Is The Army." On *H.M.V. BD*1063, The "First Nighter" Orchestra has recorded two of the hit tunes, "I Left My Heart at the Stage Door Canteen" and "This Is the Army, Mister Jones."

"Hutch" has selected "We Mustn't Say Goodbye" and "I Never Mention Your Name (Oh, No!)," which he has recorded in his inimitable style on *H.M.V. BD*1066.

Two fine blues will be heard if you play *H.M.V. BD*5827. They are recorded by—pause for breath—The Dixieland Jazz Group of "N.B.C.'s" Chamber Music Society of Lower Basin Street—and the numbers are "Memphis Blues" and "Careless Love."

There is a good record this month by Joe Loss and his Orchestra. It is *H.M.V. BD*5824, on which is recorded two good dance numbers—well presented by Joe and his Orchestra—"Put Your Arms Around Me, Honey" linked with "I Wonder Why," both fox-trots.

Columbia

DOMENICO CIMAROSA is known chiefly by his rather delightful comic opera "The Secret Marriage." This month, Columbia release two records containing superb recordings of a lesser known work by Cimarosa, and although it has been "freely transcribed" by Arthur Benjamin, it possesses all the beautiful characteristics of the composer; his Neapolitan nature asserts itself in bright sparkling melodies, and the passionate character of the slow movements.

The work, "Concerto for Oboe and Strings" has been recorded by the world famous oboist Leon Goossens with the Liverpool Philharmonic Orchestra conducted by Dr. Malcolm Sargent, and the whole performance is perfect. There are three parts, therefore the second record also contains another exceptionally fine recording by the same performers, "Sinfonia" (From the Easter Oratorio—Bach). The records are *Columbia DX*1137-8.

The Liverpool Philharmonic Orchestra, under the baton of Constant Lambert, have recorded "Carnival (Roma) Suite" (two parts) by Bizet on *Columbia DX*1136. The performance is outstanding.

In the U.S.S.R., Tchaikovsky's opera "Eugen Onegin" has retained its hold throughout all the changes that have taken place in that great country, and for the average Russian it expresses his romantic nature. The two Columbia records *DX*1134-5 give us the opportunity of hearing the talented soprano, Joan Hammond, singing the passionate confession of love (Tatiana's Letter Scene). The recording, in English, is in three parts, and she is accompanied by the Liverpool Philharmonic Orchestra conducted by Constant Lambert. On the fourth side, Joan Hammond treats us to "Louise—Depuis Le Jour" in French, in this instance with the Hallé Orchestra under Warwick Braithwaite.

"From the Land of the Sky Blue Water" and "By the Waters of Minnetonka" are the two numbers played by the Albert Sandler Trio on *Columbia DB*2129. A very nice record.

Victor Silvester's Jive Band submit two numbers for this new style of dancing. They are "Way Down in New Orleans" and "Stompin' at The Savoy." *Columbia FB*2980.

"'Bye For Now" linked with "Heavenly Music" form Turner Layton's contribution for this month on *Columbia FB*2973. The one and only Robb Wilton raises many healthy laughs with his comedy sketch "The Munition Worker" which occupies both sides of *Columbia FB*2974. Carroll Gibbons and the Savoy Hotel Orpheans have made a topping record for dancing out of "If I Had My Way" and "Tell Me The Truth" fox-trot and waltz respectively, *Columbia FB*2976.

Parlophone

"SATURDAY Night Jump" and "October Mood" are played in fine style by the No. 1 Balloon Centre Dance Orchestra on *Parlophone F*2001. Geraldo and his Orchestra have just made two recordings which I recommend for dance enthusiasts, "Ragtime Cowboy Joe" and "I Want To Be In Dixie" on *Parlophone F*1998.

Harry Parry and his Radio Sextet have selected "Hallelujah" and "No Gin Blues" for Nos. 121 and 122 of the 1943 Super Rhythm-Style Series. They are on *Parlophone R*2894. For Nos. 117 and 118 of the same series, you must turn to *Parlophone R*2892 and listen to John Kirby and his Orchestra playing "Minute Waltz" and "Impromptu."

Zonophone

IF you are fond of good playing of the organ—as I am—you will enjoy *Zonophone MR*3719 on which Reginald Dixon has recorded two fine medleys, "Jerome Kern Medley—Part 1" and "Cole Porter Medley—Part 2."

Harry Roy and his Band provide another number for those who can dance the "Jives," it is called "Atlantic Jive," which, incidentally, is by Harry himself. On the other side of the record—*Zonophone MR*3718—they play "When Can I Have a Banana Again?"

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).

Station Identification

SIR,—I recently happened to pick up the August issue of PRACTICAL WIRELESS and saw the letter from A. J. Newman. The following details may be of some interest to him and other readers.

United Nations Radio, located in Algiers, has two short-wave outlets: Allied Force H.Q. in North Africa (Algiers) on 33.46 metres (8,960 kc/s), and Radio France on 24.75 metres (12,120 kc/s) which relays the 33.46-m. transmission from 16.00-17.15 G.M.T. and from 20.00-20.30 G.M.T.

These stations give news in English at the following times: 15.00 G.M.T. on 33.46 m. only; 16.00, 17.00 and 20.00 G.M.T. on both wavelengths.

