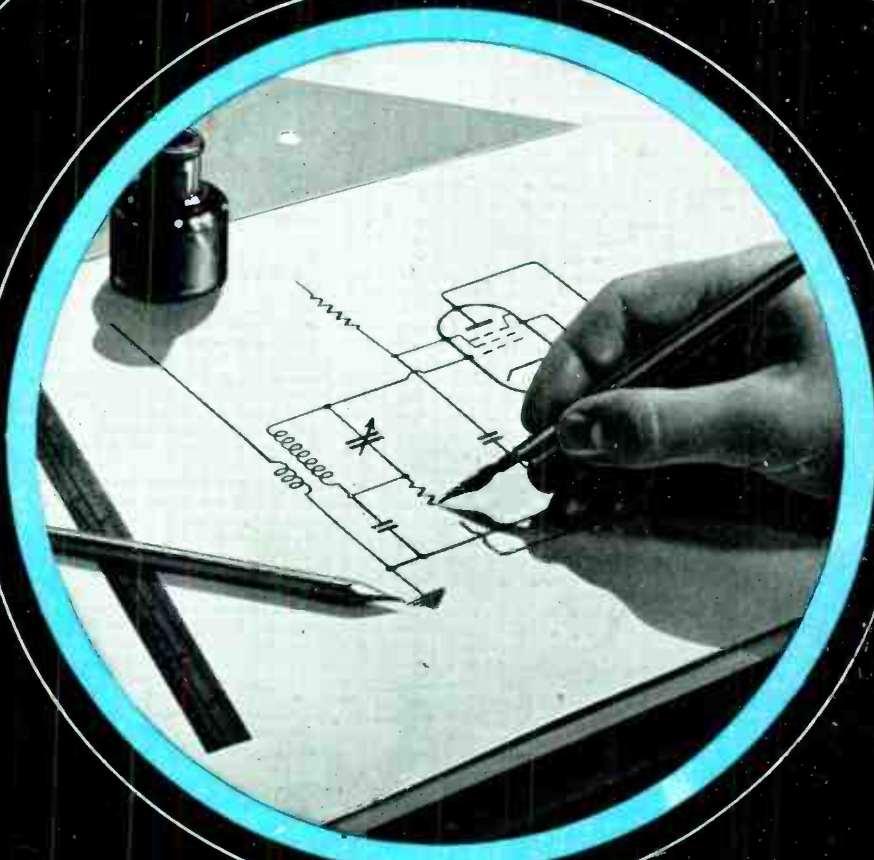
Wireless World

RADIO and ELECTRONICS



JUNE 1945

1/6

Vol. LI. No. 6

IN THIS ISSUE: TROPICAL PROPAGATION PROBLEMS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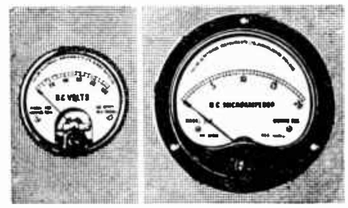

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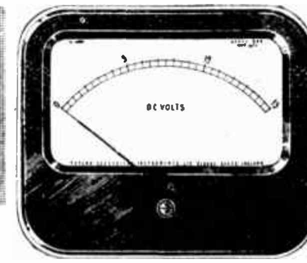

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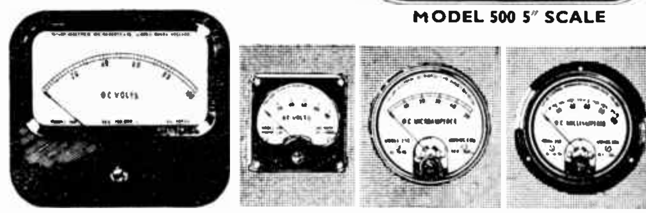

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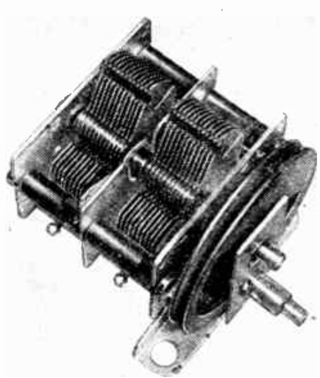

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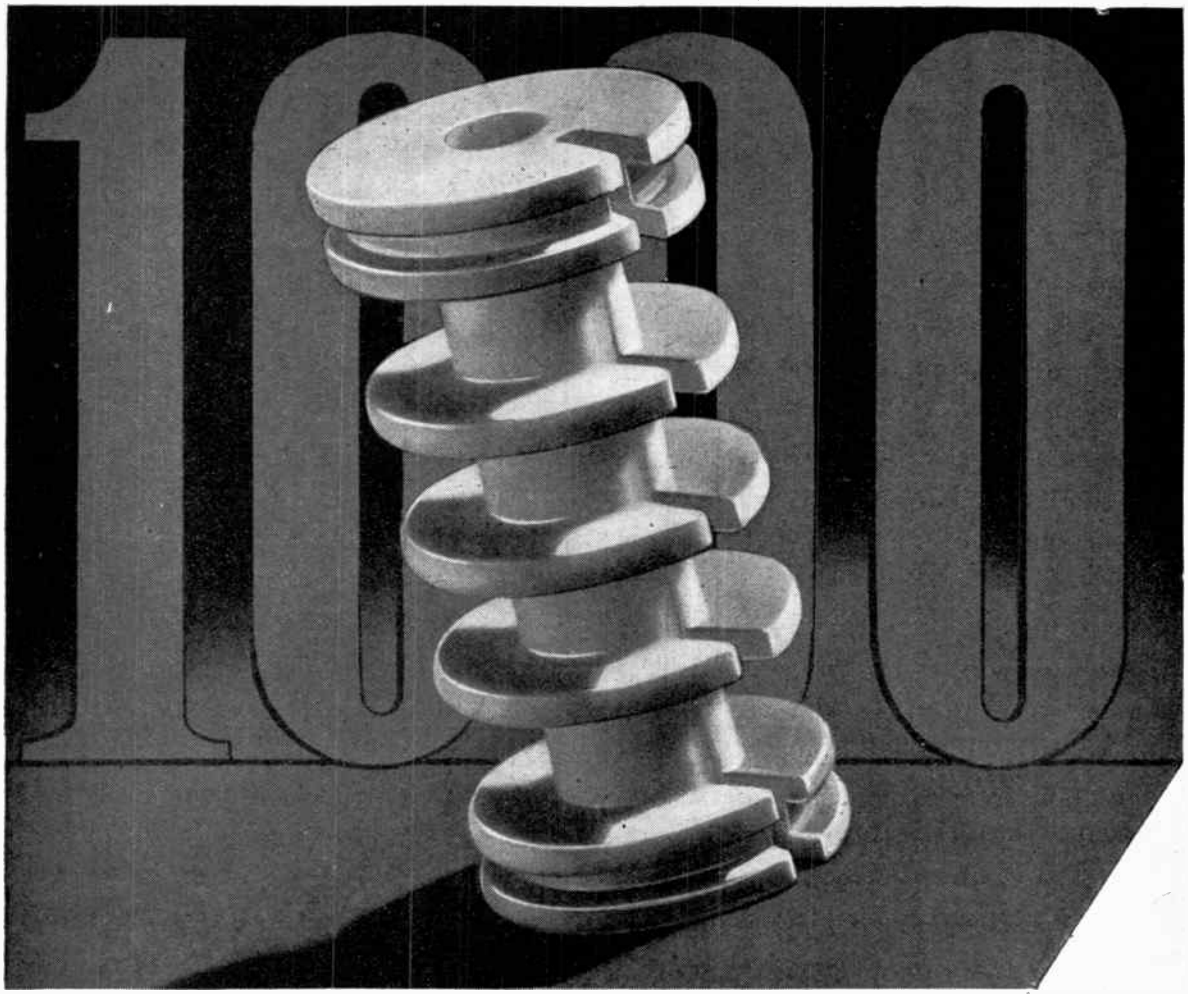
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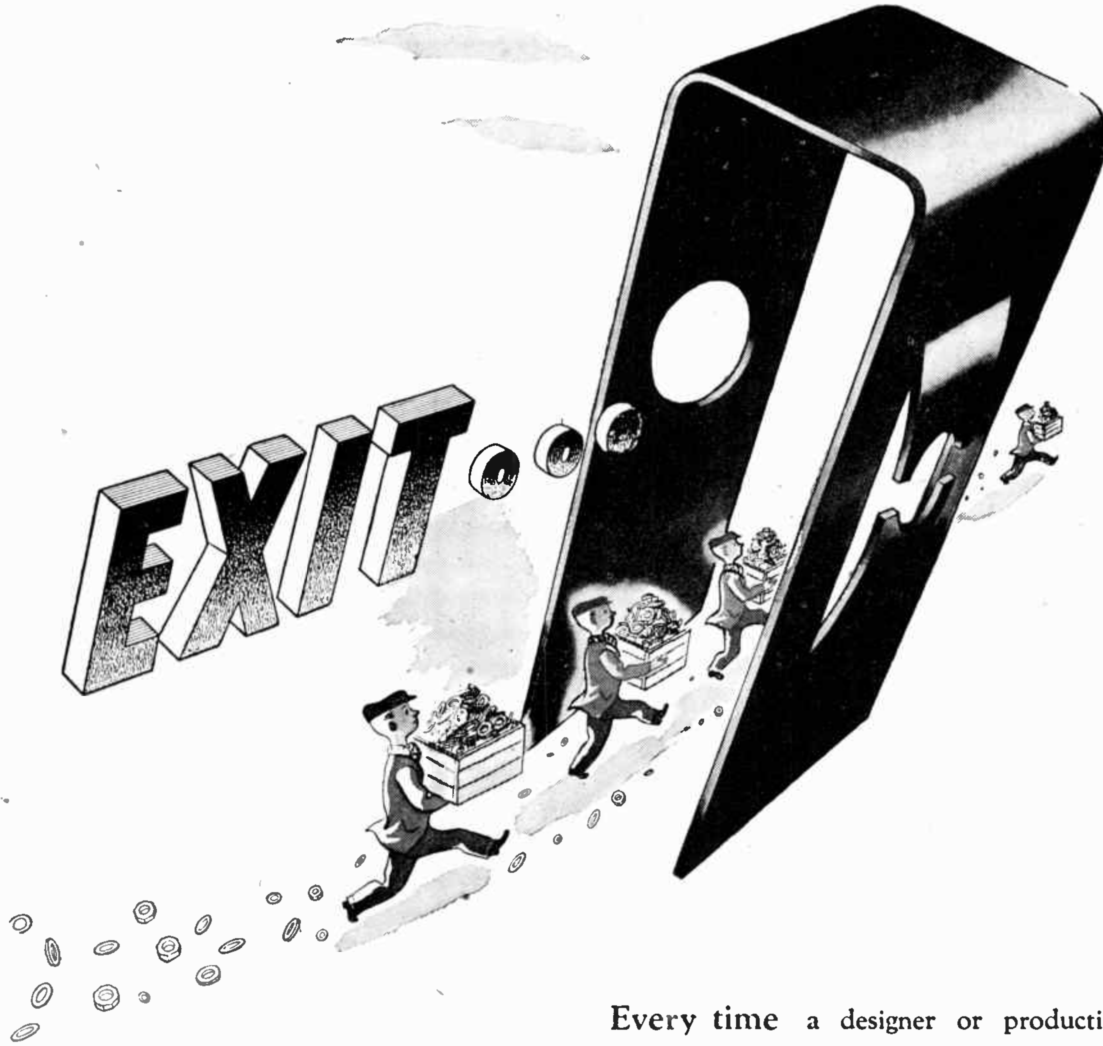

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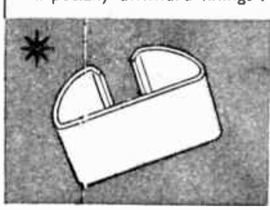

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Wireless World

Radio and Electronics

35th YEAR OF PUBLICATION

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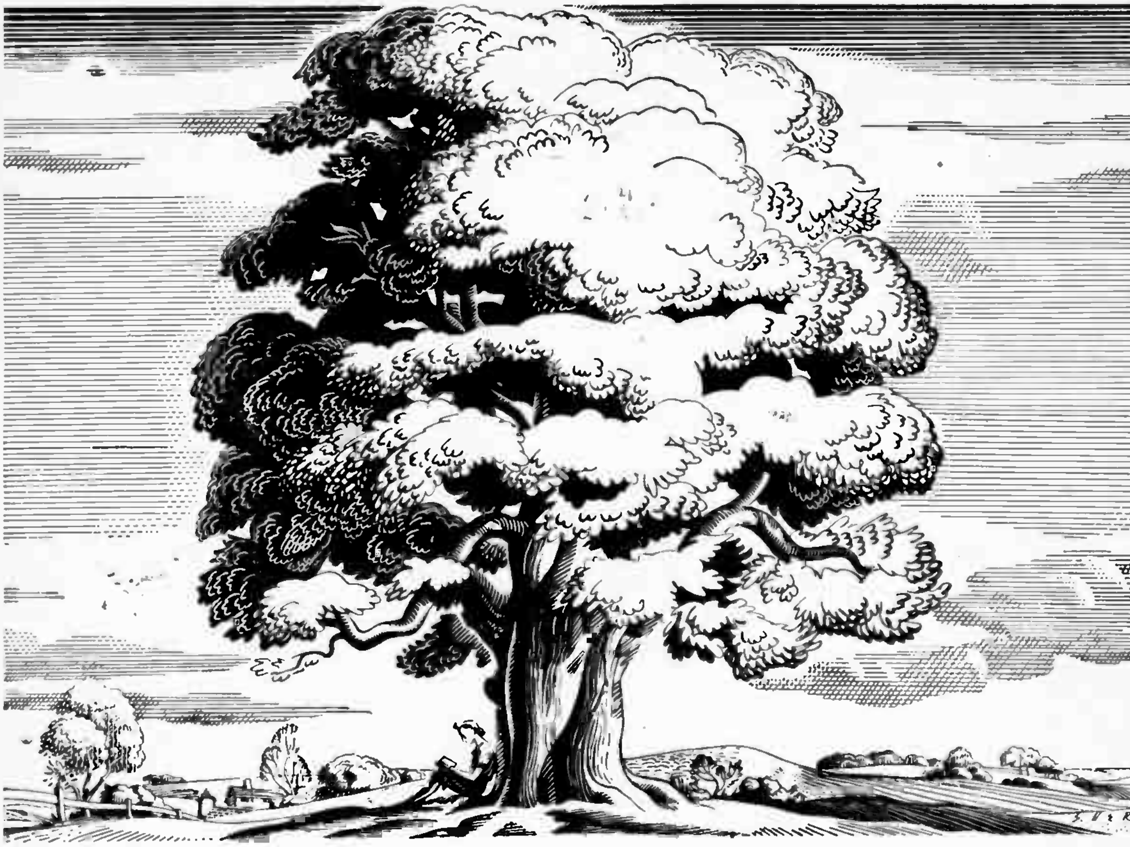
As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.



Wireless World

Radio and Electronics

Vol. LI. No. 6 — JUNE 1945 — Price 1s. 6d.

Monthly Commentary

Wireless Contributions to Victory

IT is a black mark against radio that Hitlerism rose to power largely by exploiting mob psychology with the help of the speech amplifier and loudspeaker, devices first developed for radio purposes. That fact has been freely admitted by Germans. Broadcasting was afterwards used as one of the most powerful agencies for consolidating that evil power. But, as we said a month or two after the outbreak of war, "If wireless put Hitler in, it will assuredly play an important part in getting him out."

That prophecy has now been fulfilled. Indeed, to over-stress the contributions of wireless to victory would be difficult; all those concerned have justifiable cause for pride. More than once, at times of gravest national peril, wireless has come to the rescue. There is the highest authority for saying that in the Battle of Britain the part played by radiolocation was decisive; without its help our 40 or 50 squadrons of fighters—all we then possessed—could not have been used to such good effect. And we believe that it will ultimately be agreed that the contribution of radiolocation to curbing the submarine menace has been equally impressive. But the official story of this has not yet been told; for the present we must accept a tribute paid by Grand Admiral Doenitz, Hitler's successor as German Führer. "At the end of 1943 and the beginning of 1944," he said, "one development became very obvious, which long ago —even in peacetime—we had feared; that the enemy might deprive the U-boat of its essential feature—the element of surprise—by means of radiolocation. By these methods he has conquered the U-boat menace. . . It was not superior strategy or tactics that gave him success in the U-boat war, but superiority in scientific research."

Writing soon after the 1914-1918 war, the German Admiral Scheer said: "The English received the news of our movements through their directional wireless which they already had in use, but which was only introduced by us at a much later period. . . In possessing [direction-finding stations], the English had a great advantage in the conduct of the war." Thus it would seem that, just as we were ahead of our enemies in the technique of the older form of direction-finding, so we have maintained our lead over them in the newer "reflection direction-finding" (to use one interpretation of the mystic letters RDF). We of *Wireless World* like to think that our own humble contribution—the organisation of the National Wireless Register in 1938—played some small part in the success of radiolocation by helping to find the right men to develop and operate the gear.

In acclaiming the new applications of our technique we must not forget the part played by communications in general. In many directions the broad strategy of the war has been such that we have stood to gain more from wireless than has the enemy, who has been fighting mostly at the end of internal lines of communication.

All of us have good cause for gratification in the thought that wireless has done so much, but we must not rest on our laurels. The Pacific war will probably call for the use of communications and similar devices on an ever-growing scale, and there is also the more difficult task of adapting wartime technical developments to peacetime needs. For that it is essential that the earliest publication should be made of much detailed information that is still under the security ban.

Here *Wireless World* is anxious to play its part. Ever since the journal was taken into the confidence of the authorities on the subject of radiolocation long before the outbreak of war, we have been on our guard against making even oblique references to matters which might give the enemy an inkling of what was afoot. But we feel that the time has now come when we should be able to publish freely most of the information that will be of value in expediting the change-over from war to peace, and in particular in helping the export trade to establish itself. And another of our functions will be to serve as an unprejudiced medium for discussion of the many problems that must be solved if wireless is to play its part in the winning of the peace.

AC/DC COMPARATOR

A Simple Method of Calibrating AC Meters

By W. H. CAZALY

THE device to be described enables DC and AC at audio-frequency to be compared closely enough for the calibration of workshop AC meters directly against DC meters. Usually AC meters are calibrated indirectly through the medium of thermocouples, which are expensive in themselves for the lower ranges of current indication (a 25 mA vacuo-junction, for example, costs three or four pounds) and require to be used with microammeters which are rather expensive instruments. It is also possible to mark the dial of a DC meter in RMS terms if the AC to be measured is rectified for use by the meter, but some calculation is involved and rectifiers vary so much in their characteristics that selection of individual testing are necessary for accurate results. Although the average workshop is usually equipped with more than one AC meter, they may cover very different ranges, so that one cannot be readily checked against another, and, especially with the contemporary shortage of meters, it is seldom that one really good meter can be kept for use solely as a standard. The advantages claimed for the device described here are cheapness of apparatus, no necessity for precision in any of its components, ease of construction from readily obtainable parts, little demand for skill in manipulation, direct expression of RMS values of AC in terms of the current readings on the DC meter used as a standard, and accuracy—conservatively from 1 to 5 per cent.—quite high enough for most workshop requirements. A further advantage lies in the ability to compare fairly low AC and DC—of the order of 20 mA.

The device is based on the fact that the resistance of a small low-wattage incandescent filament lamp—the ordinary torch bulb, for instance—varies considerably with the temperature of the filament. This temperature is dependent, for a given set of physical conditions, on the power dissipated in the filament, and at all frequencies but those so low that the filament has time to cool between peaks of AC, the RMS value of sine-wave AC used to heat the filament is the same as DC in amperes that would heat the filament to the same temperature. Thus AC produces the same resistance change in the filament as equivalent DC and this may be used to compare their magnitudes. The idea is not a new one, of course, but the author does not recall its use in the form now proposed, except in a bolometer circuit for RF measurements which is not very suitable for use at AF. Another effect of filament temperature, the emission of light, is well known and employed in AC/DC comparators that contrast light intensities produced by AC and DC, but these forms of comparator require rather large amounts of light and are not very accurate without special apparatus. The device under discussion, however, is operable with the filaments below visible heat.

