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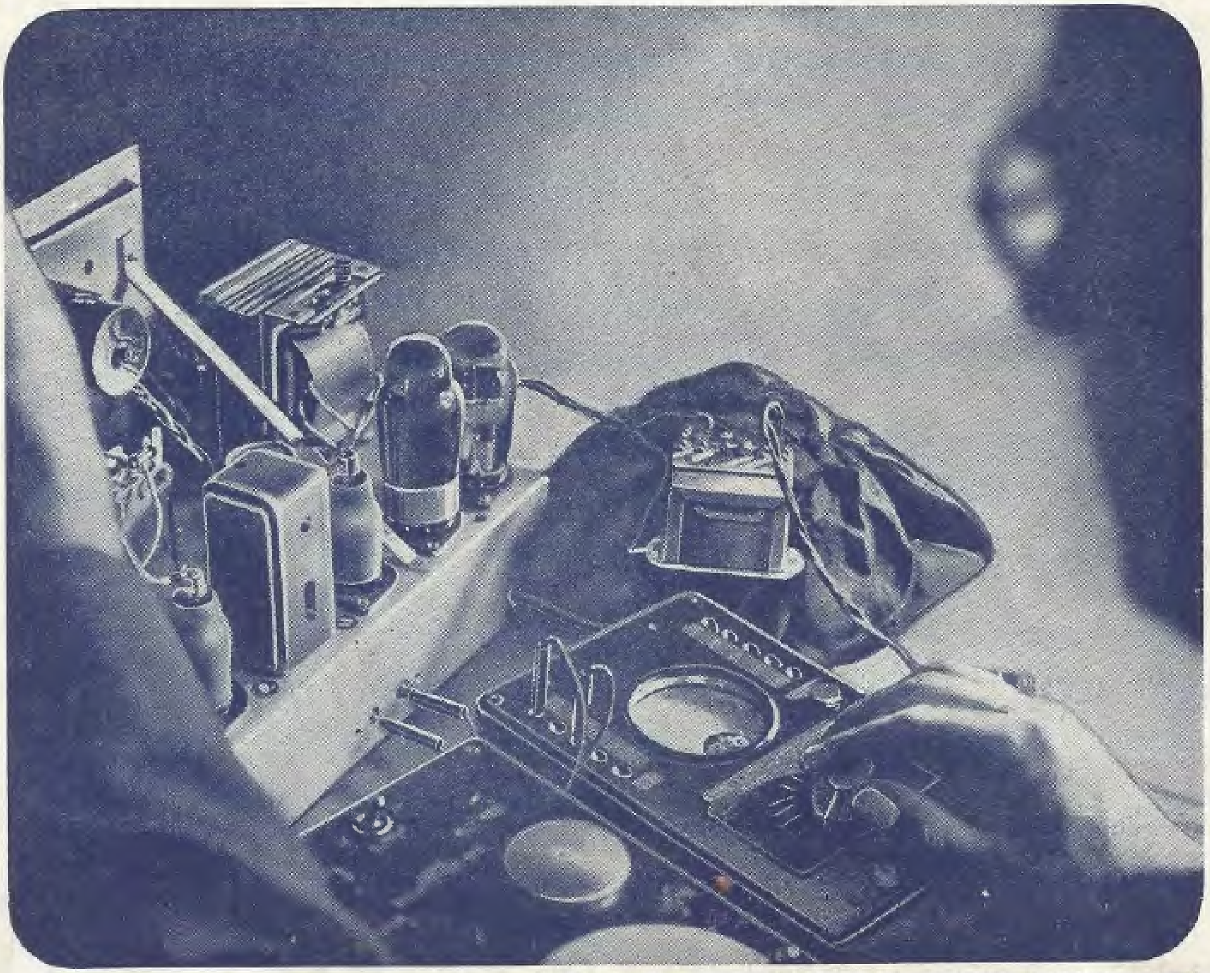
MONTHLY
ONE SHILLING

The Wireless World

COVERING EVERY WIRELESS INTEREST

JUNE, 1941



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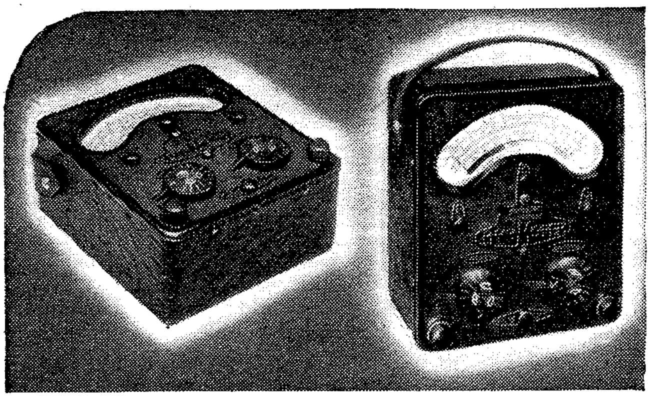
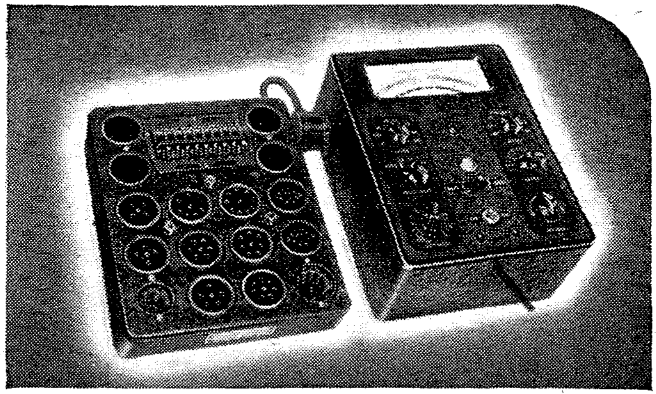
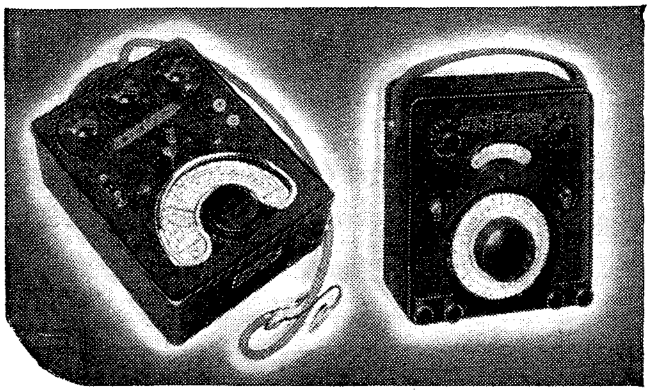


"Avo" Valve Tester with Universal Panel





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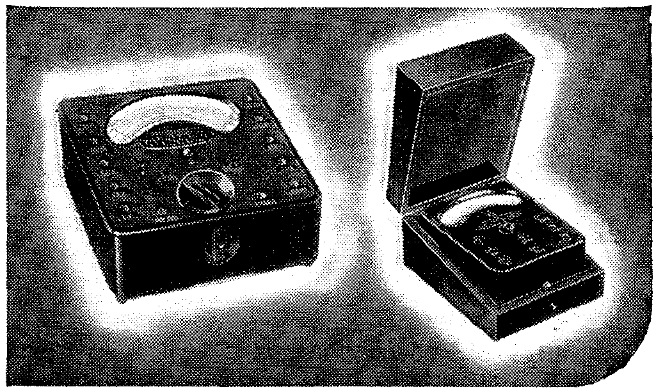

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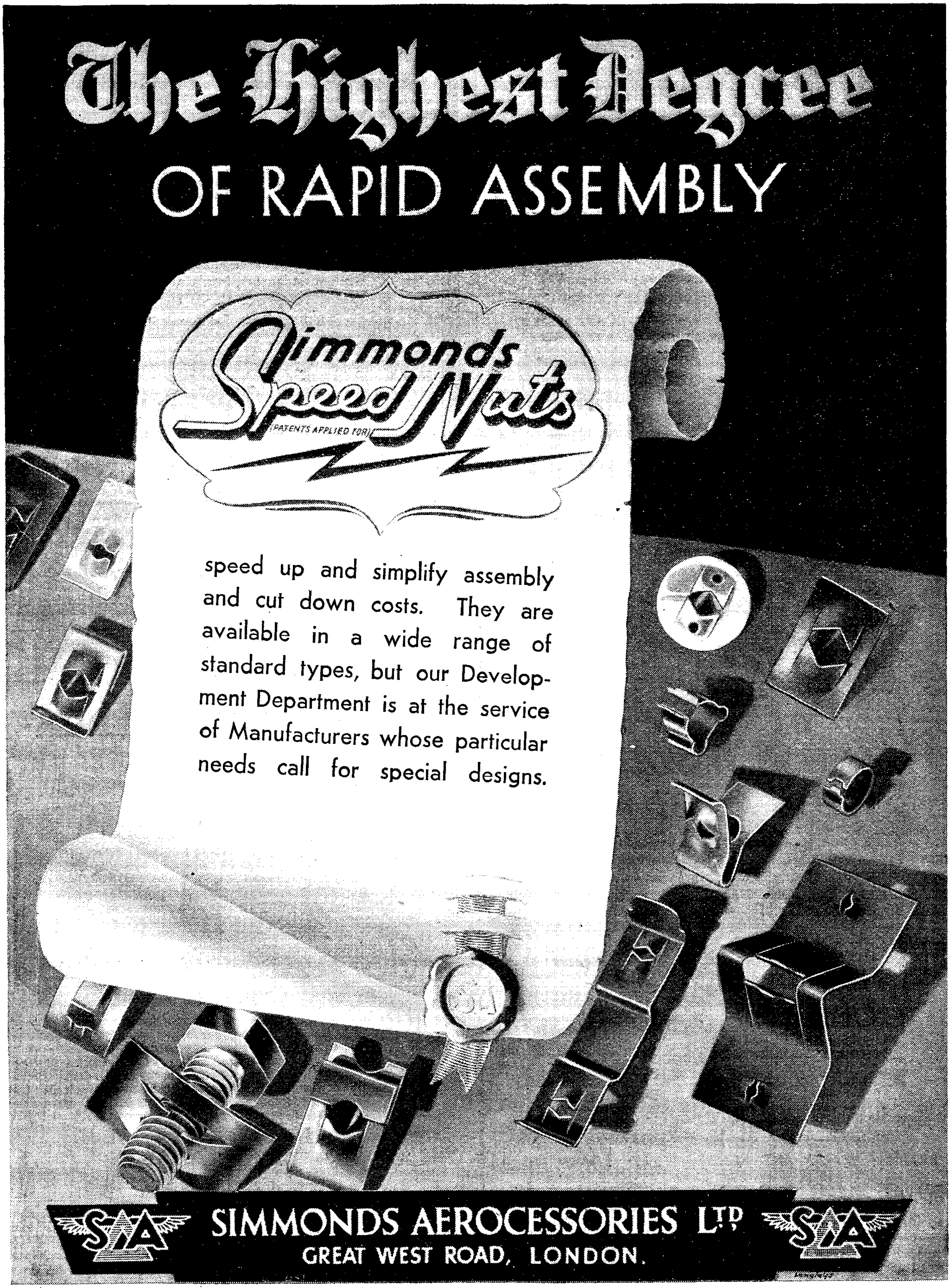
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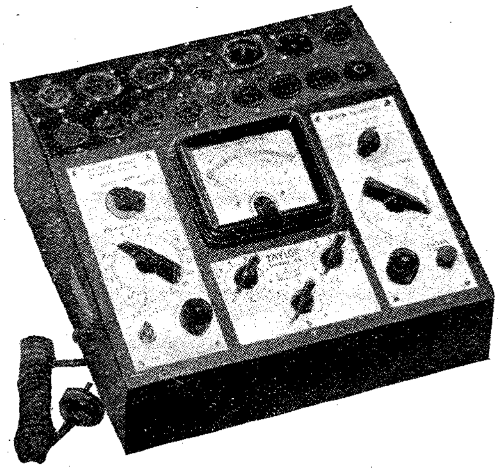

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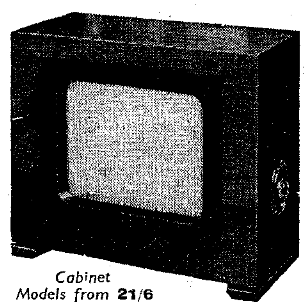

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C 60/500	60 MA	18-30 H	500 ohms	8/8
C 100/400	100 MA	20-34 H	400 ohms	10/8
C 150/185	150 MA	20-34 H	185 ohms	15/4
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15-watt A.C. ,,	£7 18 9	£9 8 0

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Wire-ends. All L.T. Windings Centre-Tapped

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SP 300	300-0-300 v. 60 ma., 4 v. 2-3 a., 4 v. 2-3 a., 4 v. 2-3 a. ...	13/4
SP 301	300-300 v. 150 ma., 4 v. 2-3 a., 4 v. 2-3 a., 4 v. 1 a., 4 v. 1 a.	17/4
SP 350A	350-350 v. 100 ma., 5 v. 2a. (not C.T.), 6.3 v. 2-3 a. ...	16/-
SP 350B	350-350 v. 100 ma., 4 v. 2-3 a., 4 v. 2-3 a., 4 v. 2-3 a. ...	16/-
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SP 351A	350-350 v. 150 m.a., 4 v. 3 a., 4 v. 2-3 a., 4 v. 1 a., 4 v. 1 a.	22/-
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Auto Transformers. Step up or down. 100-125 v. to 200, 230 or 250 v. A.C., 60 watts, **11/4**; 125 watts, **15/-**; 250 watts, **22/-**

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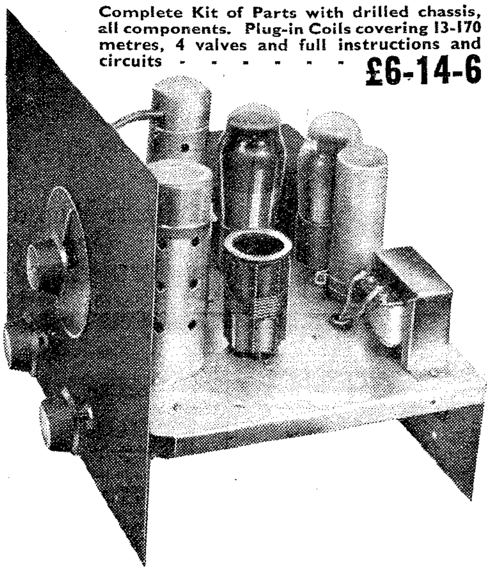

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Extra Coils 9—15, 200—2000m. also supplied.

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Short-Wave Coils, 4- and 6-pin types, 13-26, 22-47, 41-94, 78-170 metres, **2/-** each, with circuit.

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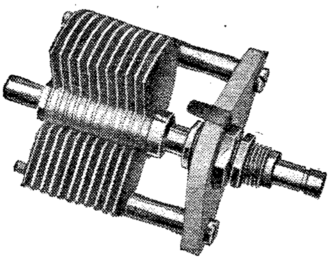
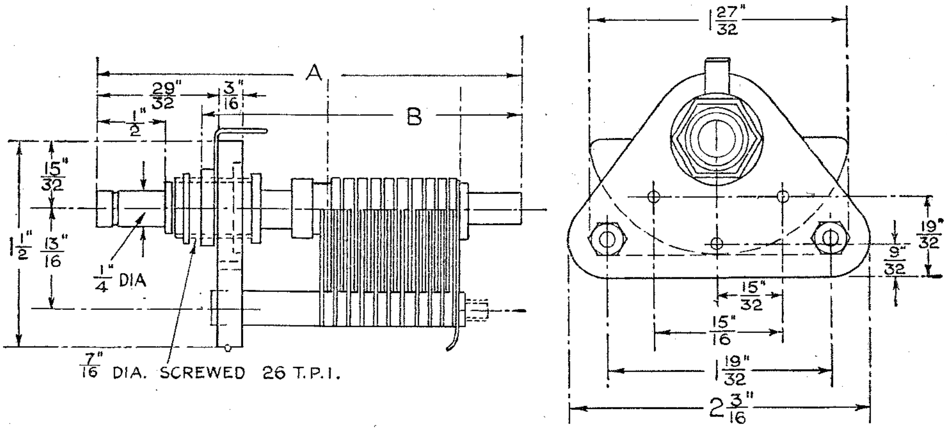
STANDARD (VCX) SERIES CONDENSERS

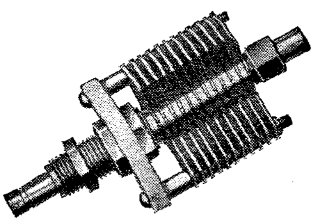


VCX

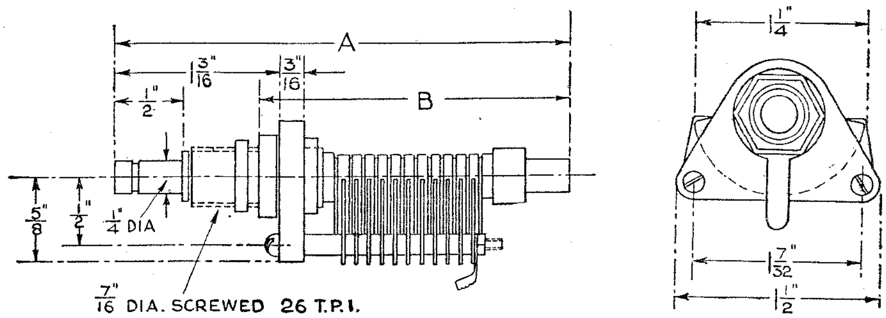
The VCX series condenser can be mounted by means of the three holes where both rotor and stator are required to be insulated from panel.



MIDGET (MCX) SERIES CONDENSERS

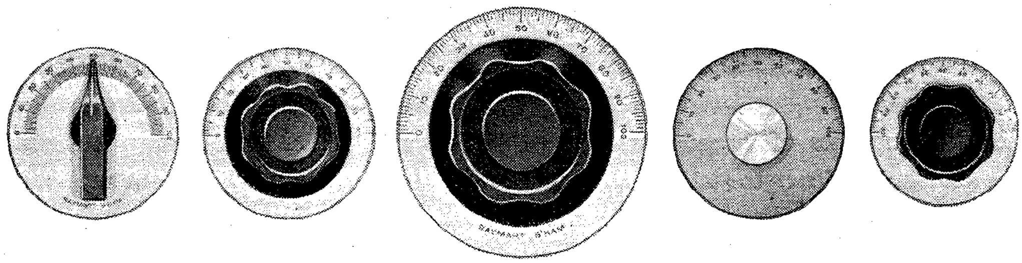


MCX



Special condensers can be made with intermediate capacities. The ganging feature may also be omitted with a consequent saving in length. Such alterations, however, can only be considered where the quantity justifies the resetting of machines to make the special parts required.