In addition, from 21.15-23.30 G.M.T. Press despatches and special reports for M.B.S. (22.40 G.M.T.), C.B.S. (22.51 G.M.T.), B.B.C. (23.00 G.M.T.) and N.B.C. (23.17 G.M.T.) are transmitted on 33.46 m. only.

All these details are taken from "Cairo Calling," the official organ of Egyptian State Broadcasting.—C. D. HAMMETT, Radio Officer, M.N. (At Sea).

African Broadcasting Stations

SIR,—The following information regarding a couple of African broadcasting stations may be of interest to readers.

Addis Ababa Radio.—31.28 metres. News in Amharic at 4.14 p.m. daily. English programme begins at 5.30 p.m. daily. At 6 p.m. the news is relayed from the B.B.C.

Belgian Congo Radio.—The following are the daily transmissions from Leopoldville: From 10.55 a.m. to 12 noon, on wavelengths of 14.97, 16.88, 25.6 and 47.78 metres. At 5.30 hours on 25.6 and 47.78 metres only (African regional). From 9.45 a.m. to 9 p.m. on 16.88, 25.6 and 47.78 metres.

Omdurman Radio.—32.54 metres, Nightly, 6.30–7.30. Arabic programme—Thursdays, 7.30-8.0. Local news and notices in English; local talk.

The location of Radio Congo-Belge answers the request of R. Allen, of Mottingham, published in the July issue of PRACTICAL WIRELESS.

In conclusion, I would like to mention my appreciation of your excellent journal, which is sent out to me regularly.—S. C. WALTERS (M.E.F.).

Stray Earth Lead

SIR,—On reading about the stray earth lead (p. 454, October issue), it occurred to me that readers may be interested in the following little dodges:

A very simple way of testing the earth lead is to connect a mains bulb (or test meter) between it and each side of the mains in turn. If the earth is good the bulb will light when connected to the live side of the mains.

The above idea is also very useful for making an A.C./D.C. receiver much safer, especially when testing it, providing the mains are A.C. Connect the mains bulb between the receiver's chassis and earth with the set switched on. If the bulb lights reverse the mains plug (or connections to it if 3-pin), thereby connecting the chassis to the neutral side of the mains instead of the live side, and thus eliminating the likelihood of a nasty shock from the chassis.

Another dodge is to save the little rubber "tubes" produced when baring the ends of wires and cables, and to use them instead of systoflex to cover bare wires where they are likely to touch other conductors.—R. V. GOODE (York).

Selling and Servicing

SIR,—Your article on selling and servicing is, I consider, one way of showing up what's going on in the radio trade. I, myself, was in business four years previous to the outbreak of war. Soon after war broke out I went into a factory to help the war effort. Unfortunately ill health came along and I was released on grounds that factory work was not suitable. I am now in business again but am being strongly objected to by some of the local radio firms. Yet these firms are allowed to have their say as to who and who should not open up in business.

A gentleman came to me and explained that a certain engineer was asked to look at the pick-up on his radiogram and from what I can gather the rubber damping had perished. The engineer took the pick-up away and returned in three days' time, replaced the pick-up, and produced a bill for £3 15s.

After fitting the pick-up this gentleman asked the engineer to look at the radio. He did! Spent two hours and charged a further £3. This was £6 15s. in all, and the same evening the radiogram faded out altogether.

I have since had this job in hand to service, and I never saw such a mess.

Another example is a Serviceman's wife wanting her radio repaired. The smoothing condenser had packed up but music and speech could be heard in the distance, and hum was prominent. A charge of £4 15s. 6d. was made for fitting new condensers.—F. E. SMITH (Chelmsford).

SIR,—Reading your article in the December issue on "Selling and Servicing," I would like to put before you our case in applying for a retail licence.

Being a reputable radio engineer, I felt a great rebuff at the way I was treated by the Local Price Regulation Committee when I faced them on the matter. We have made a name for ourselves in the district as quick and efficient service people, and the public show an inclination to buy off us as well as from other traders in the town, and as we are a distance out from the town centre we naturally expected a better deal than what has been meted out to us.

Apart from carrying on a successful servicing business we are compelled to go out to work on munitions, and this was brought to the fore by a member of the P.R.C. when I was interviewed, and I was blatantly asked if the wages I received from such was not enough. I would like to know if there is any justification in pointing such a question at anyone who is attempting to do a service to the public in these times.

One trader known to us before we opened this shop would not attempt to service a set, even some sets that he himself had supplied, and as the public have complained of his incivility towards them, and the fact that they have a bus ride of a minimum 1½d. fare to get their spares and accessories, we feel we are entitled to the retail licence for which we applied, and when this fact was pointed out to the P.R. Committee the retort was, "Well, can't they walk?—H. B. UNDERWOOD, (Ashton-under-Lyne).

SIR,—I have pleasure in giving details of my position as a radio and electrical serviceman and dealer.

I opened my own business in High Street, Sutton, on April 19th last after being in the trade for some 16 years. The premises are rated as business premises, being a shop on the main road here, catering for general repair work being equipped with suitable test-gear and a very comprehensive stock of spare parts and service components and service data dating back to 1932.

Application was made to the B.O.T. for a retail licence in April, but was automatically turned down within a week or two.