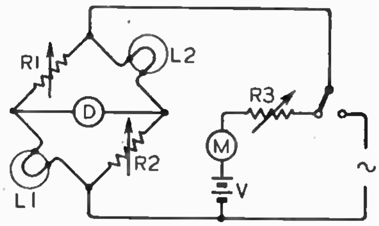


Fig. 1. Basic circuit of comparator.

The basic circuit used is that shown in Fig. 1. This is a bridge in which two lamps, L1 and L2, and two variable resistances of low temperature coefficient, R1 and R2, form the elements. Since these elements are resistive, the bridge can be balanced with either DC or AC energising current. A DC energising source is shown consisting of a rheostat R3, a DC meter M, and a battery V. The switch S connects the bridge at will to either the DC supply or the circuit (not shown) supplying the AC to be compared. Operation is basically as follows:—First, S connects the bridge to the unknown AC that is to be compared. If this AC is sufficient to heat the bridge lamp filaments enough for their resistances to be changed appreciably from what they are when cold, the bridge can be balanced by adjustment of R1 and R2. Next, S is switched to the DC supply. Without altering the settings of R1 and R2, the DC then passed, controlled by R3 and measured by the meter M, is adjusted until balance is indicated by the detector D. This DC will be making the filament resistances of L1 and L2 change to the same extent as was brought about by the unknown AC previously used to energise the bridge. If the AC is sine-wave, the value in amperes of the DC equals the RMS magnitude in amperes of the AC.

As will become apparent, this device is not particularly suitable for ordinary measurement of AC, because the power required is considerable compared with that which is necessary to operate ordinary AC meters. Its prime use lies in the calibration of AC meters. The simple basic circuit shown in Fig. 1 has a major disadvantage from the viewpoint of simplicity and cheapness; it requires balance detectors that are sensitively responsive to DC and to AC. For DC, a very sensitive galvanometer could be used; for AC a valve voltmeter of high sensitivity or a vibration galvanometer might be used. These instruments are more in the nature of somewhat expensive laboratory, rather than workshop, equipment. However, this disadvantage can be removed by superposing 1,000 c/s AC on the DC for balance purposes, which enables high - inductance headphones, which are cheap and one of the most sensitive of balance detectors at that frequency, to be used. When the AC being compared is at 500-1,500 c/s, it can provide its own balancing note in the phones, but at lower or high frequencies, to which either the phones or the ear are not very sensitive, 1,000 c/s can still be superposed. It is essential only that this 1,000 c/s balancing component should be too small to make any appreciable difference to the heating of the filaments. As, however, balancing current of the order of 2 or 3 mA at 1,000 c/s is sufficient for the purpose, even with a low-impedance bridge such as this, no difficulty arises on this account.

The circuit in practical form with 1,000 c/s superposition is given in Fig. 2. The 1,000 c/s component of the energising current is introduced by means of a transformer T1, which can be fed from some audio-frequency source such as a BFO or a small valve oscillator. The secondary of this transformer is wound of wire of sufficient thickness to carry the compared currents without overheating, and is tapped to provide various amounts of balancing component. The author made a suitable transformer out of a speaker transformer, the original secondary being replaced by a winding tapped at every 20 turns up to about 160, which gave a good selection of taps for experimental purposes. Since the impedance of the bridge is low, a telephone transformer with a fairly high step-up ratio is practically a necessity to match high-impedance phones to the bridge. Again a speaker transformer was found suitable. A valve amplifier between this transformer and the phones adds considerably to the ease with which balance can be found, but is not essential. A possible alternative to a BFO and input transformer may consist of a simple valve oscillator built on the lines of the circuit given in Fig. 3. The valve should be of the medium impedance type—say, 3,000-6,000 ohms. The grid condenser may be 0.01 μF and the grid leak 50,000 ohms. The transformer should be of the cheap variety, which is not very satisfactory for AF amplification owing to lack of adequate inductance in its windings, but which is more likely to provide about 1,000 c/s than a better component. This transformer is adapted by taking off about a quarter of the secondary winding and putting on, in the space thus left, a third (output) winding. This winding may consist, for comparison of currents of the order of 0.5 A, of 26 SWG wire, of as many turns as possible to fill the space and tapped at every 20 turns (for experimental purposes). The output need not be of good sine waveform, but the oscillator should not squegg, as the high-order harmonics so produced may, on account of the stray reactances of the bridge, partially obscure the balance point.

The values of R1 and R2 depend on the ratings of the lamps used in the bridge. The choice of lamps is governed by the orders of magnitude of the currents it is wished to compare. No precise knowledge of the characteristics of the lamps is needed in using the device, but as a matter of interest and to initiate design, some rough measurements were made on various lamps obtained from a number of sources. The results are set out graphically in Fig. 4. The author has so far experimented only with lamps of low wattage rating of the small M.E.S. torch type, since interest mainly centres upon the comparison of small values of AC and DC, but there is evidence to indicate that car type lamps exhibit similar variations of resistance with temperature and could be used for the comparison of AC and DC of the order of several amperes. From the graphs, an idea of suitable values for R1 and R2 may be gathered. For maximum sensitivity to changes in energising current, the bridge should be balanced when all ratios are unity, i.e., $\frac{R1}{L1}=\frac{R2}{L2}=1$. The bridge can be balanced, of course, when R1 and R2 are different, but in those conditions the current divides unequally through the bridge, heating one lamp more than the other, which reduces the sensitivity of the bridge to changes on energising current and therefore its ability to discriminate between closely adjacent values of current. If R1 and R2 are made smoothly variable from 1 or 2 to about 50 ohms, lamps rated at from 6 V, 0.04 A to 6 V, 0.5 A can be used, for the comparison of currents of the order of 20 mA to 1 A. The total current energising the bridge when ratios are unity is twice the current through one lamp, and the voltage required to pass this total current is twice that required across the lamps. In practice the author, being unable to obtain suitable commercial rotary vari-

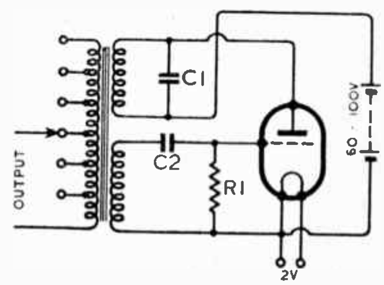


Fig. 3. Valve oscillator for production of 1,000 c/s balancing component. For constructional details, see text.

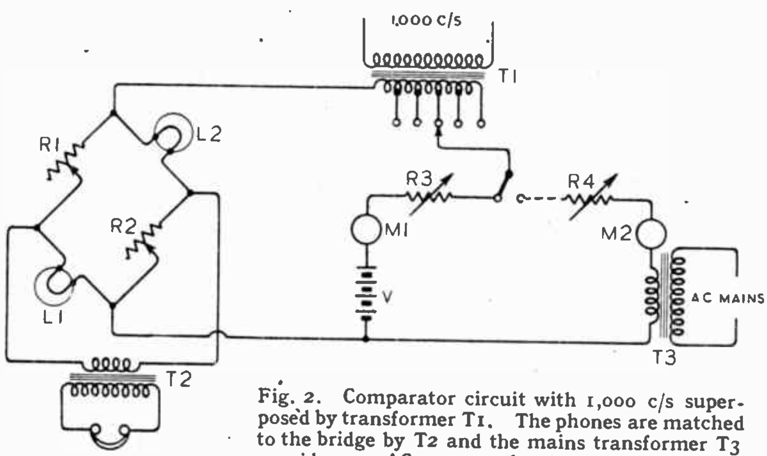


Fig. 2. Comparator circuit with 1,000 c/s superposed by transformer T1. The phones are matched to the bridge by T2 and the mains transformer T3 provides an AC source of voltage roughly equal to that of the DC battery V. M1 is the DC meter used as a standard, and M2 the AC meter being calibrated. See text for values of R1 and R2.

able resistances, made up a couple of slide-contact devices by winding the wire from (unused) electric fire spirals (straightened) in the form of grids, on the lines shown in Fig. 5. Contact was made by crocodile clips. Crude as this idea is, it worked and was perhaps excusable in the sixth year of war. For very low-rated lamps, such as the 6 V, 0.04 A type (used in the rear lamps of some cycle dynamo lighting sets), R1 and R2 may have to attain as much as 150 ohms each when the full rated current is being passed through these lamps, and it is more convenient to use normal rotary variable resistances.

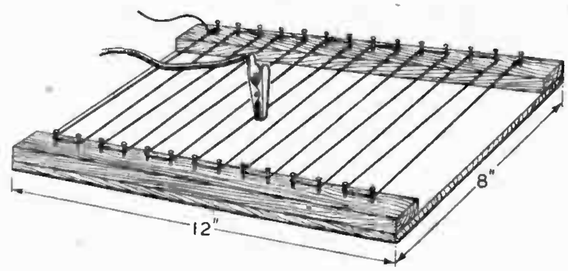


Fig 5. Slide-contact variable resistance. A straightened electric fire spiral is stretched across a simply made rack. Two of these elements are needed, one each for R1 and R2.

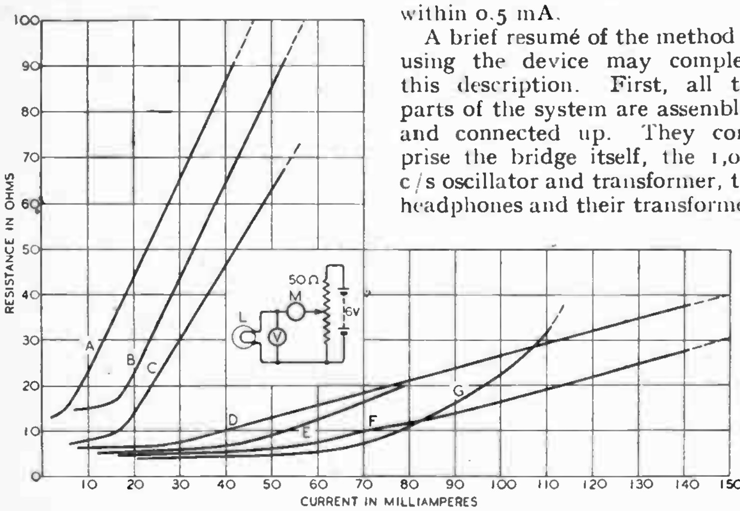


Fig. 4. Current/resistance curves for a representative series of lamps. A, 6 V, 0.04 A ; B, 6 V, 0.06 A ; C, 3.5 V, 0.06 A ; D, 6 V, 0.15 A ; E, 3.5 V, 0.15 A ; F, 6 V, 0.3 A ; G, 3.5 V, 0.15 A (American lens-tip type).

The best lamps to use are those which have the steepest IR curves. It will be seen from Fig. 4 that filament resistance does not begin to change much until certain minima of current are exceeded. These conditions, represented by the flat portions of the curves, are probably due to the surface area of the filaments being sufficient to radiate small amounts of heat as fast as they are set up. Once the creation of heat in the filaments exceeds this probably fairly steady loss, temperature, and therefore resistance, rises steadily and almost linearly. The thicker the filament, the longer is the flat part of the curve, and the longer the filament, the greater the overall resistance change. Thus, the 6 V, 0.04 A type of lamp exhibits the steepest curve and, in practice, enables sharp balances to be obtained with quite low currents. So far, this is the lowest rated lamp the author has been able to procure, and has made possible the comparison of AC and DC of the order of 20 mA within 0.5 mA.

A brief resumé of the method of using the device may complete this description. First, all the parts of the system are assembled and connected up. They comprise the bridge itself, the 1,000 c/s oscillator and transformer, the headphones and their transformer, the DC meter that is to be used as a standard with the DC controlling rheostat, and an accumulator battery of twice the voltage of one of the lamps. The AC meter that is to be calibrated or checked, another rheostat to control the current through it, and a course of AC such as a mains transformer with a low-voltage secondary constitute the AC circuit by which the bridge can be energised. For calibration, the bridge is connected first to the DC supply, and the current adjusted by means of the rheostat R3 to the value it is desired to compare. Then, by manipulation of the slide-contact resistances R1 and R2, the bridge is balanced (i.e., minimum sound heard in the headphones). The resistance R3 may have again to be adjusted, alternatively with R1 and R2, until exactly the desired current is passing through the bridge. The bridge is then disconnected from the DC source and connected to the AC circuit. The AC rheostat is now adjusted until balance is again obtained. The AC then being passed will have an RMS value equal to the DC current previously passed. Then the process is repeated with the next desired calibration current. In this way the scale of the AC meter can be fully marked against corresponding DC meter indications. With proper care, meters can be calibrated to within 1 or 2 per cent. of the DC used as a comparison standard, which is amply accurate for workshop purposes.

FM "WALKIE-TALKIE." This American Signal Corps pack transmitter-receiver, type SCR 300, has been used to some extent by the British Army. The set, measuring 17×12×7 in., weighs 35 lb.

TROPICAL BROADCASTING

Choice of Frequencies

By T. W. BENNINGTON

The technical problem of providing economical broadcast coverage for wide tropical areas is likely to assume importance after the war, especially with regard to the British Crown Colonies and Protectorates. "Long-short" wavelengths will probably be used for the purpose, and it is concluded here that, considered in the light of present knowledge, the existing channel allocations in these bands are inadequate.

IT has for a long time been recognised that the factors affecting the choice of wavelengths suitable for a local broadcasting service are not the same in tropical as in temperate countries. The medium-wave broadcasting band — whatever may be its deficiencies and drawbacks—still has much to recommend it for local broadcasting in the temperate zones. The ground wave has a *moderately* good range, so that fairly good coverage can be attained for a given power radiated; the noise level is (usually) relatively low so that not too great a field intensity is required to provide a workable signal with a properly designed receiver, and a good number of broadcast channels (perhaps not enough) can be accommodated without leading to complications in receiver design.

In the tropics the situation is radically different, principally because the radio noise intensity is usually so high on the medium waves that an excessively high field strength is necessary to provide a workable signal. Consequently the range for a given radiated power is excessively low, and coverage is therefore very poor. For tropical broadcasting it would appear therefore that the short waves ought to be used, for on these the radio noise intensity is much lower.

Tropical Broadcasting Bands.—These facts were readily recognised at the 1938 Cairo Conference and for local broadcasting in tropical countries the 120-metre (2.3-2.5 Mc/s), 90-metre (3.3-3.5 Mc/s), and 60-metre (4.965-5.5 Mc/s) bands were allocated. Noise on these frequencies is much lower than on the medium-wave band, though of course it is necessary, if good coverage is to be attained, that sky wave, and not ground wave transmission should be effected. The range of the ground wave is even smaller than on the medium waves. That is why different frequencies were allocated to the stations for day and for night working; it was necessary to take account of the diurnal ionosphere variations. But knowledge of the ionosphere was not at a very advanced stage at that time (it can hardly be deemed to be so even now, though much more has been learned) and it may be that, had more been known about the subject, these particular tropical broadcast bands would not have been chosen. It would seem, for example, that, because the sun's rays are stronger in the tropics than in temperate regions, the ionisation of both the refracting and absorbing layers of the ionosphere would be higher. If this is so the use of higher frequencies for local short-wave broadcasting would be not only possible but absolutely necessary, than for a similar *short-wave* service in the temperate zones. Let us therefore consider some of the factors affecting broadcasting in the tropics, and see whether any better results might be achieved if other arrangements were in force.

The Tropical Zone.—Geographically, if not ionospherically, the tropical zone comprises those regions lying between the parallels of latitude 23½ deg. N. and 23½ deg. S. If the ionosphere conditions do not correspond with the geographical ones, then the obvious course would be to define the tropical broadcasting zone as that within which the ionosphere exhibited tropical characteristics. The geographical limits to the zone in which the use of the tropical bands allocated by the Cairo Conference was permitted were, in fact, the parallels of latitude 30 deg. N. and S. But the definition of the "radio tropical zone" is not quite so simple.

Although it is true that the ionosphere will set the high limit to the frequencies of use over a given distance and, to some extent, the lower limit also, still it is largely conditions of temperature and climate that control the noise, at least on the lower frequencies. For the tropics are the breeding ground of the thunderstorms which give rise to noise, and although the noise itself is propagated by way of the ionosphere, the efficiency of such propagation will vary very much with frequency. In fact, it is evident that neither the zones of greatest noise intensity nor the regions of the ionosphere where the ionisation is at a "tropical" level, will correspond exactly with the geographically defined tropical zone. Nevertheless, for the sake of simplicity we may assume that they do, and in that way reduce the matter to a workable basis without committing any very great error.

Within the tropics lie some of the most populous countries of the world, including the following countries of the British Commonwealth: Anglo-Egyptian Sudan, Australia (northern part), British Guiana, British Honduras, British Somaliland, Burma (southern part), India (southern part), Kenya, Malaya, Oceana, Rhodesia (Northern and Southern), Tanganyika, West African Colonies, and West Indies (large part).

When the enormous size of these tropical regions is considered, together with the fact that they are not usually at a very advanced stage of economic development, it is seen that there is an additional reason for the use of short waves for the broadcasting service. If the medium waves

Tropical Broadcasting—
were used the service areas would —during daylight—be limited by the distance range of the ground wave, and this, even if the noise level were relatively low, would not be great enough economically to serve such large areas, most of which are of an entirely rural character. Far too many stations would be required. By the use of short waves however, the distance range of a station is much enhanced, because the transmission is effected by the sky wave, and therefore the service area—albeit the service given is now of the second grade — is very much larger.

The Main Requirements.—It may be well at this stage to define, in the main, the characteristics of what constitutes a suitable wavelength for local broadcasting in the tropics. The term "local broadcasting" is used in this article in contradistinction to the term "long-distance broadcasting." It means that service is given in an area which stretches *from the transmitter outwards* though the limits of the area may be many hundreds of miles distant.

(1) It must be of so high a frequency that the radio noise intensity is relatively low, and so only a moderate field of intensity is necessary to give a workable signal.

If this entails a frequency on which the ground wave range is so small that the sky wave must be used to give the required coverage—and our previous considerations indicate that it will—then

(2) It must be of high enough frequency at any particular time of day that the ionospheric absorption is not too great; otherwise the distance range will be reduced and the coverage limited.

(3) It must be of low enough frequency at any particular time of day that energy radiated even at the greatest angles to the horizontal will not penetrate the refracting layer of the ionosphere; otherwise there will be an undesirable skip zone.

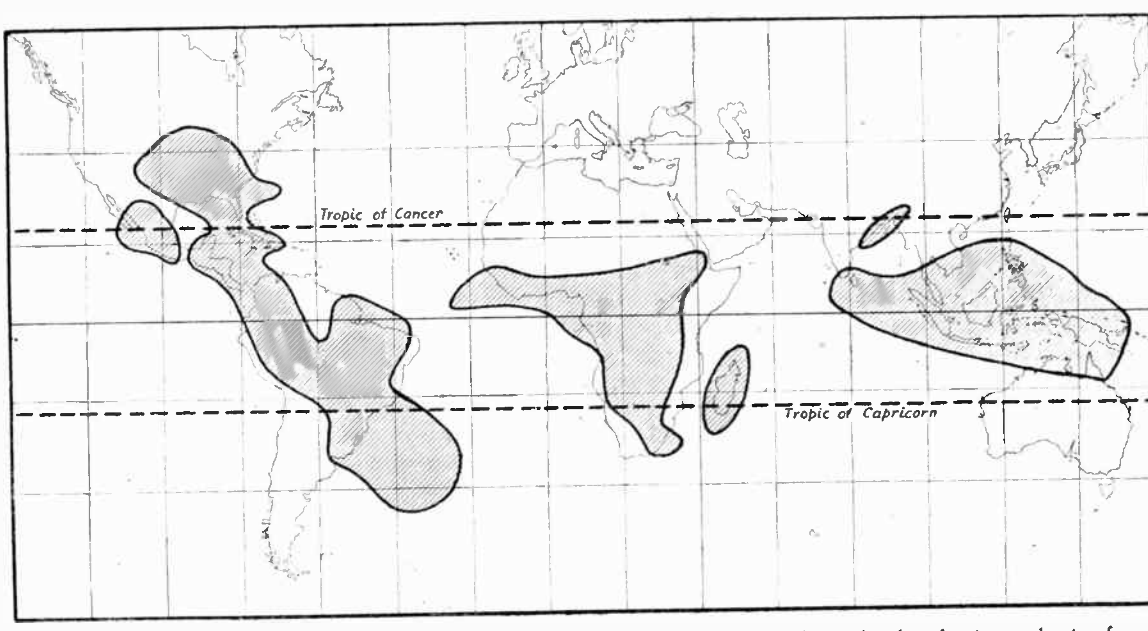
We may now examine the conditions on various frequencies in order to see which of them will best fulfil the above requirements. Let us consider the noise situation first.