PRECISION DIALS AND KNOBS



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The
Wireless World

31st Year of Publication

Covering Every Wireless Interest

JUNE, 1941

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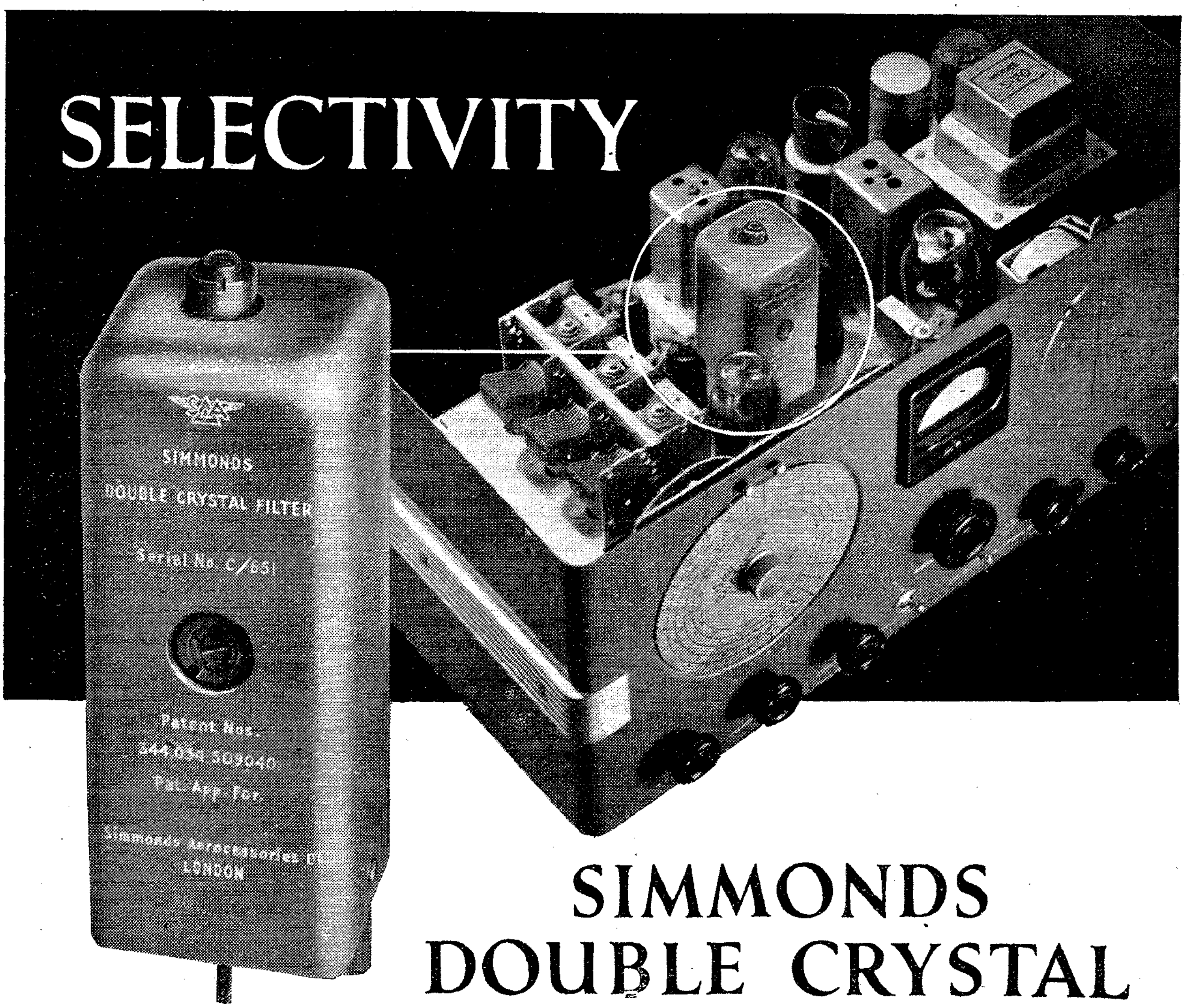
As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.



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SIMMONDS AEROCESSORIES LTD
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The
Wireless World

COVERING EVERY WIRELESS INTEREST

ESTABLISHED 1911

Vol. XLVII. No. 1068 JUNE, 1941 Price One Shilling

Presentation of Broadcast News

Is a Change of Technique Overdue?

WHAT most technical wireless people call the "programme side" of broadcasting is little concern of ours. In conformity with the clearly expressed wishes of the vast majority of our readers, we confine ourselves to the other side of wireless—to the means rather than the end. But, although we leave the details of programme organisation and make-up severely alone, it is our duty to keep a watchful eye on the broader and more fundamental issues, especially when it seems that our medium of communication is not being used to best advantage.

Now the dissemination of news is the most important function of broadcasting at the present time, and it has long been our opinion, confirmed by careful observation of the reactions of listeners of different types, that there is room for improvement in the technique of news presentation. In the first month of the war, when the Press of this country showed signs of resenting B.B.C. competition, we urged that there was no real foundation for antagonism, and that Press and broadcasting should be complementary channels of distribution, only needing to find the right techniques for changing conditions. We said "the trouble at present is that broadcasting is too much like the newspapers, and the newspapers are too much like broadcasting."

No Basic Change

That trouble still persists after nearly two years of war. One often reads long passages in the morning papers that contain not only the substance but very often the exact phrasing of something that has been heard during the previous evening's news bulletin. The make-up and style of the broadcast bulletins has undergone little fundamental change since 1939—or, for that matter, since 1922.

As compared with the Press, broadcasting enjoys the advantages of extreme speed and living actuality. It suffers under the handicaps of being unable (in the present absence of a television service) to employ such graphical aids as pictures, maps and diagrams to explain and amplify the news; in addition, the listener, unlike the reader of the printed page, cannot absorb information at his own pace. Consequently, news bulletins must be read at a compromise speed—too slow for some listeners and too fast for others.

These inherent advantages and disadvantages should obviously be taken into account in devising an improved technique of news presentation, and as a first step we suggest a sharp line of demarcation should be drawn between real news on the one hand, and commentary, exposition or speculation on the other. News proper might be broadcast in almost telegraphic phrasing, with the utmost economy in words. Change of speed in reading is a dramatic trick that is perhaps not to our national taste, but, skilfully done, it makes for easy assimilation of facts by the listener. The telegraphic trick of repeating numbers and extremely significant words or phrases might be helpful; the time spent in repetition would be more than offset by savings effected elsewhere. The interlarding of bulletins with "geography lessons" and passages from reference books annoys the well-informed listener, and belongs more properly to a commentary. Intuition, skill and a sympathetic outlook are needed for the arrangement of the items of a bulletin in their proper order, and pains should be taken to see that the burning question of the hour (in the estimation of the average intelligent listener) is dealt with first—even if there is "nothing to report."

New-style Newspapers, Too?

Although there has been little change in the Press so far as the fundamentals of news presentation are concerned, there seems to be a growing realisation of the fact that its function is changing. The newspaper cannot compete with broadcasting in speed of reporting events, but it has advantages in explaining and commenting on the news. This, we think, is now being realised by the Press, and we look forward to the time when the two channels of news distribution will be more nearly complementary.

Making the Most of Short Waves

Improving the All-wave Receiver

By L. A. MOXON, B.Sc., A.C.G.I.

DURING recent years, SW broadcasting has made rapid strides. Great improvements have been made on both the transmitting and receiving sides. The number of stations operating has greatly increased; the use of beam aerials and higher powers has made better signals available; and the development of the "all-wave" superhet has extended the circle of SW listeners far beyond the select few.

There remains, however, a long way to go. Short waves still fall far short of the standard of reliability desirable, or even that to which we are accustomed on medium waves. An American station which provides excellent entertainment one evening may the next be submerged by noise, distorted by selective feeding, jammed by morse interference, or perhaps not audible at all. The reasons for this are various. In the first place, of course, we have to rely entirely on the various reflecting layers for long-distance reception, and these layers, though extremely useful, are very capricious servants. They sometimes go more or less completely on strike; at others they pass the signal on to us in a distorted, badly fading or noise-ridden condition.

It is unfortunate that the receiver tends to introduce further elements of unreliability. It adds more noise, which may entirely swamp the signal. Second-channel and other forms of interference are added by the frequency changer. It is possible for the AVC circuits to operate in such a way as to render distortion produced in transit more obtrusive, or even to produce similar distortion in a synthetic manner. In addition, the simpler receivers provide little encouragement to the listener wanting to tune in a short-wave signal, and he may be compelled to exercise great skill and patience.

All these deficiencies in the receiver present serious problems to the designer, and it is the purpose here to show how they can be overcome or minimised. The value of an RF stage for improving the ratio of signal to noise, and reducing second-channel interference is well known, and some design considerations for making the best use of it will be outlined. Band-spreading will be considered in some detail as it is essential to a solution of the tuning problem; the latter also demands a very high degree of "staying put" on the part of the oscillator circuits, and the very accurate scale calibration that this makes possible. The uses of double frequency changing will be discussed, and finally a number of minor design points which repay attention will be considered.

Importance of an RF Stage

Engineers, yielding to public demand, have evolved what might almost be called a standard receiver; the familiar three waveband, four-valve superhet with frequency changer, an IF stage operating at about 465 kilocycles, double-diode-triode for detection, AVC and AF amplification, and a high-slope output pentode. This design can give quite good results, but requires elaboration if a maximum of short-wave reliability is to be approached. Probably the first essential is to increase the signal-to-noise ratio by addition of an RF stage.

There are two main sources of noise in receivers, the tuned circuits and the valves. Assuming adequate gain from the first valve, only this and the preceding circuits need be considered, since other sources of noise will have much less amplification following them. In any conductor a certain amount of noise is generated by thermal agitation of electrons, and the voltage produced is proportional to the square root of the impedance of the conductor. In the case of SW tuned circuits, low impedances are the rule and circuit noise can usually be neglected in comparison with valve noise. The latter can be taken as proportional to the square root of the anode current, I. Although not strictly true when applied to different types of valve, this has been found a useful guide in practice. As amplification of the signal is proportional to the effective conductance G, we can state

$$\text{Signal-to-noise ratio} = \frac{G}{\sqrt{I}} \times \text{a constant.}$$

Mains RF pentodes and hexodes all take very roughly the same anode current. The advantage of having, as first valve, a variable-mu pentode with a G of 2.4 over a frequency changer with a conversion conductance of 0.8, is obvious, and measurement confirms the expected improvement of 3 to 1. A television type of RF pentode used with a working slope of 7 gives a further reduction of 3 to 1 in valve noise which is then comparable with the circuit noise. This limits the additional improvement to about 2 to 1. If a high-slope RF valve is fitted, its use is best confined to short waves. Such valves are not in general suited to medium wave use on account of their very limited signal-handling capacity and the large signals likely to be applied. They offer no compensating advantage, since thermal noise on medium waves limits signal-noise ratio to that obtainable with a low slope valve.

The gain of the RF stage may be regarded as just adequate if it is equal to the improvement in signal-noise ratio expected from the stage. Under these conditions a quota of noise will be added by the frequency changer equal to that which the

Making the Most of Short Waves—

signal has collected from the RF valve. The RMS addition of the two components gives an increase of 3 db. in total noise, and this is only just appreciable. It may be possible to get greater gain, but noise level sets a limit to the amount of sensitivity which can be usefully employed. This limit can be achieved in practice (with or without an RF stage) by making the FC, IF, AF and output stages as efficient as possible. Unnecessary RF gain is harmful for the following reason.

Over a range of a few hundred kc/s on either side of the frequency to which the set is tuned, little attenuation can be expected from the signal circuits, and all stations within this range will reach the frequency changer. If two signals which happen to be spaced by a frequency equal to the IF of the receiver are present in sufficient strength, they will beat together to produce an appreciable IF component, which may cause interference with all weak stations over quite a wide tuning range. The RF stage amplifies not

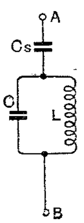


Fig. 1. Basic circuit of the simple image rejector described in the text. In the absence of circuit losses, the impedance between A and B would be infinite for the wanted signal and zero for the image.

only the wanted, but *both* the unwanted stations, and the interference tends to be increased in proportion though some help is afforded by the selectivity of the usual extra circuit. Those who like "gadgets" may find a variable gain control useful. Otherwise slightly more than the "just adequate" gain is quite a good compromise. Some increase in gain may be permitted on the longer SW bands in view of the greater signal selectivity, but it is desirable to avoid extreme variations over the frequency range. This argument does not apply to receivers with double frequency changing and a high value of first intermediate frequency.

Battery valves have much lower values of both G and I than mains valves, and are about the same from the noise point of view. On account of the low slopes it appears essential to use tuned anode couplings in order to get adequate gain. With mains valves some form of transformer or tapped coil coupling is usually more satisfactory.

The additional tuned circuit that an RF stage brings with it is some help with image rejection. In an

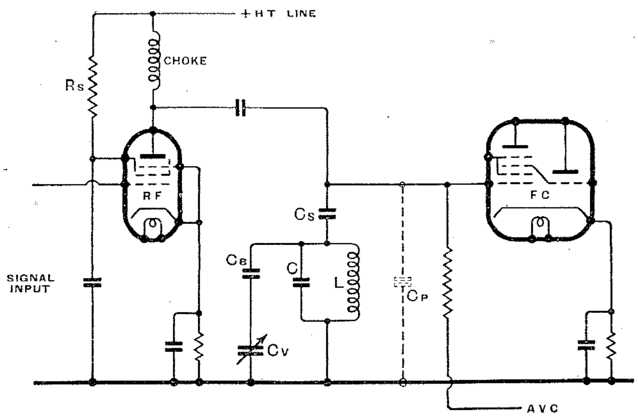


Fig. 2. Showing application of image rejector to a practical design: switching complications omitted. C_P represents the stray capacities across the coupling impedance. For band-spreading a section Cv of the gang condenser is connected, in series with a small capacity C_B, across the circuit LC.

average design, with an IF of 465 kc/s, it contributes some 12 db. to a total of 20 db. rejection at 15 megacycles. This is not a very satisfactory improvement, and in one receiver* a further 10 db. was obtained by using a band-pass intervalve coupling.

Image Rejection

In a later receiver a total of 40 or 50 db. rejection was obtained by means of a simple image rejector of which Fig. 1 shows the principle. This circuit, used as an anode coupling impedance, would give maximum gain at the resonance of LC. At some lower frequency the circuit LC, looking like an inductance, forms a series resonance with Cs and produces a very low impedance. This can be utilised for image rejection by suitable choice of Cs. The practical application of the circuit is illustrated by Fig. 2. Its working is somewhat modified by the capacity C_P consisting of various strays—the interelectrode capacities of the RF and FC valves, the self-capacity of the HT feed choke, wiring, and possibly switch capacities. These must be kept as low as possible, since their effect is to reduce the effective impedance, and therefore gain by the factor

$$\left[\frac{C_S}{C_S + C_P}\right]^2$$

An average value for Cs may be about 25$\mu\mu$F, and C_P can be kept down to about 30$\mu\mu$F. At 16 metres a coupling impedance of more than 1,000 ohms is unlikely, but this is adequate if a high-slope valve is used. From 25 metres upwards the gain may then be excessive unless Rs or C is increased.

Fig. 3 shows the measured selectivity of the image rejector at 15 Mc/s compared with the estimated performance of a simple circuit with similar losses. The tapping-down effect of C_P helps to keep the losses low and improves the suppression of double beats as well as images.

It will be appreciated that the oscillator must be tuned to a lower frequency than the signal. In theory,

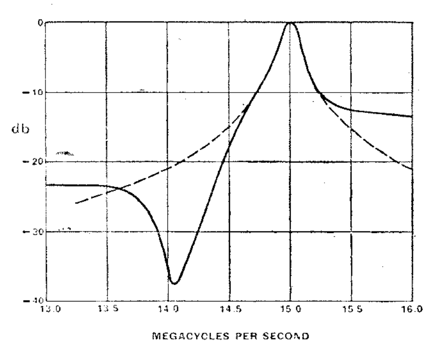


Fig. 3. Measured selectivity of image rejector at 15 Mc/s. The estimated curve for a simple tuned circuit with similar losses is shown in dotted lines. Some additional selectivity is given by the aerial circuit.

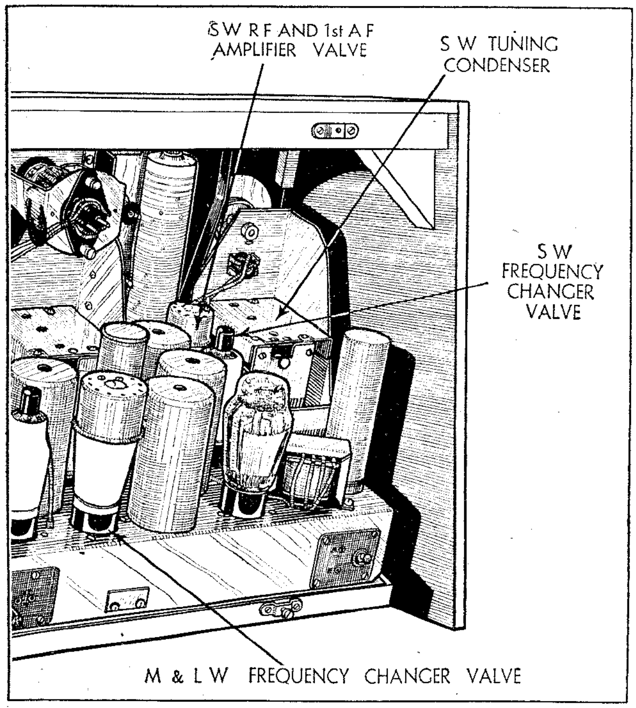
* The Murphy Model A76.

Making the Most of Short Waves—

Cs could be replaced by an inductance and the oscillator tuned high, but in practice difficulties arise over stray capacities.

This circuit was developed for use with a band-spread receiver using switched inductances pre-set to each of the short-wave broadcast bands (the Murphy A92). The value required for Cs depends on C, Cp and the IF. It was not found to be very critical, but had to be changed for each band, with the exception of 25 and 31 metres, which were able to share one value.

Most short-wave broadcasting stations lie within seven narrow bands, all less than 300 kc/s in width and centred around 6.1, 7.25, 9.6, 11.8, 15.22, 17.8 and 21.6 megacycles respectively. It is standard practice to cover the entire frequency range, or at least up to 18 Mc/s, by capacity variation and a single set of tuning inductances. As each station's share of the tuning scale is less than a thousandth part, it is not surprising that tuning tends to be difficult.



(Left) Components associated with the double frequency-changing system of the Murphy Model A36 receiver.

The useful portions of the tuning range constitute only a small proportion of the total. It is the function of band spreading to open out the wanted parts of the scale and make it easy to adjust the receiver to the desired frequency. There are many possible means to this end, as illustrated in Fig. 4. Referring to this family tree, the left-hand side requires little discussion; slow-motion drives and mechanical or optical magnifying scales are very useful devices, but the very high mechanical standard required by the ideal is not readily achieved in mass production. Some American communications receivers employ very successful precision drives and geared-up scales which enable the receiver to be tuned accurately to any desired frequency within a wide range. For broadcast reception there is some advantage in being able to switch rapidly from one band to the next without tuning through a lot of intervening noises, and this is most readily achieved by electrical band-spreading methods.