I understand that two local dealers opposed the granting of same, and someone has tried to get evidence of selling by retail by sending various folk in to purchase with, of course, no success, as I have strictly maintained a service repair business here since opening.

As there are to date some seven retail radio and electrical businesses closed in this High Street alone since the war started, with myself the only shop opened in the near area since then, and the sole business ready to cater for the greatly needed want for service replacements and spare parts, I feel that my request for a licence is justified.

I may add that five of the shops closed belonged to multiple firms.—J. LEVITT (Sutton).

SIR,—I have read the comments passed by L. E. Healey (Clacton) in the December issue, and my circumstances are identical with his.

I have applied to the Board of Trade for a licence to sell radio components, and have been refused three times although the nearest radio shop is just over half a mile from where I am at present situated. I also find it difficult to explain to customers why I cannot sell the small wireless components of which I fortunately have a fairly good stock.

I am a Grade 4 man, and have eight years' practical experience in radio and allied electrical trades. I have also read of cases of men who have been discharged from the Army, and cannot presume their previous business occupations owing to the fact that a licence has been refused.

Evidently it seems that a large firm could, if they wished, open a retail wireless business right opposite my shop, and after careful study of the position of other small men it seems that the Board of Trade is solely for the benefit of the larger firms.

I am of the opinion that an association for the benefit of the small business man will fail if we are not whole-heartedly in support of each other.

I sincerely trust that PRACTICAL WIRELESS is very successful in helping to bring the small business men who read this journal closer together.—J. R. BRICKWOOD (Brixton).

SIR,—The writer was very interested to read your editorial in the December issue of PRACTICAL WIRELESS, and is prompted to write this letter.

He has been the subject of just such a case as you mention. We are contractors to the Air Ministry, having executed P.A. installations on aerodromes, in factory canteens, and "Music While You Work" in factories. Apart from this, 1,600 domestic radio receivers have been serviced since September, 1939, despite difficulties of supply, labour, petrol rationing, etc.

To begin at the beginning, the writer has received an engineering training at Loughborough College, accepted throughout the world as one of the greatest centres for this type of education. He holds the Oxford School Certificate and London Matriculation, and completed three years' course in radio and electrical engineering.

On the outbreak of war, the writer curtailed his course at Loughborough (this should have been five years) and joined Messrs. Boulton and Paul, Ltd., the aircraft manufacturers, in January, 1940.

As the service engineers (?) were called up, he was repeatedly asked to service radio receivers for various people. Melton, being a small town, was quite aware of his previous training, and consequently the demand grew. In 1940 he decided to help the traders who had lost their servicemen by doing service in his spare time, and this has continued until four months ago. It may be said here that the writer's employment with Messrs. Boulton & Paul, Ltd., occupies eight hours per day.

Some six months ago a stir was made in the trade papers about private house trading, and as this argument was likely to be brought to bear in this case, it was decided to open a retail shop This has been done, *but the application for a licence has been refused.*

The position is now briefly this. The business as it stands to-day has been created *entirely* by the demands of the public—not by the writer's desire to make money. This aspect does not interest him. The writer is a *radio engineer*, trained and in possession of the latest Taylor and Avo test gear, with a modern, fully equipped service shop, embodying fluorescent lighting and every conceivable service aid. A Ford 8 van is used for delivery purposes, and on Government contract work, and here again, certain people tried to stop the "C" Defence Permit being issued. We employ one shorthand typist and shop assistant, one assistant service engineer, and five part-time wiremen, joiners, etc. Over 500 radio receivers have been serviced this year up to date.

On applying for the licence four local firms visited all the other Melton traders with a petition which they required to be signed, stating that this business was not required by public need.

We are still servicing radio receivers for these four firms, also one firm in Nottingham.

We consider that if anybody is entitled to a licence in this town, it is us. On several occasions, we have stated that this business would be discontinued, owing to the opposition which certain people created. The demand for service, however, made such a move impossible.

Our sole interest lies in "keeping the sets working."

We would mention, in closing, that this business is registered under the Registration of Business Names Act, 1916. Further, the writer intends to go to America to the G.E.C. in Chicago after the war, to receive a year's training in advanced radio and electronic theory. This was the normal course at Loughborough before the war, and this will serve as a further indication that he is no "back-yard repairer."—J. PIDGEON (Melton Mowbray).

Station CSW

SIR,—In reply to L. H. Cox, of North Wales, who wanted information regarding a station with call sign "CSW."

On checking it I find that station CSW on the 31-metre band is located at Lisbon (Portugal). It used to be known as CSW7 and its programmes were beamed to North America.

The times of transmission are: (G.M.T.) 19.15-20.00 hrs.; 20.15-23.00 hrs.; 23.05-01.00 hrs. Frequency is 9,740 kc. Also on 25 metre band is station CSW3 also of Lisbon, transmitting to the surrounding countries. It is not equipped with beam antennæ.

Incidentally, has any reader noticed that VP3BG (Georgetown, British Guiana) on 6,130 kc. has been coming in loud and clear of late, and also two new, strong stations located in St. John's, Newfoundland.—E. J. DEMPSTER (Guildford).