As has been mentioned before in these pages,[1] atmospheric noise is caused by the radiation of radio frequency energy by lightning strokes in thunderstorms, and it is in the tropics that these thunderstorms most frequently occur. The noise emanating from the thunderstorms is propagated both as a ground wave and as a sky wave, so that most of the radio noise in temperate zones originates in the thunderstorms of the tropics. Owing to the nature of the current pulses in the lightning strokes more radio energy is radiated at low than at high frequencies, so the noise intensity in the first instance decreases with increasing frequency. Its intensity in any particular geographical zone will, however, vary with frequency in a complex manner—depending not only on the noise intensity produced, but also on the propagation characteristics for the various frequencies.

But so far as the tropics are concerned—at least the land areas within them—we may assume that they are either within the actual thunderstorm-producing areas or so close to them as to be affected mainly by the noise ground waves. This assumption may not be quite true all the year round, since the noise zones move north and south with the seasons, but at least it is justified as showing the worst conditions to be expected.

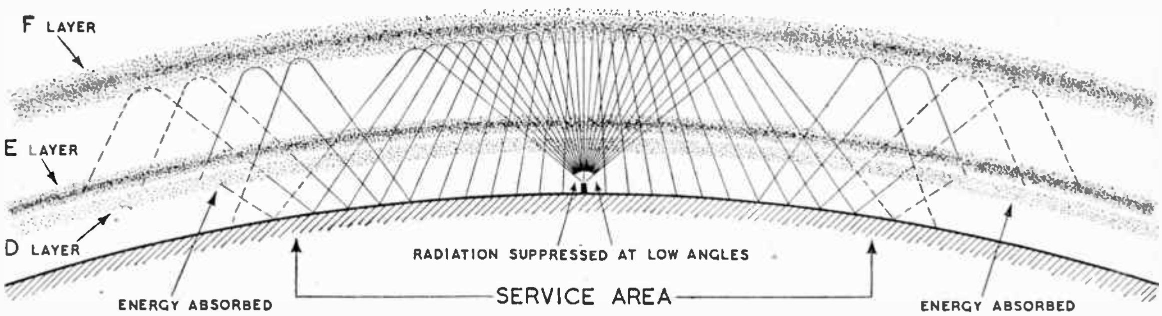
If we examine the tropical noise intensity on one or two spot frequencies this will give us an idea as to how the noise decreases with

[1] See "Radio Noise" *Wireless World*, Nov. 1944.



Thunderstorm areas of the world, where most of the radio noise is produced (from the thunderstorm charts of Dr. C. E. P. Brooks).

increasing frequency, and enable us to see which frequency bands are most likely to fulfil requirement (1) above. The measurement of noise presents certain difficulties such that it is found more convenient to measure, not the noise intensity itself but the intensity of a signal which is at a specified level above the noise. In the case of broadcast reception a greater signal-to-noise ratio is necessary than for most other radio services, and in highly developed countries a figure of 40 db. is considered desirable and is in fact generally quency somewhere near the middle of the medium-wave band may be compared with that of 1.0 millivolt/metre, the minimum field intensity for broadcast reception in a quiet country district in the British Isles. But it must be stressed that both these figures—3.6 mV/m. in the tropics and 1.0 mV/m. in this country—are for districts where there is no man-made noise, and in all the urban districts of the countries considered considerably higher field intensities are in fact required. In the tropics the man-



Idealised picture of a local short-wave broadcasting service, using F layer skywave transmission.

achieved. However, the minimum requirement for tolerable reception is that the signal field intensity should be 20 db. above that of the noise. Such figures, giving the minimum field intensity necessary to provide a satisfactory signal in the presence of the noise, would be directly to our purpose, but reliable data on this subject applicable to the tropical zone are extremely scanty. However, the following figures are obtained from a careful consideration of what data are available.

Minimum Field Intensity for satisfactory tropical broadcast reception (20 db signal/noise ratio)

1 Mc/s. µV/m	2 Mc/s. µV/m	4 Mc/s. µV/m	8 Mc/s. µV/m
3,600	1,550	570	170

The above figures are indicative of the situation considering the noise alone, at what is, generally speaking, the worst season of the year, and it is seen that on 4 Mc/s the required field intensity is approximately one-sixth, and on 8 Mc/s one-twentieth of that on the medium waves. The figure of 3.6 millivolts/metre for a fre-

made noise is usually particularly bad because of the common use of large numbers of electric fans, and these practically control the required field intensity on short waves in many districts. One reliable authority gives the following values of required field intensity in the presence of such man-made noise: 4 mV/m. on 2.3 Mc/s, 2 mV/m. on 4.6 Mc/s, and 1 mV/m. on 9.4 Mc/s and higher, when only 100 µV/m. was necessary in the absence of the noise.[2] So, the noise situation being a very variable one, we may continue to work with the figures given in the table, bearing in mind that they are for quiet districts only.

There is, of course, a diurnal variation in the radio noise intensity, the thunderstorm production being dependent upon the diurnal variation in temperature, and other meteorological effects. This variation in the noise intensity is such that a maximum occurs in the late afternoon and a minimum in the early morning, and it is of a considerable magnitude. There is not a *great* difference in the intensity of the noise, however, between noon and midnight local time, so we may take the above figures of required field intensity as applying roughly to the whole period between noon and midnight.

Range and Coverage. — The next step is to find out the maximum distance at which the required field intensities would be maintained on the various frequencies. We will ignore for the moment the question as to whether the ionisation of the refracting layer would be high enough to refract the frequencies we are considering, or whether they would penetrate through it. We will assume the former condition to apply.

On the frequencies 1 Mc/s and 2 Mc/s—within or near the medium-wave band—propagation would be by ground wave only during the day, and at night there would be sky wave propagation also. On the other frequencies considered only the sky wave would be of real importance, both by day and by night. The range for the required field intensities shown above for the various frequencies would depend upon a number of factors, chief of which are (a) the power radiated, (b) directivity of the aerial system, (c) ground absorption, (d) ionospheric absorption.

In order to arrive at some figures which will give an indication of the conditions to be met we must therefore make various assumptions. We will assume, in the first place, a radiated power of 50 kW and the use of a non-directive aerial system, it being remembered that we aim to give local all-round coverage. We need not here concern ourselves with the type of aerial which would be necessary for this purpose, but it ought to be mentioned that in

[2] All-India Radio.

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practice, its directivity in the vertical plane would be a matter of considerable importance. The ground absorption will depend, of course, upon the nature of the terrain, and will be no different in the tropics from that encountered in temperate zones, so we may consult the usual data for transmission over a good earth in a temperate zone in order to determine the distance range of the ground wave.

On those frequencies where the sky wave is made use of it is ionospheric absorption which will determine the range. This is more difficult to assess than the ground absorption, and little data are available. The ionospheric absorption occurs mainly in the lowest part of the ionosphere and is dependent upon the amount of ionisation in the absorbing region. This will be much greater in the tropics than in temperate regions, because in the tropics the sun is more directly overhead and its ionising rays are therefore stronger. It is evident that the ionisation will vary greatly with time of day, being greatest at midday and practically negligible during darkness, owing to the high recombination rate in the absorbing region. The ionospheric absorption in the tropics then will be negligible at night and no different from what it is in temperate zones, and between sunrise and sunset it will vary in amount, with the maximum occurring at noon. In order to determine the sky wave ranges then we will estimate the effect of ionospheric absorption at noon and at midnight only, in order to indicate the worst and the best conditions likely to be met.

Ionospheric absorption varies inversely, of course, with frequency, it being less on the higher frequencies because the rate of collision between the electrons and ions in the ionosphere—which are its intrinsic cause—depends upon the magnitude of their *motion* when acted upon by the radio wave, and this is less when the electric field of the wave reverses itself more frequently in a given time. The distance range will therefore increase markedly as the frequency is increased.

Taking all the above factors into consideration the following are the estimated ranges for the required field intensities on the different frequencies we are considering.

Thus, on 1 Mc/s and 2 Mc/s the ground wave only is of use during the day, and on 1 Mc/s (300 m) owing to the high field intensity required to overcome the noise, this only has a range of 50 miles. On 2 Mc/s (150 m) though the required field intensity is less, this is more than counteracted by the increased ground absorption, and so the distance range falls to only 38 miles. On 4 Mc/s (75 m) sky wave propagation is obtained and the distance range goes up to 220 miles, whilst on 8 Mc/s (37 m) it is further increased to 820 miles, because both the noise intensity and the ionospheric absorption are reduced.

Estimated distance range for required field intensity for 50 kW radiated

	1 Mc/s	2 Mc/s	4 Mc/s	8 Mc/s
Noon	50* miles	38* miles	220 miles	820 miles
Midnight	270	460	1,350	3,300

* Ground wave only.

At night the ionospheric absorption becomes of a very low value and so the distance range on all the frequencies is much enhanced, though it is, of course, still much smaller on the lower frequencies than the higher, because of the greater field intensity required to overcome the noise on the lower frequencies.

The net result of our investigations, so far, is to show that (a) the higher the frequency the better will the coverage be, *provided that the wave does not penetrate the ionosphere*, and (b) that at the time of day when the ionospheric absorption is highest *economical* coverage can only be obtained on frequencies higher than 4 Mc/s, though at night it could probably be obtained on frequencies nearly down to 2 Mc/s. (For reasons mentioned earlier on, the *degree* of coverage aimed at is usually less in tropical than in more highly developed countries, and it has here been considered that *economical* coverage is attained if the transmitter has a range of 500 miles. It should be noted also that the ionospheric absorption varies markedly over the day, and that the ranges would be greater over most of the day than those shown for noon.)

Conditions for Refraction.—But it is evident that it will be no good using 4 Mc/s or 8 Mc/s at any time of day if the ionosphere refracting layer permits it to penetrate, even at the highest elevation angles, for the production of a skip zone surrounding the transmitter must be avoided. So we had better examine the conditions in order to see what is the *highest* frequency which will be refracted.

It is assumed that the wave will be refracted at the F or F_2 layer. If the wave is to be returned at all distances from the transmitter outwards it is necessary to use a wave which is below the critical frequency of the refracting layer at any time of day. Then it will be returned at vertical incidence and at all greater angles of incidence, and the earth will be illuminated by the downcoming rays from the transmitter outwards. The critical frequency varies very much, of course, with time of day and season of year, but, as has already been said, because the ionising rays of the sun are stronger in the tropics than in temperate zones, the critical frequency will be generally higher there. The use of higher frequencies than for the same purpose in a temperate zone will therefore be possible.

The following table gives approximately the estimated lowest

Estimated lowest critical frequencies for tropical zone, F_1 F_2 layer

	Midnight Mc/s	Diurnal Minimum Mc/s	Noon Mc/s	Sunset Mc/s
June	4.0	3.0	6.5	6.0
March and Sept. ...	4.0	3.5	8.5	7.5
December ...	3.5	2.5	7.5	5.0

critical frequencies of the F and F_2 layers throughout the geographical tropical zones for four significant times of day and for four seasons of the year.

It is seen that the critical frequency varies in a rather complicated way with the seasons, and this is to be expected because we are considering an area which extends into opposite hemispheres. It should be noted, however, that although the seasonal variations are in the opposite sense in the two hemispheres the ionospheric variations are not necessarily so, being somewhat more complicated than we can deal with here. However, the figures given are thought to be valid for the whole of the geographical tropics, and it is seen that highest daytime frequencies prevail at the equinoxes and lowest night-time ones during December.

As has already been said, it is advantageous for several reasons to make use of the highest frequencies possible, but obviously it would not be advisable in a *local* broadcasting service to make too frequent changes in the working frequency, either diurnally or seasonally.

The table indicates, in the first place, that 2.5 Mc/s (120-metre band) is hardly ever necessary—it is certainly the lowest frequency ever necessary—for night-time use. It is to be noted that a *local* broadcasting service is not often required to function between midnight and sunrise local time. 3.5 Mc/s (90-metre band) is shown to be a very useful and even necessary frequency for use during local evening hours up to midnight—but 5.0 Mc/s (60-metre band) is too high for night-time use, and, we see, somewhat too low for the daytime. It might, of course, be of considerable use as an intermediate frequency for use during certain periods of the day, as, for example, around sunset at certain seasons. But it is evident that over considerable periods of the day a higher frequency than this should be employed, and, if it is to be of some use at all seasons of the year, this would appear to be in the region of 6.5 Mc/s (46 metres). This would have a considerable period of utility all the year round ranging from 6 to 11 hours daily, according to the season. It might be thought that the use of a frequency so high as 6.5 Mc/s for local broadcasting would lead to unwanted distance ranges, and thus to interference with other services operating on or near the same frequency band outside the tropics. There are two ways in which this could be prevented: (a) by restricting the use of 6.5 Mc/s to certain hours when the ionospheric absorption is relatively high and thus the range is relatively small and the wave is not likely to reach to distances where it can cause interference; (b) by adjusting the elevation angle of the aerial system so that low-angle radiation does not take place. This latter step is in any case necessary if a *local* area is to be served, i.e., the energy must be radiated at relatively great elevation angles, and that radiated at low angles would be a waste of power so far as service within the area was concerned.

There remains the possibility of energy reaching to great distances by *multiple* hops at the greater angles, but if the wave is only used when high ionospheric absorption necessitates its use this danger should not be great.

It seems, therefore, that in order to provide efficient service in tropical countries at all seasons and necessary times of day the use of the two higher of the tropical broadcasting bands at present in use is desirable, together with that of an additional band at about 6.5 Mc/s. The utility of these three bands would seem to be somewhat as is indicated in the above table.

The above figures for distance are, of course, very approximate. The ionospheric absorption varies markedly throughout the indicated periods of use and the ranges vary accordingly. In the afternoon, for example, when 5.0 Mc/s is of use there is still appreciable absorption, whereas after dark, when 3.5 Mc/s is of most use, it is almost negligible.

The figures do indicate, however, that economical coverage of tropical areas could be accomplished by the use of these frequencies. Even where there is a considerable amount of man-made noise the field intensities, at least at distances somewhat less than those shown above, should be adequate for satisfactory reception. Incidentally, to put down the same field at 500 miles as it is estimated would be put down by a 50 kW transmitter on 6.5 Mc/s at 700 miles, a transmitter operating at the middle of the medium-wave band would have to radiate about 53,000 kW.

There remains the possibility of covering an area by making use, not of the F layer of the ionosphere, but of the E layer instead. This could be done during the daytime only and by the use of a relatively low frequency. However, this would introduce considerable complications into the aerial arrangements, for a different angle of elevation would have to be employed when using the E than when using the F. Furthermore, as the ionospheric absorption decreases markedly with increasing frequency there does not seem much point in using a relatively low frequency in order to secure reflection from the E, when a higher one may be relied upon to be reliably returned from the F.

Utility of bands

	3.5 Mc/s	5.0 Mc/s	6.5 Mc/s
Most important period of use.	Early morning and late night according to season.	Late afternoon and early evening according to season.	Period ranging from 0900 to 1500 in December to 0800 to 1900 at equinox.
Approximate ranges at time of use.	750 miles.	600 miles.	700 miles.

GEAR FOR AMATEURS

IT is expected that amateur transmitters will soon need a large quantity of components, accessories and other apparatus; to help the industry to meet this demand, the Radio Society of Great Britain (Little Russell Street, London, W.C.1) has issued a list of what is likely to be needed. Copies are available to manufacturers.

STABLE VHF OSCILLATORS

Design of a Tunable Line Oscillator for 280-450 Mc/s

By B. J. SOLLEY

BOTH for laboratory and communication purposes it is desirable that an oscillator should have a high degree of frequency stability. At the higher frequencies this becomes even more important, since with direct modulation a mixture of AM and FM is detrimental to efficient operation.

At the lower frequencies highly stable operation is obtained most commonly by thermostatically controlled quartz crystals. The technique of frequency multiplication is useful for extending the range of operation up to the limit of useful power amplification at the higher frequencies. Above this limit resonant transmission lines and cavities are employed in order to obtain a comparable degree of frequency control, temperature compensation being used where the greatest possible constancy is desired.

In the case of lines of very high Q the maintenance of temperature constancy is rendered more difficult by the large physical size of the line elements and various methods of compensation have been devised to overcome the effects of temperature changes. In the case of copper a change in length of about 16 parts per million per degree Centigrade occurs and a frequency change of corresponding order results. At certain frequencies the frequency change may be even greater than this due to changes in inductance with skin effect.

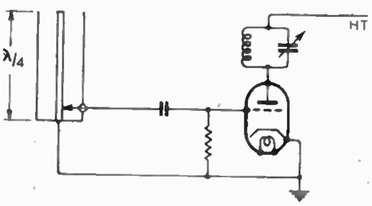


Fig. 1. Tuned-grid, tuned-anode oscillator with quarter-wave resonant line as the grid circuit.

In the absence of thermostatic control the most useful methods of combating temperature effects are: (1) the use of materials of low expansion coefficient, such as "Invar," and (2) automatic capacity compensation. The second method makes use of a small capacity formed by a disc placed in close proximity to the line and so disposed that the capacity decreases as the line length increases, so providing a compensating frequency adjustment. The capacity law may be so adjusted as to provide good compensation over a range of frequencies without the need for adjustment, and this law is readily calculable in any particular case. Unlike crystal control circuits, however, much greater consideration must be given to the manner of connecting a resonant line into an oscillator since the frequency is very sensitive to reactive loading and the Q is maintained only under conditions of extremely light resistive loading. At the higher frequencies at which lines are used the power factor of many materials increases rapidly and the advantages of an initially high Q resonator may be easily forfeited, unless the greatest care is exercised in the design. Some indication of the difficulties which may be encountered in this respect can be gained from the author's experiences in the development of a tunable oscillator for laboratory use in the 50-100 cm. range.

Design Requirements

The instrument was required to fulfil the need for an oscillator with a carrier of high stability and low power, capable of being amplitude or pulse modulated, with inappreciable resultant FM content, and having smooth continuously variable frequency adjustment, with the minimum of controls, covering a range of 280 to 420 Mc/s.

The overriding consideration of frequency stability pointed to the use of a resonant line as the tuning element at the frequency specified, in order to obtain a high Q with the possibility of some form of micrometer tuning adjustment.

A consideration of the conventional methods of using lines at these frequencies shows that there are two basic systems, using acorn valves at low power. These are shown in Figs. 1 and 2. The first is the well-known tuned-grid tuned-anode circuit with the resonant line acting as the stabilising element in the grid circuit operating in the ¼-wave shorted mode.

The features which decided against the use of this circuit, and its variations, in the present case were the dual tuning adjustments and the manner of connecting the plate tank circuit.

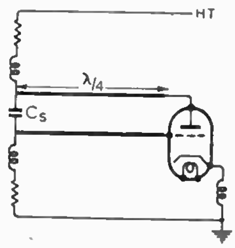


Fig. 2. Colpitts oscillator with quarter-wave tuned line frequency control.

The circuit of Fig. 2 is the more popular Colpitts oscillator adapted for use with lines. The cathode choke is inserted in order to permit the cathode to assume a potential determined by the grid-cathode and plate-cathode capacities. More efficient operation is sometimes obtained by the use of a ¼-wave concentric line for the cathode-heater feed so as to present a higher impedance between cathode and ground. Tuning may be accomplished by varying (a) the line length, by means of a sliding shorting condenser, (b) a capacitor placed at or near the potential antinode at the valve end of the line, or (c) the condenser C_s. When the latter method is used the end of the line is no longer a potential node and may commonly assume a potential about half of that which exists at the other end of the line. With this system the mode of resonance may vary effectively from a $\frac{1}{4}$-wave to a $\frac{3}{8}$-wave condition.