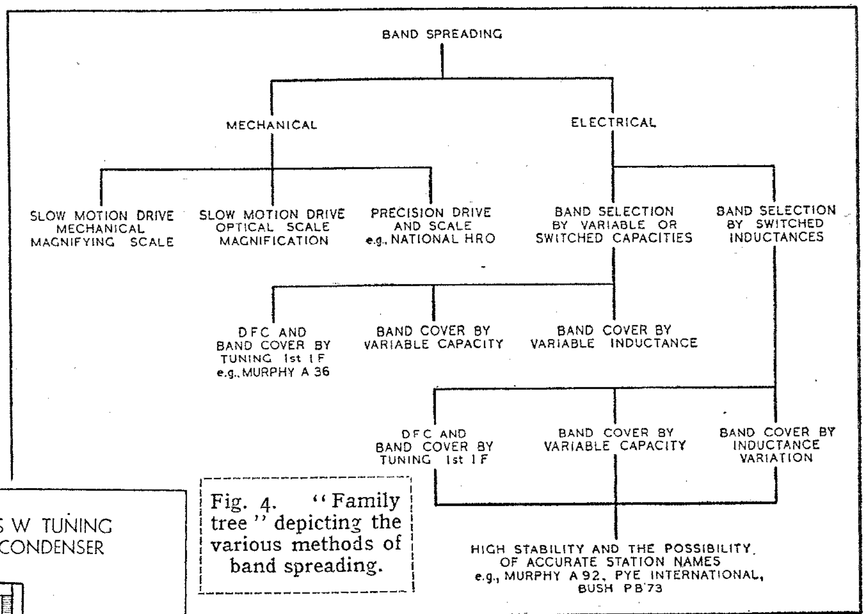


Fig. 4. "Family tree" depicting the various methods of band spreading.

One interesting method is to provide means of arresting the tuning condenser at specified points. This may consist of a notched disc with a spring-controlled arm locating in the notches and giving a definite "feel" to the correct setting. An auxiliary means of tuning with its own scale must be employed to cover the bands thus selected. This method was employed some years ago on the Murphy A36 receiver, which employed double-frequency changing. SW signals were converted to an intermediate frequency in the medium-wave band, and tuned-in as medium-wave signals. The medium-wave tuner, therefore, provided the auxiliary means. An alternative would be to vary the oscillator inductance about 8 per cent. by means of an iron dust core or piece of non-ferrous metal moving inside it. A small auxiliary tuning condenser can be used, but is not satisfactory over a wide tuning range. A given spread at 6 Mc/s, compared with 18 Mc/s, would require 27 times as much charge of capacity, so that full cover of the former would severely cramp the latter. The inductance method possesses the same fault, but only to the extent of 3 to 1, which is tolerable. The double-frequency changing method described has the advantage of a constant band-spread scale calibration in terms of frequency differences. That is to say, a difference of 100 kc/s on the band-spread scale remains 100 kc/s whatever the band selected by the main tuning control.

All systems which cover a wide frequency range by variable capacity share one disadvantage: that of tuning drift on the higher frequency bands, especially during the warming-up process. This is discussed in the next instalment. No wide-range inductance tuning devices are available, and the only alternative seems to be the use of separate oscillator inductances for each band, selected by a switch. This is no longer the formidable problem it would have been some years ago, thanks to the development of iron-dust cores which enable compact and easily adjustable coils to be constructed. In this way it is possible to produce really stable circuits, and there are two alternative methods of band-spreading, with a possible third. These will be described and discussed in a concluding instalment.

(*To be concluded.*)

Short-wave Receiving Conditions

PROSPECTS FOR JUNE

(COMMUNICATED BY THE ENGINEERING DEPARTMENT OF CABLE AND WIRELESS, LTD.)

ALTHOUGH somewhat more settled than during the preceding month, short-wave receiving conditions during April were, nevertheless, not as favourable as those during the corresponding month of 1940.

Ionosphere storms occurred on fifteen days of the month as follows: On four consecutive days commencing April 10th and 18th and, in addition, on the 3rd and 7th (first week) and on the 24th, 25th, 26th, 28th and 29th (last week). In this connection readers of these reports may recall that, in the April issue of this journal, published on March 20th (see page 118), the possibility of a relatively high disturbance factor was suggested for a few days in the vicinity of April 9th and 17th and, in addition, at the beginning and end of the month.

Sudden ionosphere disturbances of the Dellinger type occurred as follows, these and other times given in this report being G.M.T. on the 24-hour clock notation: (A) April 19th at 1019, (B) April 20th at 1040.

The effects of (A) and (B) were in each case confined mainly to easterly and southerly routes, and were in evidence for a period of about fifteen minutes; those on April 19th were, however, the more pronounced.

Particulars of the broadcast bands which, it is considered, should prove most reliable during June under normal conditions of propagation at the times stated for five selected routes are given below; these may serve as a guide when considering the possibilities of reception from places not too remote from those specified.

Attention is drawn to the fact that a number of factors, for example, (a) transmitting power, (b) efficiency of aerials at both the transmitting and receiving end, and (c) ionosphere abnormalities, may often result in better reception being obtained on wavebands other than those quoted. Moreover, transmission on each of the stated wavebands may not necessarily be available.

Tokio: Midt, 19 or 25 m; 0400, 19 m; 0700, 16 or 19 m; 1000, 16 m; 1300 and 1500, 16 or 19 m; 1800, 19 or 25 m; 2000, 19, 25 or 31 m.

Whereas in winter difficulties may be encountered for several hours on this route, in summer, and in particular during the month of June, favourable conditions persist throughout most, if not all, of the 24 hours. Echo effects may be prevalent during the period 1900 to 2100.

Montreal: Midt, 25 or 31 m; 0400, 31 m; 0900, 19 or 25 m; 1100, 1500 and 1900, 16 or 19 m; 2200, 19 or 25 m.

Under normal propagation conditions the most favourable period for reception should be between 1200 and midnight. The most difficult period is likely to be for a few hours in the vicinity of 0700.

Singapore: 0100, 19, 25 or 31 m; 0500 and 1000, 16 m; 1500, 16 or 19 m; 1900, 19 or 25 m; 2200, 25 or 31 m.

The period from 0100 to 0500 is expected to be a difficult one; in addition, the route may on occasions be subject to echo effects for one or two hours around 0700 due to signals traversing the major arc of the Great Circle (i.e., via Southern Australia and West Indies).

Salisbury, Rhodesia: Midt, 25 or 31 m; 0300, 31 or 41 m; 0600, 16 or 19 m; 1000 and 1400, 16 m; 1700, 16 or 19 m; 2000, 19 or 25 m.

Conditions should be favourable for reception throughout most of the 24 hours; signals may, however, be subject to echo effects around 0400 and to weakness for a short period around 1100.

Rio de Janeiro: 0100, 25 or 31 m; 0500, 31 m; 1000 and 1500, 16 m; 1800, 16 or 19 m; 2200, 19, 25 or 31 m.

Signals may be subject to weakness between 0500 and 1000 and to echo effects for one or two hours around 2000.

In temperate latitudes in the Northern Hemisphere, the highest values of critical frequency (F layer) usually occur during winter day and the lowest during winter night; the values for summer, both day and night, are normally between these two extremes.

As a result of the smaller range of critical frequencies encountered in summer, the usefulness of a frequency band employed for inter-communication within the Northern Hemisphere at this season may extend over several hours; in fact, under favourable conditions satisfactory long-distance communication (for example, with the Far East) may often be carried out for over 24 consecutive hours without the necessity of a change of frequency.

The E layer, in contrast to the F layer, has its maximum critical frequency in summer at about local noon; in consequence, under certain conditions of layer height it may frequently become the controlling factor in "skip-distance" calculations, particularly during late forenoon and early afternoon.

At the time of writing this report it would seem that conditions during June, and particularly during the latter part thereof, are likely to be more stable than of late.

Maintaining a Service

ALTHOUGH some journals, especially those from the Western Hemisphere, at times fail to reach this country owing to enemy action, every effort is made to obtain duplicate copies or, if this is not possible, photostat reproductions of the journals, in order that the Abstracts and References section of *The Wireless Engineer* may be a complete bibliography of articles on wireless and allied subjects published in the world's journals.

In this section of our sister journal the space devoted to abstracts from journals published in enemy countries is considerable. This fact has greatly enhanced the value of the section.

In addition to some 280 abstracts and references, the May issue contains articles on the rhombic transmitting aerial and receiver aerial coupling circuits.

Published on the first of the month, *The Wireless Engineer* is obtainable to order through newsagents, or direct from our publishers at Dorset House, Stamford Street, London, S.E.1, at 2s. 6d., including postage.

Makeshifts —— *Wartime Measures to Meet a Shortage of Servicing Components*

By W. H. CAZALY

IT must be made quite clear at the outset that the advice that follows on alterations to the circuits and components of probably very well designed receivers is necessarily of a generalised nature, and that the results that may follow on such alterations cannot be forecast with certainty. There is far more than meets the eye in even an apparently simple design of commercial broadcast receiver, and improvement seldom accrues from incautious and unintelligent "monkeying" with the products of experienced circuit engineers. On the other hand, we are faced nowadays with exceptional conditions, and if a receiver is put out of commission through a lack of some component that is unprocurable, it is worth while making some attempt to get it going again, even if the attempt is not very successful. After all, the patient can only be killed once! And the maintenance of domestic radio reception in these days is of such importance—it may even be a matter of life or death—that liberties with the circuits may be permitted that would be rightly frowned upon in less unsettled times. It must be borne in mind that many of the factors involved in successful emergency adaptations will be peculiar to the particular cases the reader has to deal with and cannot be foreseen by the author. If some suggested alteration does not work, it may be either because the components involved are unsuitable for change, or because all the factors operating have not been taken into account. The only thing to do is to have a shot at it, anyway. With this warning, one can now proceed

Valve Types

A shortage of replacement valves is likely to cause the greatest difficulties. Receivers may have to be adapted to work either with valves of characteristics different from the originals or without certain valves. As used in the stages of a typical superheterodyne receiver, valves fall into functional categories that will be dealt with in turn.

If a signal-frequency RF valve breaks down, reception is still possible without further alteration if the aerial is connected directly to the grid of the frequency-changer, via a very small pre-set condenser, which should be adjusted to suit the aerial used. A certain all-round reduction of goodness of performance may be noticed; the signal/noise ratio may be higher than previously, especially on short waves, and AVC may not operate quite so efficiently. Local station reception will be hardly affected.

If a spare valve of a different make is available with characteristics similar to those of the original, probably no alteration at all will be necessary. If, however, the replacement valve is not of the variable mu type—it may be an old tetrode—it will be better to use it in the IF stage, and to place

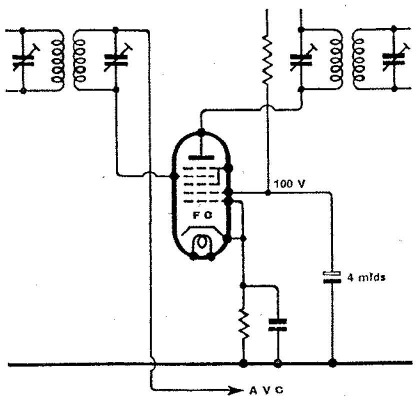


Fig. 1.—A frequency-changer valve may often be used as an IF amplifier if the oscillator grid and anode are given fixed working potentials as shown.

the IF valve thus released in the RF stage. The AVC feed to the new IF valve should be disconnected and the grid returned to the chassis or to some point of negative potential if it is of the type that requires negative bias to keep it stable. If the new valve is not metallised, possible instability from this source may be avoided by covering the glass envelope with "silver" foil (in one continuous piece) and earthing this foil to the chassis.

It is possible to make use of a frequency-changer as an amplifier, employing only the signal amplifying portion and earthing the oscillator grid, while the oscillator anode is taken to a suitable point at HT and earthed by a condenser. This is shown in Fig. 1.

The frequency-changer offers more serious problems. It cannot be dispensed with, and of whatever type the replacement is, it must make the best use it can of the existing oscillator circuits. The values of inductance and tracking capacities of this circuit will have been taken care of by the designers, and it is inadvisable to attempt any alterations in this direction. All that can be done is to connect the existing oscillator assembly leads to the appropriate pins of the replacement valve. This subject is rather too involved for adequate treatment here, but it is hoped to return to it in a later article.

Dispensing with the IF Amplifier

Should an IF valve break down, the choice of a replacement—if one is available—should be governed by the considerations outlined for the case of an RF valve. If no RF valve of any kind is available, the IF amplifier must be dispensed with and the output of the frequency-changer fed direct to the diode rectifier. Local station reception at least will still be possible, but considerable loss of volume and selectivity may make the set almost useless for anything more. The arrangement is shown in Fig. 2. If the lack of a suitable IF amplifier is likely to be prolonged or permanent, it may be best to dispense with AVC and replace the diode rectifier by a leaky grid detector—utilising, perhaps, the existing triode portion of the DDT. This is a more sensitive type of detector than is the plain diode. To increase signal strength, it may be worth while to attempt to use fixed reaction on the IF coil. For this, some thirty or forty turns should be wound on the IF coil former about half an inch away from the secondary; if the winding is put on as if it were a continuation of the secondary, reaction will be in the right sense. This reaction winding can be energised from the anode of the leaky grid detector through a pre-set condenser. A little experimenting with the number of turns will be necessary, and when stable reaction—not oscillation—is obtained, it should be left fixed (not too near the point of oscillation, or quality will suffer badly) and the transformer tuned to the IF. Band-pass response will be poor, but this trick may add a little much-needed strength to the signal. The AVC line should be taken direct to some earthy point—depending on whether the frequency-changer does or does not require a steady initial bias. It may be worth while, in this connection, to take this AVC line to a potentiometer across some source of considerable bias and use it as a RF manual volume control.

The above outline partly covers, evidently, the procedure possible to adopt if the double-diode-triode breaks down and cannot be replaced. Since the signal strength in a superhet is normally considerable by the time it reaches the rectifier circuit, it may be well to try anode-bend rectification, since this deals with signals of considerable strength without the distortion—within limits—that might easily arise with leaky grid detection. AVC must be dispensed with. "Power grid detection" may also be utilised, but this is likely to put an excessive load on the HT battery in a battery receiver, since the current taken with the high anode voltage required and no bias may be several mA. This high anode current will preclude the use of resistance-capacity coupling to the output stage and a transformer will have to be used—not more than 1 : 1.5 step-up—so that it may be inconvenient.

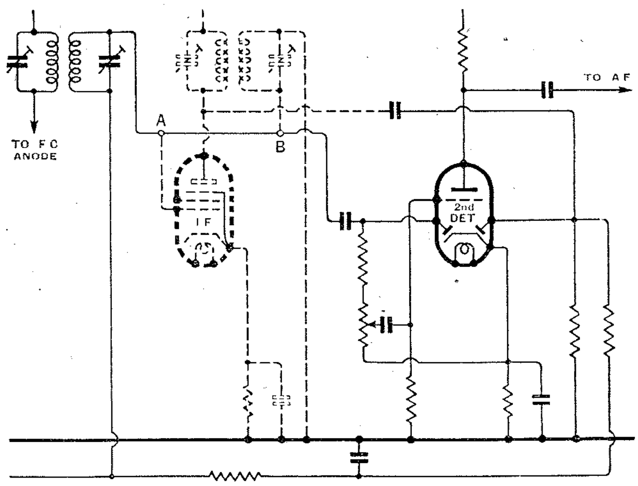


Fig. 2.—An unused IF stage is shown in dotted line. The connection from the first IFT secondary, A-B, should be as short and direct as possible to avoid coupling with other parts of the circuit; it may even have to be of screened wire. Re-adjustment of the first IFT trimmers will probably be necessary.

Replacing Battery Valves

The output stage of a battery receiver presents straightforward problems. A pentode and a triode output valve may be exchanged, if due attention is paid to matters of bias. The comparative inefficiency of the triode may to a certain extent be offset by turning up the volume control. If bias is obtained "automatically" by the potential developed across a resistance in the HT negative lead, this resistance may have to be changed for another value calculated from the formula

$$\frac{\text{Bias voltage required}}{\text{Total anode current taken with new valve}}$$

Current is expressed as a fraction of an ampere.

When changing from triode to pentode output, of course, an extra lead to HT will have to be provided for the pentode screening grid. Quality will be appreciably improved by fitting a correctly wound transformer to match the pentode to the speaker. If one of the pentodes used in a QPP output stage breaks down, the remaining one can be used without more alteration than reducing the bias—which will be obtained from a battery—so that it falls on the midpoint of the straight part of the Ia/Vg characteristic curve. Output will be considerably reduced and the volume control will have to be turned down. Class B output is not much used nowadays, but if a breakdown occurs in such a stage, it will be best to replace the whole of it by pentode output. For this, a bias battery and a new intervalve transformer will be needed, the latter to replace the original Class B driver transformer, which, having a step-*down* turns ratio, is quite unsuitable for ordinary use.

The output stage of a mains receiver presents much more serious problems, because it normally accounts for more than half the total anode current, upon which depends the energising of the speaker field coil, the anode voltage applied to the valves (through the voltage drop in the field coil) and, perhaps, automatic bias to valves other than the output. If possible, the replacement valve should take nearly the same anode current as the original valve, and if the bias is obtained by a cathode resistance, the maker's figures should be consulted to see if the original resistance is approximately correct. If it is not, it will have to be replaced by a calculated value based on the anode current of the valve and its correct bias at that value of anode current. If a pentode is substituted for a triode, the speaker transformer should be replaced by a more suitable one in the interests of quality, but if this cannot be done, quality can be partially preserved at the expense of sound volume by connecting a resistance of the order of anything from 4 to 20 ohms, as determined by experiment, in series with the speech coil.

It is not advisable to try to replace the original output valve by one taking considerably more anode current. If one taking appreciably less anode current is used as a substitute valve, it will be possible to make up for the lower total anode current of the set by connecting a resistance across the HT smoothed power supply, as shown in Fig. 3. If such a "bleeder" resistance is not used, the lower anode current through the speaker will not only insufficiently energise its field, but will raise the anode voltage on all the valves, which is not good for them and may set up instability. Also, the change in anode current and consequent anode voltage caused by the action of AVC on controlled valves will lessen the effect of AVC and may cause a kind of motor-boating. The wattage of the "bleeder" resistance should be

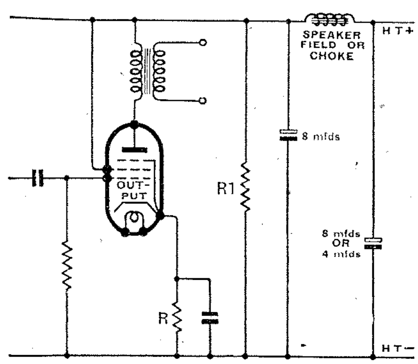


Fig. 3.—Alterations consequent on the fitting of a replacement output valve taking a considerably lower anode current than the original. The value of the bias resistance R will be $\frac{E \times 1000}{I}$, where E is rated bias voltage and I total anode current in mA. The added "bleeder" resistance R1 will be $\frac{250 \times 1000}{I_1 \times I_2}$ ohms, where I_1 is total anode current of original valve and I_2 is that of substitute valve, both in mA.