Proposed Club for Liverpool

SIR,—I read with interest the proposed forming of a club in Manchester in Thermion's column in the December issue, and I would like to take this opportunity of proposing one for Liverpool, there not being one (to the best of my knowledge) here. I am sure there are still some people on Merseyside who are interested in radio, anyway they take in PRACTICAL WIRELESS. Interested readers in Merseyside are invited to write to B. G. MEADEN, 10, Alfriston Road, West Derby, Liverpool, 12.

Replies to Queries

Measuring A.C.

"I have a good milliammeter and have tried to take some measurements in my mains receiver, but cannot get any reading. I cannot see why this should be so as current must flow and perhaps you can explain this to me."—J. P. (Hounslow).

IF the supply you are endeavouring to check is A.C., this means that it is continually changing its direction or polarity, and therefore before the needle has time to pass across the scale it is driven in the opposite direction and owing to the frequency of the supply the needle does not move—at least only over a very small part of the scale. A moving-iron instrument will measure A.C. at, say, mains frequency, but if a moving-coil meter is used you must modify it by including a rectifier so that the current to be measured is converted into a uni-directional current.

A Wattage Calculation

"I have been reading an article on resistors, and there is one point which puzzles me. It gives the calculation of the wattage rating of the resistor as 'current squared times resistance in ohms.' I am not very good at mathematics, and it seems rather confusing to me why it should be necessary to square the value of the current which is flowing. Surely the rating of the resistor should be dependent only upon the current which is flowing and not upon a value which is so much higher as mentioned. Perhaps you can explain this little point to me, and it may also be of help to others who find this same difficulty."—H. K. (Mitcham).

THE wattage is, as you state, dependent only upon the current which is flowing through the resistor and not upon any higher value. The reason why the square of the current is used in the formula is bound up in the fact that the wattage is dependent upon the voltage as well as on the current which is flowing, and in the particular formula referred to only the current and the value of the resistor are given. Therefore, to ascertain the wattage, which is the product of the voltage and current, the voltage must be first ascertained. According to Ohm's Law, voltage is the product of current and resistance, or to use the standard symbols, E equals R x I. Wattage equals E x I, and therefore by substitution wattage must equal R x I (which equals E) multiplied by I. When two similar terms are multiplied together they are expressed thus: a^2 (a squared), and therefore in the above formula R x I x I we can take out the two terms I and express them thus: I^2. Therefore the formula becomes I^2 x R, and this explains the reason why the square of the current has to be employed when only the current and resistance values are given.

Repairing a Valve

"One of the valves in my set has become loose round the point where the glass enters the bakelite base. The glass bulb can be pushed down until it is fairly well held, but I wonder if this results in any inferior performance. Does this constitute a fault which would come under the maker's guarantee and which could enable me to get a free replacement?"—C. P. (York).

WE do not think the trouble can legitimately be called a manufacturing fault, and it may be due to the way the valve has been handled in inserting and removing it from the valveholder, or undue heat due to the proximity of another valve, etc. The valve should always be held by the bakelite base when inserting or removing from the holder, and the looseness will not affect results provided the glass bulb is not rotated. If this is done, there will be a possibility of either breaking the leading-in wires or of creating a short-circuit between them. To avoid this, and to refix the bulb, ordinary Chatterton's Compound, or any strong adhesive, may be run round the junction of the base and glass, and a strip of ordinary insulation tape fixed round it. A fairly wide band may be cut from small diameter rubber tubing and slipped over the base so as to overlap the two parts and hold them firmly.

Transformer Details

"I have a home-made mains transformer having an eight turns per volt primary. The primary is wound with 36 S.W.G. enamelled wire. I wish to wind two secondaries to give 4 volts at 2.5 amps. for rectifier, and 4 volts 3 amps. Could you please give me details of these windings, e.g. gauge of wire, number of turns? Is the primary wound with sufficiently thick wire to carry the current?"—F. B. (Bromley).

FOR the 4-volt windings 32 turns will be required, as the basis of your windings is 4 turns per volt. The gauge of wire for both windings may be 18 S.W.G. These two additional turns will provide a further load of 22 watts upon the transformer, but you do not state the H.T. secondary loading, and therefore we cannot advise you whether or not the primary winding is suitable. The 36 gauge primary may be considered to take a maximum current of .1 amp.

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.

How a Pick-up Works

"I have only been interested in the hobby for a short time and am puzzled to know how the gramophone pick-up produces the music from the record through the wireless receiver. Is it possible to explain this briefly as I cannot find anyone who seems to understand the details?"—L. S. (Stockwell).

THE principle is really quite simple and may be regarded as just the opposite to the headphone or loudspeaker. In these items a current flows through a wire wound round a magnet, and as the current varies so does the magnetism. This attracts the diaphragm and the current fluctuations therefore give rise to fluctuations in the diaphragm, moving the air and so reproducing the sound. In a pick-up the magnet has usually two poles, and the needle is inserted into a holder which is extended so that it forms what is called an armature between the two poles. As the needle is moved by the sound grooves on the record, the armature moves, and this varies the magnetic field causing a varying current to flow in the windings. This current variation is applied to a valve, just as in the case of wireless signals, and so produces the signal.

P.W. 88

"Recently I built your 'Simple Short-wave One-valver' (P.W. 88), and although results have been very good, I find that there is one fault.