The principal objections to this circuit are due to the direct connection of the valve into the line, thus presenting a substantial resistive and reactive loading due to

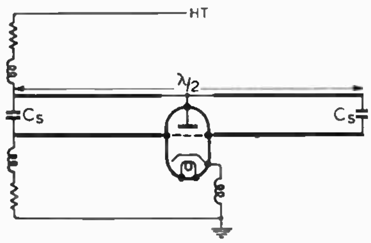


Fig. 3. Colpitts circuit with half-wave line.

the grid-anode capacity. The reactive loading has the effect of increasing the line length, which must be shortened in order to restore the frequency. This results in loss of Q in addition to the loss caused by the power factor of the valve capacity.

An improvement is effected with push-pull operation since the effective loading is halved. Similar improvement may also be obtained by the use of the single-valve circuit shown in Fig. 3. In this case the valve is placed at the centre of a half-wave line shorted at each end. The valve loading is thus shared equally between the two $\frac{1}{4}$-waves each side of the valve. A third method suggested to overcome the defects mentioned consists in the use of a $\frac{1}{4}$-wave line as before, but with the valve tapped down to a point

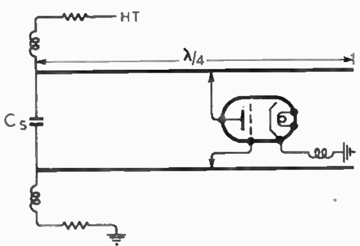


Fig. 4. Quarter-wave line tapped to reduce losses.

of lower impedance nearer the short. This case is shown in Fig. 4. A considerable gain in stability is obtainable by using the method of Fig. 4, but as will be shown later, an even better performance can be achieved with a similar circuit using a different coupling principle.

The problem of damping, and the maintenance of high Q, led to a reconsideration of some previous work on the design of a selective absorption wavemeter operating in approximately the same range of frequency and using a concentric line. Briefly, this wavemeter consisted of a capacity-tuned concentric $\frac{1}{4}$-wave line of high Q, the variable tuning capacity having the form of a spring-loaded plunger facing the "open" end of the inner member and actuated by means of a micrometer screw with 2in. thimble of special design. A coverage of 260 to 435 Mc/s is obtained for a linear plunger travel of 5 mm. at the rate of one turn per mm., giving a total of 500 scale divisions of the thimble.

The high Q of this line is maintained by attention to the following points:—

1. The ratio of radii is 3.4, this being nearly the optimum value with any given outer radius.

2. An outer diameter of $2\frac{1}{2}$in. is used, giving a theoretical Q of 4,000 or more for a silver-plated line.

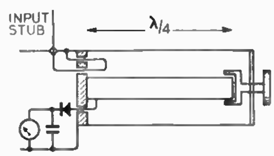


Fig. 5. Concentric line wavemeter of high Q.

3. No connections are made at or near the high potential end of the line. For example, the small input coupling loop projects only a short distance into the cavity of the line; the detector is tapped into the inner member at a small distance from the short, equal to about 5 per cent. of the line, and the inner member is practically self-supporting from the centre of the shorting block, a polystyrene spider being used to maintain concentricity at a position about $\frac{1}{4}$ of the line, reckoning from the shorted end.

These details are illustrated in the diagram of Fig. 5. All the conductors pass through the shorting block via small holes in push-fitted ebonite or polystyrene bushes. No details of the micrometer are shown.

The excellent results obtained with this instrument seemed to ensure a ready-made basis for the design of a stable tunable oscillator, if the problem of valve loading could be solved to permit the use of a small acorn triode. The familiar technique of tapping the valve down the line was tried and discarded as being unsuitable since the minimum tap position for the bare maintenance of oscillations was still found to give

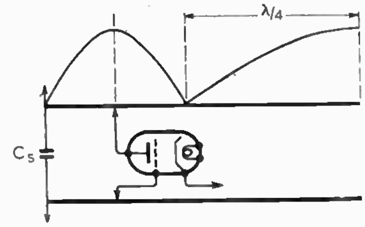


Fig. 6. Complex wave distribution giving increased frequency of operation.

excessive damping, in addition to undesirable capacity loading. A curious point of some interest was found to be present with this type of coupling, namely, the possibility of complex wave distribution. Under certain conditions it was found that a frequency very much higher than that to be expected from calculation could be obtained. An investigation of this effect with a twin line of greater length showed that this was due to multiple $\frac{1}{4}$-wave operation. One distribution most readily obtainable is shown in Fig. 6. The valve capacity is equally distributed between the two "deficient" $\frac{1}{4}$-wave sections, and the third section is a complete $\frac{1}{4}$-wave, so that the resultant oscillations may have a frequency greater than twice the original frequency for normal distribution. This distribution is easily obtained when the cathode tuning is favourable, and is analogous to the vibration of a string in harmonic mode.

Loop Coupling

Experiments along these channels showed that any direct connection to the line at positions at all in excess of about 5 per cent. of the line-length resulted in considerable damping. Thus for one particular case, with the valve tapped in at the minimum position for oscillation, the Q had been reduced to some two or three hundred. As a consequence it was

Stable VHF Oscillators—

decided to try purely indirect coupling by means of a loop, so as to eliminate any direct connection and to remove the valve and its mountings from the field of the line. A series of experiments were made using the circuit of Fig. 7 with a Mullard RL18 valve as oscillator, this being of a type convenient for making the necessary connections and capable of oscillating up to a limit of some 800 Mc/s.

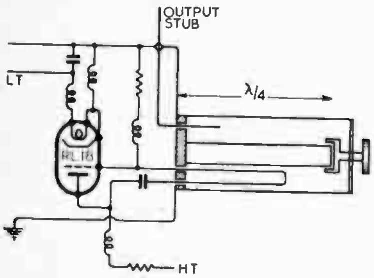


Fig. 7. Quarter-wave oscillator with external valve and loop coupling.

In the first experiment the loop dimensions were 3 cm. by 1 cm. of No. 16 SWG copper wire. No oscillations were obtained. When the loop was increased to 4 cm. by 1 cm. oscillations were detectable, with the plunger fully home (plunger face about 1 mm. from the end face of the inner member) at a frequency of 344 Mc/s. On reducing the tuning capacity the frequency rose steadily to 396 Mc/s and then the oscillations seemed to stop. It was found that the frequency had jumped to a new value of 337 Mc/s. Further reduction in tuning capacity resulted in only a slight rise to a maximum of 341 Mc/s at minimum capacity setting. On reversing the tuning procedure the frequency dropped slightly to 334 Mc/s, then jumped up suddenly to 383 Mc/s, from which value it decreased steadily to its initial value of 344 Mc/s for maximum capacity setting.

Evidently the circuit couplings were producing the same effect as is frequently obtained with tight mutual coupling to single-valve oscillators, and known as Ziehen or frequency-jump effect.

During these experiments it was noted that a rather high degree of frequency constancy was present at various points, and that the tuning calibration below the "break" corresponded roughly with that obtained using the same line in its wavemeter function. It was assumed, therefore, that the nearly uniform frequency present above the break must correspond to the loop resonant frequency.

It is known that, unlike the usual double-frequency effect in passive coupled circuits, in the case of an oscillator where a double frequency results from tight coupling of a secondary mesh, the oscillations cannot occur on both frequencies at once, although it can occur on either according to the distribution of impedance between the two meshes. This proved to be the case in the present oscillator.

Loop Dimensions

In this case the solution to the jump effect appeared to be the obvious one of displacing it so as to occur "outside" the desirable range of the instrument. In order to achieve this a closer investigation of the jump effect was undertaken, using loops of various dimensions. Curves were drawn indicating the behaviour of the system for each change. Some of these are reproduced here in Fig. 8. In each case a plot of the line is given operating in its wavemeter function, since this represents fairly closely the natural resonance of the tuned line by itself.

For the first three curves of Fig. 8, the low-frequency portion of each one, i.e., above the break, indicates that oscillations are

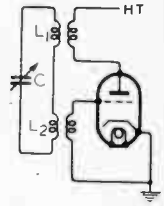


Fig. 9. Meissner oscillator circuit.

taking place at a frequency determined by the loop dimensions, while the high-frequency portion of each curve, below the break, shows that the frequency at each point corresponds fairly closely to the natural frequency of the line itself. The actual frequency obtained is somewhat higher in each case than that of the line. This may be attributed to the fact that the loop coupling reduces the reactance of the line in accordance with the usual theory of coupled circuits. This effect is therefore quite opposite to that which usually results due to the valve capacity, as in previous circuits, and as such constitutes a very valuable gain, since it permits the use of a slightly longer line and hence of a greater initial Q. In the last curve of Fig. 8 the break point has been displaced to a position "outside" the range of the line, and the frequency is dominated by the line tuning only.

The system is very similar to the Meissner oscillator circuit shown in Fig. 9. Here the grid and plate coils are coupled not directly but via a resonant link circuit $L_1 L_2 C$, which is designed for high Q and controls the frequency of oscillations. The resemblance is further substantiated by the fact that under certain conditions the loop may be in-

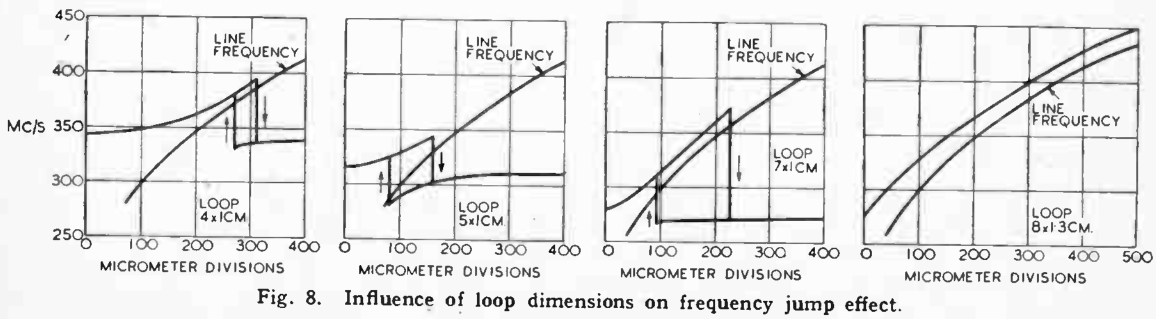


Fig. 8. Influence of loop dimensions on frequency jump effect.

duced to take charge of the frequency with little influence due to the line. This could be produced with heater-cathode chokes of certain value, and may be explained on the basis of cathode potential changes. If the cathode is permitted to assume a potential sufficient to provide a high degree of grid-anode coupling at the loop frequency, then the loop becomes a preferred resonant circuit with consequent loss of control by the line. Thus, optimum limits were found necessary for the choke values, outside of which the effects mentioned could occur. In the later experiments these consisted of five turns of No. 22 SWG wire wound on $\frac{1}{4}$in. diameter polystyrene formers with one turn spacing.

It appears then that the oscillator is intermediate in character between a Meissner and a Colpitts. Were the loop split into independent grid and plate sections with no direct coupling, the circuit would then be a true Meissner. The physical difficulty of achieving this is evident from the nature of the tuning line, in the field of which both sections must be placed for coupling into the line. An analogous situation arises in the case of magnetostriction oscillators, in which grid and plate coils may be so approximated that self-oscillation may result when the rod is removed, the frequency being that of the coupling coils.

Oscillator Stability

Some curves illustrating the stability of the present oscillator are given in Fig. 10. The performance was found to be quite adequate for the purpose for which it was required, and no attempts were made to obtain any improvement in the instrument other than a slight extension of the frequency range.

Some indication of the potentialities of the oscillator may be gained from the following representative figures:—

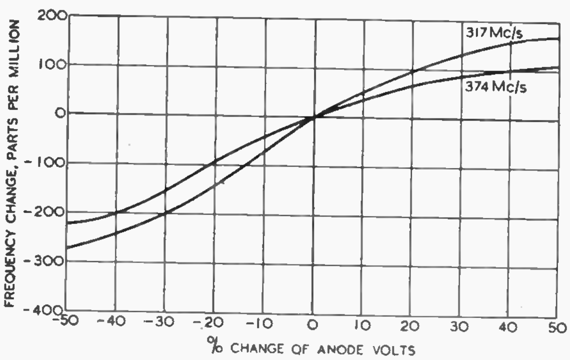
Frequency shift for 12 valve replacements=0.16 Mc/s at 338 Mc/s.

Frequency shift for 50 per cent. modulation at 400 c/s with 10 mW output=0.11 Mc/s at 317 Mc/s.

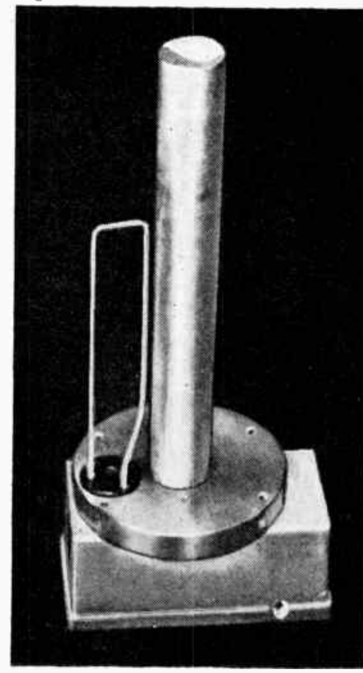
Maximum drift on stabilised power pack for four one-hour periods=0.11 Mc/s at 317 Mc/s.

Maximum overall calibration change over one year=0.75 Mc/s from 280 to 450 Mc/s.

The latter figure includes changes due to mechanical factors associated with the tuning mechanism. An identical oscillator fitted with a pre-set end-cap and tuned to 400 Mc/s has given an overall frequency change of the order of 0.2 Mc/s at the end of a one-year period.

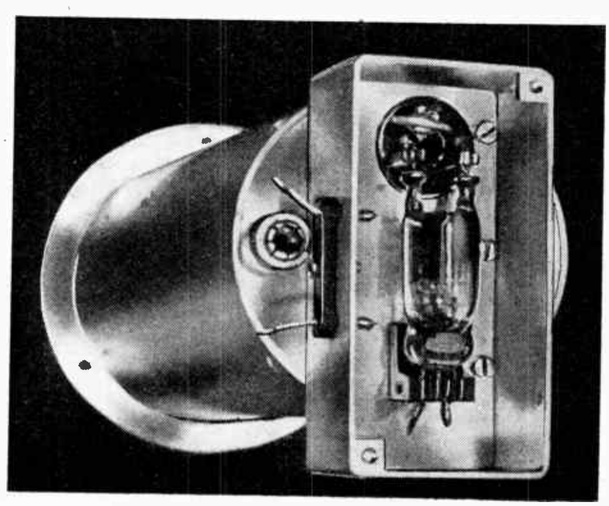


(Left) Fig. 10. Frequency stability of oscillator of Fig. 7 at 317 and 374 Mc/s.



(Right) Inner conductor of concentric line and coupling loop.

These figures represent a considerable improvement over any other oscillator of comparable simplicity of design which has been tried. Further refinements could without doubt be made for purposes where an even higher degree of constancy is desired. The most obvious one would be to use a line of larger diameter in silver-plated "Invar" or similar material, with some capacity compensation along the lines previously described.



View of end of quarter-wave line with screened valve mounting.

THE NEW RECEIVERS

Discussion on "Design of Broadcast and Television Receivers for the Post-war Market": Radio Section, I.E.E., 17th April, 1945

THE discussion was opened by L. H. Bedford, M.A., B.Sc., who said that the two main factors influencing the trend of design after the war would be (a) the expansion of television and (b) the increase of labour costs in the radio industry relative to the average increase for industry as a whole. Television would alter the pre-war ratio of simple to elaborate sets. The latter might be expected to be replaced by television receivers, the broadcast sound receiver being eventually regarded as the "second set." The solution of the economic problem of supplying sets at price levels which would be regarded as "good value" appeared to lie in the mechanisation of manufacturing methods, the standardisation of components, including valves, and the omission of unnecessary elaborations, e.g., the "magic eye." Push-button tuning, although technically frivolous, represented a logical answer to the public demand for simplification of controls, and was likely to be a permanent feature of all but the simplest sets.

The very extensive development of radar during the war appeared to affect television only to a limited extent; apart from a much-extended knowledge of pulse and time-base circuits, the main advance appeared to be in the production of improved screens and electron guns for cathode-ray tubes.

In the discussion which followed it was pointed out that the home market would be able to absorb only a fraction of the potential output of the radio industry if it continued at its present level of production. There was, however, a world shortage, but we should have to act quickly and improve our production planning if we were to compete successfully with other countries for this market. For the immediate post-war period we should concentrate on sets designed primarily for export which could also be sold in the home market.

WHERE WE LEFT OFF.—A good example of a "television only" receiver of 1939—the Murphy A56V. The equipment embodied 15 valves, plus 3 rectifiers, and cost £30. Picture size was 7½ins. by 6in.

The pre-war broadcast receiver attempted to combine too many functions; it was difficult to tune on short waves and the quality of reproduction from the local station was often spoilt by AVC. There was much to be said for the idea of two sets for every household—a quality receiver for the local station and, for long-distance reception, one of the export models.

Valve Standardisation

In the past, British sets for export were often equipped with American valve types to facilitate servicing; there was an urgent need for a comparable British standard range of valves.

The development of miniature components during the war would have some influence on design, particularly in relation to car radio receivers and "personal" portables, but it was necessary to guard against the temptation to reduce unduly the size of high-powered sets until we had also discovered a "miniature watt."

A lively argument developed on the desirability of including a "magic eye" tuning indicator. Several speakers claimed that it gave them satisfaction to know that they were accurately tuned, even if they could not detect any difference by ear. Others suggested that an ordinary broadcast receiver should be tuned by ear and that provided the quality was acceptable the exact tuning point was immaterial.

On the question of providing higher quality of reproduction of sound transmissions, it was held that too much emphasis had in the past been given to high frequencies in the "kilocycles" region and that there was a tendency to overlook distortion at the lower end of the scale. The taste of the general public, long debased by hearing only cheap receivers, would have to be re-educated before high-quality sets could be regarded as a commercial proposition, and to accomplish this it would be necessary to set aside a B.B.C. channel—probably at UHF—which could be relied upon to maintain the highest quality throughout the day.

The opener's remarks on the limited contribution which radar technique has to make to the development of television receiver design were generally welcomed as a salutary check to popular misconceptions fostered by imaginative articles in the lay Press.

In the present state of the art, projection methods could not compete economically with direct viewing of the image on the fluorescent screen. There was a strong case for standardising ordinary cathode-ray tubes, and here we might give a lead to valve manufacturers. The development of tubes for projection was a legitimate field for unrestricted competition.

Picture Brightness

There was room for improvement in the brightness of direct viewing screens, so that they could be used in a normally lighted room. A tube face with a surface designed to discriminate against reflections from external sources would facilitate a solution.

Simplification of controls in post-war television sets was essential; both focusing and synchronising controls should disappear, leaving only those for main tuning, sound volume and brightness. The cost of the set to the purchaser should include any special aerial equipment needed. There would be a limited market for comprehensive instruments with provision for broadcast, television and gramophone reproduction. If housed in a single cabinet this would make an unwieldy piece of furniture, and it was worth while considering the possibility of building such equipment on the unit system.