Makeshifts—

ample for continuous passing of the current. It should not be forgotten that even a general-purpose triode, passing only about 5 mA with 250 volts on its anode, can give an output that is enough for many domestic purposes. If such a triode replaces a pentode that took 40 mA, the "bleeder" will have to carry 35 mA at 250 volts—i.e., be 7,000 ohms rated at 8 watts minimum.

If one of the pentodes in a mains push-pull output stage goes out of commission, probably it will still be possible to use the remaining valve as a straight output pentode, but a "bleeder" will be necessary to pass current equal to that passed by the defunct valve, and also it will be necessary to examine the bias resistance circuit. If bias was originally obtained through a resistance common to both cathodes, the resistance should be doubled in value (so that the original bias is developed across it with the anode current of only one output valve passing through it). Another trouble may arise from an increase of hum after the change has been made. The only remedy for this lies in an increase of the smoothing in the power supply, preferably by the use of an extra condenser in parallel with the existing smoothing condenser.

The rectifier presents a very awkward problem if it cannot be replaced by the usual diode type. If by a lucky chance the receiver happens to be of the AC/DC variety *and is being used*

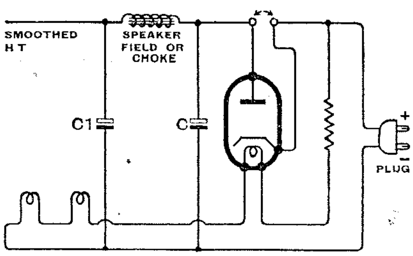


Fig. 4.—The rectifier of an AC/DC set may be dispensed with on DC mains (not AC), by joining the cathode and anode sockets on the valve holder, as shown. As C and C1 are polarised electrolytics, the mains polarity must be correct.

on DC mains, the rectifier can be cut out altogether, as shown in Fig. 4. But, in this case, certain precautions must be taken. The mains plug *must* be plugged in "the right way round," because the smoothing condensers will be polarised and will blow up if the mains supply connection is reversed. The best thing to do is to fit a non-reversible plug and socket, so that, in the course of domestic upheavals consequent upon dusting and such-like non-technical interference, the lay person cannot reconnect the set wrongly. Moreover, in case the receiver should be taken to a district supplied from AC mains, connection to which of the altered circuit will have disastrous results, a note about the alterations should be stuck to the back of the set in a conspicuous place.

Mention must be made of the possibility of using valves with different heater voltages and currents. Thus, 4-volt AC valves might be replaced by the 6.3-volt variety or vice versa. The safest and best way of doing this is to provide a separate filament or heater transformer for the new valve or valves, the design of which can be readily worked out from the *Wireless World* Data Charts, based, perhaps, on laminations from a good-sized unwanted choke or AF transformer. In such a case the load provided on the heater windings of the existing mains transformer by the valves that have been replaced must be simulated by a resistance, in order to prevent undue rise of heater voltage which would damage the original valves still remaining. Thus, if two 4-volt AC valves taking 1 A each were taken off the 4-volt heater circuit, their heaters would have to be replaced by a resistance of 2 ohms capable of passing 2 A. Or, if one 6.3-volt valve were taken out, the load its heater represents (at 0.3 A) would have to be replaced by 21 ohms. A small heater transformer is not very difficult to make, and care only has to be taken over insulation and layer-winding of the primary. The connections are shown in Fig. 5.

Extra L.T. Winding

Another possibility is that of making a small low-voltage auto-transformer fed from the original heater circuit. Yet another way, if room can be found for it on the original transformer, is to put on an extra winding; the extra load will probably not make much difference to the heating of the transformer. It involves finding the number of turns used in the original heater winding, by counting them or by calculating from the ratio of input primary volts to the output volts of this heater winding (ascertained preferably by an AC meter), the turns on the primary and so the turns ratio needed for the new secondary. Results should always be checked up by an AC meter, as incorrect heater current will seriously shorten the life of a valve.

The volume control is another component that may be difficult to replace.

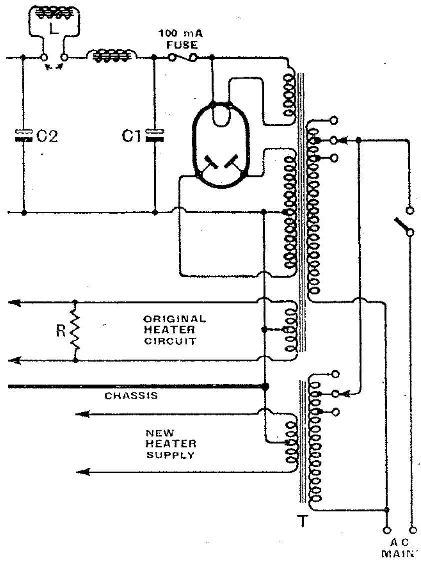


Fig. 5. Connections of an extra heater transformer T. R is a resistance to compensate for reduction of load on the original transformer, L is an extra choke, of 10 to 15 H, that may be inserted when more smoothing is required.

If only one of a lesser resistance value is obtainable, it may be possible to use it in series with a resistance that will make up the total to the value of the original. Control will only be partial and, if the slider of the new component is insulated from chassis, the series resistance may be put either at the "live" end—if loud volume is seldom wanted—or at the earthy end, if the set is normally used at average or considerable volume. If the new component is of higher value, it can be put in parallel with a fixed resistance, so that the combination will make up the original load on the diode, as can be calculated from the formula $R_1 = \frac{R \times R_2}{R_2 - R}$ where R is the value of the original volume control. R_1 is that of the fixed resistance, and R_2 that of the new volume control.

If no replacement volume control at all is procurable, it is possible to use a step control, with a stud switch and a string of resistances. Even a 3-way switch will provide a useful measure of control, by providing high, medium and low levels, the medium being fixed at the most favoured level. Another way of controlling sound output if the earlier stages of a receiver are already taken care of by AVC is to provide attenuation in the speech coil circuit, as shown in Fig. 6.

Larger condensers, of the electrolytic type up to many μF, may be scarce. In the smoothing circuits of the power supply, their lack is serious and not too easy to remedy. In Fig. 5 is shown a typical power supply unit; C1 is essential, and in the majority of domestic radio receivers, 3μF is the least value it should be. It can be made up from smaller condensers connected in parallel, each being rated at 500 volts peak, or from larger condensers in series of lower peak rating—but in the latter case a 100-mA fuse should be included as shown, because if one of the series condensers short-circuits, the other will soon follow suit, and such a short-circuit, unless the receiver were switched off at once, might damage both the rectifier and the transformer. In any case, short-circuiting one of the condensers would double the value of this reservoir condenser, raising the anode voltage and causing a heavy current to pass through the rectifier that might soon damage it. The main smoothing condenser C2 can only be of less capacity if additional inductance is provided in series with the existing choke or field winding, otherwise intolerable hum is likely to result. The extra choke L (if needed for any reason) should be of low DC resistance—not more than 200 ohms—and about 10 or 15 henrys inductance when passing the total anode current; C2 might then be of 4 instead of 8 μF capacity. Smoothing is also possible by using a choke-capacity tuned filter which is tuned to the fundamental 100 c/s of the rectified supply ripple; it will not be sufficient alone but may be enough with the existing field or choke smoothing and enables a smaller extra choke to be used.

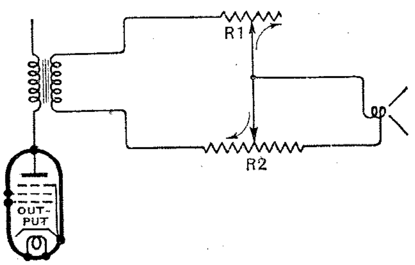


Fig. 6.—Volume control at the loudspeaker. R1 should be about equal to the speech coil impedance—anything from 2 to 20Ω. R2 should be about 5 times this value. The two components should be ganged.

Large-capacity low-voltage electrolytics used to by-pass cathode resistors present very awkward problems for replacement. Leaving them out will very seriously affect quality. If nothing can be found to make up even half their value, the drastic step may have to be taken of replacing automatic by battery bias even in mains receivers, which may be done as shown in Fig. 7. The bias batteries should be positioned as far away as possible from any parts of the receiver that get warm, should be of the best quality obtainable, and should be checked (preferably under an artificial load) every month or so, or at the least sign of distortion in quality; if they fail for any reason, the valves will pass very heavy anode current that may damage both themselves and the power supply unit.

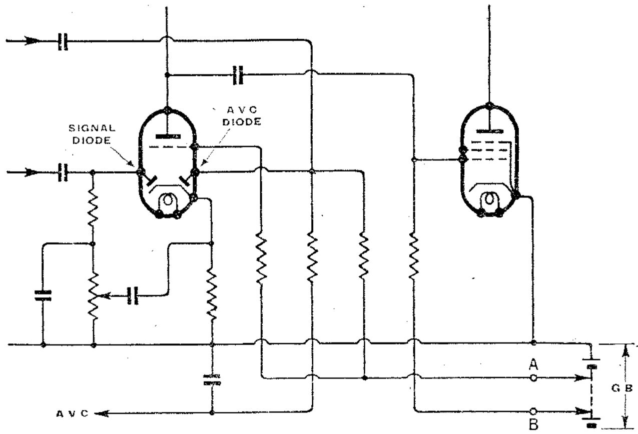


Fig. 7.—This gives a general idea of how battery bias can be used in a mains receiver. No cathode bias resistors are used in the circuits of any of the valves, all cathodes being returned direct to chassis. GB is a 27V battery, the tap A supplying delay to the AVC diode and bias to the RF valves (usually about 3 volts) and B applying normal bias to the output pentode.

In battery receivers, decoupling and voltage dropping through resistances feeding screening grids can be obviated by taking extra leads from these screening grids to suitable voltage taps on the HT battery. A small amount of decoupling, with small condensers and resistances, may in some cases still be necessary.

The foregoing covers many of the things that can be done without any profound knowledge of receiver design. It is very far, of course, from being a complete and exhaustive treatise on the subject; its purpose is merely to enable the man with a little knowledge and a lot of common sense to preserve, if not unimpaired, at least in working order, a domestic service that has now become a national necessity.

"Wireless Servicing Manual"

New Edition Now Available

IN publishing a new edition of this well-known book on wireless servicing, opportunity has been taken to carry out a certain amount of revision including extensive alterations in the section devoted to valve base connections which has been brought completely up to date. An entirely new chapter has been added dealing with automatic frequency control, a feature which is to be found in several modern receivers.

For those who are entirely unfamiliar with the book it may be said that, as its name implies, it consists of a very complete treatise on the servicing of wireless receivers. In the first place it deals very thoroughly with all types of testing apparatus, including cathode-ray gear, and advice is given on the most suitable type of equipment to obtain, both commercial and home-constructed instruments being dealt with, constructional details being given in the latter case. More important still are the chapters that deal with the most efficient method of using the equipment.

Later in the book, actual fault tracing is described in detail, obscure troubles as well as the better-known ones being dealt with. Short-wave receivers are considered in a separate chapter. Apart from actual fault tracing special interest attaches to the chapters which deal with aerial and earth installations and with the fitting of extension loudspeakers.

In the appendices will be found a collection of tabulated data, including the ever-useful copper wire tables and colour codes as well as valve base connections. Details for constructing a capacity and resistance bridge and a valve testing bridge will also be found in this section of the book.

This book is published from the offices of *The Wireless World* by our publishers, Iliffe & Sons Ltd., Dorset House, Stamford Street, London, S.E.1, at a cost of 6s., or by post 6s. 6d.

Noise in FM Receivers

Further Light on the Behaviour of Discriminator and Limiter Circuits

THE problems of noise in frequency-modulated systems have been carried a stage further towards solution by a very methodical series of investigations with the cathode ray oscillograph on the life history of a noise pulse in its passage through the receiver.[1]

It has been shown that when a noise pulse of very short duration is applied to the input of a receiver, the output is in the form of a train of waves having a frequency the same as that at the centre of the IF passband, and a duration equal to the reciprocal of fc the cut-off frequency. With the usual FM band width of 200 kc/s the cut-off frequency would be 100 kc/s and the duration of the pulse 10 microseconds. Thus, with an intermediate frequency of 5 Mc/s, there would be 50 cycles in the wave-train.

The shape of the envelope of this wave-train is determined by the shape of the selectivity curve and a double-peaked curve results in the formation of a marked secondary lobe as shown in Fig. 1A. The secondary lobe is still discernible when the response is flat topped, but disappears when the curve is rounded. Lack of symmetry tends to fill in the valley between the two lobes as in Fig. 1D.

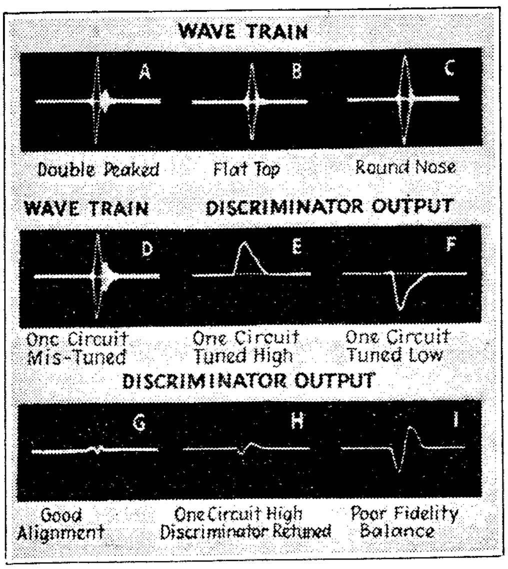
The discriminator output resulting from noise wave-trains of different types is a useful indication of errors of alignment in the RF circuits. If the low-frequency peak in a double-humped selectivity curve is higher than the other, the discriminator output has the form shown in Fig. 1E. If the high frequency peak is greater, the output falls below the zero line as shown in Fig. 1F. Similar curves to these are obtained by mistuning the secondary of the discriminator one way or the other.

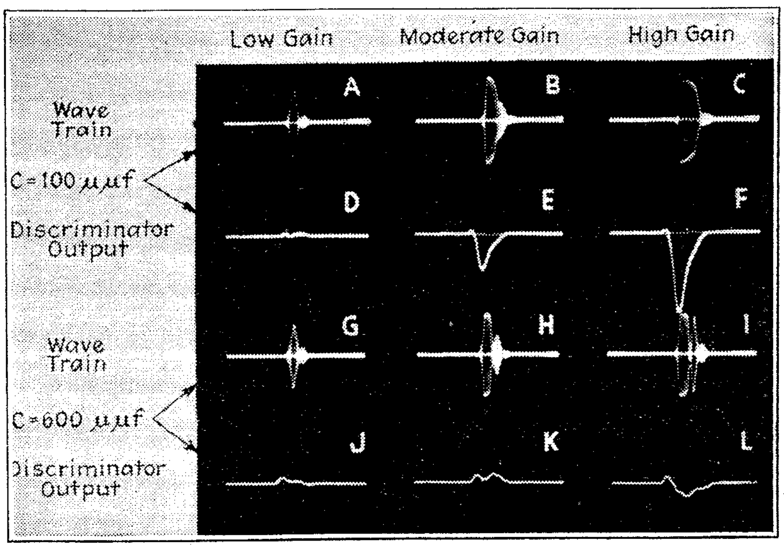
The usual discriminator output consists of two separate diode circuits connected in series, and these should be balanced from the point of view of frequency response. The output circuit is earthed on one side and not at the centre, so that it often happens that there is more capacity across one side than the other. The effect of an out-of-balance capacity of 10 $\mu\mu$F across 100,000 ohms is shown at I in Fig. 1.

At an early stage in the investigations it was discovered that the shape of the wave-train was considerably modified by the signal strength, and this was found to be due to the effect of grid current in altering the tuning of one or more of the RF circuits. The limiter grid circuit was, of course, the worst offender, and some idea of the magnitude of the detuning effect which may be met with is given by the curves in Fig. 2.

The trouble may be minimised in several ways. A larger tuning capacity giving a lower L/C ratio may be used, or the circuit response may be broadened by damping. Another useful expedient is to ensure that both primary and secondary of the RF transformers have circuits of equal Q, and that less than critical coupling is employed.

The oscillograms shown so far were taken with noise only and they are not valid for signal-to-noise ratios of more than 1/10. For higher signal-noise ratios, the noise output is a function of the interaction between the signal carrier and the noise wave-train after passage through the RF circuits. The result may be amplitude or frequency modulation, or a combination of both, depending on the phase of the noise and carrier waves.





(Left) Fig. 1. Oscillograms of noise wave-train (A to D) and output from discriminator (E to I). The lack of balance in the last oscillogram is equivalent to 10 $\mu\mu$F across 100,000 ohms on one side of the output circuit.
(Right) Fig. 2. Illustrating the detuning effect of grid current at high noise amplitudes. The more marked valleys between lobes in G, H and I indicate that mistuning is less with a lower L/C ratio (larger tuning capacity, C).

[1] "Impulse Noise in FM Reception," by V. D. Landon, *Electronics*, Feb., 1941.

Noise in FM Receivers—

To investigate the matter more closely, special equipment was built to ensure constant phase relationship between the signal carrier and noise impulse generators. A 10,000 c/s

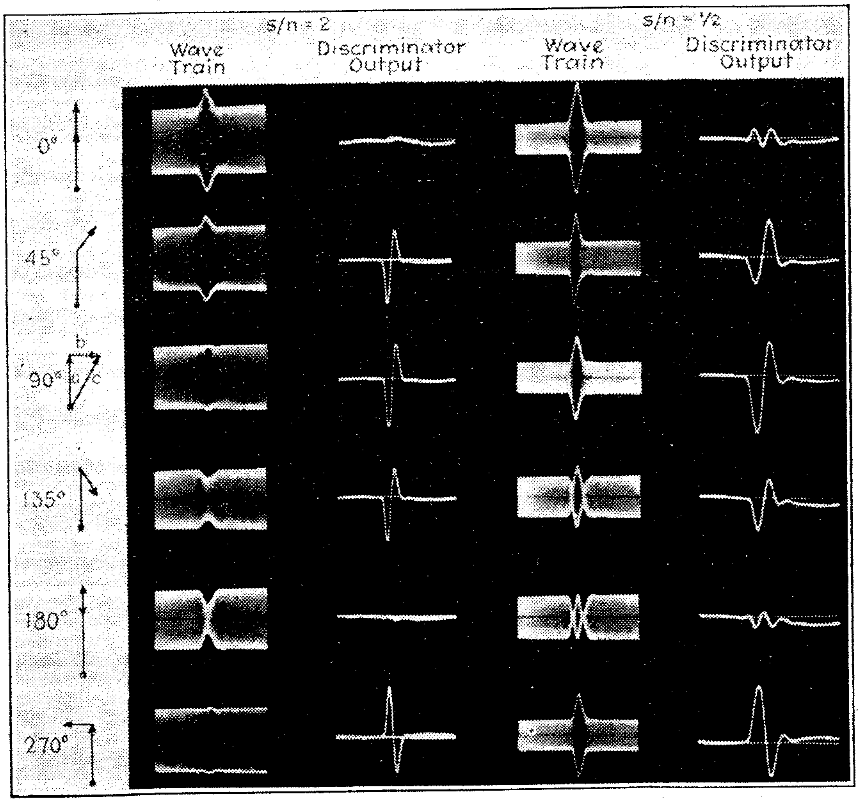


Fig. 3. Oscillograms, in the presence of a signal, of noise wave-trains and discriminator output for different phase angles between the noise impulse and signal carrier. In the right hand set of records the signal-to-noise ratio is less than unit and although the wave-train is considerably modified, the discriminator output preserves the same character. This is probably due to limitation of high frequencies in the audio circuits.

oscillator was used as the master driver, and its output was divided, one section being multiplied to a frequency of 5 Mc/s, and the other passed to a circuit designed to produce narrow uni-directional pulses at 10,000 per second. Finally the output from both branches was brought together and applied to the input of an IF amplifier with 200 kc/s band width and a mean frequency of 5 Mc/s. The phase between the signal and noise impulse was varied by altering the tuning of one circuit in the frequency multiplier.

