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# Standards for Television

## *Ensuring an Early Post-war Start*

IN last month's issue we examined two proposals for the drastic reorganisation of British broadcasting after the war. One of these, put forward by members of the Cossor research staff, dealt in considerable detail with the use of ultra-short waves as a supplement to our existing broadcasting service. Television was included as an integral part of this short-wave service; indeed, the whole scheme amounted to a complete "Plan for Post-war Broadcasting," so far as technical organisation is concerned. In discussing the plan last month, we confined out comments to its more general aspects; we will now consider the proposals for television.

As will be remembered, the Cossor scheme provided for transmissions with a definition of 525 lines, and 50 frames per second, interlaced. Carrier frequencies for the nation-wide distribution system envisaged would be in the band 49.5-64.5 Mc/s. A single-sideband system, as proposed, would enable each channel, with its accompanying frequency-modulated sound transmission, to be kept within a 5-Mc/s band. The 15-Mc/s band demanded for television would thus be divided into three such channels, which would be shared among the 12 stations considered to be necessary for covering all the more populous areas of Great Britain and Northern Ireland. As compared with the pre-war standards, the proposals imply a rather higher standard of definition (525 against 405) and a rather higher carrier frequency.

The plan was presented in its entirety before a meeting of the Institution of Electrical Engineers, and during the discussion that followed it was the television proposals—as opposed to those for sound broadcasting—that evoked most of the comments. Many speakers contended that an increase of 525 lines over the pre-war standard of 405 was not sufficient to warrant a change; it would be better to make the earliest possible start and leave high definition until later. Others maintained, taking the analogy of the cinema, that colour transmission was highly desirable. Almost all considered that the promise of continuity of whatever service was decided upon was essential and that the public would never give full support to the service if there were constant threats that receivers would soon become obsolete.

It was particularly gratifying to us that everyone supported the view that, whatever standards may be adopted, nothing should be done that might hinder the re-establishment of the television service when the war ends. Writing in our November issue, we urged that it was better, if we must accept the principle that any change would involve delay, to restart with pre-war standards for the London area adopting new standards if necessary, for the provincial stations. But if, as we are now assured, the new standards could be put into operation virtually as soon as the old, there seems little point in temporarily reviving a system of transmission that will generally be regarded as obsolete. If, as is argued, the proposed 525-line transmission can be developed into something that is virtually perfect, there is a very strong argument for adopting it as the "final" system.

### *Compensating Pre-war Set Owners?*

If a change is to be made there is the question of compensation for those who already have 405-line receivers, bought with the understanding that they would not become obsolete during a period of years that had not expired when war broke out. Though we should deplore any attempt to shirk obligations towards these set-owners on a legalistic quibble, it is felt that the existence of the pre-war receivers should not be allowed to stand in the way of establishing post-war television on the soundest possible lines.

An advantage of the Cossor scheme is that it would employ what it virtually established present-day technique, both in transmission and reception, and no method of manufacture inherently different from what has already been practised on a fairly large scale would be involved in the production of receivers. Indeed, it seems to be a good working principle, when planning post-war television standards, that the system to be adopted should go as far towards perfection as is possible within the framework of existing technique and reasonably well-tried practice.

# AUDIO-FREQUENCY GENERATOR

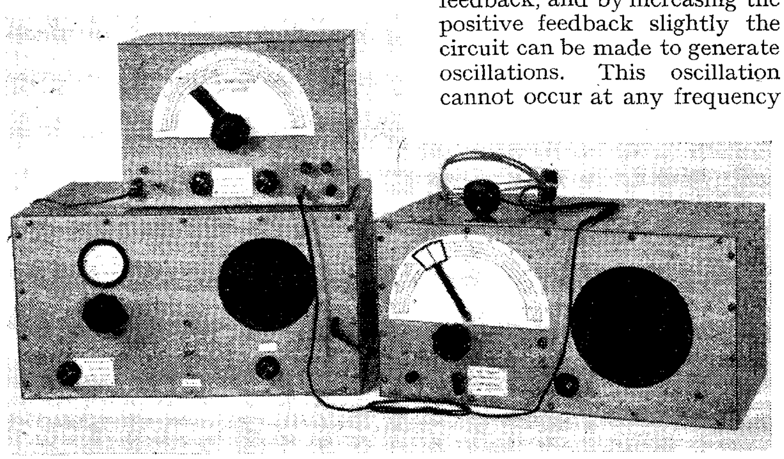
## Resistance-Capacity Tuning with Wien Bridge Feedback Circuit

By
S. K. LEWER,
B.Sc.

UNTIL recently, practically all audio-frequency oscillators were either of the beat-frequency type or of the simple regenerative type having an inductively coupled feedback circuit as its resonant element. The disadvantages of these types have been recognised and considerable efforts have been made to overcome them. The major difficulties were associated with the production of a pure sinusoidal waveform, the maintenance of frequency calibration and the uniformity of voltage output over the full range of frequency. The application of the principles of the Wien bridge has led in recent years to the development of a new type of resistance-capacity tuned oscillator of relatively simple design in which these difficulties are very easily overcome.

This new type of oscillator, which has sometimes been described as the phase-shift oscillator or negative-feedback oscillator, appears to be due to H. H. Scott [1,2], and has been put into production by certain manufacturers. Its chief features are stability of frequency and amplitude, simplicity in circuit design and construction, immunity from the effects of variations in supply voltage and valve characteristics, quick warming-up, low cost, and with the commonly available components, an improved graduation of the tuning scale.

In principle, the resistance-capacity tuned oscillator consists of a resistance-coupled amplifier back-coupled through a Wien bridge. The form of bridge which is most convenient for this purpose is shown in Fig. 1. The feedback voltage is applied to the terminals A and B, and the output from the terminals is taken to the input of the amplifier. Both positive and negative feedbacks are obtained by connecting X to the grid of the first valve and Y to the cathode, B being earthed, so that the arm $R_4$ actually cmprises the cathode bias resistance of this valve. The terminal A is connected through a blocking condenser to the anode of the second amplifier valve. It will be shown later that the bridge is balanced only at one frequency dependent on the values of resistance and capacity in two arms of the bridge (AX and XB). Except at the frequency for which the bridge is balanced, the negative feedback exceeds the positive feedback, and by increasing the positive feedback slightly the circuit can be made to generate oscillations. This oscillation cannot occur at any frequency other than the balance frequency.



Three different examples of structural design for the audio-frequency generator. The circuit used in each case is that shown in Fig. 3 except that the smaller instrument is not provided with a built-in speaker.

Fig. 2 shows the manner in which the two-stage amplifier is coupled to the bridge. Voltage obtained from the anode of $V_2$ supplies negative feedback at the point Y through the voltage-divider $R_3R_4$, and positive feedback at the point X through the resistance-capacity network $R_1C_1R_2C_2$. The phase at Y will be the same as that at A, and the voltage across YB will obviously depend on the ratio $R_3R_4$. The phase and voltage amplitude at X,

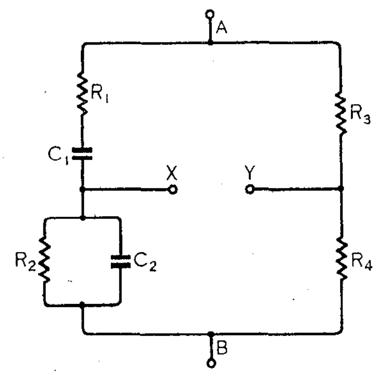



**Fig. 1. Form of Wien bridge used in the resistance-capacity tuned oscillator.**

however, requires more detailed study. For the bridge to be balanced, there should be zero phase difference and zero voltage between X and Y.

First consider the phase shifts due to AX and XB respectively. At any frequency $f = \omega/2\pi$ the current in the series arm AX leads the voltage across it by an angle whose tangent is $1/\omega R_1C_1$, while the corresponding phase-shift in the parallel arm XB is $\omega R_2C_2$. The resultant phase-shift at X will be zero when $1/\omega R_1C_1 = \omega R_2C_2$, i.e. when $\omega^2 = 1/R_1R_2C_1C_2$ or

$$f = 1/2\pi\sqrt{R_1R_2C_1R_2}.$$

For practical reasons, it is convenient to make $R_1 = R_2$ and $C_1 = C_2$, so that the frequency at which there is zero phase-shift becomes $f = 1/2\pi R_1C_1$.

At this frequency it is essential that the voltage amplitudes at X and Y should be balanced (except for the slight excess of positive feedback necessary to maintain oscillation). This condition may be expressed as $Z_{AX}/Z_{BX} = R_3R_4$. Substituting the respective values for the impedances,

$$Z_{AX}/Z_{BX} = \sqrt{R_1^2+1/\omega^2C_1^2} \Big/ \frac{1}{\sqrt{1/R_2^2+\omega^2C_2^2}}$$

Since by choice $R_1 = R_2$ and $C_1 = C_2$,

$$Z_{AX}/Z_{BX} = \sqrt{R_1^2+1/\omega^2C_1^2}\,\sqrt{1/R_1^2+\omega^2C_1^2}$$
$$= \sqrt{1/\omega^2C_1^2R_1^2+\omega^2R_1^2C_1^2+2}.$$

At the balance frequency, as shown above, $f = 1/2\pi R_1C_1$ or $\omega R_1C_1 = 1$, so that $Z_{AX}/Z_{BX} = 2$: hence $R_3 = 2R_4$.

It should be noted that the frequency of oscillation will be inversely proportional to the capacity. In other types of oscillator where the resonant circuit comprises inductance and capacity, the frequency is inversely proportional to the square root of the capacity. The R–C type of oscillator therefore has a more convenient tuning scale, better suited to most purposes.

The frequency would be affected to some extent by a dependence of the phase-shift on the supply voltage to the feedback amplifier, but in the conventional type of amplifier this condition is usually absent, and by including automatic control of the amplitude of oscillation, a very high order of frequency stability is easily obtained.

Automatic amplitude control is essential if good waveform and frequency stability are to be achieved. It may conveniently be incorporated by choosing a diode-triode valve as $V_2$ and coupling the rectified output back to the grid of $V_1$ in a manner similar to customary practice in radio receivers.

## Construction

Several different oscillators were built on these basic principles, and except for quite unimportant modifications the same circuit arrangement was successfully used in all cases. Fig. 3 shows a practical circuit diagram for an oscillator having four overlapping tuning ranges: 30–220 c/s, 150–1,100 c/s, 450–3,000 c/s, 2,000–14,000 c/s. The lowest frequency is dependent on the internal gain characteristic of the oscillator and on the maintenance of good insulation in relation to the high-value frequency determining resistances. The upper frequency limit is determined by the shunting effect of stray capacities across the resistances in the bridge circuit and in the feedback amplifier. Oscillators have been built, using the same principle, for frequencies up to about 4 Mc/s.[3] The coverage of each range and the amount of overlap are capable of easy adjustment to suit particular needs.

The output from the oscillator section is not adequate for most purposes and therefore an amplifier is added and a built-in speaker is provided. In the first experimental assembly, it was evident that serious disturbance of the waveform and frequency arose from varying conditions in the output stage as the gain control was adjusted. The troublesome effects were traced to capacity coupling between the first grid circuit of the oscillator section and the anode circuit of the output stage of the amplifier, and to a minor degree there was some disturbance of frequency stability due to acoustic feedback from the loudspeaker, presumably arising from vibration of the variable-condenser vanes. The disturbing effects of electrostatic coupling were readily overcome by providing very thorough screening around the oscillator section, and inserting a buffer stage between the oscillator section and the output amplifier section. The dotted line in Fig. 3 indicates where the screening should be arranged.