SLOW-SPEED RELAYING

Reducing Bandwidth at the Transmitter and Restoring it at the Receiver

By W. STOCKMAN
(Editor of "Populär Radio," Stockholm)

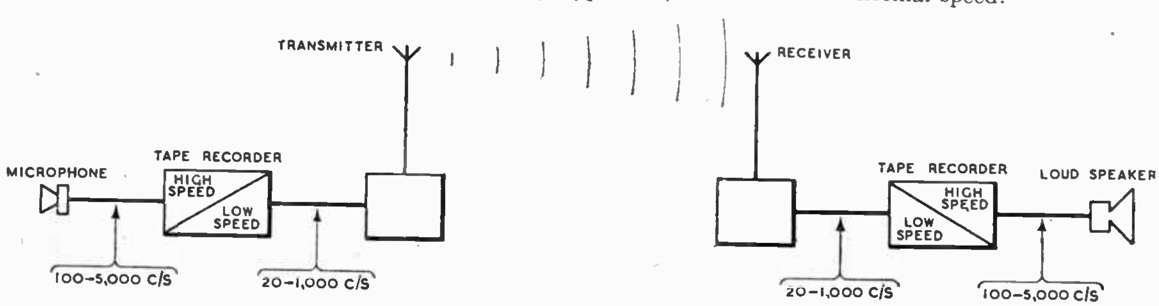
IN long-distance relay transmission of speech and music the quality is usually more or less destroyed by atmospherics and selective fading. When listening a short time ago to a special broadcast relayed by the Swedish broadcasting network, the following idea, which the writer had in 1942, again turned up. A speech, which is to be broadcast, might be recorded on disc or tape and, in later modulating the transmitter, reproduced at a lower speed. The speech frequency would then be lowered in the same proportion as the speed radio. When receiving this transmission, the speech would be recorded at the lower speed and afterwards reproduced at the correct speed. Making use of this process, the bandwidth of the receiver may be reduced in proportion to the speed ratio without cutting any high frequencies, and as a consequence the noise level will be lowered and the influence of selective fading reduced. Ordinary fading can be minimised by using diversity receiving equipment.

Of course the transmission cost would be increased due to the increased sending time, but would it not be worth the extra cost to have the speech transmitted with greatly increased clarity and without laying undue strain on the listeners' ears? The method seems quite feasible as tape recording is often used both at transmitter and relay station.

Naturally this method makes it impossible for listeners outside the service area of the relaying station to receive the transmission with ordinary apparatus, but this fact seems to be rather unimportant when the transmission is intended for a different country.

In practice a frequency range of perhaps 100-5,000 c/s would be transposed to 20-1,000 c/s. The lower frequencies in this range will, using ordinary equipment, be reduced in the modulating amplifier of the transmitter and in the low-frequency circuits of the recording apparatus, but in the case of speech this may be rather an advantage, and in music transmission it is better to lose some bass notes than having the entertainment value spoiled by severe noise and distortion.

Using the new method, the transmitting station in getting into touch with the relaying station would only have to announce for example: "This speech will be transmitted at one-fifth normal speed."



Illustrating the process of frequency transposition at transmitter and receiver.

VALVE TESTING

Rapid Determination of Amplification Factor and Anode Impedance Under Operating Conditions

By F. E. PLANER, Ph.D., M.Sc.

It is often necessary to determine rapidly the approximate values of the amplification factor and anode impedance of a valve. While there exist, of course, bridge circuits which enable these quantities to be measured quickly and accurately, such instruments may not always be available. The setting up of suitable bridges, or the measurement of the static valve characteristics, in particular in the case of multigrid valves, where the operating conditions would have to be established first, is often a somewhat lengthy process.

The following notes describe a simple method which allows the rapid determination of these two quantities without requiring any major changes in existing circuits.

Fig. 1 shows the equivalent circuit of a resistance-coupled amplifying valve having an amplification factor μ and anode impedance P. R is the anode load across which the output voltage E_1 appears, and E_0 is the generator voltage which is given by $-\mu E_g$, where E_g is the alternating voltage impressed upon the grid of the valve.

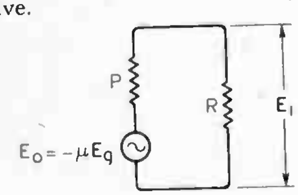


Fig. 1. Equivalent circuit of a resistance-coupled amplifying valve.

If now the load resistance is shunted by a condenser having a capacity C, as shown in Fig. 2, the output voltage will fall to a new value, E_2. Connecting this condenser across the anode load does not affect the operating conditions of the valve, and both the anode and cathode potentials remain unaltered. If the frequency of the generator and the values of C and R are known, μ and P may be determined merely by measuring the AC grid voltage E_g and the output voltages with and without the condenser connected across R.

The anode impedance P may then be found as follows:—

Referring to Fig. 1, $E_1 = \dfrac{E_0 R}{P + R}$.

Similarly $E_2 = \dfrac{E_0 Z}{P + Z}$, where Z is the impedance of C and R in parallel. Substituting for Z it will be found that the absolute value of E_2 is given by the expression $E_2 = \dfrac{E_0 R}{\sqrt{(P+R)^2 + \omega^2 C^2 R^2 P^2}}$.

Dividing E_2 by E_1, and solving for P finally gives for the anode impedance:—

$$P = \frac{1}{\dfrac{\omega C}{\sqrt{(E_1/E_2)^2 - 1}} - \dfrac{1}{R}}, \text{ where}$$

$\omega = 2\pi \times f$ (frequency in c/s).

If a decade condenser box is available or a beat frequency oscillator, either C or f may be varied until E_2 is exactly 3 db. below E_1, or $E_1 : E_2 = 1 : 0.707$. The above expression than simplifies to $P = 1/(\omega C - 1/R)$.

Once P has been determined μ may be found from the expression for E_1. Disregarding the negative sign which merely indicates the phase relationship, we have

$$E_1 = \mu E_g \frac{R}{P+R}$$

$$\text{or } \mu = \frac{E_1}{E_g}\left(\frac{P}{R} + 1\right)$$

It is evident that the value of C must not be comparable with that of the stray capacitance of the circuit, and the frequency should be chosen accordingly. Either 50 c/s. or 1,000 c/s. will in general be found quite suitable for the measurement.

The method may be extended to inductive anode loads, but the resulting expressions will then become more complex. One application of the above principle would consist in the provision of

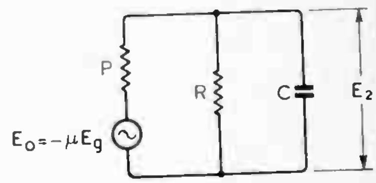


Fig. 2. The addition of a condenser C across the anode load resistance causes a fall in the AC output voltage. If C, R and the frequency are also known the amplification factor and anode impedance may be calculated.

suitable push-button operated condensers in electronic devices enabling rapid checks on valve characteristics to be made.

HARDY ANNUAL

THE aim of the compilers of the B.B.C. Year Book for 1945 has been to review, not merely the broadcasting history of 1944, but the work of five years of wartime broadcasting and its effect upon the B.B.C.'s activities last year.

Wireless World readers will be especially interested in the article by Sir Edward Appleton who, in reviewing recent radio progress, adds "it is my view that *revolutionary* changes in our ordinary radio services, such as broadcasting and television, are not to be expected as a result of the intensive effort of recent years." If local stations for ultra-short-wave broadcasting are added to our present services in this country, Sir Edward states that it is almost certain that at least some of them will use FM.

In the article by H. Bishop, chief engineer, some interesting facts on the extension of the Engineering Division and the Training School are given. In 1939 the Division numbered 1,300, last year there were over 4,000. Over 800 women and 1,600 men have passed through the Training School since it was opened in 1941 for the training of wartime recruits to the Engineering Division.

The book, which includes 40 pages of photographs and a comprehensive reference section, costs 2s. 6d.

TELEVISION STANDARDS

Has the 405-line System Been Fully Exploited?

By O. J. RUSSELL, B.Sc.

THE problem of the development of television as a general medium of entertainment, has been the subject of intense discussion in technical circles recently. The proposals outlined in the Report of the Television Committee have been the main reasons for this renewed interest in television. It is felt, however, that certain ideas that have been expressed by various persons, neglect quite a few important technical considerations, while on the other hand important factors which, although not exactly within the province of technical designers, are still of importance in the development of a television entertainment service, have been neglected.

Possibly the most controversial point in the Report, and the point that has raised the most heated discussion, is the proposal to retain the present definition standard of 405 lines, interlaced. The proposal has been attacked in general upon the grounds that this is an inadequate standard of definition, and that it is wrong to commit the country to this standard for some years to come. This attitude is clearly expressed by R. W. Hallows, who regards the proposal as "flogging the almost dead horse of 405 line television."[1] It is generally recognised that the suggested 1,000-line system proposed as the next advance in British television technique, is unlikely to be technically or economically practicable for many years to come.

It is extremely interesting, however, to consider whether a standard of 405 lines actual definition is inadequate. There is a strange dearth of information upon the actual resolution of current high definition systems. This is all the more puzzling when it is recalled that the theory for calculation of resolving power of television systems using accurately defined apertures has been exhaustively studied. In actual practice, however, the effective spot size of modern electronic television systems is a rather ill-defined patch approximately circular in shape. Current trends in America are expressed by the adoption of 525-line transmission standards, which necessitate vestigial sideband transmission in order to accommodate the necessary bandwidth at the lower carrier frequencies. It has been proposed that British standards should be amended to the higher number of lines, in order to utilise the radio bandwidth available most effectively. The bandwidth required for 525-line transmission would be 3.2 megacycles, as compared with the 1.9 megacycle video bandwidth required for the Alexandra Palace signals.

Comparison With Cinema Standards

A consideration of the necessary number of lines required for a satisfactory television image may lead us to some startling conclusions. While no definite resolution figures have been published upon the performance of high definition systems, it seems reasonably certain that nothing like the theoretical resolution has ever been attained. Naturally, resolution of television images is referred to the cinema screen as standard, which for all practical purposes, may be taken as perfection. Some figures are available for the resolution of cinema film emulsion,[2] but the actual resolution attainable in a normal projector is less than this. Factors such as the projection lens aberrations, inevitable mechanical imperfections in the projector, coupled with shrinkages and distortions of the film itself, reduce the definition appreciably. The resolution of a projected image from a 16 mm. film under the best conditions corresponds to about a 700-line image in the centre of the field, but only to 300 lines or so at the edge of the field. The resolution of the cinema under ideal conditions, may attain to a standard of 1,000 lines, but it is doubtful if the average cinema definition really exceeds perfect 600-line standards at the centre of the picture. The estimates made by various workers upon the required minimum definition for cinema standard definition make rather interesting reading. Thus an early article by J. H. Owen Harries,[3] based upon a figure of 0.00065 radian for the resolving acuity of the human eye, and assuming the best cinema seats with a viewing angle of 30 degrees, places the definition as that of a perfect 308 lines. When the London high-definition service was opened, surprise was expressed at the use of 405-line definition, which was tacitly assumed to be more than adequate. The opinion has been expressed that 405-line images were capable of results little short of perfection. Thus E. Wikkenhauser[4] ". . . according to many theoretical investigations, a 240-line image gives ample definition for home use, and the 405-line picture would have a definition nearly equal to a large cinema screen, *which definition is really not necessary for the home*" (my italics).

Furthermore, we may quote E. H. Traub[4] as showing that a definition of the order of a perfect 240 lines should be entirely adequate: "It has been shown again both on paper and in practice, that 180 lines represents a highly satisfactory definition sufficient for a public service, and that 240 lines gives a picture of such excellence as to leave no room for criticism whatsoever. To go beyond this figure would be to go beyond the capabilities of the resolution of the human eye, which can be regarded as a minute of arc under the worst conditions." In the same symposium of representative opinion, E. L. Gardiner,[4] after pointing out that in some instances mechanical systems (in which the spot size is accurately defined) gave better pictures than some cathode ray systems using many more lines, comes to remark . . . "Opinion

Television Standards—

has during the last year been unanimous that 240 lines represents a definition which is quite satisfactory for the majority of purposes," and further goes on to say . . . "I would advocate the use of a 180-line standard . . . at 50 frames as quite adequate for entertainment purposes."

While it is clear therefore, that a definition standard of 405 lines is adequate when fully exploited, it is also clear that the quality of the images as received on normal commercial receivers was nowhere near the maximum theoretical resolution. It is questionable whether the actual home receiver definition was even equivalent to that theoretically attainable from a 200-line image. The absence of any definite figures upon the performance of television receivers is thus more understandable. It appears fairly certain that a perfect 405-line image would be adequate for all purposes and would even approach the maximum necessary for home use. It may therefore be a little premature to abandon all interest in the present standards, as Mr. Hallows would have us do.

Spot Size

One of the main factors reducing the effective resolution of electronic television receivers is the increase in size with brightness of the cathode ray spot. Further, the cathode ray spot itself is not sharply defined, and it seems possible that some improvement in the production of a more accurately defined spot may be expected. It seems rather pointless to increase the number of scanning lines when the spot size is already too large. It is as well to remember that American 441 line receivers employing 6-inch tubes deliberately sacrificed bandwidth as the performance of the cathode ray tube was unable to exploit the full bandwidth.

It is perhaps as well to remark that this "modulation increase of spot size" is a problem which so far has defied solution by vacuum tube engineers. To quote E. L. Gardiner again,[4] "Unfortunately the public, and a great many engineers of limited television experience, still imagine that the number of scanning lines employed is the deciding factor in the clarity and excellence of a received image. While this is largely true of image analysis at the transmitter, it does not hold very closely by the time the viewing screen is reached, owing to the loss in image quality arising from distortion and high frequency losses through the system." This remark seems true enough to repeat to-day, as a number of factors are often overlooked, which are of vital importance in deciding the quality of the television image. It must be remembered, for example, that the iconoscope type of camera does not provide a true DC level, and has no clearly defined contrast characteristic analogous to a photographic "gamma." The recent American orthicon camera apparently does have a stable gamma characteristic, and provides a definite DC level. It is probable that some of the improved performance of the new American systems may be due to this new camera, rather than to the increase in the number of scanning lines.

From the above it will be fairly clear that no undue concern need be felt at the prospect of British television standards remaining at the present definition level of 405 lines for a considerable period. At the same time it is to be noted that a great deal of experimental work needs to be done before the performance obtained with the present system reaches the maximum practicable. Some of the points which need investigation have been touched on in this article.

Interlacing

There is a further point that might be investigated is the desirability of retaining interlacing, or of employing a sequentially scanned picture. It appears certain that interlacing does offer a number of difficulties, and some improvement in the resolution of images might be achieved by employing vestigial sideband transmission to accommodate a 405-line image sequentially scanned at 50 frames per second. Such a transmission could be received upon present receivers with the minimum of alteration, and for a further slight cost the old receivers could be modified to utilise fully the extended bandwidth.

It should perhaps be pointed out that technical considerations are not the only considerations necessary for the provision of a public television service, and that æsthetic and psychological factors may be of considerable importance.[5, 6]

References

1 "Television Committee's Report," by R. W. Hallows, *Wireless World*, May, 1945, pp. 130-132.

2 "Optical and Mechanical Characteristics of 16 mm. Motion Picture Projectors." *Nat. Bureau of Standards Circular C.* 437.

3 "Some Developments in Tele-Analysis," by J. H. Owen Harries, *Journal Television Society*, Vol. 1, No. 1, pp. 1-12.

4 "High Definition Television Service in England." *Journal Television Society*, Vol. 2, pp. 34-43.

5 "Objectives for Post-War Television," by J. Worthington, Miner, *Journal Television Society*, Vol. 4, No. 2.

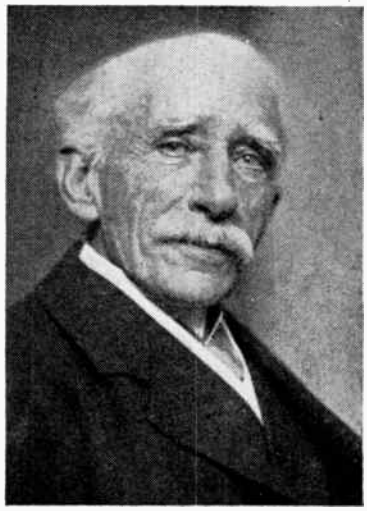
6 "Television After the War," by O. J. Russell, *Journal Television Society*, Vol. 4, No. 3, pp. 60-64.

TO WHAT BASE USES

". . . Then try Virgo pills. You simply swallow two of these pills with a glass of water. Now watch what happens . . ." *Reproduced from the "New Yorker."*

VALVE PIONEER

The Late Sir Ambrose Fleming



IT is with regret we record the death of Sir Ambrose Fleming, D.Sc., F.R.S., in his 96th year, on April 18th.

John Ambrose Fleming was educated in London at University College, Gower Street, and at the Royal College of Chemistry. He graduated B.Sc. and worked at South Kensington under Professor F. Guthrie and presented his first scientific paper on "The Contact Theory of the Galvanic Cell" at the inaugural meeting of the Physical Society in 1874.

He relinquished in 1877 a teaching post at Cheltenham College, taken up in 1874, to go to Cambridge chiefly with the object of working under Clerk Maxwell in the then recently erected Cavendish Laboratory. There for two years, he says, "I enjoyed Maxwell's stimulating teaching and intercourse." In the year that Maxwell died, 1879, Fleming was appointed scientific adviser to the Edison Telephone Co., and three years later to a similar position with the Edison Electric Light Co., formed to introduce incandescent electric lighting into this country.

In 1885 he was appointed Professor of Electrical Engineering at London University; a position he held until 1926.

It was in October, 1904, that Fleming, then scientific adviser to the Marconi Company, whilst studying phenomena in incandescent lamps which had already been observed by Edison, discovered that a perfect device for rectifying the current induced in a receiving aerial existed in a high-vacuum tube containing two electrodes.

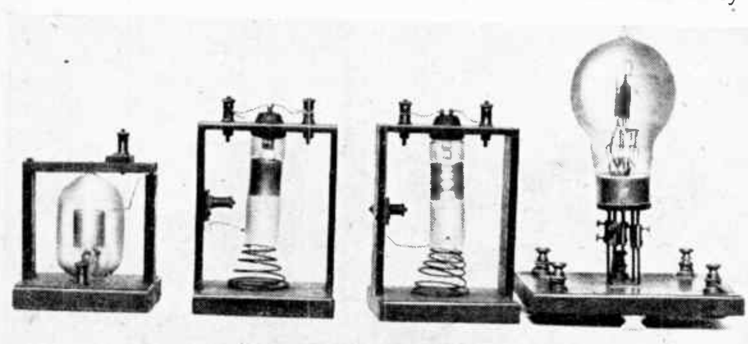
In the following month Fleming took out the fundamental patent, No. 24,850, covering the thermionic valve. The title of the patent was "Improvements in Instruments for Detecting and Measuring Alternating Electric Currents." This valve, which was soon used in practical wireless reception by the Marconi Company, was the first technical application of the emission of electrons from an incandescent conductor *in vacuo*.

The early Fleming valves had carbon filaments surrounded by a metal cylinder, but in 1908 Fleming found that tungsten wire possessed advantages in that it could be heated to a higher temperature.

Writing in *Wireless World* in 1925, Fleming states: "I was well aware that the anode current could be reduced by holding near the valve a permanent magnet, but unfortunately it did not occur to me in sufficient time that this could be controlled by inserting a grid or spiral wire or metal mesh cylinder between the anode cylinder and the filament, and giving to this grid small positive or negative potentials."

Fleming was the author of many scientific papers and standard text books, amongst them, "Fifty Years of Electricity" (1921) and "The Thermionic Valve" (1919), published from the offices of *Wireless World*.

Sir Ambrose received many awards and honours for his work in electrical physics. In 1892 he was elected a Fellow of the Royal Society, and in 1910 was awarded the Society's Hughes Medal. In 1921 he received the Albert Medal (R.S.A.), in 1928 the Faraday Medal (I.E.E.), in 1931 the Duddell Medal (Physical Society), and in 1935 the Kelvin and Franklin Medals. He was knighted in 1929.



Some early types of Fleming thermionic valves.

PICTURE TRANSMISSION

ELEVEN photo-telegraphic services, handling nearly 2,000 illustrations a month, are now operated by Cable and Wireless; before the war there were only three services (to Melbourne, New York and Buenos Aires) transmitting about 45 illustrations monthly.

As the result of technical improvements, speed of transmission has been speeded up threefold. With the present sub-carrier frequency-modulation system the time needed to transmit a photograph 10in. by 6in. is something between 6 and 10 minutes, depending on propagation conditions.

As apparatus becomes more readily available, photo-telegraphic gear will be installed at all the more important of the company's stations. One of the latest additions is a service, at present working experimentally, between London and Colombo, Ceylon. This is a part of C and W's plans to develop telecommunications generally in the SEAC area.