The results of combining two elements in different phases are shown by the oscillograms of Fig. 3. At 0 deg. and 180 deg., amplitude modulation is at maximum and frequency modulation, as shown by a small discriminator output, is at minimum, while at 90 deg. and 270 deg. the conditions are reversed. At intermediate

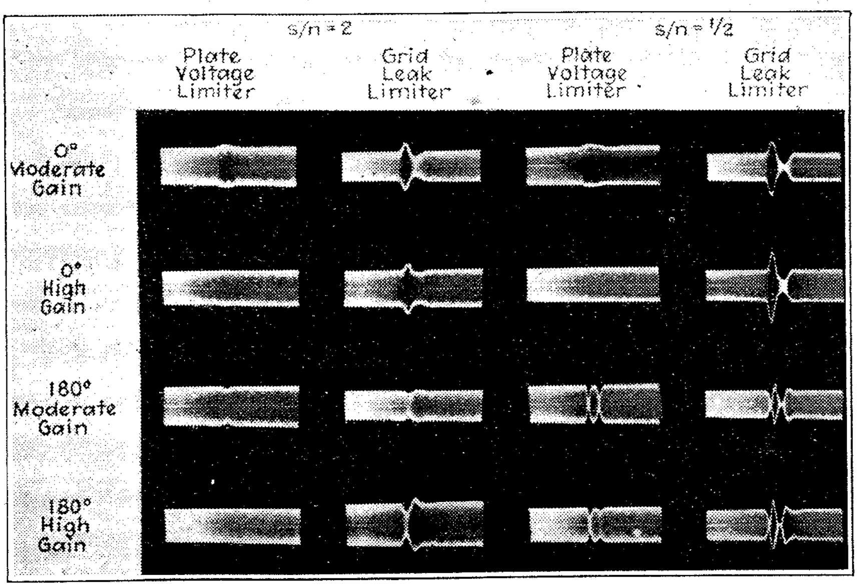


Fig. 4. Waveforms of impulse noise and carrier for different types of limiter.

phases both modulations are present. The effectiveness of amplitude limiting stages as noise suppressors is called into question when it is revealed by these oscillographic records that frequency as well as amplitude modulation may result from noise impulse, and the action of the limiter stage was accordingly further investigated.

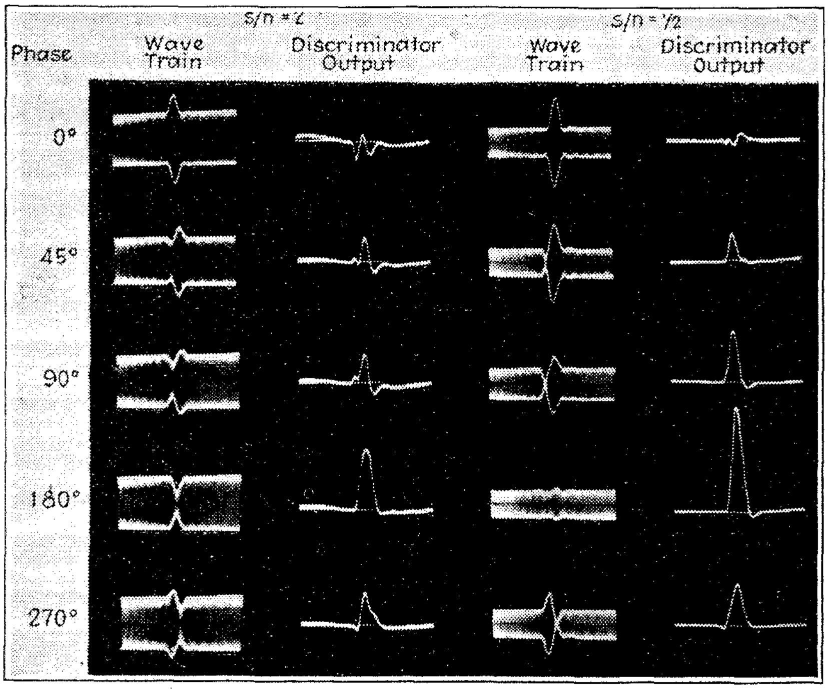
In Fig. 4 the wave-trains resulting from the injection of a noise impulse are shown for various signal-noise ratios, and phase relationships. The amplifier gains have been adjusted to show the action both above and below the threshold of the limiter stage. In the plate voltage limiter a low anode voltage is used, and the RF swing at the anode is limited to something less than the DC anode volts. The grid leak limiter depends for its action on the self-biasing action of the valve caused by the flow of grid current in the leak as the signal is increased. Values of 100,000 ohms and 20 $\mu\mu$F were used in the limiter grid circuit to give as short a time constant as possible.

It will be seen that from the point of view of amplitude modulation the grid leak limiter is not as good as the plate voltage limiter. The grid condenser does not charge up quickly enough to follow the rising front of the impulse. Also, when the response starts there is a tendency for the valve to over-bias, and the carrier is attenuated for a short time after the pulse has ceased, until the mean grid voltage is restored.

By themselves the oscillograms of Fig. 4 do not tell the whole story. The curves of Fig. 3 show that amplitude modulation does not come through the discriminator when the noise pulse and the carrier are synchronised, and Fig. 2 proved that grid current in the

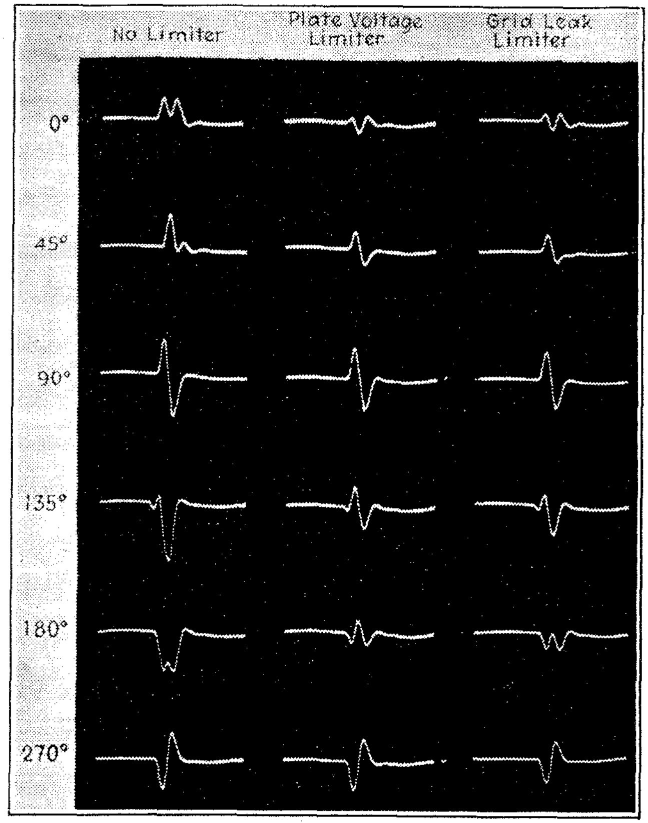
Noise in FM Receivers—
limiter may actually increase the noise by its detuning effect on the preceding RF circuit. Fortunately it is in just such circumstances that the limiter action is most effective, i.e., when the carrier is not exactly in the centre of the pass band of the amplifier.

If the carrier is tuned to the edge of the pass band, beats are generated between the noise wave-train and the carrier. The fequency of the beat is fc, or the cut-off frequency, i.e., half the band-width, and the beat note goes through one cycle in 1 / fc seconds. As was seen earlier in the article, this is the duration of the noise wave-train. In the first oscillogram in Fig. 5 the noise train starts 180 deg. out of phase with the carrier and causes a small valley hardly deep enough to show in the reproduced photograph. As it grows it changes its phase until at the peak it is in phase with the carrier, after which it reaches a phase difference of 180 deg. at the moment of returning to zero amplitude. The phase relations on the left of the figure refer to the peak conditions. As the relative phase changes the valley of the beat note travels progressively across the noise pulse. The corresponding discriminator outputs show that for the off-tune condition greatest noise occurs with 180 deg. phase difference between noise and carrier. Yet in these circumstances there is least evidence of amplitude modulation in the original wave-trains.



(Above) Fig. 5. Noise wave-train and discriminator output with carrier tuned to edge of pass band.

(Right) Fig. 6. Illustrating noise reduction by plate and grid leak limiters with carrier off tune. Carrier tuned to edge of pass band; signal-noise ratio, 2.



The discriminator output is shown for both plate and grid leak limiters, and it will be noticed that the performance of the grid leak limiter is at least as good as that of the plate limiter in spite of the disturbed wave-train which the former type of limiter produces (Fig. 4).

It would seem, therefore, that the effectiveness of the limiter is dependent on some factor other than that of simple amplitude limitation. If the curves of Fig. 6 with and without limiter are compared it will be observed that one effect of the limiter is to equalise the area enclosed by the impulse curve above and below zero line; without the limiter the impulse is definitely asymmetrical. Analysis of the frequency distribution and total energy constant of the spectra produced by various types of impulse shows that less noise is likely to result from the symmetrical type of curve. Fig. 3 indicated that a reasonably symmetrical discriminator output was obtained without a limiter stage, when the carrier was accurately tuned to the centre of the pass band, so that the chief function of the limiter is the reduction of noise arriving when the instantaneous frequency of the carrier is off centre, e.g., when peak modulation causes mistuning. The grid leak limiter, in spite of its failure to remove amplitude modulation, provokes the least detuning due to grid current, and in practice is probably the best type to use.

The limiter stage is justified by considerations other than that of noise reduction, and its usefulness in limiting distortion due to lack of flatness in the top of the IF amplifier response curve would alone suffice to ensure its retention in FM receiver circuits.

That the limiter can be effective in reducing noise when the signal carrier is tuned at the edge of the pass band, is shown by the oscillograms of Fig. 6.

Reducing Loading on Short Waves

Offsetting the Effect of Cathode Lead Inductance

When valves are used at high frequencies the input impedance decreases as the operating frequency increases. This loss in the input circuit of the valve is the result of the increase of the input conductance due largely to the cathode lead inductance, because this cathode lead inductance is common to the anode and control grid return circuits.

It is now generally recognised that the inductance of the cathode lead of an amplifier or converter valve, which is common to both anode and control grid circuits, represents a degenerative coupling between these circuits. This degeneration exhibits itself in ordinary

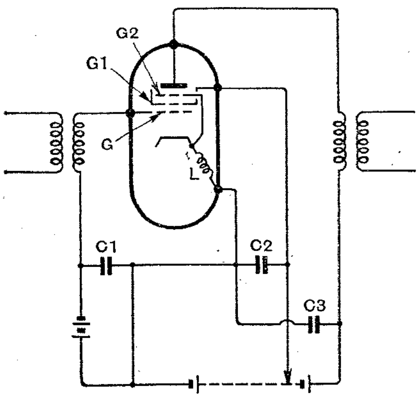


Fig. 1.—Showing how the inductance of the cathode lead, represented by L, is common to the control grid and other return circuits; it thus causes an anti-reaction or degenerative effect, increasing the loading of the input circuit.

valves as a resistance which appears in shunt with the input terminals of the valve and which decreases as the frequency increases. The common cathode lead inductance may be due to the length of the internal cathode lead or to the length of the connecting wire, or to both. The effective input conductance is, as a first approximation, directly proportional to this inductance. It also depends as a first approximation on the square of the operating frequency and on the cathode transconductance of the valve. The cathode transconductance is equal to the sum of the valve transconductance and the product of the valve transconductance divided by the ratio of the screen grid to anode current. This form of input loading probably accounts for a considerable portion, if not actually the major portion, of the input loading in many commercial valves.

A valve construction and associated circuit in which loading effects due to the cathode lead inductance are eliminated or substantially reduced is described below with reference to the diagrams.

In the schematic arrangement of a typical amplifier stage, shown in Fig. 1, the valve is provided with a cathode, preferably indirectly heated, control grid G, screen grid G1, suppressor grid G2, and anode. The input circuit is connected between control grid and the cathode, the cathode being coupled to the secondary of the input circuit by condenser C1. The output circuit is connected between anode and the usual voltage supply source, the by-passing condensers C3 and C2 being used between anode screen and cathode. The common cathode lead inductance is represented by an inductance L and may be either due to the length of the internal cathode tube lead, or to the length of connecting wire, or to both.

Split Cathode Connection

The degenerative effect due to L may be overcome by means of the circuit arrangement and valve shown in Fig. 2. Here the cathode is provided with two separate leads, the inductances of which are represented by L1 and L2. In this arrangement two leads are provided, one for the anode and screen-grid return, and the other for the control grid return. If the mutual inductance between these two leads is negligible, the common cathode impedance is substantially eliminated, and the input loading due

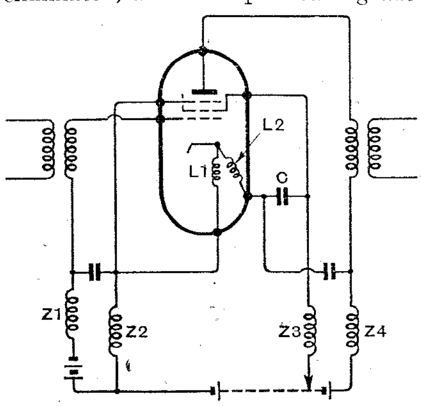


Fig. 2.—Minimising loading effects by provision of two independent leads for the valve cathode.

to this cause will be practically non-existent. However, if valves provided with two cathode leads are used in practical amplifier or converter stages, the input loading would not necessarily be greatly reduced. The reason is that if the impedance of the path through the HT supply is small as compared with the impedance of the path through L2, as it may be in an actual circuit, most of the AC anode and screen grid return current will flow through the supply path, and hence through the grid return lead. If it does so, then the object of having two leads is not fully realised, for the first cathode lead again constitutes a common inductance. However, this difficulty is removed by the insertion of choke coils or resistances as indicated at Z1, Z2, Z3 and Z4. In this way AC anode currents are prevented from flowing through the HT supply path to the cathode lead L1 and are forced to flow through the separate return lead L2. The impedances Z3 and Z4 can be used alone or the impedances Z1 and Z2 used alone. These additional circuit elements present a high impedance to currents of the operating radio frequencies and preferably, though not necessarily, a low impedance to the DC return currents

The operation of the valve can be still further improved by mounting the by-passing condenser C (Fig. 2) inside the valve and connecting it directly to the cathode.

Circuit Values

In one succesful example, in which the screen grid lead was by-passed to the control grid-cathode return lead, the impedance Z3 was a 60,000 ohm resistance and impedance Z4 a 5,000 ohm resistance; the by-pass condensers were all of 0.0002 mfd. With this arrangement an input conductance of about 130 micromhos at 60 Mc/s was

Reducing loading on Short Waves—
measured as compared to 500 micromhos in a conventional valve for the same value of anode current. The improvement was, therefore, in the ratio of 4 to 1.

Carrying the above further, the cathode may be provided with as many leads as there are electrodes in addition to the cathode. These leads can then be each separately connected by means of by-pass condensers to one of the other electrodes using suitable chokes or resistances to keep the radio frequency currents out of common paths due to common leads.

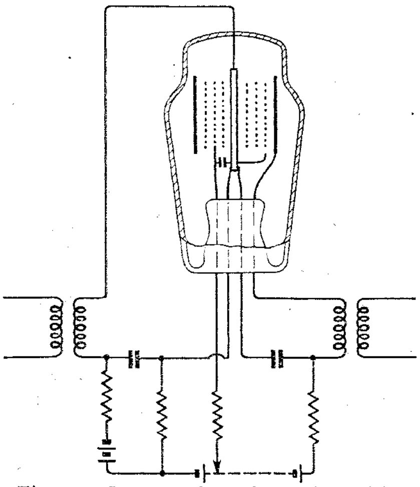


Fig. 3.—Construction of a valve with two cathode leads and a built-in bypass condenser.

The AC screen grid current in the above arrangement still flows through the first or control grid cathode lead, and since the ratio of the screen grid to cathode current was about 1 to 5 in the valve tested, the degenerative effect of the screen grid current gave rise to an input conductance of about 100 micromhos. This would leave roughly 30 micromhos for the input conductance of the valve if the degenerative effect of the screen grid current could be eliminated. The overall improvement might then be of the order of 16 to 1.

Special Construction

A valve incorporating this improvement is shown in Fig. 3, provided with two cathode leads and a by-pass condenser connected inside the envelope directly between the screen grid and cathode. This by-pass condenser, by obviating the effect of the screen grid impedance, eliminates the degenerative effect of the screen grid current and ensures better shielding at high frequencies. The condensers can be of two types; namely, commercial condensers mounted on the tube structure, or built-up condensers which make use of mica spacers at each end of the mount.

The degenerative effect of the AC screen grid current can be still further reduced by using valves designed to have a low screen grid current. It is now generally known that such valves also have the virtues of reduced fluctuation noise and increased efficiency.

This development is reported from the Laboratories of the Radio Corporation of America.