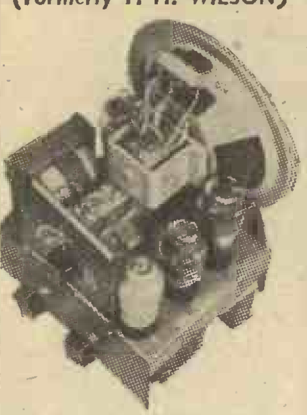
"Before reaction is used the European and Home Service can be heard very faintly, although out of the range of the tuning condenser.

"I am using all the exact components as described, and a good indoor aerial. Will you inform me if this is in order?"—H. H. (Enfield).

SOME trouble is likely to be experienced from interference by nearby powerful stations and, with a simple circuit of the type in question, it is a very difficult matter to eliminate such trouble completely. A small variable condenser in series with the aerial lead-in is about the best proposition for you to try, a suitable value for the condenser being in the region of .00005 mfd.

—AUSTERITY— RADIO, LTD.

(Formerly F. H. WILSON)



When assembled these Kits give excellent reproduction on Medium and Long Waves. Supplied complete with chassis 8in. x 6½in. x 2½in. Valves, M.C. Speaker, and wiring diagram. (Regret no cabinets.) 3 controls.
A.C. 3-V. (+RECTIFIER) KIT. V.M.H.F. Pen., Triode, L.F. Pen., Rectifier, M.C. Speaker. Price £10 10s. Post 1/1, plus 3/6 packing (returnable).
BATTERY 3-V. KIT. V.M.H.F. Pen., Triode Detector and Output Tetrode P.M. Speaker. Price £7. Post 1/1, plus 3,6 packing (returnable). Delivery 1 month.
3-gang CONDENSERS .00025 with ceramic insulation, 7/6. Also .0005, ceramic insulation, with trimmers, 10/6.
AERIAL AND H.F. TRANSFORMERS with reaction, medium and long waves. Iron cored on medium waves, loading coil on long waves. 10/- per pair.
MAINS VOLT DROPPING RESISTORS. .2 amp. 1,000 ohms, 2 variable sliders, 6/-; .3 amp. 750 ohms. 2 variable sliders, 7/-.
10-WATT WIRE-WOUND RESISTORS, 2,000, 500 and 150 ohm, 2/6 each.
CHASSIS. Undrilled steel, painted, new, 10½ x 8 x 2½in., 7/6; 8 x 6 x 2½in., 4/6 each.
MAINS TRANSFORMERS. Input 230 v. A.C., Output 300-0-300. 6.3 v. 4 amp., 5 v. 2 amp., 4 v. 4 amp., 4 v. 2 amp., 80 m.a. Screened primary colour coded. Good transformer for mixed valves. 32/6. Also Input 200-250 A.C. Output 350-0-350, 80 m.a., 4 v. 4 amp., 4 v. 2 amp. Screened primary. 30/-. Also Input 200-250 A.C., Output 350-0-350, 150 m.a. 6.3 v. 5 amp., 5 v. 2 amp. 35/-.
VOLUME CONTROLS. ¼ meg. and ½ meg. with switch, 6/6 each. 25,000 and 50,000 ohms, less switch, 4/- each.
AERIAL AND H.F. TRANSFORMER with reaction, colour coded, 10/6 pair.
SCREENED DUAL RANGE COILS, long and medium. **AERIAL AND H.F. TRANSFORMER** with reaction, size 2½ in. diam. x 3½in., iron cored on medium wave only, with circuit blueprint, 12/6 pair. 465 kcs I.F. Transformer, iron cored, screened with trimmers, 15/-. 465 kcs. Permeability tuned, iron cored, screened, 15/-. Combined volume control, 100,000 ohms, with reaction condenser, 6/6.
Please add postage for enquiries and mail orders. C.O.D. orders accepted. Owing to present circumstances, prices are subject to increase without notice.

307, HIGH HOLBORN,
LONDON, W.C.2. HOL 4631.

Classified Advertisements

LITERATURE, MAPS, etc.

RADIO SOCIETY OF GREAT BRITAIN invites all keen experimenters to apply for membership. Current issue "R.S.G.B. Bulletin" and details, 1/-, below: **AMATEUR RADIO HANDBOOK** (300 pages), paper cover, 4/-; cloth, 6/6. Radio Handbook Supplement (140 pages), paper cover, 2/9; cloth, 5/-.—R.S.G.B., 28-30, Little Russell Street, London, W.C.1.

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

MORSE & S.W. EQUIPMENT

MORSE Practice Equipment for class-room or individual tuition. Keys, audio oscillators for both battery or main operation.—Webb's Radio, 14, Soho Street, London, W.1. 'Phone: Gerrard 2089.

"H.A.C." Short-wave Receivers. Famous for over ten years. Improved one-valve model now available. Complete kit of components, accessories, with full instructions—only 16s., postage 6d. Easily assembled in one hour. S.A.E. for free catalogue.—A. L. Bacchus, 109, Hartington Road, London, S.W.8.