Letters to the Editor

Sets for Export • Misuse of Channels • Tone Control • Television Problems

Export Warnings

I HAVE read with interest the various comments regarding the post-war export market. To my mind the British manufacturer will have to plan on a vastly different scale from that of the past. Having spent a considerable time in both the Far and Near East I, personally, would have hesitated to recommend any British set of the domestic export type. One British domestic receiver which I purchased in the Southern Province of Ceylon arrived in a far from happy condition; no care had been taken regarding the packing. The wood of which the cabinet was made suffered from two major defects; the veneer soon started to blister and crack, while the wood or glue seemed to be the staple diet of white ants. Valves were of a type unobtainable in Ceylon. The aerial coil (of the high inductance type) soon frizzled out, presumably because lightning currents were too much for the 42-SWG wire with which it was wound. Little attention had been paid to mains fluctuations or "tropicalisation"; even the loudspeaker voice coil distorted physically.

My experience has been that the average American set arrives well packed, uses a standard type of valve which one can obtain anywhere east of Gibraltar, care is paid to even the small metal parts and, into the bargain, an excellent service organisation ensures that spares, circuit diagrams, etc., are freely available for some years after the sale.

If we enter the field with the intention of competing with our American friends, then a drastic overhaul of our present valve and component industry is required. Furthermore, this must be backed up by efficient servicing organisations both on the part of component and set manufacturer.

Two solutions appear worthy of consideration: (1) To set up a manufacturing concern at a suitable point in the Near East. (2) For the various manufacturing concerns to agree on a common manufacturing policy and to handle their goods through a common servicing organisation. Solution No. 1 saves shipping and has also the advantage that the many and varied problems become apparent during the manufacturing process. It suffers from the disadvantage of requiring complete agreement between our large and small manufacturing concerns. This, of course, is a little too much to hope for. One could hardly imagine our thousands of valve types being reduced to a mere dozen, all using the same type of base.

Solution No. 2 might be more acceptable to the industry as a whole. It should entail complete standardisation of such items as valves, loudspeakers, transformers, chokes, IF, wave-change switches and certain components. To ease the spares situation and also to assist sales, standardisation should follow normal current American practice wherever practicable. All approved items should bear a national mark as a guarantee of workmanship and design to an agreed specification. Lastly, a controlling authority should be empowered to ban export of any goods or equipment not up to specification.

My concluding comment is that we now have the opportunity both at home and abroad to establish a sane, sound industry. Let us profit by our past mistakes.

JOHN BANNER.

Bredon, nr. Tewkesbury.

FROM HAMBURG.—Philip Walker, Engineer in Charge for the B.B.C. on the Western Front, and a contributor to *Wireless World* before the war, was the first person to speak from Hamburg after the surrender of the city. He sends us this photograph of Wynford Vaughan Thomas, B.B.C. War Correspondent, speaking from a Hamburg studio for War Report on the first day the station operated under British control.

Channel "Hogging"

THE subject of Frequency Allocations, raised in the May *Wireless World*, is very important, but there are some aspects of it which have not been mentioned yet in your pages. As an amateur transmitter I may perhaps be accused of bias, but there does seem to be a good deal of evidence that the present allocations are unsatisfactory. The number of frequencies allotted to fixed and mobile stations appears to bear little relationship to the actual use made of these frequencies. A frequent comment made by amateurs on the operation of commercial fixed services is "Do these stations ever send any traffic?" The general impression is that commercial stations have registered many more frequencies than they use, and even those frequencies which are in use are mainly employed for sendings V's and other channel-holding but otherwise useless transmissions.

It may be relevant to quote here from the *T & R Bulletin*, June, 1937. A careful check was maintained on the band of frequencies between 7,300 and 7,500 kc/s, to ascertain the actual use made by commercial stations of these frequencies. At that time 281 stations were registered at Berne for operation in this band. Though the check was world-wide in scope, and lasted for nine months, only 26 of these stations were heard; the number in regular operation being 16. Of stations not registered at Berne, 47 were heard, but only eight of them on more than one occasion.

It appears that commercial stations spend at least 60 per cent. of their actual operation time in sending V's. Surely this kind of wasteful transmission is unnecessary in the present state of the radio art? It would be enlightening to discover how many of the 45,000 frequencies registered at Berne are ever used, and the proportion of time spent in useful traffic handling. Comparing the sparse occupancy of the commercial bands with the intense occupancy of the meagre amateur bands in pre-war days, it is difficult to understand why the amateur bands are looked upon as fair prey for new services, such as radio heating, not to mention old services such as broadcasting. The commercial stations are able to register as many channels as they desire and give the impression, on paper, that they are in desperate need of fresh channels. There should be some kind of an "occupancy" stipulation to prevent the wholesale appropriation of frequencies in this way.

"SIGNALMAN."

Television "Fallacies"

I WAS surprised to find an old hand like R. W. Hallows perpetuating some fallacies about television in your May issue.

Fallacy number one is to use the London area as any sort of guide. If sound broadcasting had depended for its early success on this area it would have taken another five years to get going. In point of fact, the percentage of licences to houses was, up to the outbreak of war, lower in the London area than in most other thickly populated areas.

The reason, I would suggest, lies somewhere between the very complete entertainment facilities of the capital and pure lack of enterprise in trying new things.

Fallacy number two concerns screen size, and here one finds Mr. Hallows assuming that every television user has large rooms, a large family or perpetually entertains large groups of friends. In fact, the average home has rooms of, say, 100 to 150 sq. ft. and the average viewing group, like the average listening group, will be about four people. For this average home the 7in. by 6in. or 10in. by 8in. picture of pre-war television sets was quite big enough.

The final fallacy is that of standards of definition, and here I smell the cloven hoof of the cinema world. The fact is that there are more picture elements in the 405-line pre-war standard picture than in any 8-mm., 9.5-mm. or 16-mm. home movies. That is a simple matter of arithmetic and photographic emulsion grain size. Incidentally, I wonder if there are 20,000 home cinema fans in London. In the case of the 31-mm. film the position is one of almost equality. The symmetrical arrangement of the elements in the television picture as compared with the haphazard photographic emulsion, appears to be more readily noted by the eye, although I must say that on most of the large picture screens that I saw before the war where lines were visible, the picture was not properly interlaced. In any case the 10in. by 8in. picture viewed at six feet is the same size relatively as a three-foot picture at about twelve feet, and as a full-size cinema screen in the most expensive and presumably best seat in the house.

I have avoided technical references, but those interested are referred to Myers' "Television Optics," and the references therein form a complete statement of the case against fallacy three. By all means let us have the best possible television, but let us not be blinded by false premises into delaying our restart, and further deluding the long-suffering public.

C. W. SHEFFIELD.
High Wycombe, Bucks.

In Defence of Electrolytics

S. GOULD'S remarks (in your April issue) on the "nightmare" of wiring on the underside of some small chassis are timely, but I cannot agree with him on the subject of high-voltage electrolytics.

My experience in the Services has shown me that, provided the manufacturer has had some say in the design—especially the size and method of termination—the modern product is as good as, and sometimes better than, the other components in the set.

D. B. EDWARDS.
Harrow, Middlesex.

Valve Colour Code ?

THERE has been a certain amount of discussion lately on standardisation of radio valves, and it can only be hoped

NEWS CENTRE. —Men of Royal Signals operating the radio equipment at the "Hôtel Scribe", Paris, whence correspondents' copy has been transmitted to this country. This one-time fashionable hotel was turned into a news nerve centre. Bedrooms were converted into broadcasting and recording studios and teleprinters and transmitters installed.

Letters to the Editor—

that pressure being brought to bear will influence all those concerned.

At this juncture it would be a good plan to colour-code valves. The criterion, in my opinion, should be not the *use* made of the valve, but its *useability*, i.e., the code should indicate heater volts (for parallel connection) and heater amps. (for series connection).

The object can be achieved with six colours. The following table shows how the colours might be used for "body" and "dome" markings on the valve envelopes:—

Colour	Lower 2/3	Upper 1/3
Black	1.4V DC	150 mA
Red ...	2V DC	200 mA
Gold ...	4V AC	300 mA
Green	5V AC	—
Blue ...	6.3V AC	—
Grey	Higher voltage	Higher current

Metallised valves of all DC and of the 4V AC types would be unicoloured black, red and gold respectively. 6.3V valves would be metallised blue upwards to the dome, while the dome colour would indicate the heater current for their application in series circuits.

Clear-envelope valves could be coded by small coloured rings near the base for volts and near the dome for current.

The colours suggested are easily remembered, as they closely correspond to the sequence used for the resistor code.

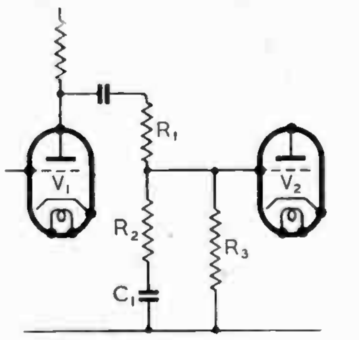
K. E. MARCUS.

Uxbridge, Middlesex.

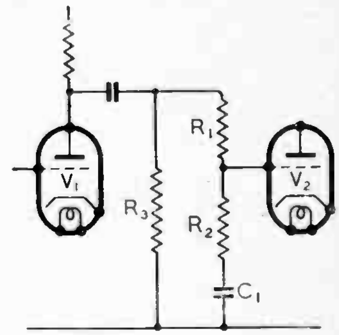
"A New Versatile Tone Control Circuit"

READERS may be interested in the following modification of the usual tone control circuit, as outlined in G. N. Patchett's article in the March issue.

The accompanying diagram



(a)



(b)

(*a*) shows a circuit sometimes used for bass boost, the operative components being R_1, R_2 and C_1.

R_3 has to be included as a grid leak for V_2, and its presence modifies the performance of the circuit since its shunting effect on the combination R_2 C_1 may be serious at low frequencies. R_3 sets a limit, in fact, to the degree of bass boost obtainable.

There is no reason, however, why R_3 should not be transferred to the input side of the tone control circuit, as in diagram (*b*) where it has no effect on the performance of the bass boost circuit, while still providing the necessary DC path between the grid and cathode of V_2.

Surely Mr. Patchett is not justified in suggesting that if bass or treble boost is used in an amplifier the output stage must be capable of handling a "much greater output than normal"; i.e., that a 10 db. boost in the bass calls for ten times the output power? Since such tone control is normally used to correct for a loss in another part of the chain; e.g., recording or pick-up characteristic, or in intervalve couplings, it is unlikely that the output stage would be called upon to handle an abnormal amount of power. The implication is only true if one is attempting to correct for loudspeaker deficiencies by "cooking" the amplifier characteristic.

DOUGLAS WINGET.

London, N.W.10.

Hearing Aids

ALEXANDER POLIAKOFF'S letter in the May issue of *Wireless World* must surely be a revelation to hearing-aid users in this country. I use a "Microelectric" aid of American make, sold at 28 guineas. I was asked 47 guineas for a valve aid before the war, and have never seen anything under £20. How can deaf people avoid exploitation if they are unaware of any reliable organisation likely to help them? I have been asked many times for advice on hearing aids; the high price and fear of being "had" is always a deterrent to purchase. There is an assured market for a reliable instrument at a fair price. More publicity by the National Institute for the Deaf would help us a lot.

R. B.

Catalogue Received.—Radio Instruments, Ltd., Purley Way, Croydon, have produced an illustrated list of transformers and chokes which will be available as soon as the necessary materials are released. Mains as well as coupling transformers are described and a range of transformers with toroidal windings is mentioned.

WORLD OF WIRELESS

B.B.C. STANDARD FREQUENCIES

FOUR of the frequencies employed by the B.B.C. are now controlled to within ± 1 part in 10^6 of the nominal frequency. The following frequencies can, therefore, be used as a reference standard: 200, 6,180, 9,510 and 17,810 kc/s.

Reception of one or more of these frequencies should generally be possible throughout the world for a period each day.

Transmission times may, unfortunately, change with alterations in the B.B.C. services, but the present schedule (GMT) is:—

200 kc/s	0400-1330,	1430-0045	
6,180	0400-1330,	1430-2215,	2230-0045
9,510	0400-0800,	1730-0215	
17,810	0900-1515		

CINEMA TELEVISION

REPORTS from America indicate that there is a growing tendency to link television and cinema interests. This is borne out by the proposals recently made by the Society of Motion Picture Engineers for television frequency allocations for the cinema industry.

The proposals include an allocation of 60 channels in a band of 1,200 Mc/s for an immediate cinema television service with a standard of definition of 800 lines. It is pointed out, however, that 1,200-line transmission is necessary, even for monochrome, to equal the definition of modern films.

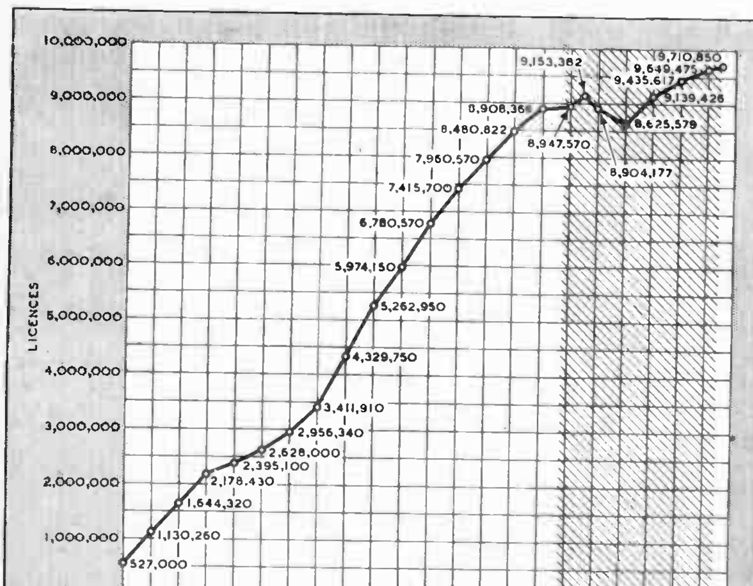
For future development of the service it is requested that a band of 10,000 to 20,000 Mc/s above 6,000 Mc/s be allocated for relay services and colour transmission.

Proposals for the allocation of 75 channels of 20 Mc/s bandwidth for a cinema television network have previously been made by the U.S. National Theatre Television Service as recorded in our January issue.

LICENCE RECORD

IT has just been announced that the record total of 9,710,850 wireless receiving licences in Great Britain and Northern Ireland was reached by the end of March this year. As will be seen from the graph reproduced on this page, there has been a steady increase in the number of licences since December, 1941. Previous to this date there had been a gradual decline from the previous record of 9,153,382 reached in August, 1940.

The remarkable thing is that, despite the shortage of receivers and the many sets that remain unusable because of the shortage of replacement components, the total of licence holders continues to rise.



Effect of the war on broadcast receiver licensing.

World of Wireless—

Moreover, the rise is at a rate as great as, if not greater than, the pre-war years when it was expected saturation point would shortly be reached.

I.E.E. REPORT

THE report of the Council of the Institution of Electrical Engineers presented at the 73rd annual general meeting on May 10th records that, in response to a request from the Postmaster-General, the Council has reconstituted the Committee on Electrical Interference with Broadcasting. The chief task of the new committee is to review the recommendations contained in the Report made in July, 1936, and to consider the desirability of modifications resulting from the introduction of new forms of high-frequency equipment.

At the request of the Air Ministry, a Committee on Radio Requirements for Civil Aircraft has been set up. Its task will be to formulate technical airworthiness requirements for the design and installation of radio equipment in civil aircraft. In view of the urgency of the task, the work of the Committee is being expedited by all possible means.

The total membership of the Institution has reached a new record —26,665; this is an increase of 2,107 on the previous year. There are at present 12,568 corporate members on the register. It is stated that the formation of local Radio Groups has resulted in a marked increase in the membership of the Radio Section, which is now over 2,600.

DR. E. B. MOULLIN

BY his appointment to the new Chair of Electrical Engineering at Cambridge University, Dr. E. B. Moullin returns to the electrical laboratory which he laid out and equipped between 1920 and 1929 when he was a lecturer at the University. Dr. Moullin, who holds the M.A. degree of both Cambridge and Oxford, was appointed Donald Pollock Reader in Engineering Science at Oxford in 1929, which position he still holds.

It is understood the University has been trying to establish the Chair for some years, and that it has now been made possible by the support of the I.E.E., of which Dr. Moullin is a vice-president. He was chairman of the Wireless Section in 1939-40, and is also a member of the Radio Research Board.

Dr. Moullin's considerable research in radio engineering is well known. His studies include work on radio-frequency measurements, background noise in receivers, aerials and dielectric losses. He invented the original thermionic voltmeter manufactured by the Cambridge Instrument Company.

Dr. E. B. MOULLIN.

R.C.M.F. REPORT

THE annual report of the Radio Component Manufacturers' Federation refers to the need for the establishment of some form of central research organisation to cover the whole field of radio development. The view of the Radio Industry Council, expressed in the report, is that any plans for the establishment of a radio research organisation must provide for control to be placed in the hands of the industry. In particular, the council will oppose any plans which involve surrendering the initiative in research to a Government establishment or scientific body outside the industry.

The question of financing such a research organisation is raised by the R.C.M.F., and the suggestion is made that the R.I.C. investigate the possibilities of diverting a proportion of the annual licence fee to this purpose.

The following member firms constitute the Council of the Federation for the ensuing year: Belling and Lee, British Rola, A. F. Bulgin and Co., Morgan Crucible Co., Plessey, Reliance Electrical Wire Co., Tannoy Products, Telegraph Condenser Co., Telephone Mfg. Co., Westinghouse Brake and Signal Co., Wingrove and Rogers, Wright and Weaire.

"SPECTEMUR AGENDO"

THIS is the phrase on a symbolic design presented to the Radio Industries Club and reproduced on the chairman's report presented at the 14th annual general meeting. Translated, it is "By our deeds so shall we be known."

The report records a 21 per cent. increase in membership, which now totals 495. Taking into consideration the membership of the two affiliated clubs in Scotland and Wales, the grand total is 793.

It is recorded that the collections for the Electrical Industries Benevolent Association, taken at the monthly luncheons, amounted approximately to one hundred guineas during the past year.

SIR ROBERT RENWICK, Bart., Controller of Communications, Air Ministry, and Controller of Communications Equipment, Ministry of Aircraft Production, who has been elected President of the Radio Industries Club for 1945/46.

IN BRIEF

America's Old Sets.—According to a recent survey undertaken in the United States for Sylvania Electric Products, more than 29 per cent. of America's broadcast sets are over seven years old, whilst a further 31 per cent. are between five and seven years old.

Patents in America.—It has been announced in New York that the Philips Company in America will, after July 1st, issue its own patent licences direct to manufacturers. Hitherto, sub-licensing under the 700 Philips U.S. patents has been done by large American companies, mainly by R.C.A.

School Broadcasting.—The growing importance of school broadcasting in the new educational system was stressed recently at a meeting of the Central Council for School Broadcasting. The Council's report on the work of the past year states that the number of registered listening schools is now about 14,000. The first summer school, for tutors in training institutions of all kinds, to discuss school broadcasting, will be held in London this year. A school in Tottenham is to be wired in the most up-to-date way as an experiment in post-war installation, and, when completed, can be inspected by anyone interested, by arrangement with the local authority.

Back Numbers.—Our Publishers are anxious to obtain copies of *Wireless Engineer* for the months of January, February and March, 1945. If any of our readers have these back issues, and are prepared to dispose of them, will they please communicate with our Publishers.

FM Possibilities.—It is learned from a recent survey of 111 stations affiliated to the U.S. Blue Network that only one does not intend introducing frequency modulation. At present only three of the stations are operating FM transmitters, but 35 have applied for construction permits and a further 65 intend making application. The remaining seven are undecided.

B.S.W.L.—Details of the activities of the British Short-Wave League, which recently celebrated its tenth anniversary, have been received from the Hon. Secretary, Norman Stevens. The League gives free technical advice to its members, has a "components clearing service" and a station identification service. Further details are available from the Hon. Sec., 53, Madeley Road, London, W.5.

Radio Relay Statistics.—The number of subscribers to radio relay exchanges is still rising—an increase of 24,000 is recorded for the three months to December, 1944, making a total on that date of 551,703.

Short-wave Society.—The Edgware Short-wave Society is being reformed and a general meeting is to be held at the Edgware Conservative Constitutional Club on June 2nd. Old and prospective new members can obtain particulars from E. R. Radford, Hon. Sec., 1, Gibbs Green, Edgware, Middx.