Frequency Measurement

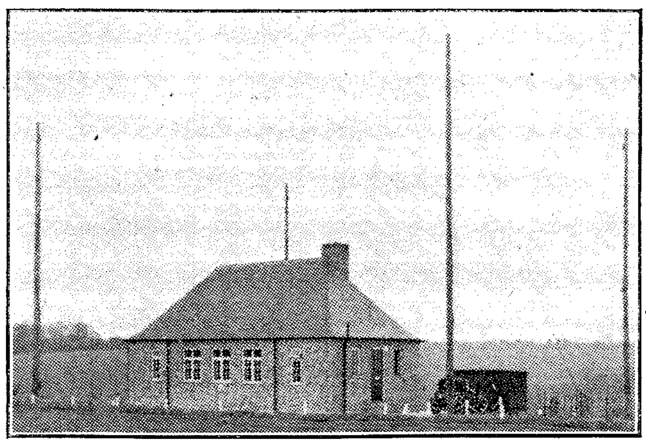
THE G.P.O. CHECKING STATION

IT is the responsibility of the General Post Office, as the Department entrusted with the control of all wireless communications in this country, to see that transmitters operating under its licence adhere as closely as the existing state of technical development permits to their allotted frequencies. The matter first became of great importance when the value of short waves for world-wide communication became evident in about 1924. Soon after that date the G.P.O. set up a frequency standard, with the necessary associated apparatus, for the accurate measurement of the frequency of signals received from stations under its control. This apparatus was installed at the Post Office Research Station, Dollis Hill, on the outskirts of London.

Dollis Hill proved to be an inconvenient site for routine measurements and still more for the important subsidiary work of investigating interference, and so the frequency measuring station was transferred to Colney Heath, near St. Albans. The accuracy attained at the new site ultimately rose to within 12 parts in a million, but this was not considered good enough when crystal-controlled transmitters became almost universal, and it was decided to equip a new station, transferring operations to a new site in clear open country, where reception conditions are good, particularly from the point of view of freedom from all kinds of interference.

The latest checking station is described by C. F. Booth and G. Gregory in the October, 1939, issue of *The Post Office Electrical Engineers' Journal*. It is pointed out that, in addition to its primary function of measuring the frequency of transmitters under G.P.O. control within the range of 15-30,000 kc/s, a station like this must be laid out for the investigation of jamming, the measurement of incoming signals from overseas, observation on the choice of frequencies for new services, and at the same time to keep a watch on the activities of British amateur transmitters. In addition, it must perform special interception work where required. The station must also be prepared to measure, on request, the frequencies of stations under the control of other administrations.

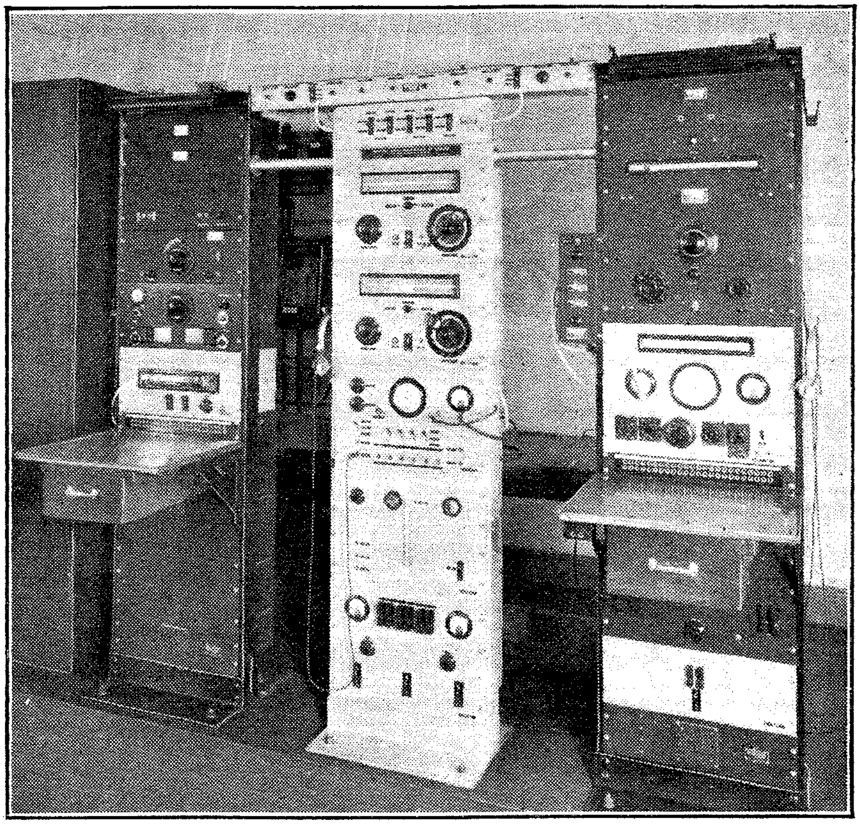
The specification for the equipment of the new station was a stringent one. The stability over a period of weeks of the frequency standard was to be within ± 1 part in a million, with a short-period stability of ± 1 part in 10 million. These requirements were satisfied by a Marconi-Ekco type 482-C cry-

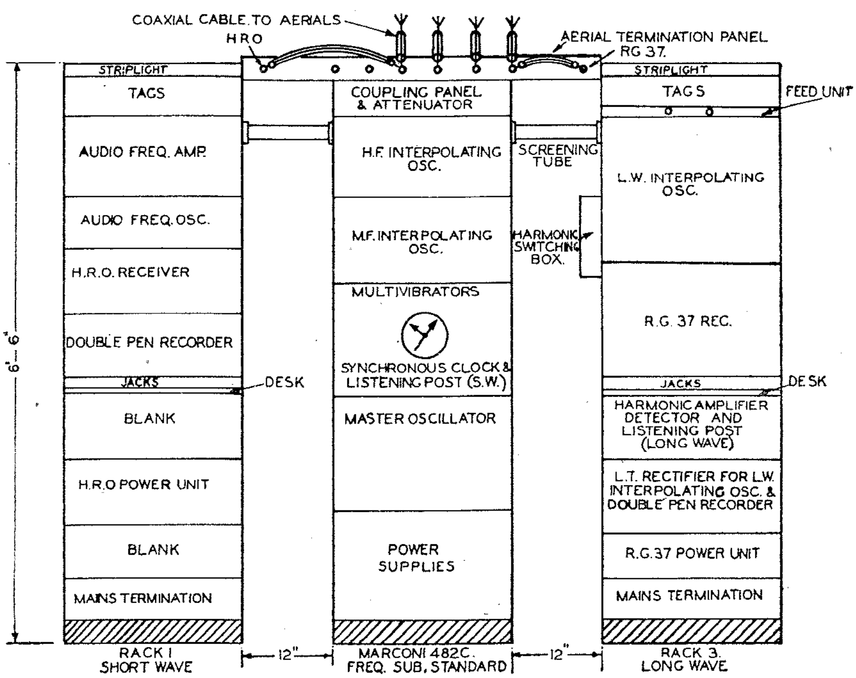


Courtesy "P.O. Elect. Engrs'. Journal."

The G.P.O. frequency control station; several types of aerial systems are installed, in order to ensure good reception of the wide range of wavelengths which can be measured.

Frequency Measurement—





Courtesy P.O. Elect. Engrs.' Journal.

Frequency measurement equipment at the G.P.O. station; the key shows the functions of the various units.

stal frequency standard, which, in addition to generating the fundamental frequency, provides a number of harmonics and includes two interpolating oscillators, a crystal-controlled clock, and facilities for listening. The complete measuring equipment was built up around this unit, and the arrangement of apparatus for collecting and "presenting" the signals for frequency measurement is shown in the key of the accompanying photograph. The receivers used are a Marconi-Ekco RG37 and an American HRO "communication" set.

Means are available for checking the station's sub-standard frequency unit from the Rugby time signals, and regular checks are also made against the primary standard frequency generator at Dollis Hill.

Three main methods of measuring the frequency of received signals are in use. The first, that of normal interpolation, operates over the range 14.5 to 30,000 ks/s and is used when the highest accuracy is not essential.

The second method, used between 1,000 and 30,000 kc/s, depends on inter-modulation, a harmonic from the 1,000-kc/s multivibrator being modulated by the output of the interpolating oscillator in such a way that the sum or difference frequency produced coincides with the frequency of the signal under observation. The accuracy over the greater part of the range is of a very high order; errors are greatest towards the long-wave end of the range, so this method is mainly used for routine short-wave measurements.

Graphical Records

To increase the accuracy of measurement on long and medium waves a third method, that of audio-frequency interpolation, is used. In addition, the principle of allowing the signal to beat directly with a harmonic of one of the multivibrators and recording the beats against time as shown by the crystal clock, may also be employed, with the limitation that the signal must be of a frequency within about ± 30 c/s of a multivibrator harmonic. One pen of the recorder is actuated by the resultant slow beats and the other pen marks an impulse each second from the clock.

One of the many checks made on the accuracy of the station's apparatus consists of carrying out simultaneous comparisons between the substandard frequency generator at that station and the standard at Dollis Hill. Simultaneous measurements of the same transmitter are made at the two stations and very good agreement is reached. In the case of observations of the N.P.L. standard frequency transmissions, it is stated that the frequencies as determined at the two stations seldom differ by more than a few parts in 10 million.

The Psychological Pause

A Phase in the Learning of Morse

As readers of a previous article[1] may remember, it can be taken as a fairly well-established fact that there are two stages in learning Morse, just as in learning to skate or to ride a bicycle, to quote two parallels only. The first stage is the conscious assimilation of the alphabet, so that when dash-dot is heard, N is thought of: the second is the driving of this into the subconscious mind, so that when dash-dot is heard it is impossible *not* to think of N.

Again, it can be accepted that teaching methods should differ from one stage to the other: slowly sent letters with slow dashes and dots during the short first stage; quickly sent ones with long pauses between letter and letter, these slowly decreasing as the learner gains speed, during the second stage. (Incidentally, it may be worth mentioning that my own experience indicates that if anyone feels like learning non-wireless systems of Morse signalling, and if these systems work at low speeds, lamp, for example, it is best for this study to be done either during the first stage or else left until the end of the second stage is neared: i.e., when the learner is at about six words a minute or at about 20, respectively. If he tries to learn lamp with a friend as a relaxation when they are doing about twelve words on buzzer, it will merely tend to delay the progress of the second stage.)

Now during this second stage a "pause" almost invariably occurs, a horrid period that may last for days or even weeks, during which the learner makes no progress, curses the shade of Samuel Morse, bites pieces off the end of his pencil, swears that he will never manage it—even chucks up the whole thing in despair. This "pause" often happens at about 14 words a minute or at about 18: some particularly unfortunate people may get it twice. Some, on the other hand, never meet with it at all: they are usually, but by no means invariably, of the stolid, easy-going type; and if one of such favoured persons wants to learn how really unpopular he can make himself, he need only remark happily to some fellow-learner whom he has caught up and passed that he "really can't see what all the trouble is about. Why, I just do a bit better every week, and if you chaps would only——." The rest is likely to be a strangulated silence.

Despite this scepticism, the pause is a very real one, and there is little doubt that it is due to a quarrel between the conscious and subconscious minds (to put it most unscientifically). The bossy conscious worries: "I can't get it. . . . What *was* that letter? . . . Oh, I *am* making a mess of it. . . . This will never do, it's worse than last time"; and the squashed subconscious cannot make heard its gentle: "Let me alone, I'm getting it all right. . . . Oh, *do* let me alone!"

Helping the Subconscious Mind

Now there are several dodges that can be tried, all with the object of distracting momentarily the conscious interferer, and it is especially worth noting that if this can be done *once*—if, that is to say, *one* transmission of a goodish length can be taken reasonably well at an "impossible" speed, it is almost certain that the sticking point will be passed, for good and all. Next time that this speed is heard the subconscious will be able to assert itself: "I did it yesterday—I told you I could do it," and the conscious will ungracefully subside with a grumbled: "Well, perhaps you're right, go ahead, but don't worry me" (which is, of course, exactly what is needed).

One such dodge, mentioned with all due reserve, is to get slightly drunk. Another, more generally applicable, is to recite mentally (or better still audibly) some passage of poetry or the Bible or the multiplication table or anything else favoured while a transmission is being taken: in this case, for obvious reasons, it should be a test in code, not in plain English. Another, ridiculously simple and often ridiculously effective, is to do with the left hand something demanding a certain degree of attention while the right hand writes down the text—for example, to balance a pencil across the forefinger or to keep a pencil standing upright on end by checking it as it falls with the circle formed by forefinger and thumb. Such devices have the advantage that the transmission can be in plain language or code as desired, but may distract the *eye* too much and make writing too difficult. Others which may be tried, and which need no visual attention, are buttoning and unbuttoning one's coat, turning a coin over and over in the left hand, and such like: the trouble is that, as a rule, these do not demand sufficient attention to keep the conscious mind from interfering. What is "sufficient" here, however, obviously varies from one person to another and even for the same person from day to day: sometimes the subconscious has already so nearly asserted itself that very little is needed for it to take full charge, and here very simple devices will suffice. It is a matter for the learner himself to try; and it is amusing to note that the fact that he is thus observing himself may in itself supply the needed extra attention.

Another possibility, often recommended by teachers although as a rule with no idea why desirable, is that of forcing oneself to copy one letter behind in code, or several letters behind in plain language, so that no letter is written down until well after it has been sent. Here the conscious mind is kept busy remembering the letter or letters: it is particularly effective when the transmission is taken on a typewriter (a thing that all beginners should learn to do), and above all if the learner is only a fair typist, something about midway between the "three pecks and a damn" class and the machine-gun expert. Yet another is to form the letters with excessive attention, almost drawing them rather than writing; or to make them extremely small and yet legible—I have as a souvenir of the last war a full-length Army test message taken down, quite legibly, on a scrap of paper the size of a Coronation stamp by a learner whom (he said) this dodge saved from "drink and despondency."

It is a matter for personal experiment. In any case, let it yet again be emphasised that if only the pause-speed can be *once* passed it is extremely rare for any further trouble to recur at this speed, so that a little experimentation may save the learner "weeks of 'orrid doubt" and "faith and 'ope and cursing and despair" (to quote Kipling from memory).

R. R.-H.

[1] On Learning Morse; *The Wireless World*, August, 1940.

THE WORLD OF WIRELESS

CENSUS OF SERVICE ENGINEERS

Forces Will Take 87 per Cent.

THE publication of the Revised Schedule of Reserved Occupations and Protected Work, in which it will be remembered service-men continue to be reserved from 35 years of age, was thought an opportune moment to reveal the result of the second Service Questionnaire issued by our contemporary, *The Wireless & Electrical Trader*.

When the first census was undertaken by *The Trader* soon after the war began, it was estimated that with the reservation age at 30, as it then was, 66.5 per cent. of the pre-war service engineers were liable for military service. The latest census, which is based on 416 replies covering 875 engineers, reveals that the percentage of the originally employed service personnel which will be left in the retail side of the wireless industry is 13. The details of the other 87 per cent. are:—

	per cent.
Already called up	44
Already volunteered	31
Liable for call up	12

The census also shows how the remaining engineers are likely to be supplemented. *The Trader* states that this is taking place in two ways—by the employment of "improvers" of all ages and by the return of managers and owners of retail businesses to the service bench.

Unless the Schedule is modified in the very near future the following is an analysis of servicing personnel (based on the number of pre-war engineers) likely to remain available in the retail side of the industry:—

	per cent.
Fully-trained engineers (reserved)	13
Owners and managers	39.5
Improvers (reserved)	18

It is stressed, however, that this does not mean that the personnel available is equivalent to 70.5 per cent. of the original staffs, for it must be remembered that the majority are not up to the technical standard of the pre-war engineers.

FREE EUROPEAN AMATEURS

Hospitality from the R.S.G.B.

IN extending greetings and good wishes to the large number of European amateur wireless men at present in this country, the Radio Society of Great Britain, through *The T. & R. Bulletin*, offers to publish notes from any representative group. Poles and Czechs, Free French and Belgians, Norwegians, Danes and Dutch are among those at present in these islands. They no longer have a journal of their own, and the offer of space in the Society's journal will doubtless be much appreciated. It will serve not only as a connecting link between exiled amateurs of the same nationality, but will also give an opportunity for them to get into personal touch with British amateurs with whom they worked in peacetime.

CARAVAN RECEIVERS

Interpreting the Regulation

IT is understood that whilst the Home Office regulation of last summer, prohibiting the use of a receiver in road vehicles, has not been altered the police have been given wider discretion regarding the application of the regulation to caravans.

It will be remembered that soon after the announcement banning car radio it was made clear that the order would not apply to caravans off the highway which were habitually used as residences, having no motive power and the wheels removed. The police are now to use their discretion regarding the use of receivers in caravans even if they have motive power. They must, however, be off the highway.

It should be remembered that when on the road the receiver must be rendered unusable by the removal of valves and the disconnection of batteries.

BONDS OF FRIENDSHIP

AT the present time, when the ties between Great Britain and America are binding the two countries closer together, the following cablegram from Mr. Sarnoff, president of the R.C.A., to Mr. Donisthorpe, at the Tenth Annual General Meeting of the Radio Industries Club, is of special interest.

"Each year, since Marconi's first wireless message from England to America forty years ago, radio has strengthened bonds of friendship between our countries, to-day it carries cordial and affectionate geetings to British Radio Industries Club and best wishes for success of Annual General Meeting this year, next year and many years to come.—David Sarnoff."

B.B.C. SHORT-WAVE TRANSMISSIONS

THE latest schedule of the B.B.C.'s short-wave European programmes, which will be current when this issue is in print, shows that there are a number of changes in the wavelengths to be used for the transmissions of news in English in the European and World Services. The times (BST) of transmissions and the wavelengths used are given below.

00.00	49.59,* 41.49,* 30.96.*
00.45	31.32, 31.25, 25.53.
01.30	49.59.*
02.00, 02.45, 06.30	31.32, 31.25, 25.53.
08.15	31.55, 31.25, 25.53, 19.82, 19.66.
10.00	49.59,* 41.49,* 31.55, 30.96,* 25.53, 25.29,* 19.82, 19.66, 19.60.
13.00	31.25, 25.53, 19.82, 16.84, 13.97, 13.92.
15.00	19.82, 16.84, 13.97, 13.93, 13.92.
15.30	49.59,* 41.49,* 25.38,* 25.29.*
18.00	31.75, 25.53, 19.82, 16.84, 13.93, 13.92.
20.00	31.25, 25.53, 24.92, 19.82, 19.66, 16.84.
22.45	31.25, 25.53, 19.82, 19.60.

The wavelengths marked with an asterisk are used in the European Service.

MAINTAINING ELECTROLYTIC CONDENSERS

THE Radio Manufacturers' Association draws attention to the risk of serious deterioration to electrolytic condensers that arises when sets remain out of use for long periods. To prevent "deforming" the Technical Advisory Committee recommend that the receivers should be switched on for 5 or 10 minutes every six months, or at the most every 12 months, and that during this "reforming" period they should be watched to see if any abnormal symptoms manifest themselves.

"WIRED WIRELESS" INTERFERENCE

IT is reported in *Broadcasting* (U.S.A.) that a Federal Communications Commission investigator has traced interference with broadcast reception at Providence, Rhode Island, to harmonic radiation from a local relay service operating a radio-frequency distribution system.

U.S. AMATEURS' TEST

AMATEUR radio operators in the U.S.A. recently took part in what is probably the greatest radio practice drill ever undertaken—the origination and relaying of 3,700 separate messages between as many local chapters of the American Red Cross and the headquarters in Washington, D.C., St. Louis, and San Francisco.