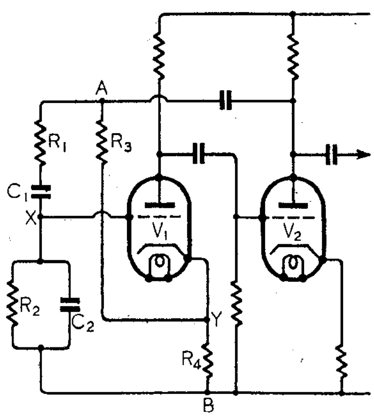



**Fig. 2. Two-stage amplifier circuit showing method of connecting bridge.**

The acoustic feedback effect disappeared when the final model was completed (the loudspeaker being mounted in the same cabinet as the oscillator-amplifier), but it is a point to be watched in any design where the frequency-determining condenser is liable to be affected by vibration from the loudspeaker. The effect is negligible, of course, if the loudspeaker is located separately from the oscillator unit.

The necessity of avoiding electrostatic feedback in the circuit arrangement means that certain obvious precautions must be taken in the placing of the components and the wiring, but there are some other considerations which determine at least partly the layout of the components. The feedback potentiometer $R_5$ which provides a variable control of the feedback, must be accessible during testing but must not be so placed as to invite variation of its setting by the user after the oscillator has been calibrated. The best arrangement is perhaps a recessed mounting so that the necessary adjustment can be made with a screwdriver operating in an end-slot in the potentiometer spindle through a suitable aperture in the panel or screening box.

Further, the trimmers belonging to the variable condenser must be readily accessible for setting-up purposes, although if necessary they could be mounted separately from the variable condenser assembly in some more convenient position.

The frequency-determining resistances ($R_1$ to $R_4$ in Fig. 3) must be chosen so that the several ranges have a suitable overlap at each end of the condenser scale, and it is very desirable, therefore, that they should be capable of easy replacement during the initial adjustments.

It is also convenient to be able to replace $R_{26}$ and $C_{12}$, the automatic gain control time-delay components, since the satisfactory operation of the oscillator may be found to depend on the value of the time-constant. Similarly, the cathode-bias and feedback resistance $R_6$ should be accessible in order to ensure that the optimum value is being used. These components can only be selected by trial-and-error, and by bearing this in mind while the wiring-up is being carried out, the subsequent testing and adjustment are greatly simplified. All the other components function in the usual way and do not call for any special consideration.

It is important to note that the frame of the variable condenser (which is usually connected to the rotor assembly) is at grid potential, the resistance to earth being of the order of megohms. This calls for a mounting of very high resistance, so that the calibration may not be affected by any subsequent change in the leakage resistance of this mounting, and similarly an insulated coupling must be used between the condenser spindle and the control knob. It is not necessary to place a screen around the condenser assembly itself, as it is sufficient (and probably preferable) to arrange the screen to protect all the circuit elements belonging to the first two valves. Since the frame of the variable condenser is at AF potential, it is necessary to balance this comparatively large capacity by connecting a condenser of 50–100 $\mu\mu$F across the upper section ($C_2$ in Fig. 3). The effective frequency-determining series and parallel capacities may then be made approximately equal over the working range by suitable adjustment of this balancing condenser.

The choice of valves need not present any difficulty, as the required characteristics are not at all critical. For the oscillator section a variable-mu pentode and a diode triode are essential, while on the amplifier side the buffer may be a triode or any kind of tetrode or pentode, and the characteristics of the output valve are obviously determined by the magnitude of the power output required.

All the intervalve couplings must be capable of passing frequencies extending to the upper and lower limits of the required range without appreciable attenuation, which in effect means that the coupling condensers should be of ample capacity. Extra filtering in the HT supply to the first two valves is incorporated by means of $R_{25}C_{13}$, partly to minimise hum from the rectified AC source and partly to decouple the oscillator and amplifier sections in the interests of frequency stability and waveform.

Provided that the pairs of resistances $R_1$ to $R_4$ have been fairly accurately matched, it should be sufficient to adjust the respective trimmer capacities across the variable condenser until the waveform and amplitude remain satisfactory over the full sweep of the tuning control. A trial-and-error process will be necessary, since the setting of the feedback potentiometer $R_5$ is rather critical, and at any setting which is not the optimum it will be found that the waveform and the amplitude vary throughout the tuning range.

If the capacity of the variable condenser to earth is known, the balancing condenser $C_2$ can be adjusted to have a similar value. Otherwise, it could be set at various values while the other adjustments are being made until the performance on all ranges is found to be satisfactory.

To achieve satisfactory operation it is practically essential to use a cathode-ray oscillograph for making the initial adjustments, but if this is not available, it should be possible to arrive at a reasonably satisfactory condition

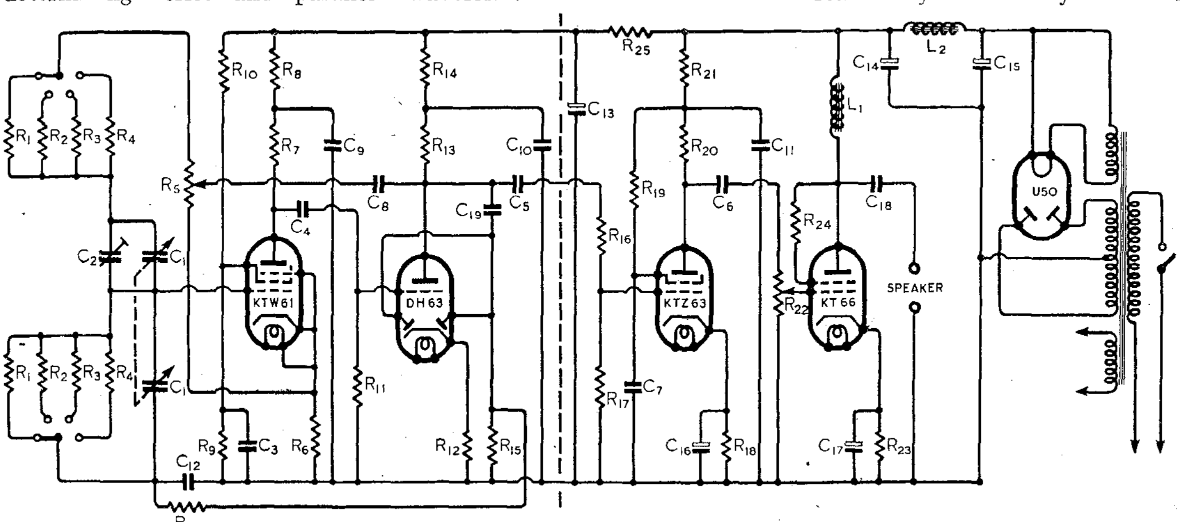



Fig. 3. Practical circuit of resistance-tuned oscillator having four tuning ranges: 30—220 c/s, 150—1,100 c/s, 450—3,000 c/s, 2,000—14,000 c/s.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| R1 5 MΩ, | ½ watt | R7 30,000 Ω, | 1 watt | R14 50,000 Ω, | ½ watt | R21 50,000 Ω, | ½ watt |
| R2 1.03 MΩ, | ½ ,, | R8 30,000 Ω, | 1 ,, | R15 100,000 Ω, | ½ ,, | R22 0.5 MΩ | |
| R3 375,000 Ω, | ½ ,, | R9 50,000 Ω, | 1 ,, | R16 0.5 MΩ, | ½ ,, | R23 333 Ω, | 2 ,, |
| R4 130,000 Ω, | ½ ,, | R10 30,000 Ω, | 1 ,, | R17 100,000 Ω, | ½ ,, | R24 100 Ω, | ½ ,, |
| R5 10,000 Ω, | | R11 0.5 MΩ, | ½ ,, | R18 600 Ω, | ½ ,, | R25 20,000 Ω, | 3 ,, |
| R6 2,000 Ω, | ½ ,, | R12 1,000 Ω, | ½ ,, | R19 0.5 MΩ, | ½ ,, | R26 1 MΩ, | ½ ,, |
| | | R13 15,000 Ω, | ½ ,, | R20 20,000 Ω, | ½ ,, | | |

| | | | | | |
|---|---|---|---|---|---|
| C1 | 0.0005 + 0.0005 μF | C8 to C12 | 1 μF, 400 V wkg. | C18 | 4 μF, 500V wkg. |
| C2 | 100 μμF, air trimmer | C13 to C15 | 8 μF, 600V peak | C19 | 0.05 μF, 400V wkg. |
| C3 to C7 | 0.1 μF, 400V wkg. | C16 and C17 | 50 μF, 50V peak | L1 and L2 | 20 H, 75 mA. |

by using a valve voltmeter to measure the amplitude and by relying on the ear for the purity of tone.

The frequency stability of the oscillator is practically unaffected by all normal mains voltage fluctuations. A variation of supply voltage between 260 and 160 V. was found to result in less than 0.1 per cent. variation in the generated frequency. Stability of this order is reached within about 30 seconds after switching on from a cold start. The long-term stability of the frequency calibration depends chiefly on the constancy which can be achieved in the values of the resistances forming the tuning network. Ageing and humidity may prove to be the most serious disturbing factors, and for high precision work only the very best resistances should be used. The commonly available resistances, however, appear to give a frequency stability of better than 0.5 per cent. over a period of several months, with a day-to-day stability 10 to 100 times better than this.

The waveform, as measured at the anode of the output valve, is practically sinusoidal at all frequencies except the very lowest, i.e. below about 60 c/s, where the distortion becomes quite apparent on an oscillograph. The acoustic output is also dependent, of course, on the characteristics of the speaker and cabinet design.

In the various models which have been constructed, no great importance was attached to the maintenance of constant voltage output throughout the frequency ranges, but it was observed that appreciable deviations from the average level occurred only at the extreme top and bottom of the acoustic scale. In one model, which was not especially good in respect of uniformity of output voltage, the deviation from average level exceeded 2 db only when the frequency was above 11,000 c/s. The output characteristics of the four ranges of this particular instrument are shown in Fig. 4.

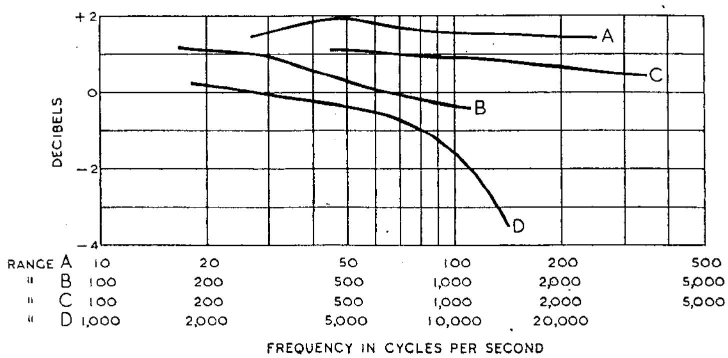



**Fig. 4. Output voltage variation for four frequency ranges. The output corresponding to 0 db is 30V RMS across 100,000 ohms.**

The question of calibration is regarded as being outside the scope of this article. No new technique is involved, and any of the usual methods may be employed. The choice will, of course, depend on the degree of accuracy required and the apparatus available. It may, however, be added that it has been found to be quite practicable to calibrate the frequency scale in steps of 10 c/s as high as 5,000 c/s and in steps of 1 c/s below 200 c/s.

In conclusion, the author wishes to express his thanks to Mr. J. M. W. McBride and to Mr. L. Stenning for the assistance derived from discussions with them on this subject.