RECEIVERS & COMPONENTS

VALVES. Comprehensive selection of British and American Valves in stock. Your enquiries invited.
MIDGET COILS. Midget, aerial and H.F. medium and long wave, T.R.F. coils. Ideal for T.R.F. midget receiver, 11/- per pair.
REPLACEMENT bobbins, to fit standard speaker transformers, tapped for Power and Pentode, 4/-; Ditto, L.F. smoothing choke bobbins, 300 ohms, 50/60 milliamps, 4/-.
MAINS DROPPERS. 1,000 ohms, 0.2 amps., fitted two variable taps, 4/6; 750 ohms, 0.3 amp., do. taps, 5/6; heavy quality dropper, on substantial porcelain former, do. taps, fixing feet; superior job, 850 ohms, 0.2 amp., and 800 ohms, 0.3 amps., 7/6 each.
SCREENED braided cable, single, 1/- yard.
VALVEHOLDERS. Chassis mounting, paxolin, English, 5- and 7-pin, and Mazda octal, American international octal, and 4-, 5-, 6- and 7-pin American, all at 9d. each. Amphenol, Mazda octal, 1/-.
JACK PLUGS. Ex G.P.O., 1/6 each.
LINE CORD. Superior quality, 3-way, 50 ohms, per foot, 0.3 amp., 6/- yard; do., 2-way, 5/- yard.
MIDGET rotary switches, S.P.D.T., 3/6.
SLEEVING, 2 mills., 4d. yard; 7 mills., 8d. yard.
CONDENSERS. Tubular wire ends, 350 v. working, .01 mfd. and .1 mfd., 9d. each, 8/- doz.
KNOBS. Standard, 1½in. diameter knobs, 9d. each, 8/- doz.
NUTS/BOLTS. 4 B.A. brass round heads, nuts and bolts, 6/6 gross (2 gross in all). Hexagonal 4 B.A. nuts only, 3/6 gross.
Everything for the serviceman and experimenter. Licence to export to N. Ireland. Lists available. Stamped addressed envelope with all enquiries, please. Postage on all orders.
O. GREENLICK, 34, Bancroft Road, Cambridge Heath Road, London, E.1. (Stepney Green 1334.)

FRED'S RADIO CABIN.
COMPARE OUR PRICES.
DUAL RANGE COIL, with variometer tuning, fully screened in copper can, 2/3 each. No circuits.
SOLDER, 1lb. reels, fine all-tin instrument solder, 3/6 lb., or ¼lb. reel, 1/-.
CRYSTAL DETECTOR, New Type on ebonite base, 2/6 each. **CRYSTAL** and Catswhisker in metal box, 6d. each.
SLEEVING, 3½d. per yard length. 1 doz. lengths, 3/-.
Tubulars, 0.1 mfd., 7d. each, 6/6 doz., also .01 mfd. at 6d. each, 6/- doz.
GRID LEAKS, 1.5 meg., 6d. 1.0 meg., 6d.
EX H.M.V. Variable Mica Condensers, .0003 mfd., 2in. spindle, new, 1/9 each.
CLARION slow motion dial, illuminated disc drives, useful for short waves, 2/6 complete.
EX-G.P.O. Telephone Plugs, 1/3.
SINGLE SCREEN CABLES. 8d. per yd.

(Continued on page 132.)