The test, which was sponsored by the American Radio Relay League, was designed to test the ability of radio amateurs to serve the Red Cross in any national emergency. The 3.5 and 7 Mc/s amateur bands, which offer

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reliable domestic communication day and night, carried most of the traffic which consisted of 15-word messages.

EXPORT PROHIBITION

UNDER a Board of Trade Order (S.R. & O., 1941, No. 492), which came into force on April 24th, receiving valves and electric insulated (other than paper-insulated) wire and cable, are among articles which may not be exported to any destination without an export licence. The Order also prohibits the exportation without licence to certain specified destinations of paper-insulated electric wire and cable, insulating materials containing mica and certain mica manufactures.

U.S. TELEVISION

ACCORDING to our American contemporary, *Broadcasting*, it is expected that television stations in the States will very soon be granted facilities by the Federal Communications Commission for "full-time commercial operation." It will be remembered that the F.C.C.'s authorisation of "limited commercial operation" was rescinded in March, 1940, following a dispute between the Commission and the parties concerned.

The standard of transmission favoured is 525 lines, 30 frames interlaced, as recommended by the National Television System Committee. The proposed 30 hours per week operation is likely to be reduced to 15 hours.

FROM ALL QUARTERS

New Summer Time

IN this and the succeeding two issues of *The Wireless World* the use of the designation BST will denote time two hours ahead of GMT.

Amateur Radio Conference

ARRANGEMENTS are being made by The North Manchester Radio and Television Society for the holding of a Conference of radio amateurs at which various matters will be discussed, including "The Future of Amateur Radio," "The Shortage of Radio Components," and "The Radio and its Possible Uses in Home Defence." Invitations have been sent to various allied Forces in this country to send representatives. All interested are invited to attend the Conference.

NEWS IN ENGLISH FROM ABROAD

REGULAR SHORT-WAVE TRANSMISSIONS

Country : Station	Mc/s	Metres	Daily Bulletins (BST)
America			
WNBI (Bound Brook)	17.780	16.87	4.0‡, 6.0.
WBOS (Millis)	9.570	31.35	11.45.
WCAB (Philadelphia) .	15.270	19.65	12.30 a.m., 7.45.
WCBX (Wayne) ..	9.650	31.09	9.55‡, 11.45‡.
WCBX	11.830	25.36	7.30‡.
WCBX	17.830	16.83	2.0‡, 3.0, 4.0†, 4.15‡, 5.0†, 5.30‡.
WGEO (Schenectady) .	9.530	31.48	8.30†, 10.55§‡.
WGEA (Schenectady) .	15.330	19.57	1.0, 2.0‡, 6.0, 7.45.
WPIT (Pittsburgh) ..	15.210	19.72	6.0.
WRUL (Boston) ..	11.790	25.45	8.15§‡, 9.30‡.
WRUL	15.350	19.55	8.15§‡, 9.30§‡.
Australia			
VLQ (Sydney)	9.615	31.20	9.0 a.m., 9.0.
VLQ5	9.680	30.99	2.30, 5.30, 9.15, 11.30.
VLQ2	11.870	25.27	9.0 a.m., 3.40, 7.55.
VLQ7	11.880	25.25	3.15, 9.0, 12.0 midt.
VLQ8	17.800	16.85	8.0 a.m.
China			
XRVC (Chungking) ..	7.508	39.96	12.30 1.10, 10.30, 11.30.
Egypt			
SUX (Cairo)	7.860	38.14	7.50, 11.10.
Finland			
OFD (Lahti)	6.120	49.02	8.15, 11.15.
OFD	9.500	31.58	1.15 a.m., 8.15, 11.15.
OFE	11.780	25.47	1.15 a.m., 9.40 a.m., 8.15, 11.15.
OIE	15.190	19.75	1.15 a.m., 8.15, 11.15.
French Equatorial Africa			
Brazzaville	11.970	25.06	9.45.
India			
VUD2/3 (Delhi) ..	9.590	31.28	10.0 a.m., 2.30, 5.50.
VUD	11.830	25.36	10.0 a.m., 2.30, 5.50, 7.15.
VUD3	15.290	19.62	10.0 a.m.
Iran			
EQB (Teheran) ..	6.155	48.74	8.30.

Country : Station	Mc/s	Metres	Daily Bulletins (BST)
Japan			
JLG2 (Tokio)	9.500	31.57	11.30.
JZI	9.535	31.46	7.0.
JZJ	11.800	25.42	7.0.
Manchukuo			
MTCY (Hsinking) ..	11.775	25 48	9.0 a.m., 11.5.
Sweden			
SBO (Motala)	6.065	49.46	11.20.
Thailand			
HSP5 (Bangkok) ..	11.715	25.61	1.45.
HS6PJ	19.020	15.77	1.45.
Turkey			
TAP (Ankara) ..	9.465	31.70	8.15.
TAQ	15.195	19.74	1.15.
U.S.S.R. (Moscow)			
49-metre band	—	—	2.0 a.m., 8.30, 10.0, 12.0 midt.
41 „ „	—	—	8.30, 10.0.
31 „ „	—	—	6.0, 8.30, 10.0.
25 „ „	—	—	1.0, 6.0, 8.30.
19 „ „	—	—	} 8.33 a.m., 1.0.
16 „ „	—	—	}
Vatican City			
HVJ	6.190	48.47	9.15.

LONG- AND MEDIUM-WAVE TRANSMISSIONS

	kc/s	Metres	
Egypt			
Cairo	1,348	222.6	7.50, 11.10.
Ireland			
Radio-Eireann ..	565	531	2.40, 7.40, 11.5†, 11.10‡.
U.S.S.R.			
Moscow 1	172	1,744	12.0 midt.

It should be noted that the times are **two hours** ahead of GMT, and are p.m. unless otherwise stated. The times of the transmission of news in English in the B.B.C. Short-wave Service are given on the preceding page.
* Saturdays only. § Saturdays excepted. † Sundays only. ‡ Sundays excepted.

which is to be opened at 2.30 p.m. on Sunday, June 8th, at the Cheetham Liberal Club, 433, Cheetham Hill Road, Manchester. Further details can be obtained from the Club Secretary, Mr. R. Lawton, 10, Dalton Avenue, Thatch Leach Lane, Whitefield, Manchester.

"The Trader" Fortnightly

As a wartime measure our contemporary, *The Wireless & Electrical Trader*, has changed from weekly to fortnightly publication. It is understood the volume of each issue will to some extent be increased and that it is intended to include two of the service sheets which have been a popular feature of *The Trader* for a considerable time. The first fortnightly issue was dated May 10th.

The R.C.M.F.

At the recently held Annual General Meeting of the Radio Component Manufacturers' Federation, Mr. H. G. Aytoun Key, of Benjamin Electric, was elected chairman for the forthcoming year. Speakers at the meeting paid tribute to the work of the Federation in representing the collective interests of the component section of the wireless manufacturing industry. It is proposed to draw up a complete list of the products of the various member firms in order that outside enquiries as to sources of supply may be dealt with more expeditiously.

Edinburgh Day Classes for Service Men

Sufficient applications have been received by the Edinburgh branch of the Scottish Radio Retailers' Association for day classes to be started in co-operation with the education authorities for the training of service men to fill the gaps in the industry caused by the demands of the Services. Some of the necessary equipment for the training has been given by wireless firms in the city.

Hands Across the Sea

British amateur G5LY has written to the American Radio Relay League stating that of 70 QSL cards sent to American amateur transmitters, only one recipient replied. The Editor of *QST* writes, "How about it, fellows? A card to our friends across the pond means a great deal these days!"

Cuban Amateur Reserve

As a result of a Presidential decree Cuban amateurs are to be formed into a volunteer emergency reserve to be known as the Auxiliary Corps of Radio Amateurs. Under the guidance of the Ministry of Communications, the corps will be a valuable reserve of trained men with equipment for use in a national emergency.

Receiver Sales in Canada

During 1940 there was an increase of over 20 per cent. on the previous year's sales of receivers in Canada, the total being approximately 438,000. The sales of U.S. receivers in Canada, which have been rising steadily since 1932, are expected to be adversely affected by the recently imposed taxes on sets.

Dr. G. W. C Kaye

It is with regret that we record the death of Dr. G. W. C. Kaye, D.Sc., F.R.S., who since 1922 had been superintendent of the physics department of the National Physical Laboratory. Dr. Kaye, who had received many professional honours, died on April 16th, a few days after his 61st birthday.

R.C.A. Laboratories

It was recently announced by the president of the Radio Corporation of America that a branch of the parent company was to be established for research work. It will be known as R.C.A. Laboratories and will be housed in new premises to be built at Princeton, New Jersey. Mr. Otto S. Schairer will be vice-president in charge of R.C.A. Laboratories, with Dr. C. B. Jolliffe as chief engineer, Mr. E. W. Engstrom as director and Dr. V. K. Zworykin and Mr. B. J. Thompson as associate directors.

U.S.-Norway Direct Radiotelegraph Circuit

The reopening of the direct radiotelegraph circuit between the United States and Norway, which had been closed since Germany took over control of the country in April, 1940, was recently announced by R.C.A. Communications. The Norwegian terminal is the Oslo station of the Administration of Posts, Telegraph and Telephone, which has been reconditioned. During the past year, all radiotelegraph traffic from the U.S.A. for Norway has been handled over the Berlin circuit, except for the first few weeks, when it was transmitted via Stockholm, Sweden.

Australia's Transmitters

Australia now has a total of 129 broadcasting stations. Of this number 26 medium-wave and 3 short-wave transmitters are operated by the National Broadcasting Service. The remainder are commercial stations. According to recent figures issued by the U.I.R., the average power of the transmitters is very low, being approximately 1.6 kW.

The Wireless Industry

A range of new power type loudspeaker units is described in a leaflet (No. 25) recently issued by the General Electric Co., Ltd., Magnet House, Kingsway, London, W.C.2. The types listed include omni-directional diffusion units for halls and factories, weatherproof moving coil driving units for horn loading, including a folded type designed for mounting on car-bumpers, etc.

◇ ◇ ◇

Mr. G. H. Walton has been appointed works manager of British Insulated Cables, Ltd., on the retirement of Mr. E. A. Bayles, who continues his association with the company in a consultative capacity.

◇ ◇ ◇

R. A. Rothermel, Ltd., announce that from May 1st the price of the Rothermel New Junior Pick-up has been increased from 23s. 6d. to 26s.

LETTERS to the EDITOR

The Editor Does Not Necessarily Endorse the Opinions of His Correspondents

Post-war Amateur Transmission

IN discussing the outlook for amateur transmitters after the war, all your contributors and correspondents take the gloomy view that the G.P.O. will refuse to restore the privileges (or should it be "rights"?) enjoyed previously by the amateur.

Why should the G.P.O. do any such thing? The frequency bands occupied by amateurs are allotted by international agreement, and presumably can only be diverted to other uses by similar agreement. So long as these bands are occupied by amateurs in other countries, the G.P.O. could not usefully employ them for its own purposes, and so the motive of self-interest would not arise—except, perhaps, with regard to the ultra-short waves.
C. T. C.

WHY be almost apologetic for saying that a transmitting amateur without a knowledge of morse "seems all wrong." There is a great deal more than "mere conservatism" (I again quote from your April Editorial) behind that point of view. A "phone only" transmitter would get very poor value from the few watts allowed by his licence and would be quite unable to observe the common courtesies of non-interference with morse transmitters.

RADIOPHARE.

IT seems that the majority of British amateurs believe that a more difficult code test would be beneficial to the amateur movement. I do not know how the R.S.G.B. feel about this, but it is interesting to note that the Society's American counterpart, the American Radio Relay League, is reported (by *Radio News*, February, 1941, issue) to have approached the Federal Communications Commission with a view to "the lowering of standards of admission to the ranks of the licensed amateur."

Radio News continues: "It is said the A.R.R.L. believes there should be more amateurs and accordingly has asked the F.C.C. to make the entrance examinations leading to a licence a little easier. Code restrictions will be lowered instead of raised, and it may become a possibility that amateurs will be licensed with considerably less than 13 w.p.m. code speed requirements and lighter technical requirements. The exact code speed prerequisite . . . is supposed to be in the neighbourhood of 4 to 5 w.p.m."

E. A. S. JONES,
(ex 2FOA).

Gibraltar.

[The two cases seem hardly comparable. The U.S.A., in process of re-arming, naturally wishes to have a large body of amateurs from which to draw recruits for the wireless branches of its fighting services. In this country, so far as the present discussion is concerned, we are thinking solely of the post-war position.—ED.]

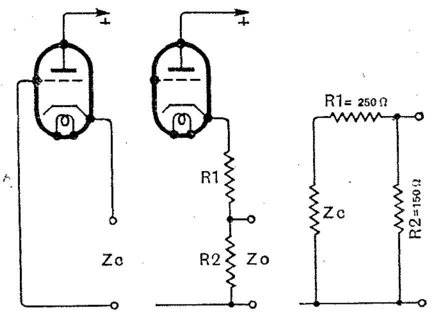
"Mystery" Record Players: G.P.O. Ruling

IT is considered that the publication of the article on "Mystery" Record Players in the April *Wireless World* might encourage some of your readers to construct similar apparatus, and you will appreciate that if such a device were connected to an efficient aerial it would radiate appreciably. Its possession and use would then be regarded by the G.P.O. as infringements of the Defence Regulations (S.R.O., 1939, Nos. 1687 and/or 1688). The P.M.G. has no objection to the use of this class of apparatus provided signals are of so low a field strength that no radiation can be detected outside the premises in which the device is housed.

E. F. H. GOULD,
For Engineer-in-Chief, G.P.O.
(Radio Branch).

The Cathode Follower

I SHOULD like to suggest that the formula given for the impedance of a cathode follower in the article "Photographing Transients," by Dr. T. H. Turney, in your issue for April, 1941, page 99, is inaccurate.



(a) (b) (c)

The fundamental formula for the output impedance of a cathode follower (diagram (a)) is

$$Zc = \frac{1}{\frac{1}{R_A} + g} = \frac{1}{g} \cdot \frac{\mu}{\mu + 1},$$

i.e. Zc is equal to the resistance of R_A and $\frac{1}{g}$ in parallel.

Thus in the circuit given (b), the output impedance

$$Z_o = \frac{1}{\frac{1}{R_2} + \frac{1}{R_1 + Z_c}},$$

which, in the case under consideration, cannot be less than

$$\frac{1}{\frac{1}{R_2} + \frac{1}{R_1}}$$

or 93.66 ohms.
even if $Z_c = 0$.

Actually Zc will be about 100 ohms, so Zo will be about 105 ohms, a value considerably different from the 20 ohms given in the article mentioned.

Cardigan. E. F. GOOD.

Club for South Manchester

WILL any young reader who is interested in the formation of a radio and television club in the South Manchester area please communicate with me? J. ROBERTS.
30, Milton Grove,
Whalley Range,
Manchester.

Vibrator Power Packs

A New Development in Smoothing for Use with Sensitive Receivers

THE standard type of vibrator pack as designed for use with broadcast receivers has proved itself to be not only efficient and reliable but also remarkably silent in operation. When it is used in conjunction with communication receivers of advanced design, the extreme sensitivity and also the extension of the wavelength coverage is apt to disclose traces of contact noise which would pass unnoticed under the conditions of use for which the unit was originally designed.

Low-frequency Ripple

Masteradio, Ltd., have recently investigated the matter, and have evolved a modified form of smoothing which enables communication sets of the most sensitive type to operate at full gain while drawing their HT supply from a vibratory rectifier. We have recently had an opportunity of trying out the new system, which is termed the "Silent Surge" circuit, and there can be no doubt that it marks a considerable step forward.

The residual ripple from a standard vibrator pack arises chiefly from contact pulses in the LT battery leads, and is radiated over a wide band of frequencies. Low frequencies are particularly troublesome, and may affect the 50-kc/s band which is included in certain communication sets.

Balanced Smoothing

In the normal vibrator system the battery circuit, although of low impedance, is not symmetrical to earth, and the small intermittent field which is established is sufficient to cause trouble when the receiver sensitivity is high. The method of overcoming this difficulty which Masteradio have adopted is first to prevent the greater part of the contact pulse from reaching the battery leads by connecting a large reservoir condenser of the order of 1,000 mfds. across the LT supply inside the vibrator screening, and, secondly, to use a balanced smoothing circuit in the external battery leads. With this method the battery may be earthed on either side or left unearthed altogether without evoking any interference. A modified form of this smoothing circuit has been developed in which a part of the unwanted ripple can be used for the balancing out of residual hum in the filament circuits of sets using directly heated valves, and also for reducing the ripple in the rectified HT supply leads, thus enabling less expensive smoothing to be used.

Another improvement has been effected in units of the self-rectifying type by shunting the contacts with a resistance-capacity circuit, the time constant of which bears a definite relationship to the duration of the spark. In this way the transients occurring at the corners of the square waveform are removed and there are fewer high-frequency components to filter in other parts of the circuit. The current rating of the vibrator can be exceeded by a considerable margin without deterioration of the contacts when this circuit is employed.

We were given the opportunity of handling a National H.R.O. receiver deriving its HT supply through the new circuit, and were unable to find any part of the wavelength spectrum where vibrator noise was more than a whisper. Tests with an oscilloscope also demonstrated convincingly the smoothing out of unwanted ripple components.

RANDOM RADIATIONS

By "DIALLIST"

Tell-tale Lamps

HOW many of us have run down accumulators and shortened the lives of H.T.B.'s by leaving battery wireless sets switched on when we imagined that they were off? It's so easy to do it with two designs of receiver. The first is the one whose volume control does not actuate the battery switch when turned counter-clockwise as far as it will go. I have one of that kind: the volume control is just a plain rheostat and the wave-change switch has four positions: SHORT, MEDIUM, LONG and OFF. The set, however, becomes silent when the V.C. is at its minimum position, though both H.T. and L.T. current are still flowing merrily. The other design that may catch you out is the one whose wave-change switch has a GRAM position. You turn the knob absent-mindedly when you've finished listening, and don't notice that its indicator registers GRAM. Again the loudspeaker's voice is stilled; again the load on the batteries continues unchecked and unsuspected. With battery sets of either of these kinds the only safe way is to fit a tell-tale in the shape of a small 0.06 amp. filament lamp placed in a conspicuous position so that it is bound to catch your eye. The lamp is, of course, wired in parallel with the valve filaments. The tiny extra load makes little difference to the life per charge of the L.T.B. and the lamp genuinely earns its keep by acting as a safeguard.

The Americans, MW and SW

HOW have the medium-wave Americans been coming in during the winter months? I'd like to know, if any readers care to write, for I haven't been able to try for them much myself. For various reasons I can't rig up a decent medium-wave aerial, and the little set I have here needs the best of aerials if it is to be of any use as a distance-spanner on the MW band. Only on rare occasions have I been able to hear anything of "broadcast band" Americans. I imagine, though, that if I heard them at all with this supremely inefficient gear, others with good apparatus may have had fine reception. On the short waves I'm rather luckier, for the set isn't too bad on them, and the rather comic aerial seems to suit its SW circuits fairly well. My best results have been on the 19-metre and 25-metre bands; but that may well be because my Heath Robinson outfit isn't happy on other short-wave bands. Perhaps a little later on I'll be able to manage a better set and a less comic aerial.