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# REVIVING OLD IDEAS

*(From " Radio," New York)*

A WELL-KNOWN engineer said that, should he have a hand in the development of post-war radio-electronic products, he would set a group of men to digging in the dust of the past in search of new ideas.

What he means, of course, is that many ideas have been born much before their time, and are, therefore, worth reviewing in the light of more recent developments. A scheme that proved a washout in its time may now prove to be the answer to a trying riddle.

A case in point is the original R.C.A. loop-operated receiver employing the Type 199 tubes. In a sense this receiver represented brilliant engineering, but the use of a loop antenna at a time when gain was both expensive and difficult to obtain was definitely a *faux pas*. But some years later, when gain became cheap and relatively easy to obtain, the loop was resurrected and to very good advantage. Yet, not until someone put two and two together to make a very profitable four for the entire radio field.

It is also interesting to observe that a condenser phonograph pick-up was developed—and a few manufactured—around 1924 or so. It was designed for use in conjunction with an RF oscillator and some form of detector, and had no advantages over other types of pick-up that we can recall. But there are indications now that the capacity pick-up, used in conjunction with a small FM unit, may find widespread use in the post-war period.

Loudspeakers are another case in point. Small speakers with rather good efficiency and frequency response can be developed if the cone has sufficient rigidity and at the same time a rather large excursion. The answer to this problem may well rest in the use of a single-turn voice coil. If that is the case, it will be found that a single-turn voice coil was first used in a dynamic speaker about 1924.

The future is always indebted to the past in some manner, and it is good engineering practice to constantly revalue old ideas in the light of new developments.

# MATCHING

## I.—Maximum Power and Minimum Distortion at Audio Frequencies

By S. W. AMOS,
B.Sc. (Hons.)

**It is not generally appreciated that all the coupling circuits used in radio, whether AF, RF or IF, are examples of matching, either for maximum power transfer, maximum voltage transfer or optimum performance in some other quality. It is the purpose of these articles to discuss the laws of matching with particular reference to some of the types of AF and RF circuits used in receivers and transmitters and the conditions for optimum performance will be given.**

POSSIBLY the simplest form of matching circuit is that illustrated in Fig. 1, which shows a source of power (a dynamo, for example) connected to a load (a lamp is shown in the illustration).. The problem is to get maximum power (illumination) into the load, which has a resistance of $R_l$ ohms, the dynamo being assumed to have a resistance of $R_i$ ohms, and to be running at a constant speed thus giving a constant output of E volts. From Ohm's law we have that the current in amps. in the circuit is given by—

$$i = \frac{E}{R_i + R_l}.$$

Thus the power, P, in the load is given by—

$$P = i^2R_l = \frac{E^2R_l}{(R_i + R_l)^2}.$$

We can find out when this power

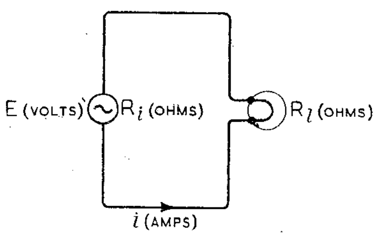



**Fig. 1. Circuit illustrating simplest form of matching.**

is a maximum by considering a numerical example. Suppose E = 6 volts and $R_i$ = 5 ohms. By giving $R_l$ various values and evaluating the power from the above expression for each value we obtain the curve shown in Fig. 2 (a), which shows that maximum power is given when the load has a resistance of 5 ohms, which is the resistance of the generator. This is an important conclusion and one of very general application. We will call it the first law of matching thus—For maximum power in the load—

$$R_l = R_i \quad .. \quad .. \quad (1)$$

Suppose we desire the condition for maximum voltage developed across the load. From the circuit of Fig. 1 the voltage across $R_l$ is given by—

$$E_l = iR_l = \frac{ER_l}{R_i + R_l},$$

The value of this expression has been plotted in Fig. 2 (b) for various values of $R_l$. From this curve we can see that $E_l$ tends to the value E and the greater $R_l$ is compared with $R_i$ the nearer does $E_l$ approach E. In radio when we say that one resistance has to be great compared with another we make the first ten times the other whenever possible. We can therefore state the second law of matching thus—

For maximum voltage across the load—

$$R_l = 10R_i \quad .. \quad .. \quad (2)$$

We have so far assumed $R_i$ constant and $R_l$ variable, the reverse sometimes occurs, i.e., $R_l$ is fixed and $R_i$ is controllable. In this case maximum power is dissipated in the load when maximum voltage is generated across it and this occurs when $R_i$ is small compared with $R_l$, say, one-tenth of $R_l$.

Now a valve is a generator of alternating potential. Consider Fig. 3 (a) which represents a triode of internal resistance (anode impedance) $R_a$ feeding into a load $R_l$, the alternating input to the grid being $E_g$ volts. Fig. 3 (b) is the electrical equivalent of the circuit in which the valve is shown as a generator of internal resistance $R_a$ delivering $\mu E_g$ volts, where $\mu$ is the amplification factor of the triode. Fig. 3 (b) compares directly with Fig. 1 and we have therefore the immediate results that, for maximum power in the load, $R_l$ must equal $R_a$ and for maximum alternating voltage across the load, $R_l$ should be great compared with $R_a$. The practical significance of these results is clear. If a triode valve is to be used for power output purposes with a loudspeaker approximating to a pure resistance connected directly in its anode circuit as in Fig. 3 (a) then we shall get maximum power into the speaker by making its resistance equal to the internal resistance or impedance of the valve. When the triode is used as a voltage amplifier to realise the full amplification factor of the valve the load resistance should be very much greater than the anode impedance. In practice $R_l$ rarely exceeds three times $R_a$ (in which case the stage gain equals $\frac{3}{4}\mu$) because the signal handling capacity of the valve is severely curtailed by the use of loads of value greater than this.

The matching condition for greatest power output used up to now, namely $R_l = R_a$, does not

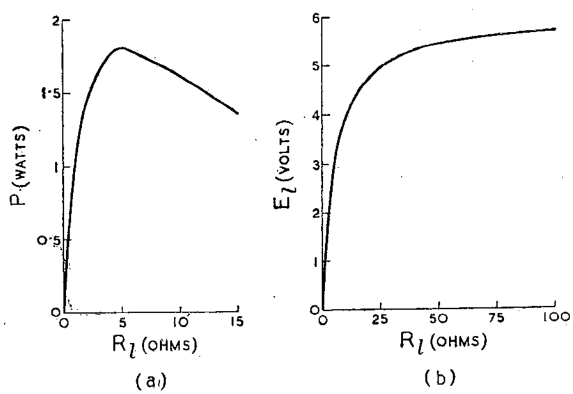
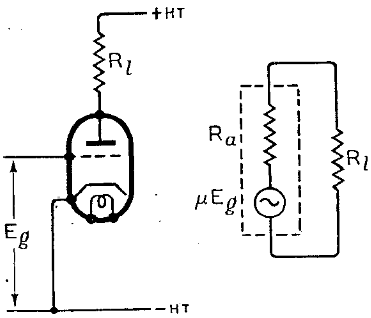



**Fig. 2. Curves illustrating dependence of (a) power and (b) voltage across $R_l$ on the value of $R_l$. Both curves apply to the circuit of Fig. 1, where E=6 volts and $R_i$=5 ohms.**

hold when the loudspeaker is fed by means of a transformer from the anode circuit as shown in Fig. 4. A complete explanation of why this is so is beyond the scope of this article: it is sufficient to say that it is because the anode potential of the valve can, when a




(a) (b)

**Fig. 3. A triode amplifying stage (a) and its equivalent circuit (b). The latter compares directly with Fig. 1.**

transformer is used, swing from zero to twice the value of HT used, whereas in the other circuit the positive potential peak was limited to the value of the HT volts. For the transformer coupled loudspeaker the condition for maximum power transfer is $R_l = 2R_a$ where $R_l$ is the value of the loudspeaker resistance reflected into the primary of the output transformer. If the turns ratio of the latter is $n : 1$ and the speech coil resistance is R, then the condition for maximum power transfer may be written—

$$\frac{R_l}{R} = \frac{1}{k^2} \cdot \frac{L_P}{L_S}$$

or in general terms—

$$\frac{R_1}{R_2} = \frac{1}{k^2} \cdot \frac{L_1}{L_2} \quad .. \quad (3)$$

In this $L_P$ and $L_S$ are the primary and secondary inductances respectively and $k$ is the coefficient of coupling between them. Now in audio-frequency amplification in which iron-cored transformers are used $k$ is very nearly equal to unity (not quite unity, of course, otherwise there would be no leakage inductance), and, moreover, the inductances are proportional to the squares of the numbers of turns. Consequently law (3) can be reduced to the simple form—

$$R_l = n^2 R$$

in which form the majority of readers will recognise it. The author prefers version (3), however, for it applies equally to RF circuits in which coupling coefficients are often far from equal to unity and inductances are just as often not proportional to the second or any other power of the number of turns.

This method of matching two resistances by means of a transformer is one extensively used in radio. To get maximum power from $R_1$ to $R_2$ if these are connected by a transformer the ratio is given by the expression—

$$\sqrt{\frac{R_2}{R_1}} : 1$$

As just explained when this expression is applied to a triode output valve, $R_2$, the optimum load is given by $2R_a$, $R_1$ being the speech-coil resistance. To quote a numerical example, typical values for $R_2$ and $R_1$ are 3,000 and 2 ohms respectively, giving the output transformer ratio as

$$\sqrt{1{,}500} : 1 = 39 : 1$$

In order to transmit speech and music satisfactorily over a land-line it is necessary that the line be terminated at each end in a resistance equal to its characteristic impedance. This characteristic impedance depends on the dimensions of the land line but an average figure is 600 ohms. If,

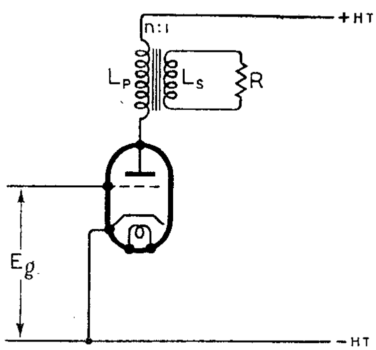



**Fig. 4. A triode amplifying stage with transformer-coupled load. The matching condition for this differs from that for Fig. 3 (a).**

therefore, the output of a receiver is required to be fed to a line an output transformer should be used, such that its ratio gives a good match between the optimum load of the output valve and 600 ohms. If the optimum load is 10,000 ohms then the ratio to use is—

$$\sqrt{\frac{10{,}000}{600}} : 1 = 4 : 1$$

For a triode, as we have seen, $R_l = 2R_a$ for maximum power output but for pentode and tetrode output valves this relationship is far from true. Such valves have very high values of internal resistance (50,000 ohms is a

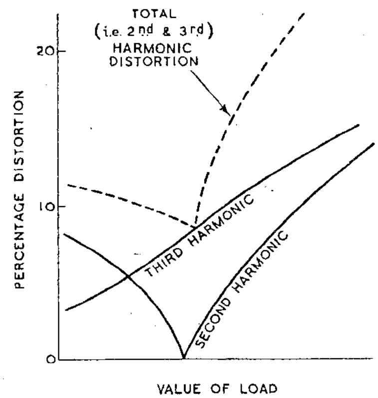



**Fig. 5. Dependence of load resistance of distortion given by pentode output valve.**

common value) and work most satisfactorily into loads with a resistance generally between one-sixth and one-third of their impedance. Now such output valves can give a rather high distortion unless considerable care is taken to match them carefully to the loudspeaker. Fig. 5 shows how the distortion given by a pentode valve depends on the value of the load it "looks" into. Curves are given for second, third and total distortion and it is immediately clear that it is possible to choose a value of load which will give the greatest freedom from distortion; in other words it is possible to match the valve to the load for minimum distortion. It is almost certain, however, that the value of load which gives minimum distortion will not give the greatest output power.