LONDON CENTRAL RADIO STORES
TRANSFORMERS. Heavy duty, weight 14lbs. Input 190/250 A.C. Output 350-0-350. 120-150 ma. 4v. 2. amp. 4v. 3 amp., 6.3v. 4 amp. 45/- each.
RELAYS. Brand new. Electro-magnetic make and break units to operate on 1½ volts at 15 m.a. To clear stock, 5/9 each.
MOTOR TUNING. Fine brand new 3-gang .0005 mfd. condenser, no trimmers, designed for motor drive. Large diameter driving disc and reduction gear for slow motion manual drive. 13/6 each.
BRASS ROD. Screwed brass rod, 2 B.A., 4 B.A. and 6 B.A. 12 inch lengths, useful for many purposes. 6/6 oz. lengths.
VALVEHOLDERS. All brand new, Celestion, Amphenol, Mazda and International octal. 1/- each.
CONDENSERS. Tubular wire end, made by Plessey, 25 mfd., 25 volt working, 50 mfd., 12 volt working. 1/9 each.
RESISTANCES. Assorted wire-end resistances by best makers. Ideal for servicemen and experimenters. To clear, 3/6 doz., 13/3 for 50, 23/6 for 100.
CERAMIC VALVEHOLDERS. Brand new, low loss, 7 pin. 1/5 each.
CONDENSERS. First-class .1 mfd. oil-filled, 5,000 volt working. Only 11/6 each.
T.C.C. TUBULAR Condensers. .1 mfd., 6,000 volt D.C. test. 8/9 each. Also 2 mfd. Tubulars, 350 volt working. 3/6 each.
T.C.C. CONDENSERS in metal cases. Special offer, much reduced to clear, 4 x 4 mfd., 70 volt working. 2/6 each.
VIBRATORS. Brand new American synchronous self-rectifying vibrator units: 12 volt input, 280 volt output, 65 m.a., fitted with 7 pin American base. 16/- each.
COUNTERS. Ex G.P.O., everyone perfect, electro-magnetic counters. 500 ohm. coil, counting up to 9,999, operated from 25 volt-50 volt D.C. Many industrial and domestic applications. 6/- each.
VALVEHOLDERS. Paxolin, 7 and 9 pin, 7d. each, 6/- doz.
DROPPING RESISTANCES. To replace 2- and 3-way line cords. With diagram showing connections. .3 amp. In strong metal case, 13/- each. Without case, 10/- each.
ELEC. RAZOR RESISTANCES. Universal input, in strong metal case, 10/- each.
TRIMMING TOOLS. Fine set of 12 bakelite handle trimming tools in roll-up leatherette case. Ideal for servicemen, 33/- set.
REACTION CONDENSERS. Fine quality job, .0003 mfd. To clear at 2/3 each.
TUBULARS. Wire-end tubular condensers, .1 and .01 mfd., 400 volt working. 1/- each.
VALVEHOLDERS. Side contact, 8 pin type, in bakelite, 1/9 each. Anode bakelite valve caps, 10d. each. W.B. metal anode caps with screened lead, 1/- each.
DIAL LAMPS. Philips' screw type dial lamps for dial illumination. 15 watt, 200-250 volt micr. screw, 1/9 each.
SPEECH COIL RIBBON Wire. Enamelled copper, gauge approx. 20 thou. by 5½ thou., 3/3 per lb. reel.
EARPHONES. Single, ex-Government, 750 ohms. 4/- each.
EXTENSION SPEAKERS. Brand new. First-class P.M. loudspeakers in beautifully polished cabinets, 61/6 each. Rexine covered, 57/6 each.
FLEXIBLE DRIVES. Ideal for remote control in radiograms, etc., approx. 3ft. length. 4/3 each.
PLUGS and JACKS. Ex-Government powerful phosphor-bronze springs ensuring a perfect contact. Overall length, including ¼in. threaded shank, 3½in. Supplied with nut for panel mounting. Price complete with best quality Plug, 5/9.
SCANNING and DETECTOR Coils. Philips' ex-television receivers. Complete in metal frame. 8/6 each.
PUSH BUTTON UNITS. Permeability iron-cored coil units. 6 spring loaded switches, 16/- each. 8 switch unit (no coils), 4/6 each. 12 switch unit (no coils or switches), 2/6 each. 6 push button mechanism without switch, 5/-.
MERCURY SWITCHES. Quick make and break, will carry 5 amps. 8/6.
T.C.C. CONDENSERS. 250 mfd., 25 volt working, in bakelite case, 2/6.
No Extra for Postage, etc.
LONDON CENTRAL RADIO STORES, 23, LISLE STREET, LONDON, W.C.2.

AMPLION twin H.F. binocular chokes, 1/9.
MAINS cable leads, 5ft., 1/- each.
ODD TWIN H.F. CHOKES, 1/6 each.
INTERNATIONAL Octal Base valve-holders, 8d. each, 7/6 doz.
NEW VOLUME CONTROLS. Less switch, with long spindle, 1 meg. 3/-.
CAN TYPE ELECTROLYTIC CONDENSER. 200 mfd., 20v. working, 3/3.
BRAIDED SLEEVING, 2 m.m., 6d. per yd. length, 5/6 doz. ; 3 m.m. 8d. yd. length, 7/- doz.
PLUGS AND JACKS, complete, 3/6.
COPPER WIRE, TINNED, 18, 20 gauge, 1/- ½lb. reel.
T.C.C. CONDENSERS, .1 mfd. 5,000v. wkg. 5/6.
TWIN TRIMMERS, ceramic 250 m.mfd., 6d. each, 5/- doz.
COPPER WIRE, heat resisting, 6d. coil.
CONDENSERS, straight, 3-gang, large spindle, 2/6 each.
MAINS DROPPERS, 0.2 amp. 3/6, .03 amp., 4/6.
PUSH BUTTON UNITS, 7-way, 2/9, 8-way, 3/-, 9-way, 3/- ; knobs, 2d. each.
CONDENSERS, "Plessey" 4-gang screened 6½in. x 3½in., 4/6.
"HENLEY" Electric Soldering Irons, new. Straight bit. 13/6 each. Pencil Bit 14/6 each. Resin-cored solder, 4/- lb. reel.
T.C.C. TUBULARS, brand new, 25 mfd., 12v. ; 50 mfd., 12v., 1/3.
SOLDER, 1lb. reels, fine all-tin instrument solder, 3/6 1lb., or ½lb. reel 1/-.
MIXED RESISTORS. Each packet contains same selection, 2/6 doz.
SWITCHES. Double-pole, double-thread, 6d. each. Also mains on-off toggle switches, 1/6 each.
T.C.C. BLOCK CONDENSERS, 100 mfd. 50v. wkg., 3/9 each.
MAINS DROPPERS, with variable sliders, total 1,000 ohms, .2 amp., 4/6 each., .3 amp. 5/6 each.
MAINS FLEX, flat, equal to 14/36 gauge, 6½d. yd., 6/- doz. yds.
Postage must be included. No C.O.D.
FRED'S RADIO CABIN FOR BARGAINS, 75, Newington Butts, S.E.11. Rodney 2180.