Talking Books.—The Central Library of the National Institute for the Blind has now available 464 talking books, each containing an average of 10 double-sided solid-stock 12in. discs, cut at 200 grooves per inch and rotating at 24 r.p.m. Over 1,700 specially designed reproducers have been issued by the Talking Book Library to individuals and institutions for the blind for use with the "books." Restrictions on record materials, etc., have limited the number of new "books" to 25 a year, and made it difficult to replace worn or broken records.

New Zealand's practice of broadcasting her Parliamentary sessions, in full, on a special wavelength by the 60-kilowatt transmitter 2YA is of interest in view of the recent suggestions that the sessions in the British Parliament should be broadcast. Apart from a few wartime secret sessions, or when information has been given which might have been of value to the enemy, all the speeches in the Dominion's House of Representatives are broadcast.

Quick Work.—All right-thinking members of the communication branch of wireless realise that time is the essence of the contract; they will appreciate the quick work of the Cable and Wireless mobile unit which provided telegraphic and facsimile services for the Press during the closing phases of the war in N. Italy. The unit, following the rapidly advancing troops, started to select a site at Lavezzola and to erect aerial masts at dawn on one day; by noon of the same day telegraphic communication with London was established. By midnight of the next day pictures of the fall of Bologna had been transmitted to London.

Radio Industry Council has now moved back to its old offices, and its address and that of the Radio Manufacturers' Association, Radio Manufacturers' War Export Group, British Radio Equipment Manufacturers' Association, and the Inter-Services Component Manufacturers' Council is 59, Russell Square, London, W.C.1.; telephone: Museum 6901-5.

Channel Islands Appeal.—As we go to Press we have received the following appeal from Radio House, 20, Halkett Place, St. Helier, Jersey:—"As 99 per cent. of the sets of this island were confiscated during the German occupation we are badly in need of gear and would like to get in touch with manufacturers or distributors and restock."

PERSONALITIES

Frank Allen, who was, until recently, works manager of the Aylesbury factory of E. K. Cole, Ltd., has now been appointed general works manager (Radio Division) and will control the Company's radio factories.

G. F. Mansbridge has relinquished the chairmanship of Dubilier Condenser Company, but remains a director.

W. H. Goodman, deputy chairman of Dubilier Condenser Company, succeeds G. F. Mansbridge as chairman.

E. J. Warren, general manager in India of General Electric Co. (India), Ltd., has retired for health reasons.

E. M. LEE, B.Sc., (Belling and Lee), the new chairman of the Radio Component Manufacturers' Federation.

A. J. Emery, who has been in charge of the Bombay Branch of General Electric Co. (India), Ltd., succeeds E. J. Warren as general manager.

MEETINGS

Television Society

"The Human Eye and the Photo Cell," by W. Sommer, D.Phil., at 6.0 at the I.E.E., Savoy Place, London, W.C.2, on May 29th.

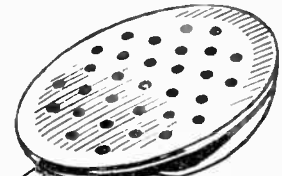
Institute of Physics

Electronics Group.—"Glass-to-Metal Seal Design," discussion to be opened by W. J. Scott, B.Sc.(Eng.), and "High Vacuum Pumps," introduced by Dr. R. Witty, at 2.30 in the Fyvie Hall, The Polytechnic, 309, Regent Street, London, W.1, on June 9th.

Institution of Electronics

"Principles of Triode Design," by J. H. Fremlin, M.A., Ph.D., at Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2, at 5.30 on June 4th.

North-West Branch.—Joint meeting with Manchester and District Branch of the Institute of Physics. "Design of Electron Guns of Radial Symmetry" by H. Moss, Ph.D., B.Sc., at 6.30 at Reynolds Hall, College of Technology, Manchester, on June 1st.



RADIO TEXTBOOKS

Plea for Co-operative Effort

By THOMAS RODDAM

IN recent numbers of *Wireless World* there has been some lively correspondence about the textbook situation. So much interest has been shown that a full-blooded examination of the position seems to be justified. It may be over-optimistic, but this writer thinks that if enough people realise the position, something might happen. It is not enough to know that the textbooks on radio are bad; this fact must be realised with all its implications. The correspondents, I am glad to see, agree with this view. There are a lot of bad little books, and I can wish the authors condemned to an eternity of reading the reviews of their books by G. W. O. H. in a contemporary.

Every bad book means one less good one—Gresham's Law[1] is always turning up. Every publisher with a bad book on his list has less money, and nowadays less paper, for the author of a good book. Nor is this all. Every bad book which is sold to the engineers of Ruritania decreases their respect for British radio engineering. Of course, export trade doesn't depend only on technical matters. Tariffs, currency problems, bribery and blackmail all play their part. Nevertheless, the opinion of the technical men has some weight. Bad textbooks mean fewer exports; trade follows the blurb. It is therefore in the interest of British industry to encourage the production of some really good textbooks on radio, solely as goodwill publicity abroad. I had resolved not to mention any specific works in this article, but one example must be given. All my generation has a considerable respect for German mathematical physicists, based entirely on our knowledge of the great classic by Courant and Hilbert. What we think of the Germans now is not relevant; mathematics is non-political and, as Hardy says, "Real mathematics has no effects on war."[2] This aspect of things is particularly important as a long-term policy. Textbooks affect the engineer at the beginning of his career. Habits of thought are formed which persist long after they are known to be without justification. The students of to-day are the chief engineers of to-morrow; they must be made to believe that this country has some good radio engineers in it.

This goodwill aspect of textbooks will, I think, be accepted by the reader. I hope he will also accept the application of Gresham's Law to publishing, and, quite as important, to book buying. Every bad book bought means one guinea less for buying good books, and a sense of frustration which discourages the student and makes him spend his next guinea on something more reliable.

Having decided that textbooks must be written, how can some encouragement be given to eligible young men? This problem always makes me fall into a deep reverie, only distinguishable from sleep by a skilled observer. If we consider what sort of people our potential authors are we may get some sort of answer. They may be in what is delicately called academic life. They have plenty of spare time, and they have the unrivalled advantage of being able to use their textbook draft as a lecture course and thus "try it on the dog." That, as in the traditional form, "the dog it was that died" does not seem to discourage them. The difficulty is that there is no way in which the full-time lecturer on radio can keep up to date. Without a wholesale reform I cannot see the books we want coming from this source.

Industrial Authors' Handicaps

In industry there are better-equipped potential authors. But the trouble is that they have too much to do, and they cannot relax their ordinary work at all or they will fall behind in the vicious struggle for existence. If industry took a more long-sighted view this would be changed, and a model is found in a paper in the *Proceedings of the I.R.E.*, which describes the organisation of a very well-known American firm. Engineers there are expected to devote quite a useful part of their time to what might be called "private ventures." In this country such an outlook is uncommon. Another thing that discourages the industrial authors is uncertainty. Actually this discourages all the potential authors, but it is less important to the lecturer, who must prepare his notes anyway. A textbook is, in the economic sense, capital, but it seems difficult for the technical writer to find a publisher without actually writing the whole book. Few men will sink years of their spare time in a speculation of this sort, especially when they do not know what the reward will be—or even if there will be any reward at all.

Government Servants

There remain the potential authors in Government establishments. To find out why they don't write books I bought from the Stationery Office a book of rules for the employees of one Ministry. When the appropriate paragraph is translated into the King's English, it says that any public servant who wishes to publish a book on anything at all must submit the full text before he can get permission. That is, the book must be written before the author is told whether he will be allowed to publish it. Further, if the Stationery Office decide that they would like to print it, the author must agree to their terms. If Government ink or Government paper is used, of course, this is a most serious matter. In addition, the library facilities in most Government establishments are so inadequate, and the opportunities of doing "library research" so few, that the actual work of writing any general textbook is impossible. We cannot hope for textbooks from Government ser-

[1] "Bad money drives out good."
[2] *Mathematicians Apology*, G. H. Hardy. Cambridge University Press, 1940.

vants until there has been some change in administrative policy.

I started this article in the hope that I could leave the solution of these problems to correspondents. I must, however, produce some suggestions. What is required is an enlightened publisher, backed, as one correspondent has suggested, by an enlightened Government department, who would commission a series of textbooks. Authors would be asked to write books and guaranteed a definite reward, with royalties beginning only when some number of copies had been sold. Government intervention to secure the co-operation of industrial employers in allowing the chosen men to devote perhaps one day a week to this work would be most important. Special tax concessions to authors would mean that the payments would not need to be so high: if entertainment tax is not paid for Restoration plays, authors of scientific books should not be made to pay income tax on their earnings, which are the result of work of rather more importance to the nation. The details of a scheme of this sort can only be worked out with State intervention, for so much of the recent work which must be included has been done for State use. Only a really authoritative control can free authors from some of their normal work to help with such a scheme. The difficulties are, of course, great. There are the difficulties which keep the scientists out of the Government establishments in peacetime; there are the difficulties which the machinery of Government itself creates.

What do we Want?

A separate problem is raised if we imagine we are editors of such a series. What sort of textbooks does the radio engineer want? Here it is every man for himself and the devil take the hindmost. I, to start you talking, am prepared to expose the barrenness of my desires. First, I should like to see some really good advanced mathematical texts for engineers. Books which tell the engineer how to solve the sort of equation which crops up are needed: at the moment we thumb our way through Whittaker and Watson with a glassy stare. Then a series is needed on the fundamentals of radio technology; valves, components and engineering practice. Finally, the real heart of the thing, books on propagation, circuits and aerials, complete the radio engineer's library. I will not here risk suggesting authors for those books. To do so would be to ask for trouble.

The problem is a straightforward one. We need radio textbooks to train our engineers and to advertise our national research. The authors need money to buy food and drink. All that remains is to provide a catalyst, which will start the authors off on the long road to fame. If the publishers cannot do it alone, the Government and the radio industry should be prepared to co-operate.

ARRL HANDBOOK

COPIES of the 1945 edition of the American Radio Relay League's annual publication "The Radio Amateur's Handbook" are now becoming available in this country. It contains some 512 pages with 1,278 illustrations, 133 charts and tables and 240 basic formulæ covering almost every aspect of radio communication.

A considerable quantity of new material is included, particularly in those sections devoted to the very high frequencies. For example, the chapter on the theory and operation of valves contains a description of the Klystron velocity-modulated valve and the magnetron, which are used for the generation of RF oscillations up to and even beyond 30,000 Mc/s (1 cm). It is anticipated that when amateur licences are restored in America frequency allocations will be made in these regions of the radio spectrum.

The expansion in the quantity, and quality, of the material on UHF practice and theory is in part due to the many American amateurs now enrolled in the WERS (War Emergency Reserve Service) for which a large amount of 2½- and 1¼-metre mobile radio equipment is required. Much of this gear is home-made.

There is a number of new pieces of test equipment, again largely of the UHF kind. Mention should also be made of a very ambitious 12-valve communications set covering 1.75 Mc/s to 30 Mc/s and embodying a crystal IF filter, noise limiter, signal strength meter and many other up-to-date refinements. Full constructional details, including coil winding data, are given.

The handbook can be obtained direct from A. F. Bird, 66, Chandos Place, London, W.C.2, the price being 12s. 6d., plus 7d. by post; or it can be ordered for delivery from America through the Radio Society of Great Britain, New Ruskin House, Little Russell Street, London, W.C.1, the price in this case being 10s. 6d. For security reasons copies cannot be sent from America direct to Services or Government establishment addresses.

UNBIASED

By FREE GRID

Beating the Ionosphere

It is well known that, of those of the B.B.C.'s broadcasts of speeches and commentaries from the U.S.A. which are not transmitted direct at the time of broadcasting, some come over via the SW beam link and are recorded for later rebroadcasting, while others come over in the form of actual recordings, being presumably sent by plane. At least, that is what I, in my ignorance, have always supposed, but an American G.I. with whom I was arguing about the matter in a pub recently tells me that these moth-eaten methods have long since been discarded in favour of an entirely new system developed by technicians in the land of big things.

We had just been listening to a talk from the other side of the water which was so strikingly free from atmospherics, fading and other ionospheric bugbears that I had commented upon it, since only half an hour previously I had tossed my SW receiver into a corner at home in disgust at the poor and, indeed, almost impossible conditions for transatlantic reception. The whole affair was, in fact, very puzzling and I should probably have been pondering over the matter yet if my American friend had not volunteered to explain the new technique.

Saludos Amigos.

It was, so he told me, not a case of a trained listener versed in the art of piecing together a speech punctuated by ear-splitting interference, and subsequently typing it out and hearing it read by a B.B.C. announcer. This is an old and perfectly legitimate dodge which used often to be adopted in such circumstances. Nowadays, however, there is a far better method. The speech is pieced together and typed out as before, but the few clearly intelligible words which do get through are also carefully recorded and handed over to a faithful disciple of Rudolf Pfenniger. By listening to the record of these few fragmentary words he is able quickly to create a mental image of all the delicate cadences and tonal inflections of the speaker and is soon able to transpose the typescript by hand into the necessary undulations on a blank gramophone disc.

For the benefit of those of you who have grown up since the war began I would explain that Rudolf Pfenniger was the Teutonic gentleman who first demonstrated the practicability of reproducing the human voice on a record by means of digital indentations, no vocal recordings being carried out at all.

PA Historians Forward !

As I have often had occasion to point out in these columns, nobody puts their foot into it more firmly than the B.B.C. programme-wallahs when they embark falteringly on the perilous seas of historical reminiscence. Probably the most notable instance of it was when they gave a resumé of the momentous happenings of the year 1914.

At enormous expense (probably her return bus fare) they secured the services of a well-known political hostess of the day who gave us a moving account of certain dramatic incidents which occurred at her salon on "Friday, July 30th." Let me hasten to explain that I am not blaming the good lady in the slightest. She was probably earning every penny of her return bus fare by adhering faithfully to the script of her memories which the B.B.C. had typed out for her. I do, however, blame the B.B.C.'s historical hash-up department, not only for putting the words into her mouth but for persisting in its pigheadedness in reproducing this programme from a recording some time later. I had not only pointed out in these columns that there was no such date as Friday, July 30th, in 1914, but had, in addition, drawn attention to certain other departures from that strict historical accuracy which we have a right to expect in our programmes.

I do feel, however, that I owe the B.B.C. some sort of apology, for its petty peccadilloes pale into insignificance beside a truly appalling anachronism committed by others to which several readers have drawn attention and which I have since verified in person. The anachronism occurs in a much-publicised film dealing with the life of President Wilson which was recently thrust upon us. Apparently the producer, or whoever is responsible, is so utterly ignorant of developments in the realm of sound reproductions that he imagines that microphones, loudspeakers and all the other ghastly paraphernalia of a modern election meeting were available to political aspirants in 1916. In one scene, in particular, there is clearly depicted a microphone with a battery of loudspeakers in the offing, and very modern-looking apparatus it is too.

Another Anachronism.

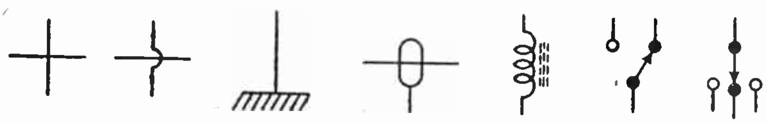
Now I do not intend to enter into a discussion as to the exact date when some misguided individual first thought of putting the fearsome weapon of sound reinforcement into the hands of politicians, but I am quite sure that it was not in 1916 nor until a good many years afterwards—not even in a land of cacophony-tolerant people like the U.S.A. True, de Forest put the grid into the valve in 1912 and so made PA theoretically possible, but many bitter years of heart-rendering cacophonic caterwaulings had to be endured by the patient American public before speech from a loudspeaker became really intelligible.

I have a perfectly clear recollection of hearing the truly fearful bellowings of the "Stentorphone" on Blackpool pier in 1921 and wrongly put down my inability to understand what was said to my ignorance of the Lancashire dialect. Just possibly the Stentorphone, which, incidentally, used compressed air to produce its nerve-shattering effects, flourished in the U.S.A. before 1921, but certainly not as early as 1916. At any rate, if anybody can bring forth reasonable proof that this incident in the picture is not a truly glaring anachronism, I will publicly eat my bowler and umbrella. The Editor will, of course, act as final arbiter regarding any so-called proof that may be adduced.

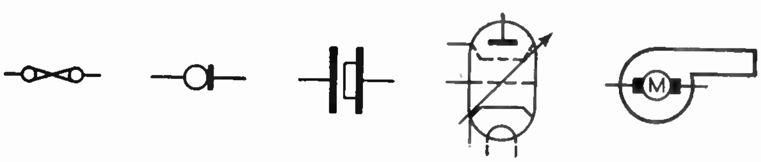
GRAPHICAL SYMBOLS

Standardising Inter-Service Practice

It is understood that a revised set of recommended graphical symbols is shortly to be issued by The British Standards Institution. In the meanwhile, the various telecommunication branches of the Services have been in need of standardised and generally agreed symbols for use in diagrams, particularly for those for illustrating newly developed practice. To meet this need, the Inter-Services Radio Circuit Symbols Committee has now issued a provisional list of symbols. This publication is intended for Service use exclusively, but no doubt the recommendations made will have some influence on the ultimate choice of symbols for general use.



(1) (2) (3) (4) (5)



(6) (7) (8) (9) (10)

A few of the symbols to which attention may usefully be drawn are accordingly reproduced here from the Services book. The long-standing controversy over the representation of crossing conductors has been side-tracked by giving the two methods as alternatives (diagram 1). The symbol for "chassis, with no direct earth connection" (2) may be compared with the well-established practice of showing the chassis as the thickened base-line of the diagram. The screened line symbol (3) seems to be lacking in graphical quality, an advantage certainly possessed by (4) which represents a dust-cored inductor. Arrowheads on the arms of switches (5) seem to help in emphasising the essential difference between switches and semi-fixed links. In (6), which is the general symbol for a fuse, two conductors seem unnecessary. No. 7 is another symbol that seems to have little graphical connection with the device—a microphone—that it represents, but (8) a piezo-electric crystal, gives a better idea of this device—at any rate when it is used for frequency control—than the symbol generally employed. The arrow in a valve symbol (9) to indicate variable-mu characteristics is almost redundant nowadays, as the nature of the valve will be evident from its function in the circuit. Finally, the growing tendency to provide standardised symbols for devices used in highly specialised apparatus is shown at (10), which indicates a motor blower.

MORE RADIO HEATERS

We learn from Rediffusion, Ltd., that recent improvements in supplies of materials make it possbile to obtain delivery of the Redifon RH2 radio heater unit within a week or two of ordering.

This model has an output of the order of 250 watts at 50 Mc/s and is designed for experimental or small-scale production processing of plastics, synthetic glues, vulcanised rubber, etc. It may also be used for dehydration and eddy current heating.

The cost of the generator is £150, complete with matching unit, and the price includes instruction of the purchaser's staff in using the set, making electrodes, etc. An experimental screened heating chamber is available as an extra, price £12, or £17 with its own coupling transformer.

RANDOM RADIATIONS

By "DIALLIST"

Times Change

HAD anyone suggested to an assembly of either practical radio men or physicists twenty-five years ago that it would ever be necessary to make national and international allocations of frequencies from 25 megacycles per second upwards, his remarks would probably have been greeted with the loudest of loud laughter. If, undeterred by this, he had gone a step further by predicting that there would one day be a scramble for channels up to 30,000 Mc/s and that experimental work on even higher frequencies would be contemplated seriously, his audience might have shaken their heads sadly over the unfortunate delusions under which the poor fellow was labouring. It was, you see, known (!) to all sane men that for good and sufficient reasons (as it then appeared) frequencies above 3 Mc/s could not possibly have any commercial future. As for those of the order of 25 Mc/s, they were clearly useless outside the laboratory . . . and here was a fellow prophesying that not merely 25 Mc/s, but 250 Mc/s, 2,500 Mc/s and—supreme height of folly—25,000 Mc/s and above would have a big part to play in the world's communications. Pathetic that anyone should be haunted by such impossible ideas!