Too Difficult!

WHEN you've been used to doing your short-wave DX-ing with a communication receiver and then have to take to an "all-wave" set of the domestic kind in its stead, you realise what a tricky piece of apparatus the latter is to work. To the man used to what is commonly called a broadcast receiver the C-R, with its many knobs, dials and switches, looks rather frightening: he probably feels when he tries one for the first time that it will take him a long while to become familiar with its working. Actually, for all its complicated appearance, the bigger set is by far the easier to use. There is, of course, an art in handling a C-R so as to get the very best results out of it. When, for example, selectivity, RF (or IF) amplification and AF amplication are all variable, the C-R artist can work wonders by giving each control exactly its right setting. But apart from such skilled achievements, the C-R is less difficult to use than the "simple set" for short-wave reception just because of its better tuning arrangements. Bandspreading combined with smooth, backlash-free slow-motion gears and large dials with clear graduations, make it so easy to find exact resonance, or to alter the tuning by the few kilocycles that separate one station from its next door neighbours on either side. But when, say, the entire 19-metre band with its score of stations occupies only a fraction of an inch on the dial and the coarse and rather jerky gears move a pointer half as thick as a poker, I, at any rate, find the tuning-in of all but the noisier short-wave stations a difficult and fiddling business. With a C-R you can always return quickly to a station if you leave it for a while to search elsewhere; with the other kind it is often a very different business.

The Debate Continues

WHAT is the highest frequency in use on the other side of the Atlantic that is picked up in this country with any kind of regularity? The question arose just before I sat down with this note, when a fellow enthusiast and I were discussing a problem. Neither of us could remember just what had happened "below ten" in 1938 and 1939. I seemed to recollect reports of reception of U.S.A. police and other transmissions on frequencies as high as 60 megacycles: he maintained stoutly that nothing with a carrier above 40 megacycles had been heard. Neither of us can get hold of his text books or his pre-war records, so there the matter has to rest, unless some reader will kindly help. And here's a further question awaiting an answer: What is the smallest skip-distance recorded for 50-megacycle transmissions? In other words, what is the shortest range outside its normal quasi-visual area at which such an U.S.W. signal has reappeared by means of its sky wave? I maintained that in certain circumstances a 50-megacycle transmission, though unreceivable at 100 miles, might be picked up at seven or eight hundred. My adversary contended that the skip distance would always be far greater; he maintained, in fact, that the signal would in all probability never reappear, that it wouldn't be receivable anywhere outside the limits of its direct-wave area. I seem to remember reading much the same thing about far lower frequencies in the now discredited text books of years ago!

S.B.S.T.

FOR the radio long-distance enthusiast this time business is getting a bit too complicated. Even before the war countries adopting some kind of summer time didn't all start it or end it on the same date. And countries near the equator didn't as a rule have special summer time at all. When on the night scheduled for its opening here you had wrestled with the problem whether putting the clocks forward an hour or back an hour was the correct thing to do and had acted accordingly, you looked ruefully at that neat world time-chart that had been so useful during the darker months and perhaps tried to work out what hour it then was in Nebraska or Japan. Another time-chart might eventually be compiled as you were able to ferret out information whether this country or that did or did not adopt a summer time and, if it did, when the change was made. In the course of a few days 6 p.m. in London might be noon in New York, then 1 p.m., then noon again. And now comes S.B.S.T. to present the D-Xer with maddening perplexities. To the best of my belief London's 6 p.m. is, at the moment of writing,

Random Radiations

New York's noon. But what it is now, or will be when this appears in print, in Moscow or Vladivostock, are mysteries too deep for my poor harassed brain to fathom.

Unfinished Argument

THE other day I ran across an officer who in times of peace is one of our keenest amateur transmitters. We hadn't met before, but when he told me his call sign I realised that he wasn't exactly a stranger, for I recalled many occasions in the days before the war when I'd listened to him working this station or that. Curiously enough, I'd a clear recollection of a Sunday morning argument on the subject of receiving aerials between him and another enthusiast, to which I had listened with the greatest interest. When I reminded him, he also remembered it. The two, who lived many miles apart, had arranged to meet and thrash out the subject at close quarters instead of through the ether. Unfortunately, the outbreak of the war knocked that idea on the head and the argument on which I had eavesdropped so long ago still awaits its continuation.

Things to Come

Like myself, this erstwhile keen amateur has had very little opportunity for more than a year and a half of indulging in our own particular kind of wireless. As we discussed past adventures on the short waves I could see that his fingers were as eager to get back to the controls of his transmitter as mine are to rest again on the knobs and switches of my big communication receiver. Even when on leave I have not been able to put it into action. All my radio gear had to be stowed away when the war came and brought an influx of evacuees. One of them now sleeps in what was once my wireless den. May it not be long before that room returns to its rightful uses! But I shall have a rare job in unpacking and sorting out the wireless gadgets that now repose in packing cases in a dry cellar. I've forgotten now which case contains what, and though everything was carefully stowed I'm sure that I shall be looking here, there and everywhere for various bits and pieces. *And*, of course, the thing that one wants most urgently is dead certain to be at the very bottom of the last case in which one rummages. But that unpacking will be a time of such joy that little bothers of that kind won't matter very much.

RECENT INVENTIONS

A Monthly Selection of the More Interesting Radio Developments

RADIO NAVIGATION SYSTEMS

THE pilot of an aeroplane navigates his craft over an area of country in which a number of beacon stations O, Fig. 1, are arranged to radiate a network of beams B. The plane is fitted with a receiver, the tuning of which is continuously and automatically varied over a wide band of frequencies. As a result it

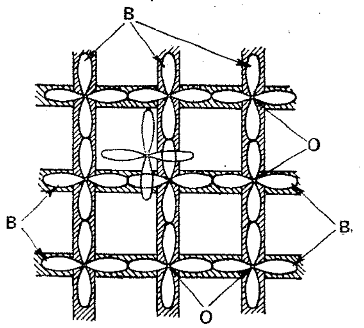


Fig. 1.

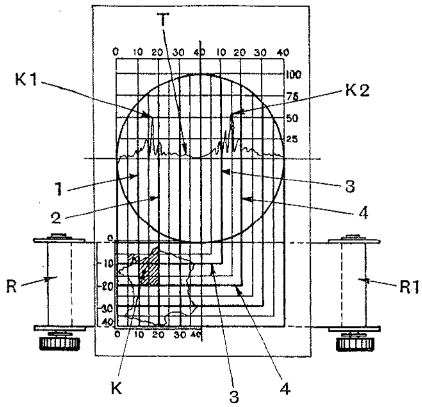


Fig. 2.
Visual system of aircraft position finding.

picks up, simultaneously, the signals from all the beacon stations within range, each being indicated in a manner that distinguishes it from the others.

The received signals, after rectification and amplification, are applied to a cathode-ray receiver, Fig. 2, where they appear as traces T of different amplitudes and positions on a calibrated fluorescent screen. The screen is associated with a chart of the locality, which is mounted on rollers R, R1 and is so arranged that by following the co-ordinate lines 1, 2 enclosing, say, the amplitude peak K1 corresponding to the North-South beam, and the co-ordinate lines 3, 4 enclosing the peak K2 corresponding to the East-West beam, the geographical position of the actual transmitter K can be identified. In the drawing a map of France is shown.

M. Wallace. Convention date (France) 21st February, 1938. *No.* 525393.

CATHODE-RAY TUBES

THE object of the invention is to reduce the risk of high-voltage leakage from the anode of a cathode-ray tube to any of the other electrodes such as the grid or cathode, or even to the focusing or deflecting coils, *via* the glass surface of the bulb. For this purpose the anode is mounted independently at one end of a tubular glass support, the other end of the support being sealed to the glass bulb of the tube at a considerable distance away from any of the other electrodes.

Since the glass support must be sealed to the metal of the anode at one of its ends, and to the glass wall of the tube at its other end, it is most conveniently made for assembly in three sections. The two end sections are each made of the particular type of glass best suited to the kind of seal required, whilst the middle section is of glass capable of being welded to both end-sections.

A. F. Pearce. Application date, 18th April, 1939. *No.* 527980.

o o o

SECOND-CHANNEL INTERFERENCE

THE drawing shows an aerial input coupling designed to minimise second-channel interference in a superhet set. The aerial primary coil L is coupled to a secondary coil L1 forming part of the first tuned input stage, both coils being in series with a fixed condenser C. The secondary L1 is also in series with a coil L2; the circuit as a whole is tuned by a variable condenser C1 and is connected across the input terminals T of the first amplifier valve.

If the signal range is 150 to 300 kilocycles, and the intermediate frequency is 450 kc/s, the local oscillator will operate over a range of from 600 to 750 kc/s and second-channel interference is liable to occur between 1050 and 1200 kc/s.

To eliminate such image frequencies, the coupling between the coils L and L1 is adjusted so that, within this range,

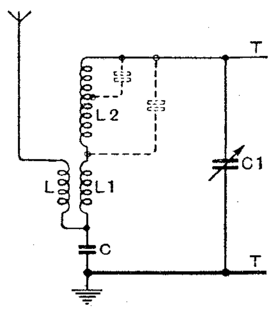


Image-frequency suppression circuit.

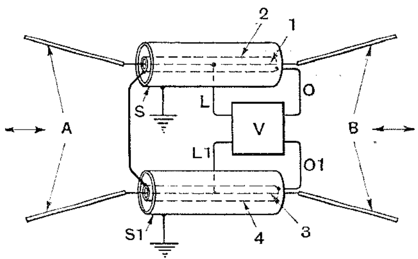
the voltages developed across the winding L1 are equal in amplitude but opposite in phase to those developed across the condenser C. They will accordingly balance out, though the desired signal frequencies will scarcely be affected and will pass through to the amplifier.

Ferranti, Ltd., and G. I. Thomas. Application date March 18th, 1939. *No.* 526503.

o o o

RADIO RELAY STATIONS

THE Figure shows a short-wave installation for relaying simultaneously in different directions, so that a signal, introduced, for instance, at any one point, can be reproduced throughout a whole chain of such stations. The system is primarily designed for working on a common carrier wave, the signal being preferably superposed as a frequency modulation. It can also be used, among other things, to stablise the frequency of a network of short-wave radio stations.



Half-wave resonators for S-W relay stations.

Two pairs of V-shaped aerials A, B, of opposite directivity as indicated by the two arrows, are so coupled together that there is little or no reaction between the input and output circuits of the common amplifier V. The coupling circuits comprise two half-wave tubular or coaxial resonators 1, 2 and 3, 4, which are equivalent electrically to a transformer having a single primary winding and a single secondary winding, with uniformly distributed capacity and inductance. Screening is effected by tubes S, S1.

In operation a signal arriving, say, from the left, is collected by the pair of aerials A, and half the energy is fed by the leads L, L1 to the input of the amplifier V. The output from the amplifier is fed by the leads O, O1 to the "primaries" 2, 4. These, in turn, energise the "secondaries" 1, 2 of the two pairs of aerials A, B and so re-radiate the amplified signal simultaneously in opposite directions.

Marconi's Wireless Telegraph Co., Ltd. (assignees of C. W. Hansell). Convention date (U.S.A.) April 1st, 1938. *No.* 527168.

The British abstracts published here are prepared with the permission of the Controller of H.M. Stationery Office, from specifications obtainable at the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1/- each.

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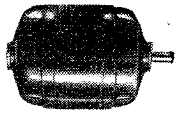

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200 volts $\frac{1}{2}$ amp. ... ... **19/6** Post free
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VERTICAL MOTOR-ALTERNATORS. 170 cycles, Marconi type, $\frac{1}{4}$ kW. and $\frac{1}{2}$ kW. Motor off 100 volts D.C., **£10.** $2\frac{1}{2}$ kW. NEWTON Vertical, 580 cycles 200 volts 25 amps., 1,600 revs. Motors, 220 volts D.C., **£20.**

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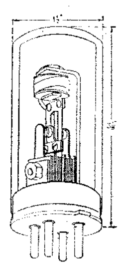

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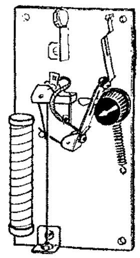

with time-lag tripping on 2 to 3 amps. Safety thermo switch with quick-break auto overload trip, for back of panel with front indicating knob, compact, 4in. x 2in. x $\frac{1}{2}$in. deep. Any voltage up to 1,000 v.

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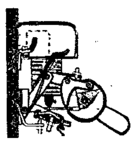

Illustration shows S.P. with cover removed.

Rating	Type	Price
6 amps.	S 11/1G	**11/6**
6 „	S 11/1Z*	**13/6**
10 „	S 11/1G	**16/-**
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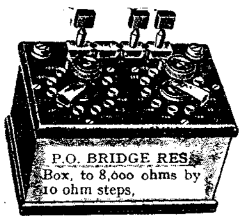

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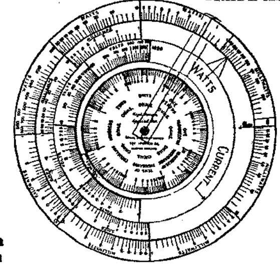

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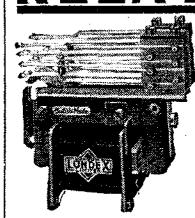

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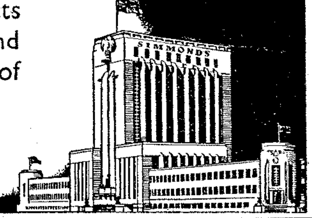

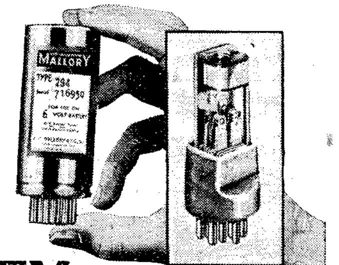

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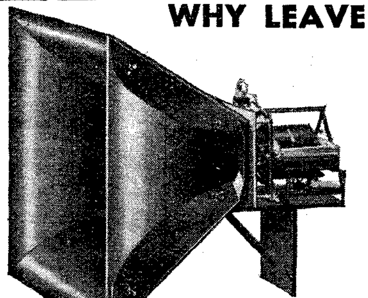

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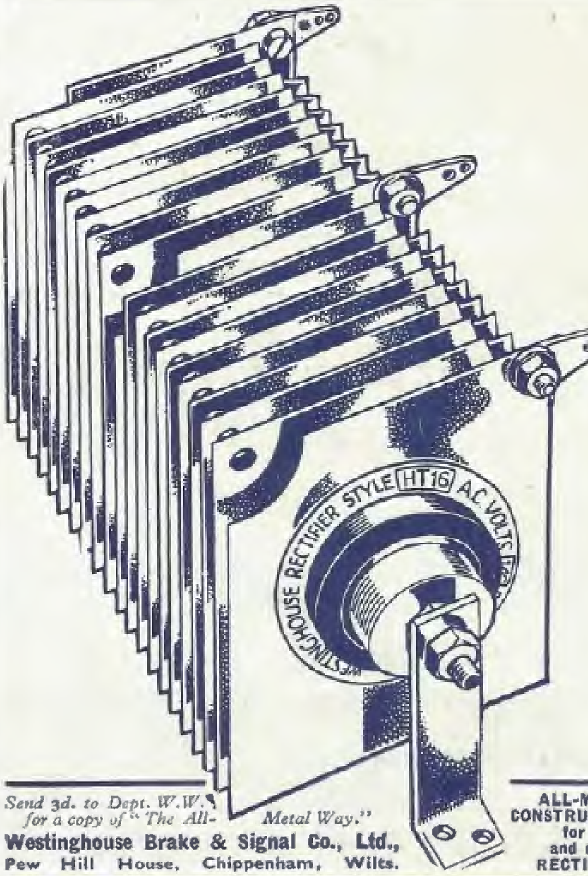

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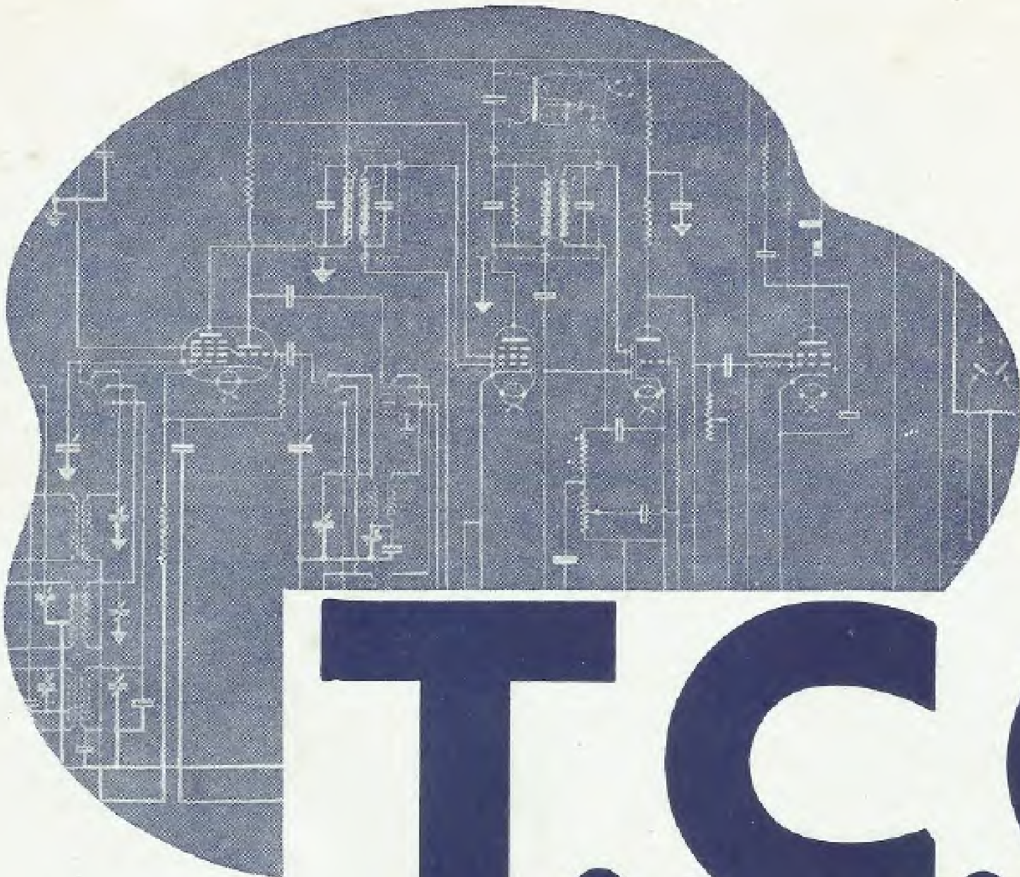

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