We will now consider intervalve transformers and see how they satisfy the matching laws. The basic circuit for two transformer-coupled valves is given in Fig. 6. This is another example of matching two resistances by means of a transformer, the resistances being the anode impedance of $V_1$ and the input impedance of $V_2$. Now the anode impedance of $V_1$, if this is a triode, may be between 10,000 and 50,000 ohms but the input of $V_2$ depends on quite a number of factors. If $V_2$ is operating in Class A conditions, i.e., with no grid current flowing, then its input resistance will depend chiefly on the frequency and the nature and magnitude of its anode load. At 1,000 c/s and for a resistive load we can take this input resistance as being about 10 megohms. For a numerical example we will consider the value 8 megohms and we will let the impedance of $V_1$ be 50,000 ohms. As no grid current flows this is a case of matching for greatest voltage transfer so that, from matching expression (2) the reflected resistance across the transformer secondary should be one-tenth the input resistance of $V_2$. This gives the transformer ratio as—

$$\sqrt{\frac{800{,}000}{50{,}000}} : 1 = 4 : 1 \text{ step-}$$

up which agrees well with the values used in practice.

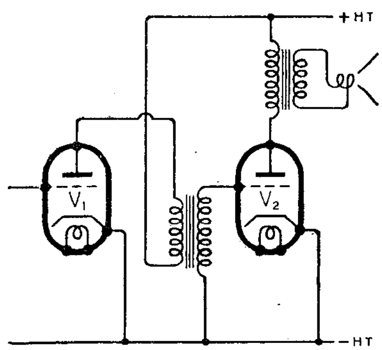



**Fig. 6. Basic circuit of transformer-coupled AF amplifier.**

Suppose that $V_2$ is a Class B amplifier, or rather one half of a Class B output stage. Two differences are now noticeable. First, grid current now flows in $V_2$ and so its input resistance is low, about 5,000 ohms say. Second, the power associated with this flow of current has to be supplied by $V_1$, which makes this example one of matching for greatest power transfer. Using expression (3) we have that the ratio of the transformer is given by—

$$\sqrt{\frac{20{,}000}{5{,}000}} : 1 = 2 : 1 \quad \text{step-}$$

down in which $R_a$ of $V_1$ has been taken as 20,000 ohms. Incidentally, the secondary resistance should be as small as possible to avoid waveform distortion due to the voltage drop when the grid current flows through the transformer secondary.

## Wireless World Brains Trust

# Future of the Disc

***MORE VIEWS ON QUESTION No. 16. (Is the disc record due for supersession, and, if so, what system of sound recording for domestic reproduction should take its place?)***

***DR. L. E. C. HUGHES considers that we are committed to the disc, but that there is room for the parallel development of a system giving a much longer period of uninterrupted reproduction. He writes:—***

WHILE I would subscribe to nearly all the contentions of Stuart Black (*Wireless World*, December, 1943) respecting the disadvantages of the disc (and, historically speaking, the advantages of the cylinder) as the geometric form of the medium for carrying recorded sound, may I emphasise the fact that the material of the recording medium is the controlling factor? We can always get adequate frequency response by adopting a sufficiently high speed of medium, i.e., resolution of the wave-form; the limiting factor is the ground-noise. This is virtually eliminated in sound-film, e.g., "Fantasia," but at what a price! I recollect that A. G. D. West estimated (in a lecture before the Royal Society of Arts) that the optimum design of sound-film for the home would have to sell at five times the cost of discs for material alone.

We are committed to discs; on occasion the quality can be extremely good. The major defect is only the limitation of playing-time. The difficulty of the varying track-speed only shows up in the varying quality towards the centre when the needle is wearing. The needle must wear, otherwise the material of the record would wear to a greater extent and reduce its own life. A distinct improvement would be to play the disc outwards instead of inwards. This method was adopted in the earliest sound-film, when Vitaphone utilised the synchronised disc as a quick answer to the pressing demand for adding sound to scene. Unfortunately, the method was not adopted when records (slow-speed, with special acoustic reproducers) were used for talking books for the blind.

We are committed to discs commercially because of the immense capital locked up, not so much in the technical equipment for their production, but in the costs of the artists. Any new system which purports to compete with discs in the ordinary market must start from scratch with no titles in its catalogue. As the great majority of artists and most large orchestras are under contract to the principal recording companies, one cannot imagine where recording material saleable on a new type of machine, not interchangeable with discs and competing with them, is to come from. Even if an *élite* market could be found for a system markedly superior to the disc system, the same difficulty of titles arises.

We have, therefore, to find a new source of high-grade sound for recording purposes. It exists only in broadcasting, and, having paid one's licence for the service of broadcasting, I see no legal hindrance to recording it for one's private interest, providing the record is not made for public sale or usage. The way out of the *impasse* lies in the production of a recording system which, while robust, simple in operation, and cheap both in first cost and running costs, would enable a domestic user to get quality which is at least as good as, if not better than, existing discs.

We are again back to the material. The major demand is for non-interruption, which is impossible on a rigid material. The only alternative is a filmic material of sufficient area to take the longest uninterrupted musical or dramatic works. This medium must be used in such a way that the ground noise is at least as low in relation to the recorded sounds as the best records or modern sound-film. With such a recording system and abundant supplies of cheap film, the enthusiast can record to his heart's content what he likes of what is broadcast, or what he likes to create in his own surroundings.

He makes his own recorded library and becomes independent of the existing vested interests. Such a system has, of course, not yet appeared, but it seems to me that these are the lines on which a new system must be introduced.

There is one possible improvement to the disc system which Mr. Black did not mention: the standardisation of the exact dimensions of the cutting stylus among the recording companies throughout the world. I am aware that a leading company has tried to give a lead in this matter, but nothing came of it. A bad fit of the reproducing needle in the groove leads, I am sure, to unnecessary wear of the record. If the two could be fitted together, and this could be done only by international agreement, I feel that records would not wear so quickly.

Likewise, mechanical tracking of the pick-up is not possible until there is international agreement on the spacing of grooves. The latter are sometimes varied to accommodate high-amplitude recording. The customer also likes to feel that the surface is fully used, forgetting that this is linked to the time of playing.

The Edison cylinder is, for artistic purposes, dead, as Mr. Black says. In the form of the Dictaphone and the Ediphone it is, however, still doing an enormous job in commerce and also helping the B.B.C. in its vast war-time job of monitoring. The apparent low ground noise arises from the restricted reproduced frequency band. Some tests with the modern electrical pick-up on a cylinder would be illuminating.

***DONALD W. ALDOUS, Technical Secretary of the British Sound Recording Association, surveys suggested improvements to disc recording and discusses possible alternative systems.***

THE question "Is disc recording obsolete?" has long been debated among recordists and others interested in the subject. Briefly, the answer generally agreed upon at these discussions is "No; the disc recording system will continue to be of great use for domestic record reproduction purposes, but numerous improvements are urgently needed." It is on the question of the desired improvements that no final agreement could be reached! (I shall confine my remarks to recordings, on any system, but produced in quantity chiefly for domestic reproduction, as the direct play-back disc system will continue for a long time to find many applications by both professional and amateur recordists, which I have covered elsewhere.[1])

Among the suggested improvements and modifications are the use of (a) the vertical or hill-and-dale cut, (b) constant amplitude recording, (c) constant groove-speed recording, (d) variable groove-pitch recording, (e) pressings in a "scratch-free" plastic, and such refinements as (f) standardisation of groove size, shape and pitch, (g) markings on record labels to show frequency characteristic used, and (h) the coefficient of compression, to permit the correct volume expansion coefficient to be used in reproduction, and, lately, (i) the use of an FM pick-up.

In view of my friend Stuart Black's comments, he will no doubt be interested to learn that a method of embossing or burnishing disc recording, in which no "thread" is removed, used in combination with constant groove-speed recording, has recently been revived in America. It makes possible 30 minutes' music or 45 minutes' speech recording on one side of a 12in. disc.[2] A polished round stylus is used for recording and play-back. The constant groove-speed method was also employed in the "Longanote" record, marketed by Filmophone Flexible Records, Ltd., in this country in the early 1930's.[3]

Regarding film recordings for home use, one can recall the technically successful Duo-Trac method.[4] An excellent survey of the question whether sound-on-film can supplant the disc record, by Mr. R. H. Cricks,[5] indicates that the electrical and acoustical parts of such a design present no difficulties, but long and costly experimental work to solve the following problems would be necessary: (1) the discovery of some less costly film base than cellulose-acetate, (2) the computation of optical components capable of the necessary standard of definition, (3) the perfection of mechanical devices for the recording, printing and reproduction of the film, as well as the snag of the complicated patent situation regarding the commercial use of certain types of film drive, use of ultra-violet light for recording/printing, and certain noise-reduction, volume-expansion devices, etc. Also the questions of a simple portable apparatus and a design for locations where no electric power supply is available must be taken into account.

I have refrained from giving a final personal opinion, as I think it would be prudent to wait until the latest views of fellow-technicians have been expressed before passing final judgment. Then perhaps someone will attempt a summing-up.

[1] "Manual of Direct Disc Recording," (*Bernards, Ltd.*)
[2] "Embossing at Constant Groove-Speed," *Electronics*, July, 1940.
[3] *Wireless World*, p. 286, March 16th, 1932.
[4] *Wireless World*, p. 277, March 19th, 1937.
[5] *Electronic Engineering*, April, 1942.

## SUSPENSION OF TECHNICAL INFORMATION SERVICE

### *A Reminder to Readers*

**SHORTLY after the outbreak of war, it was decided to suspend the service formerly conducted by the "Wireless World" Technical Information Bureau.**

**This decision, arrived at with regret, was brought about by shortage of technical staff due to the demands of the Services. It was felt that the energies of those who remained could most usefully be employed in the production of the journal, and not in dealing with individual queries, either by letter or telephone.**

**Readers are reminded that this suspension is still in force, and must remain so until the end of the war.**

# RADIO DATA CHARTS—13

## *Inductance, Capacity and Frequency : Medium Wave*

By

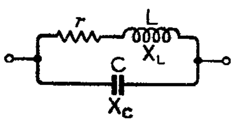
J. McG. SOWERBY,

B.A., Grad.I.E.E.

(By permission of the Ministry of Supply)

LAST month we dealt with the theory of the series tuned circuit. Continuing the discussion let us now turn to the more commonly used parallel tuned circuit shown in the figure, in which all the resistance is supposed to be in the inductive arm, approximating closely to practical conditions.

Parallel resonant circuit.




It will be remembered that at resonance the impedance of the series circuit was a pure resistance equal to the resistance of the inductance. At the same time the impedance was at a minimum. In the parallel case it turns out that the impedance is high at resonance and is largely resistive. In our working we may therefore assume the criterion of resonance in the circuit as (1) presenting a pure resistance (2) presenting the maximum impedance. The first case will be chosen here as it is rather simpler to work out and since the results obtained by adopting either criterion or resonance are exactly the same.