SOUTHERN RADIO'S WIRELESS BARGAINS

SCREWS and Nuts, assorted gross of each (2 gross in all), 10/-.
SOLDERING Tags, including Spade Ends. 6/- gross.
PHILCO 3-point Car Aerials, excellent for short-wave and home aerials, 7/6.
LIMIT Tone Arms, universal fixing for all types of Sound Boxes and Pick-up Heads, 10/-.
ACE "P.O." Microphones, complete with transformer. Ready for use with any receiver, 7/-.
CIRCULAR Magnets, very powerful, 1½in. diameter by ⅜in. thick, 1/6 each, 15/- per doz.
ERIE Resistances. Brand new, wire ends. All low value from .8 ohms upwards. A few higher value are included in each parcel, ¼, ½, 1 and 2 Watt. 100 resistances for 30/-.
MULTICON Master Mica Condensers. 28 capacities in one from .0001 etc., etc., 4/- each.
SPECIAL ASSORTED PARCEL FOR SERVICE MEN
100 **ERIE** resistances (description above). 24 assorted Tubular Condensers ; 6 Reaction Condensers, .0001 ; 12 lengths Insulated Sleeving ; 75ft. Push-back Connecting wire ; Soldering Tags, Screws, Wire, etc., 65/-. All brand new.
CRYSTALS (Dr. Cecil). 6d. ; with catswhisker, 9d. ; complete crystal detectors, 2/6 ; 75ft. wire for aerials, etc., 2/6 ; 25 yds. Push-back wire, 5/- ; Telsen Reaction Condensers, .0001, 1/9 each ; Telsen large disc drives, complete with knob, etc. (boxed), type W 184, 2/6 each ; Insulated sleeving, assorted yard lengths, 3/6 doz. ; single screened wire, doz. yards, 10/-.
LOUD Speaker Units, unshrouded, Midget type, 4/- ; Metal case condensers, .1 + .1 + .1, 2/6.
POWER Rheostats. Cutler-Harmer, 30 ohms, 4/6 each ; Pointer Knobs, instrument type, ¼in. spindle hole (Black or Brown), 1/- each ; Push-button Switches, 3-way, 4/- ; 8-way, 6/- (complete with knobs) ; Bakelite Escutcheon Plates for 8-way P.-B. Switches, 1/6 ; Hundreds of other Bargains.
SOUTHERN RADIO SUPPLY CO., 46, Lisle St., London, W.C. Gerrard 6653

WANTED.—S/P Switch to fit Milnes H.T. Unit.—W. Dunnington, Heck, Snaith, Goole.

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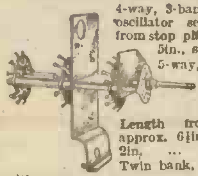

4-way, 3-bank, with shielded oscillator section. Length from stop plate approx. 5in., spindle 2in. **6/-**

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Approx. 350v.

4 mfd. 4×1⅞×2in.	6/6
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2 mfd. 4×1×1⅝in.	2/6
2 mfd. 2⅞×1×1⅝in.	2/6
Also 250 mfd. 25v. in bakelite case	2/6

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7

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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*
The "Rapide" Straight 3 (D, 2 LF (RC & Trans)) — PW82*
F. J. Camm's Oracle All-Wave Three (HF, Det, Pen) — PW78
1938 "Triband" All-Wave Three (HF Pen, D, Pen) — PW84

The "Hurricane" All-Wave Three (SG, D (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

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Selectone A.C. Radiogram Two (D, Pow) — PW19*

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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

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A.C. Fury Four Super (SG, SG, D, Pen) — PW34D
A.C. Hall-Mark (HF Pen, D, Push-Pull) — PW45*
Universal Hall-Mark (HF Pen, D, Push-Pull) — PW47
F. J. Camm's "Limit" All-Wave Four (HF Pen, D, LF, P) — PW67*

SUPERHETS.

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F. J. Camm's 2-valve Superhet — PW52*

Mains Sets : Blueprints 1s. each.
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Push Button 4, A.C. Mains Model } — PW95*

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Parvo Flyweight Midget Portable (SG, D, Pen) — PW77*

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MISCELLANEOUS

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Lucerne Ranger (SG, D, Trans) — AW422*
£5 5s. Three De Luxe Version (SG, D, Trans) — AW435*
Transportable Three (SG, D, Pen) — WM271
Simple-Tune Three (SG, D, Pen) — WM327
Economy Pentode Three (SG, D, Pen) — WM337
"W.M." (1934 Standard Three (SG, D, Pen)) — WM351*
£3 3s. Three (SG, D, Trans) — WM354
1935 £6 6s. Battery Three (SG, D, Pen) — WM371
PTP Three (Pen, D, Pen) — WM389
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Minitube Three (SG, D, Trans) — WM396*
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Self-contained Four (SG, D, LF, Cl. B) — WM331
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£5 5s. Battery Four (HF, D, 2LF) — WM381*
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The Auto Straight Four (HF, Pen, HF, Pen, DDT, Pen) — WM404*

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Mains Operated.

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Economy A.C. Two (D, Trans) A.C. — WM286

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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*.

Send (preferably) a postal order to cover the cost of the Blueprint (stamps over 6d. unacceptable) to PRACTICAL WIRELESS Blueprint Dept., George Newnes, Ltd., Tower House, Southampton Street, Strand, W.C.2.

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The Request All-Waver — WM407

Mains Sets : Blueprints, 1s. each.
Heptode Super Three A.C. — WM359*

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