At the Gallop

Twenty-five years is a short space of time, but it has seen the most astonishing developments in wireless technique. No department of applied science affecting the life and well-being of man has seen comparable advances in the time. There has been progress in our clothes, our furniture, our bicycles, our motor cars, our lighting, our heating systems, and in a thousand and one other things that affect our daily life. But all that might be termed normal, steady progress. Even in the air there have been no spectacular leaps forward: the aircraft of to-day, though faster, more reliable and capable of conveying bigger loads to greater distances, are direct descendants of the kind that might be expected of those of the 1920's. Medical science has, perhaps, made greater advances than most other branches, though it has still not found solutions of such age-old problems as lumbago, asthma and the common cold. But wireless has gone forward all the time at the gallop and there seems to be no slackening of the pace. The short waves proved to be not useless but invaluable for telecommunications. The ultra-short waves were next harnessed and set to do useful work. Now it is the turn of the micro-waves down to a length of about one centimetre, which undoubtedly have a big future for many purposes. Next may come the turn of that so far almost unexplored belt in the frequency spectrum which contains the frequencies intermediate between those producing the effects which we know as wireless on the one hand and heat on the other.

□ □ □

A Record Audience

NEVER have I seen the I.E.E. Lecture Theatre so packed as it was on the occasion of Sir Edward Appleton's paper on "The Scientific Principles of Radiolocation." I took a guest, and, expecting that there would be a crowd, I urged him to be in good time. At these functions tea is normally at 5 o'clock and the lecture at 5.30. We got there at about five minutes to five and found the theatre to all appearances already full. Deciding on the instant to cut out tea, we secured what must have been almost the last two seats available. And during the next half hour there was an unceasing inflow. They packed the gangways, the exhortation thrown on the screen by lantern slide to "sit familiar" was obeyed until we sat so close that not even a giant shoe horn could have inserted one more. They stood, the rear ranks on chairs, in the open doorways. In any event there must have been many latecomers who had no chance of hearing the lecture, and it was good to hear Sir Harry Railing, the President, announce that Sir Edward Appleton had agreed of the goodness of his heart to repeat his admirable lecture at a later date. The fact that the audience was so big is a sure proof of the interest taken in radiolocation and of the desire of electrical engineers who had not been engaged in it during the war to know more about it. That being so, it is a thousand pities that in the interests of security those who were there may say nothing of what Sir Edward spoke of in his lecture. I can't, therefore, tell you anything about the tale that he unfolded. I may, though, say that he, too, was bound by the security fetters and that there was much that he had to leave unsaid.

A Queer Idea

EVERYWHERE one goes one meets folk who indulge in a strange kind of wishful thinking. Despite the mass of evidence to the contrary that doesn't need much looking for, they are convinced that wireless sets, radiograms and television receivers are going to be much cheaper after the war than they were before it. Ask them why they are of this way of thinking and they murmur the blessed phrase "mass production," and seem to think that it is the last word on the subject. Well, we had mass-production before the war, though admittedly not on the scale that will be seen when peace returns. But even large-scale mass-production can't nullify the huge increases that there have been in wages, taxes, rates and the cost of raw materials, machinery and power. The motor industry has already announced that the prices of cars will be up by something like 40 per cent., and we might as well face the facts in radio. Wages, one of the biggest of overhead expenses, have risen by about 80 per cent. in the wireless factories. Again, no one can say when purchase tax is coming off; from certain rather guarded recent utterances by those in authority one gathers that it won't anyhow be immediately after the end of the war. In my view the cost of wireless sets has never debarred people from buying them, so long as they were good. But I'd like to see the radio industry scotching authoritatively the queer ideas about cheaper and cheaper post-war wireless sets that have been fostered by some section of the lay press. It's no good living in a fool's paradise.

□ □ □

Monitoring

THIS war has produced some strange jobs! One of the queerest I have come across is that of a recorder in the B.B.C.'s monitoring department. Since the early days of the war every enemy transmission by wireless from long, medium or short-wave broadcasting stations has been tuned in and taken down *verbatim*. The records are most carefully scrutinised, for there is no knowing when a useful piece of information may be obtained by reading between the lines. I've met people who have held these jobs and they agreed that despite long spells of boring monotony, they had on the whole a most interesting time when listening in on the monitor receivers. I can well believe it. I've not been able to do a great deal of listening to enemy stations myself during the war, but once or twice I've heard carelessly censored or unguarded sentences that have given quite a lot away. Sauce for the goose is, of course, sauce for the gander and our enemies no doubt monitored our transmissions just as assiduously as we monitored theirs. I have an idea, though, that they didn't learn from them much that they weren't meant to learn.

□ □ □

Sets for India

THE letter from H. K. L. Arora in the last issue of *Wireless World* on sets for the Indian market raised some interesting points. It is curious that British makers should have neglected this market so much in the past, believing that it was too small to be worth bothering about. Certain foreign firms were by no means of the same way of thinking. They saw that if wireless in India had small beginnings it was bound eventually to be a big thing and they went for the market wholeheartedly—and successfully. Of my many British friends in India, there wasn't one who had a set made in this country—or at any rate I can't call one to mind. They wanted British-made sets, but they could not get the kind that they needed. Now that the war has more or less wiped the slate clean by closing down production all over the world, I do hope that our manufacturers will realise the possibilities of the Indian market and that they will export sets that meet all requirements. But it is essential that they should be thoroughly conversant with those special requirements.

Catalogues Received

PAMPHLET describing moving-coil microphones made by Lustraphone, Ltd., 84, Belsize Lane, London, N.W.3.

Price list of amplifiers, receivers and components from H.P. Radio Services, Ltd., 55, County Road, Walton, Liverpool, 4. Price 1d.

Catalogue of "Radio Service Aids" from V.E.S., Radio House, Melthorne Drive, Ruislip, Middlesex. Price 3d.

GOODS FOR EXPORT

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

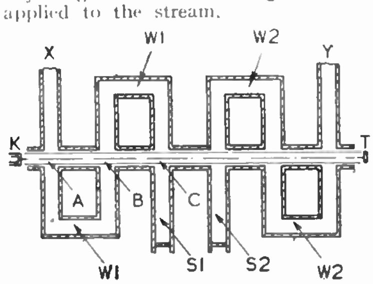
RECENT INVENTIONS

A Selection of the More Interesting Radio Developments

INTERACTION BETWEEN WAVE GUIDES

ONE wave guide is coupled to another through the electron stream of a cathode-ray tube, the combination acting as an amplifier or as an oscillation-generator.

As shown, the electron stream from a "gun" K flows through the tube to a target T. Two wave guides, W1 and W2, one serving as an input, the other as an output, are folded about the tube in a zig-zag fashion so that the relatively slow electrons meet the same phase conditions at each of the points A, B, C, at which they encounter the faster-moving fields in the guide. Under these conditions, the electron stream will be "bunched" or velocity modulated by the guide W1, and will deliver up energy to the similarly arranged output guide W2. Correct phasing is ensured (a) by the length of the folds in the guide, and (b) by adjusting the accelerating voltage applied to the stream.



Electronic coupling between wave guides.

Each wave guide is terminated by quarter-wave stubs S1, S2, so that the reflected energy is in phase with that prevailing at the points where the guide crosses the stream.

The wave in the guide is of the H1 type, that is, the electric field vector is transverse to the axis, as is the passage of the bunched electrons across the openings shown. The device will generate sustained oscillations if the points X, Y are back-coupled through a wave guide of appropriate length.

Electrical Research Products Inc. Convention date (U.S.A.) May 17th, 1940. No. 564890.

DC AMPLIFIERS

WITH direct coupling, as used for amplifying very low frequencies, the mean anode voltage of one valve is transferred to the grid of the next, so that a heavy counter-bias from large batteries is usually required to avoid overloading.

According to the invention, there is included in the anode-to-grid lead a thermo-sensitive element having a negative temperature resistance, such as a directly heated "Thermistor," i.e., a mixture of manganese and nickel oxides. The falling resistance of this device modifies the ohmic response of the other elements in the coupling in such a way that, whilst the full range of the anode swing is transferred, the mean voltage on the grid is reduced to one-quarter of the mean anode voltage.

Standard Telephones and Cables, Ltd.; P. K. Chatterjea; and T. C. Scully. Application date May 14th, 1943. No. 565609.

SHORT-WAVE AERIALS

ONE end of a flexible wire is wound around a drum, and the other end is connected to an insulating cord, which passes over a pulley at the top of a supporting mast and then down to a second drum mounted on the same shaft as the first, so that the effective length and therefore the tuning of the aerial can be adjusted by rotating the drum shaft. The arrangement is suitable for military vehicles, motor boats and the like.

A transmission line feeder is coupled to the first drum through a wiper contact in series with an inductance which serves to reduce the shunt capacity of the aerial to earth. A metal ball or other capacity-loading device may be inserted between the top end of the wire and the insulating cord, to reduce the physical height of the aerial.

Standard Telephones and Cables, Ltd., and E. O. Willoughby. Application date, May 8th, 1943. No. 565526.

AIRCRAFT INDICATORS

IN order to observe various meter readings when flying in the dark, or under conditions of low visibility, it is usual to coat the dials with a luminous paint which glows when subjected to ultra-violet light. But if a cathode-ray indicator is amongst those to be read, the projected ultra-violet rays will cause the whole of the screen to fluoresce, thereby blotting out any significant signal.

To overcome this difficulty, the "window" end of the CR tube is painted or sprayed, say with nitro-cellulose containing a small amount of picric acid. This solution is transparent to ordinary light, but not to ultra-violet rays.

Standard Telephones and Cables, Ltd., and H. Wolfson. Application date May 10th, 1940. No. 565694.

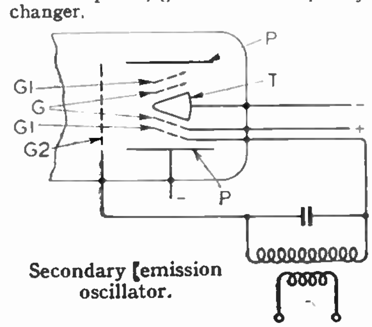
TUNING INDICATORS

BY using control voltages taken from various points of the receiving circuit an auxiliary cathode-ray device is arranged to give automatically and simultaneously the following tuning indications:—(a) The operating waveband by a vertical deflection of the electron stream into alignment with one or other of, say, three horizontal scales, and (b) the actual tuned frequency by the horizontal deflection of the stream along the selected scale. In both these cases the control voltages are applied to the deflecting plates of the CR tube from potentiometer tappings which are ganged with the wave-change switch and tuning knob respectively. (c) The intensity of the incoming signal (or the accuracy of the tuning adjustment) by the vertical height of the indicating mark formed on the screen, this being controlled by a voltage applied to one of the deflecting plates from the IF amplifier. (d) The signal output is shown by the width of the mark as determined by a voltage applied across the other deflecting plates from a tapping on a resistance in the AF stage of the set. When these indications are no longer required, the cathode-ray tube can be switched to "stand-by."

Philips Lamps, Ltd. Convention date (U.S.A.) May 25th, 1942. No. 565795.

CATHODE-RAY OSCILLATORS

THE main stream of a cathode-ray tube is focused on to a secondary-emission target T, and the released electrons are forced to oscillate across a positively biased grid. As they leave the target, the secondary electrons are attracted by a relatively positive open grid G, but are retarded and reversed in direction first by the relatively negative bias on a cylinder P, and again by the negative charge of the primary stream, so that they are kept oscillating between these limits. A second grid G1 feeds energy from the moving mass to a tuned output circuit, which is also connected to a feed-back grid G2 lying in the path of the primary stream. The arrangement can be used as an amplifier, generator or frequency-changer.



Secondary emission oscillator.

Alternatively, the method of "bunching" or velocity modulation can be applied to the tube. One resonator unit is set in the path of the primary stream, and another in the path of the secondary electrons, and the two units are back-coupled.

Flowerdale, Ltd.; A. Perelmann; and L. Young. Application date February 11th, 1943. No. 566067.

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

Rate 6/- for 2 lines or less and 3/- for every additional line or part thereof, average lines 5-6 words. Box Numbers 2 words, plus 1/-. Press Day: July 1945 issue, first post Friday, June 8th. No responsibility accepted for errors.

Under Defence Regulations 1939, Statutory Rules and Orders 1940, Number 1689, a permit (T99G) must be obtained before sale or purchase of certain electrical and wireless apparatus particularly such valves and apparatus as are applicable to wireless transmission.

NEW RECEIVERS AND AMPLIFIERS

H. P. RADIO SERVICES, Ltd., offer:

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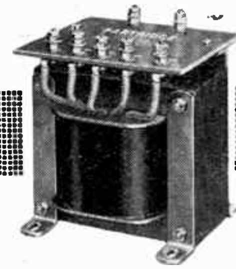

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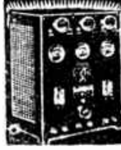

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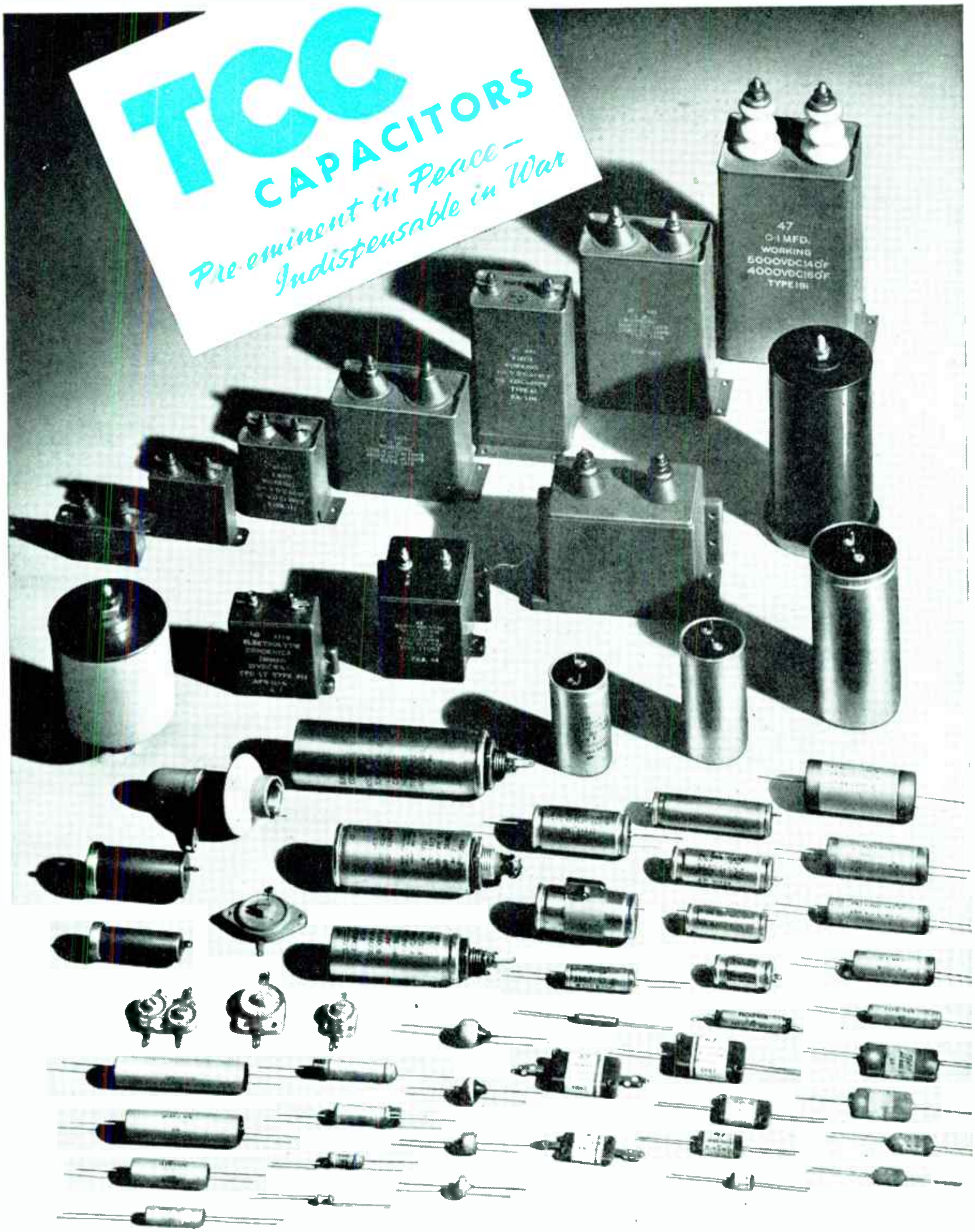

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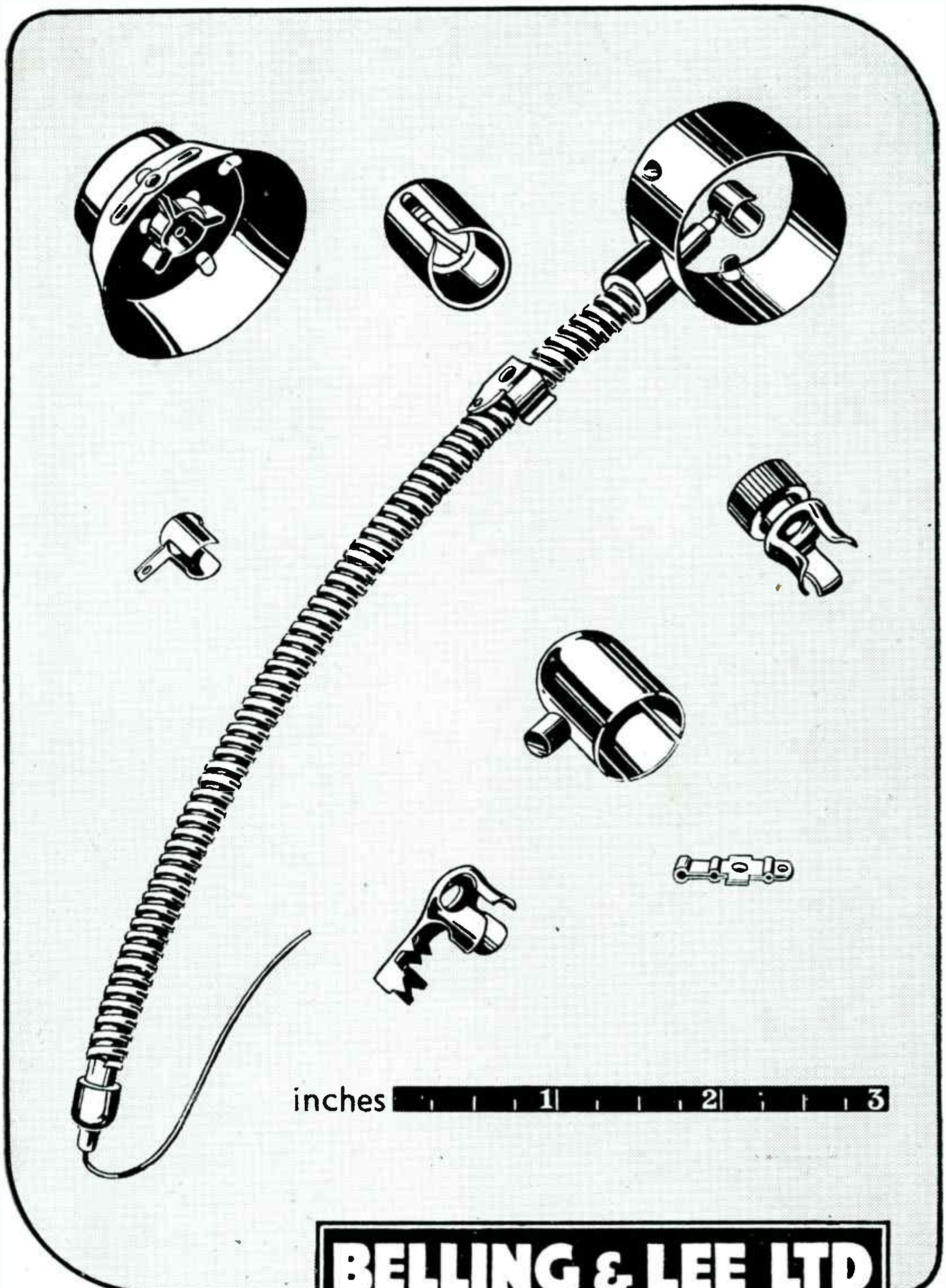
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