The impedance of the parallel circuit is clearly the impedance of the two arms in parallel with one another, and so

$$Z = \frac{(r + jX_L)(-jX_C)}{(r + jX_L) + (-jX_C)}$$

This may be rearranged in the form $(A + jB)$ and when this is done it turns out that

$$Z = \frac{rX_C^2}{r^2 + (X_L - X_C)^2} + j\frac{(X_C^2X_L - X_CX_L^2 - r^2X_C)}{r^2 + (X_L - X_C)^2} \quad \ldots \ldots (1)$$

For the impedance to be purely resistive the imaginary term to the right of this equation must be zero, hence the numerator must be zero, and so

$$X_C^2X_L - X_CX_L^2 - r^2X_C = 0 \quad \ldots \ldots (2)$$

from which

$$\omega^2 = 1/LC - r^2/L^2$$

or

$$f = \frac{1}{2\pi}\sqrt{\frac{1}{LC} - \frac{r^2}{L^2}} \quad \ldots (3)$$

It was shown in the notes concerning the dynamic resistance of a parallel tuned circuit (*Wireless World*, July 1943, p. 194) that the magnitude of this pure resistance is approximately

$$R_D = L/Cr \quad \ldots \ldots (4)$$

and it is called the dynamic resistance of the tuned circuit. Equation (3) gives us the frequency of resonance of the circuit but in practice it may be further reduced to

$$f = \frac{1}{2\pi\sqrt{LC}} \quad \ldots \ldots (5)$$

since the term $r^2/L^2$ of equation (3) is small compared to the $1/LC$ term when the Q of the circuit is reasonably high. In fact the frequency given by (5) will differ from the frequency as given by (3) by 1 per cent. when the Q of the coil is about 7. When the Q is 50 (which is a more practical value) the two formulae differ by only two parts in 10,000 (or 200 c/s in 1 Mc/s). Hence the simple formula (5) is quite accurate enough for all practical purposes except when special conditions obtain.

In addition to the above mentioned two criteria of resonance there is another—this being the frequency of the damped oscillations produced by a transient in the circuit. This is known as the *natural* frequency and it turns out that this frequency is given by the equation

$$f = \frac{1}{2\pi}\sqrt{\frac{1}{LC} - \frac{r^2}{4L^2}} \quad \ldots (6)$$

The right hand term under the square root sign is even less here than in (3) and consequently equation (6) differs from (5) by even less than (3) so that once again the approximate fromula is justified as being quite sufficiently accurate for the vast majority of calculations. However, if the Q is less than 7 the exact formulae should be remembered.

It will be of interest now to calculate the currents in the two arms of the parallel circuit. If E is the applied voltage then the current through L is

$$I_L = \frac{E}{\sqrt{r^2 + \omega^2L^2}} \doteqdot \frac{E}{\omega L} \quad \ldots \ldots (7)$$

and through C it is

$$I_C = E\omega C \quad \ldots \ldots (8)$$

The current through the whole circuit is

$$I = E/R_D = ECr/L \quad \ldots (9)$$

The ratio of the currents in the condenser (or, to a close approximation, the coil and the whole circuit is thus from equations (8) and (9)

$$\frac{I_C}{I} = E\omega C \cdot \frac{L}{ECr} = \frac{\omega L}{r} = Q \quad \ldots \ldots (10)$$

The current through the condenser or coil is therefore Q times the current passed through the whole circuit, but as the currents in the coil and condenser are nearly out of phase only a small current as given by (9) is drawn from the source of supply. In the last RF (or IF) stage of a receiver it would not be unusual to have a voltage across the tuned circuit of 30 volts. If the dynamic resistance were 90,000 ohms (a reasonable figure) the total current would be 1/3 mA. If the Q of the coil were 180 then the current through the coil would be 60 mA —quite a high current. Hence in designing coils it should not be forgotten that they may be called upon to carry currents of this order and appropriate precautions should be taken.

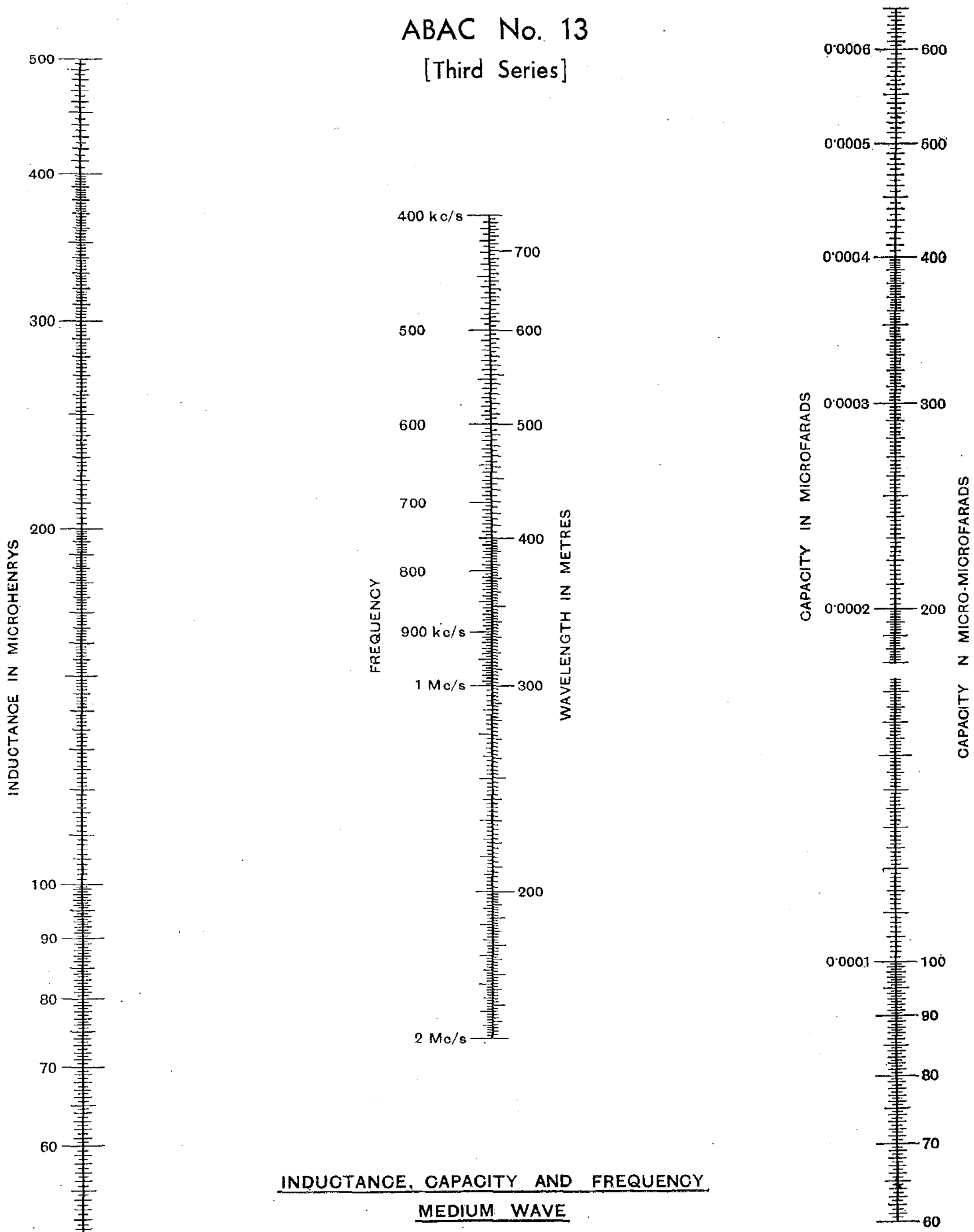
*The Chart.*—As before the chart is based upon the simplified formula (5). It is only necessary, in use, to connect two of the quantities L, C, and $f$ together with a ruler when the third will appear opposite the ruler on the appropriate scale.

*Example.*—What is the resonant frequency of a parallel circuit of 100 $\mu$H and 200$\mu\mu$F ?

*Ans.* 1.125 Mc/s (1,125 kc/s or a wavelength of 266.57 metres).

# ABAC No. 13

[Third Series]




INDUCTANCE, CAPACITY AND FREQUENCY

MEDIUM WAVE

# CARBON RESISTORS

## *Properties of the Various Types*

By R. H. W. BURKETT, B.Sc.

IT is well known that most of the resistors at present used in radio equipment are of the carbon type and have the fundamental properties of carbon modified to a greater or less degree by reason of the peculiarities of construction. The types at present in use in the order of output are: (1) composition rod; (2) composition film; (3) cracked carbon film.

The composition rod resistor comprises a cylinder of material consisting of a mixture of carbon, either graphite or carbon black, or both together with silica or other refractory material and a cement or binder such as a thermoplastic resin. The materials are blended in the proportions required to give the desired resistance, moulded into shape and then fired. The resistors are then selected for value, provided with leads and painted. There are types, however, which are insulated, and these may be provided with an outer insulating ceramic tube or covered with a synthetic resin surface layer.

The composition film type of resistor comprises a film formed by applying a paste containing carbon to a former, which may be a ceramic rod or glass tube, and then baking. This film may be spiralled to increase the resistance, and that formed on a ceramic rod is then painted with a protecting lacquer. The type produced on the glass tube is encased in moulding material without spiralling.

### "Cracked" Carbon

The carbon film type is becoming increasingly popular in this country and has superior properties to the two previous types. This resistor comprises a film of pure carbon, probably graphite, deposited on ceramic rods or tubes by passing them through an atmosphere containing organic vapours at high temperatures. This process is known as "cracking," and the resistors produced in this way are frequently referred to as cracked carbon resistors. The deposit of carbon is of low resistivity and the effective resistance of the component may be increased by reducing the thickness of the film by a polishing process or by spiralling the film by means of diamond or carborundum cutters. End caps and leads are provided and the whole resistor given some measure of protection by a lacquer or sleeving of insulating material.

Apart from the cracked carbon and one make of composition film resistors, which types have their final resistance value determined by spiralling, the resistance value is controlled by the composition of the initial mixture from which the components are made. Due, however, to the inherent variations in the materials and to slight differences in manufacture there is a scattering effect about the target value. It will thus be seen that while a large number of the final resistors will be at or near the target value, a proportion will be wide of the mark.

If the resistors are being selected to within ±5 per cent. of the nominal value, the number of rejects will be higher than if the selection is to ±20 per cent. The recently adopted "Preferred Values" have been designed to overcome this wastage of material. Each preferred value together with its maximum possible positive tolerance coincides with the next highest preferred value having the maximum negative tolerance. It will thus be seen that no matter what degree of scattering is obtained the product can be sorted into one or another preferred value.

The final resistance value can be controlled to a certain extent in the case of carbon rod resistors by spraying a ring of copper of suitable width on the component before it is painted or otherwise protected. The result is to short out a certain proportion of the resistor and thus adjust its value to the desired extent.

It is generally recognised that the resistance of a carbon resistor will vary with external conditions but the nature and extent of these variations are not so widely known. The chief causes of change of resistance are:—(1) Passage of time; (2) Loading; (3) Moisture; (4) Temperature; (5) Voltage.

The accompanying table gives a picture of the magnitude of these changes and a brief discussion of these variations will not be unprofitable.

There is sometimes a very rapid change of resistance after manufacture, but this change levels out to a slow drift for the whole life of the resistor. The change is probably due to a packing effect as the carbon particles settle into permanent positions to ease strains caused in manufacture. Usually, except when exceptional supply difficulties make it impossible, the initial large change is allowed to take place in storage or the factory and after this "ageing" or settling-down process the resistor is sorted and marked with its nominal value.

### Ageing

The resistance value of a resistor changes during the load, and, as with the time effect mentioned above, the change is rapid at first and decreases in magnitude in a short time. This steady drift then continues throughout the life of the resistor and if anything tends to increase slightly as the resistor nears the end of its useful life. The change is generally greater in the case of the composition film and least for the cracked carbon types. The change for composition film resistors should not exceed five per cent. for the first twenty-four hours of loading and after that should be of the order of a few per cent. per month. If, however, resistors are not allowed to age for a short while after manufacture the initial change is likely to be large and variations up to ten per cent. may be obtained. Some of the change may be due merely to the drying out of moisture and so will be an adjustment of a previous variation rather than a permanent alteration of resistance. The composition rod type will also change to a very similar extent, but cracked carbon resistors should be stable to half per cent. and over a period of several months' continuous loading; one or two per cent. should represent the maximum drift.

This load drift will, as has been pointed out, continue, and it is apparent that the time may come when the resistor is outside the permitted tolerance limit. It is then clear that the resistor has completed its useful life. This is one way of determining the rating of the resistor, for it will be that rating at which the resistor will remain just within defined limits for its expected life.

### Rating Systems

The problem of rating is, however, more complex than this, since, defined in this manner, rating would need amendment every time a change in production methods altered the load stability of the resistor. Other drawbacks of the method are that it is long and laborious, and unless much time is spent on it the results are hit or miss.

Further, considering the demands of standardisation, such a method may produce a number of resistors of one rating but of various sizes and this may be of great disadvantage when replacements are required.

An alternative method is to base the rating on the surface temperature rise of the resistor. This has some basis in fact since the operating temperature is very largely causative of resistance changes. The difficulties of measuring such a surface temperature have been largely surmounted and this new system of rating is supported by the Services. These ratings do not differ materially from those adopted by manufacturers except that the larger resistors tend to have their ratings reduced while the smaller units have been up-rated. This latter fact may be explained by the fact that a considerable quantity of heat is lost *via* the leads.

The work carried out on the rating of resistors tends to show that the temperature gradient from the centre to the outside of a resistor is not more than a few degrees. The temperature distribution along the resistor is, however, greater, and the temperature rise of the ends of the resistor is generally 30 per cent. less than that at the centre.

The highest temperature of the air in which a resistor can be expected to operate is about 60°C. and if a surface temperature rise of 45°C. is adopted as the normal full load working condition, this will yield a surface temperature of 105°C. which figure is generally accepted as the highest temperature that carbon resistors will withstand for a period without marked deterioration. It is for this reason that 45°C. has been adopted as the standard figure for temperature rise.

The subject of rating is not exhausted, and a system based upon the maximum permissible change due to temperature coefficient has been proposed. Such a method has had little support but its nature will be apparent when the question of temperature coefficient is discussed below.

One of the most serious causes of variation is that due to moisture. Carbon has a great susceptibility to the action of moisture and will absorb it from the air, which always contains a certain proportion. The effect is small in normal atmospheric conditions in this country, but in tropical conditions, where the air is frequently saturated and components may be expected to operate with a film of moisture on the surface, the resulting change of resistance may be intolerable.

Composition resistors, both solid and film, may vary up to 20 per cent. from initial value when subjected to cycles of high humidity. As would be expected by reason of the smaller bulk of the resistor element, the composition film will react to changes of humidity more readily even if the ultimate change is no greater. The carbon film resistor is also very susceptible to humidity, and, due to the greater delicacy of the resistance element, the resistor can easily become open-circuited.

To inhibit this effect, manufacturers protect the resistors by various methods. Composition rod resistors are sometimes covered with a ceramic tube or outer envelope of thermoplastic material. In all cases they are impregnated with wax and painted. The other types are usually lacquered with special water-resisting paints, but in one case the composition film is embedded in a moulded case. Certain cracked carbon resistors are protected by a sleeving of polyvinyl chloride slipped on the unit. This method is not too satisfactory and is regarded as a tem-

**VARIATIONS OF RESISTANCE VALUE FOR CARBON TYPE RESISTORS.**

| | Carbon Composition rod | Carbon Composition film | Cracked. Carbon film |
|---|---|---|---|
| Ageing .. | ±5 per cent. .. | ±5 per cent. .. | ±1 per cent. |
| Loading .. | ±2 per cent. .. | ±5 per cent. .. | ±½ per cent. |
| Moisture .. | +5 per cent. normally, +10 per cent. for extreme tropical conditions | +5 per cent. normally, +10 per cent. for extreme tropical conditions | 1—2 per cent. but, with new finishes now available, this will fall to 1 per cent. max. |
| Temperature Coefficient in per cent. per deg. C. | −0.03 for low resistence values rising to −0.2 for the higher values of resistance | −0.03 for low resistance values rising to −0.3 for the higher values of resistance | Usually consistent at −0.02 to −0.03 with occasional batches up to −0.08 for higher values |
| Voltage coefficient in per cent. per volt DC applied | Rising from −0.01 for low resistance values up to −0.025 for the higher values. Resistors having a large bulk tend to have a lower coefficient | Rising from −0.01 for low resistance values up to −0.025 for the higher values | Less than −0.01 per cent. |
| Noise in microvolts per volt DC | Rising to 2 for higher resistance values | Rising to 2 for higher resistance values | Normally negligible |

Note :—The figures given for ageing represent the extreme changes likely to be encountered and should be halved for the variation over a period of six months.

porary expedient only. Much work is being done on the question of protective lacquers. and the problem will probably be solved in the near future.

The amount of protection is such that a variation less than 5 per cent. for solid composition, 10 per cent. for composition film, and 1 per cent. for cracked carbon resistors should be expected under adverse conditions of humidity.

### Temperature Coefficients

The effect of temperature is almost as serious as that of humidity and in certain cases can be more important. Resistors have a temperature coefficient which is expressed as a percentage change per degree centigrade rise. This is not properly a coefficient in the case of composition resistors since the curve of resistance with temperature often displays regressions explicable only by assuming differential coefficient of linear expansion of the materials. Over a small temperature range the change is approximately linear and it is therefore the practice to regard the phenomenon as a temperature coefficient. In nearly all cases a rise of temperature will produce a reduction in resistance and the amount may vary from 0.025 up to 0.3 per cent. per degree centigrade. The table gives a rough indication of the amount of variation.

The importance of temperature coefficient can be assessed by consideration of the total temperature change likely to be encountered by radio equipment in normal use. The maximum temperature range for home use is from approx. −10°C. to +40°C. The temperature rise inside an enclosed set may be a further 30°C. and also there is the 45°C. rise likely to be encountered when a resistor is running at full load. All these effects are additive and it will be seen that in normal home use a range of −10°C. to +105°C., i.e., 115°C. may be encountered. With a co-efficient of 0.3 per cent. which can often be met, a change of 34 per cent. will be produced. Such a change may easily be tolerated in many radio circuits without serious loss of efficiency. Should, however, a circuit such as a time-base, attenuator, filter or oscillator which is set up more precisely be affected in this manner the result may be completely intolerable. In such cases cracked carbon resistors with their low and consistent temperature coefficient must be used. The above outline shows the importance of this factor, but when Service apparatus is involved which must operate equally well at high altitude, in arctic regions and also after prolonged exposure to the sun's rays in some tropical desert situation, a range of approx. −70°C. to +100°C., the effect can be seen to be even more important.

In order to mitigate the effect of high temperatures when it is known that they will work under these conditions, it is usual to de-rate resistors and so reduce the temperature rise, but such conditions cannot always be foreseen, and a loss of efficiency in ordinary use is apparent.

A less well-known phenomenon is the change due to the application of voltage to the resistors. this is normally masked by the change due to the heating effects of the current passed and is only apparent when measurements of resistance are made by the application of very short pulses of current on a suitable bridge. The standard method is a pulse of a half-second duration with 5 seconds interval between the pulses.

The coefficient is expressed as a percentage change per volt DC applied, and will vary from 0.001 up to 0.025 per cent. This figure is always negative. The smaller figure, as will be expected, is usual for the cracked carbon resistor while the larger figure will be encountered with the composition type. These figures appear to be very small, but a resistor may have up to 1,000 volts applied and a composition resistor may have consequent variations up to 25 per cent.

One of the most elusive phenomena in resistors is that of noise. On passing a current through the component an increase of background noise or hiss is apparent. This does not appear to have a frequency characteristic and is uniformly distributed over the band used for the tests. Associated with this thermal noise is an effect due to transient peaks which is apparently quite independent of the previous noise. The peaks are irregular and occur at irregular intervals. The amplitude of noise is a function of the voltage applied and is apparently associated with the dimensions of the resistor as well as being dependent on its life history and composition.

With full load applied to the component the resulting noise may vary from a few microvolts for the cracked carbon types up to a millivolt or so for very high values of the composition resistors. Such an effect must obviously be borne in mind when the first stages of high-gain amplifiers are designed.

From a superficial consideration of the above one might infer that the carbon group of resistors is totally unstable, but such a conclusion would be completely erroneous. The wide variations described will only be encountered in extreme conditions and a good designer will be able to allow for these or take care that his components are properly protected and selected to meet the conditions under which they will work.

It is, however, very apparent that detailed knowledge of these variations is necessary to designers since, armed with knowledge of the physical characteristics of the components, allowance can be made where necessary and compensating means employed if required.

Carbon resistors are produced by the million, and, when doing the type of work for which they are fitted, are extremely reliable in service. They are robust, accepting prolonged overload without marked change, and seldom break down. The components are economical in raw materials and man-power and doubtless through research now in progress they will eventually become even more reliable and consistent.

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### Ghirardi Books

BOOKS by Alfred Ghirardi on radio theory, maintenance and repair, formerly issued by Radio and Technical Publishing Company, of New York, will in future be published by the Radio and Technical Division of Murray Hill Books, Inc., of 232, Madison Avenue, New York 16, N.Y., U.S.A. By disposing of his publishing business to this company, Mr. Ghirardi will be able to devote more of his time to the writing of books on radio and electronic subjects; he will also act as Editorial Consultant to Farrar and Rinehart, Inc., the proprietors of Murray Hill books.

# TRANSFORMER SCREENING

## *Suggestions for Improvement*

By
T. A. LEDWARD,
A.M.I.E.E.

EVERY piece of electrical apparatus has its defects. There is no such thing in practice as a pure inductance, a pure capacitance or a pure resistance; the best are only near enough for practical purposes. To mention only some of the features of a perfect transformer, the coils would possess neither resistance nor capacitance, the magnetic field would wholly link all the coils *and the coils would not be coupled by any electric field.* (The term *electric* is used here in preference to *electrostatic*, as the latter term is open to criticism when applied to AC.)

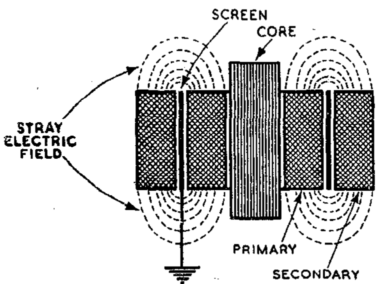



**Fig. 1. Why the conventional transformer screen may be ineffective.**

A practical transformer does not attain perfection in any of these particulars, and the importance of any of them depends upon the purpose for which the transformer is to be used, but it is the last named, i.e., absence of electric coupling, that usually receives the least attention. In many cases the electric coupling is of no importance and where screens are fitted between primary and secondary windings they are often intended as a safety device which, when earthed, will prevent a high primary voltage from contacting the secondary winding in the event of insulation failure.

But there are many instances where a transformer is used for operating test apparatus from the mains when it is highly desirable, and in some cases essential, that there should be no stray electric field between windings. This is especially the case where thermionic amplifying apparatus is used in conjunction with measuring instruments. In some cases totally different readings may result from merely reversing the connections to the supply mains.

The writer has so frequently encountered defeats of this nature that he has gone to some trouble to investigate the effectiveness of different forms of screening. He has found that the usual form of screen, comprising a sheet of metal foil placed over the primary winding and having an insulated overlap to avoid circulating currents, while being very useful and effective for many purposes, falls far short of perfection and can be greatly improved upon.

The ineffectiveness of the conventional screen is due to the spreading of the electric field around the ends of the windings, as shown in the diagram of Fig. 1. It is clear that, to be fully effective, the screen should completely enclose one of the windings. It is necessary, of course, that no part of a screen should form a short-circuited turn, so that insulated overlaps must always be provided.

In some cases it is desirable to screen each winding separately and bring out separate connections to the screens. This may be necessary where there are several windings on one core and each must be screened from the rest. In some cases, certain screens must not be earthed, but must be connected to some other part of the circuit. The cases that arise are so numerous and varied in character that it is not proposed to consider them in great detail in the present article, the purpose being rather to indicate how to achieve good screening, and how to test the effectiveness of a screen. It may be remarked, however, that trouble due to insufficient screening is most likely to arise when it is not possible, owing to the nature of the test circuit, to earth directly one end of the secondary winding.

As a simple illustration, consider Fig. 2 in which the transformer T feeds three impedances Z1, Z2 and Z3 in series. The impedances may be plain resistances, inductive or capacitative reactances, or any combination. It is required to measure the volts drop across Z2 with a mains-driven valve-operated millivoltmeter. This instrument requires an earth connection at E, so that neither end of the secondary of transformer T can be directly earthed The primary is earthed by the supply company's neutral at N. Any leakage capacitance current must flow through the impedance Z1, Z2 and Z3, the direction of flow being as shown by the arrows.

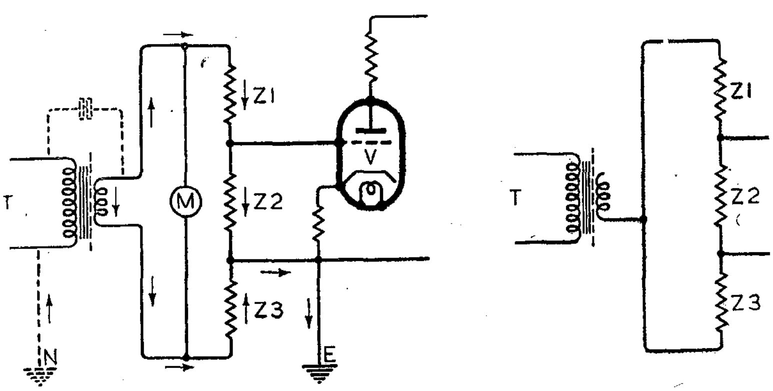



**Fig. 2. Showing how trouble may be brought about by inadequate screening.**

**Transformer Screening—**

It is seen that $Z_1$ and $Z_2$ are in parallel with $Z_3$, so far as capacitance current is concerned, so that if $Z_3$ were zero, no capacitance current would flow through $Z_1$ and $Z_2$. The amount of capacitance current which flows through $Z_2$, and so affects the voltage applied to V, thus depends upon the value of $Z_3$. This current may either oppose or assist the current due to the transformer secondary voltage as indicated on M, the reading of which is unaffected by the leakage capacitance. Whether the leakage current is added or subtracted from the transformer secondary current depends upon which way the primary connecting plug is placed in the socket. This also affects the amount of capacitance current, because if the secondary is near the high voltage end of the primary when the plug is inserted one way, it will be near the low voltage, or earthed, end if the plug is reversed. In either case, the valve-operated voltmeter will give a false reading, as it will not indicate the voltage that will exist across $Z_2$ when the measuring apparatus is disconnected.

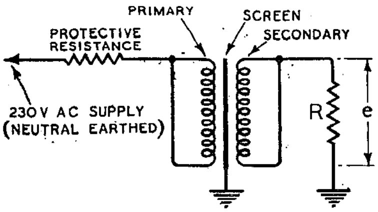



**Fig. 3. Method of applying voltage for test purposes.**

Suppose we attempt to put matters right by transferring the earth from E to one end of the secondary winding of T. Then the transformer that provides mains current for the millivoltmeter unit, *unless this transformer is efficiently screened,* will cause the same trouble as before, owing to the impedance $Z_3$ being then interposed between *that* transformer and earth. If the earth connection is removed altogether, a slight improvement may be obtained, but the result will still be inaccurate.

This illustration serves to show the desirability of properly screening all instrument and testing transformers, as, although either the valve-voltmeter or the apparatus fed by transformer T may be perfectly sound considered separately, they are unsatisfactory in combination, unless at least one screen is used.

In order to demonstrate that an appreciable error can be incurred with quite ordinary impedance values, a circuit was set up as in Fig. 2, in which plain resistances were used. These resistances were accurately measured by DC and had the following values: $Z_1$—71,900 ohms; $Z_2$—592 ohms; $Z_3$—105,300 ohms. These values can be assumed to be substantially the same on 50-c/s AC.

The transformer T was made as described later in this article and had an ordinary screen $S_1$ and a special screen $S_2$ provided (see Fig. 4). The voltmeter M indicated 6 volts, so that the voltage across B should be $592 \times 6/(71{,}900 + 592 + 105{,}300) = 0.02$ volt or 20 millivolts.

The actual readings obtained are shown in Table 1. The mains plug was reversible and under "Normal" are shown the readings with the plug in one position and under "Reversed" with the plug reversed. It will be seen from this table that the only accurate results were obtained with the special screen, $S_2$, in use and they were independent of the way in which the plug was connected. In any case of doubt it is always advisable to try reversing the plug, when the reading should not alter.

**TABLE 1.**

| | Millivolts across Z2. | |
|---|---|---|
| | Plug normal. | Plug reversed. |
| Core only earthed | 18·2 | 21·5 |
| Core and S1 earthed | 19·7 | 21·2 |
| Core, S1 and S2 earthed... ... | 20 | 20 |

Another test with the same circuit, which showed the defect even better, was made by reducing the voltage applied to $Z_1$, $Z_2$, $Z_3$ to zero by connecting both ends to one terminal of the open-circuited transformer secondary as in Fig. 2 (b). The results of this test are shown in Table 2. The reading should, of course, be zero—as it *is* with full screening.

If the transformer T were feeding a bridge in which a valve amplifier and voltmeter were used to indicate balance, it is clear that the same trouble would arise. Another case is where, in certain magnetic tests, T might feed a push-pull amplifier, when screening of T would again be important. Whenever the transformer secondary cannot be directly earthed a screen should be provided.

In view of the value of a really good screen, it is of interest to consider a simple method of testing the degree of screening obtained in any particular transformer.

The principle involved in the tests to be described is that any electric field coupling primary and secondary can be considered as a leakage capacitance which will be zero for a perfect screen. If an AC voltage be applied across primary and screen, any leakage capacitance to secondary will produce a voltage between secondary and screen. It is better *not* to energise the primary in the ordinary way for these tests, as the electromagnetically induced voltage in the secondary is not required and would be troublesome.

In applying a voltage across primary and screen, the simplest method is to earth the screen, short-circuit the primary winding, and connect it, *via* a safety resistance, to the live side of the 230V AC mains, as shown in Fig. 3. The mains neutral is, of course, assumed to be earthed by the supply company, so that a voltage of 230 now exists between primary and screen. The secondary should then be short-circuited and earthed through a resistance R; then any voltage drop *e* across this resistance, if it is not too high, will be almost directly proportional to the leakage capacitance. In making a number of comparative tests, the best procedure is to vary R to give the same value of *e* for each test, so far as this is practicable. Then R will be inversely proportional to the leakage capacitance. In all cases a low-reading

**TABLE 2.**

| | Millivolts across Z2. | |
|---|---|---|
| | Plug normal. | Plug reversed. |
| Core only earthed | 1·21 | 1·92 |
| Core and S1 earthed | 0·15 | 1·06 |
| Core, S1 and S2 earthed... ... | 0 | 0 |

valve-operated AC millivoltmeter is the most satisfactory measuring instrument.

After making a number of tests on a variety of transformers with and without screens, a special transformer was made up with windings and screens arranged, as shown in section in Fig. 4. The connections for test are also shown in this figure. In order to simplify the diagram, only one connection is shown to each winding, but the two ends of each winding should be connected together. Tests were made of leakage capacitance from primary winding A to secondaries B and D in turn, firstly with no earths, secondly with core only earthed, thirdly

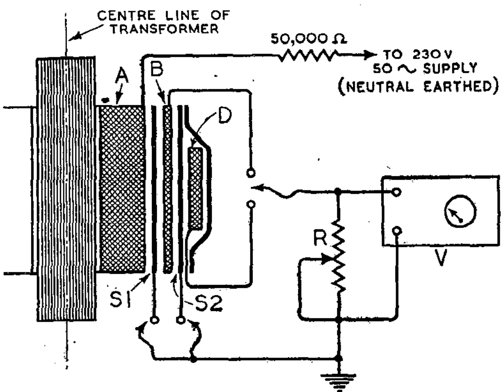



**Fig. 4. Experimental transformer with extra screening; test connections are shown.**

with core and screen S1 earthed, and fourthly with core and screens S1 and S2 earthed. The transformer was a small 25-watt size with 230-volt primary and two 4-volt secondaries. The core was the usual form made from T and U stampings. Screen S1 was of the kind most generally fitted, namely, a strip of foil with insulated overlap covering the outer layer of the primary. Winding B was wound over this screen. Screen S2 completely enclosed winding D, and comprised two foils similar to S1, but with the outer one formed over the sides of winding D as shown, and bound to the inner one. Thus no part of winding D was unscreened, except the connecting leads. The screens were, of course, only effective when earthed. R was adjusted to give a 20-mV reading for each test.

Let $e$ = volts across R

E = applied voltage

C = leakage capacitance

Then volts across leakage capacitance $= \sqrt{E^2 - e^2}$, but as $e$ is negligible compared with E, the voltage across C may be considered as equal to E. The capacitance between secondary windings and screens is, in effect, in parallel with R, but, for the conditions of these tests, it may be neglected. The reactance of C will be E/I and $I = e/R$.

$\therefore$ Reactance $= ER/e$

and $C = e/2\pi f ER$ farads.

Now $e = 0.02V$

$E = 230V$

and $f = 50$ c/s.

$\therefore$ $C = 0.02 \times 10^{12}/314.16 \times 230R\ \mu\mu F$.

$= 277 \times 10^3/R\ \mu\mu F$.

R is the only variable throughout the tests so that calculation of C becomes very simple.

Table 3 shows comparative tests of different screening for the transformer of Fig. 4. It will be seen that while the normal form of screen has reduced the leakage capacitance between A and B to about 1/18th of the value with no screen, the complete enclosure of winding D (except for leads) has reduced the value between A and D to about 1/150th of the unscreened value. The table also shows corresponding reactance values of the leakages for 50 c/s. The figure for winding D should be satisfactory for most purposes, but could be further improved if necessary by enclosing the primary also in a separate screen.

The method described for enclosing winding D is clearly only applicable to a winding of very little depth. Other methods must be used for deep windings. One way is to former-wind the coil and, after taping with suitable insulating tape, add a covering of narrow metal tape, the finishing end of which must be insulated where it overlaps the start. Other methods may occur to the reader. So long as the winding to be screened is enclosed in a conducting covering which does not form a short-circuited turn, that is all that is required.

Where an experimenter already possesses several pieces of apparatus with unscreened, or insufficiently screened, transformers and it is desired to extend their usefulness by the provision of good screening, an economical alternative to screening each transformer separately—which in some cases is impracticable—is to provide a single 1/1 ratio screened transformer which may be interposed between the mains and any piece of apparatus in use.

This article has been concerned with the desirability of good screens on instrument or testing transformers when connected to the supply mains, but while on the subject of screening, it is only natural that many other cases may suggest themselves to the reader in which a screen may be useful. A question most likely to arise is whether mains-borne interference in a radio receiver can be reduced by a screen between windings of the mains transformer.

This is a more difficult problem, and is beyond the scope of the present article to deal with fully. It may be of interest, however, to set down briefly the results of some simple tests made by the writer.

The receiver used had an unscreened mains transformer and, for the purpose of the tests, a 1/1 230-volt transformer was constructed with a screened primary. Primary and secondary were separately former-wound and the

**TABLE 3.**

| | A to B | | A to D | |
|---|---|---|---|---|
| | Capacitance ($\mu\mu$F) | Reactance at 50 c/s. (megohms) | Capacitance ($\mu\mu$F) | Reactance at 50 c/s. (megohms) |
| No earths ... ... | 198 | 16·1 | 111 | 28·8 |
| Core earthed ... ... | 185 | 17·3 | 103 | 31·1 |
| Core and S1 earthed ... | 11·1 | 288 | 9·24 | 345 |
| Core, S1 and S2 earthed | 3·08 | 1035 | 0·74 | 4320 |

primary was screened by taping with tinfoil strip. This transformer was then interposed between the supply mains and the receiver.

The location was a particularly quiet one, where mains-borne interference is not often experienced. Interference was, therefore, specially produced by running a vacuum cleaner in other rooms. The aerial was an indoor one, just under the roof. Roughly, the disposition of plug points, etc., was as shown in Fig. 5.

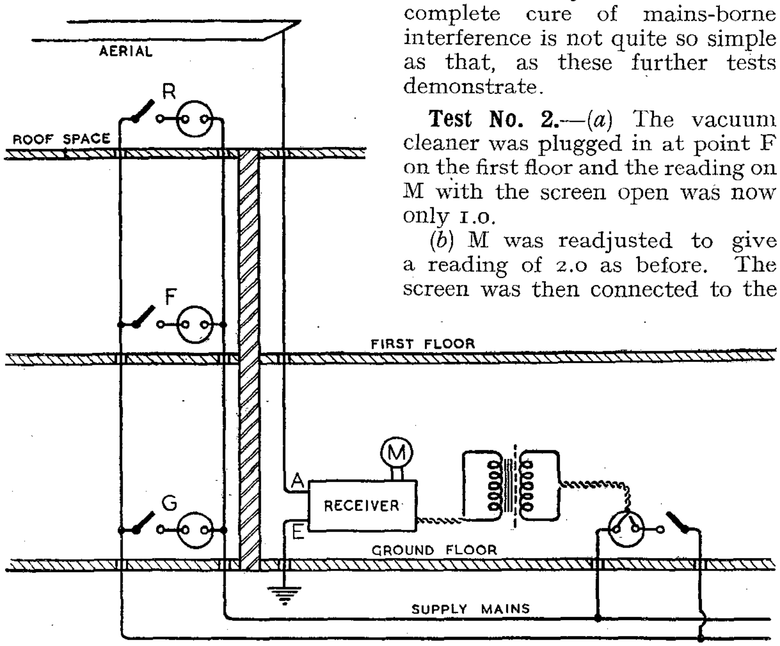



Fig. 5. **Set-up for investigating the effect of transformer screening in reducing mains-borne interference.**

**Test No. 1.**—(*a*) With the vacuum cleaner plugged in at G on the ground floor the interference was severe and practically obliterated normal reception. Under these conditions, the rectifier voltmeter M was adjusted to give a reading of 2.0. (This is only a relative value for comparison and was obtained across a tapping on a multi-ratio speaker transformer with the set de-tuned and the screen disconnected.)

(*b* The screen was then connected to the earth terminal of the set, but no difference was observed in the interference.

(*c*) The screen was then connected to the *aerial* terminal of the set and the interference almost disappeared. The reading on M dropped from 2.0 to 0.1. When a station was tuned in, the connection of the screen to the aerial did not interfere at all with normal reception.

Here, then, is a case where a transformer screen, when connected to the *aerial*, can be extremely effective in reducing mains-borne interference.

Unfortunately, however, the complete cure of mains-borne interference is not quite so simple as that, as these further tests demonstrate.

**Test No. 2.**—(*a*) The vacuum cleaner was plugged in at point F on the first floor and the reading on M with the screen open was now only 1.0.

(*b*) M was readjusted to give a reading of 2.0 as before. The screen was then connected to the aerial terminal and the reading on M fell from 2.0 to 1.1.

The normal level of interference was thus less when the cleaner was plugged in at this point, but the screen was less effective in reducing it.

**Test No. 3.**—Point R on the top floor, just under the aerial, was then tried and, with the cleaner plugged in at this point, the interference was almost negligible with the screen disconnected. The reading on M was approximately 0.1. Connecting the screen to either aerial or earth slightly *increased* the interference, the reading on M being 0.2 to 0.4.

To attempt to give a detailed explanation of the reasons for the foregoing results would require a good deal of space, but it is clear that one cannot simply fit a screen and say that all mains-borne interference will be reduced. Some of it may, in fact, be increased. Some further experimental work in this connection would seem to be justified.

## EUROPE'S 213,000,000 LISTENERS

### *Comparative Figures of Radio Density*

A SYNOPTIC table compiled by the International Broadcasting Office of the Union Internationale de Radiodiffusion, Geneva, shows the increase in the number of listeners in the European Zone during 1942. It should, perhaps, be pointed out that the European Zone is bounded on the north and west by the natural limits of Europe, on the east by the meridian 40 deg. E., and on the south by the parallel 30 deg. N. One section of the graph shows the number of listeners and the other the radio density.

Sweden retains first place so far as radio density is concerned with 254.13 receivers per 1,000 inhabitants. Second place is retained by Denmark with 243.1 per 1,000. Their respective figures at the end of 1941 were 243.4 and 233.9.

Great Britain again holds third place with a density of 197.76 as compared with 186.7 the previous year. In 1941 fourth place was held by Germany, which is now relegated to the sixth with Iceland and Switzerland in the fourth and fifth places, having 184.78 and 170.95 per 1,000 respectively. In both these countries there has been an increase—14 and 11 per 1,000 respectively.

Germany's figure shows a decrease from 177.48 to 164.95 per 1,000. This is not, sad to relate, necessarily due to fewer Germans wishing to listen to Goebbels' outpourings, but to the fact that this year's figure includes the low-density areas in Bohemia-Moravia and the occupied territories of Poland and the U.S.S.R.

In the section of the graph showing the number of receivers in each country, Germany, with which is included the territories mentioned above, leads with a total of 16,113,466. Figures not being available for the U.S.S.R., Britain holds second place with 9,139,426, and France third with 5,404,600.

The total number of receivers in Europe at the end of 1942, allowing the 1941 figures for the U.S.S.R., Norway and Egypt, for which later figures are not available, is estimated at 53,238,000, an increase of nearly 1,500,000 on the previous year's figure. Allowing for an average of four listeners to each receiver Europe had nearly 213,000,000 listeners in 1942.

**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.**

# SHORT-WAVE MARINE UNIT

## "Plug-in" Equipment for Ships

The complete ship's short-wave transmitter and receiver.

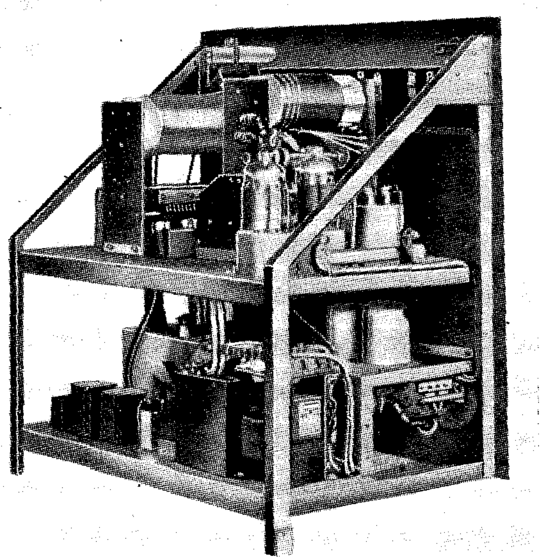
AS a result of the vastly accelerated rate of building merchant ships in U.S.A., there is a tendency to construct wireless equipment for them in single-unit form, so that it may be installed in minimum time. Such equipment, for operation on medium waves, was described in *Wireless World* of July, 1942; the set required nothing more in the way of installation than the erection of an aerial and an electrical connection to the ship's mains supply.

A companion unit for operation on short waves has now been produced by the Federal Telephone and Radio Corporation, and is described in a recent issue of *Electrical Communication*. The HF Marine Unit, as it is called, is equally self-contained, comprising transmitter, receiver and power equipment in a single housing, with a projecting operating table. It has a continuously variable frequency range of from 2 to 24 Mc/s, and, if required, may be installed side by side with the medium-wave outfit, from the generator of which it may if necessary obtain its power. In such cases the keying relays of both transmitters are wired together so that the short-wave unit may be keyed from the operating table of the medium-wave set.

The SW unit is shown in the accompanying photographs. The transmitter gear occupies the upper section of the cabinet, while the receiver is below it, and immediately above the operating table. In the bottom compartment is a motor generator supplying high-voltage DC and low-voltage AC, the latter providing heating current for the valve filaments through a transformer.

For operation under war conditions, an interesting feature of the set is that, thanks to continuously variable tuning, the transmitter may quickly be adjusted to function on frequencies not usually included in commercial ship bands; thus the detection of signals by an enemy station is made more difficult. In a similar way, by making frequent predetermined changes of transmitting frequency a safeguard is provided against the location of the ship by enemy direction-finders. There are 40 crystal-controlled frequencies provided by 10 crystals. It is stated that frequency stability with crystal control is better than 0.02 per cent.; at other wavelengths, with the self-excited oscillator, it exceeds 0.05 per cent.

A minimum of 200 watts is provided on the 2-16 Mc/s range by a pair of Type 813 beam tetrodes in parallel in the power output stage when feeding into a normal ship's aerial. Between 16 and 24 Mc/s output drops to 150 watts. Special short-wave aerials are not required to achieve these outputs, as a matching network is used for aerial tuning, thus allowing operation at any frequency with a wide variety of radiating systems. In practice, it seems that the ship's normal medium-wave aerial is generally used with the SW equipment.



The transmitter unit, which is hinged to swing forward for inspection.

The motor generator of the unit may be operated from ship's mains of either 110 or 230 volts DC. When modulated CW, as well as pure CW is required, a special generator provides, in addition to the normal anode current at 1,750 volts DC and filament current at 78 volts AC, an output at 200 volts, 700 c/s, for modulation. To prevent the application of an excessive load on the ship's mains by an over-hasty operator, the motor starter is of the escapement type. In addition, the starter is equipped with a pair of auxiliary contacts which provide a time delay of about 15 seconds and prevent keying until the heaters of the driver valves have attained their working temperature.

Although the unit is so compact, the question of accessibility of components for maintenance has not been ignored. The whole transmitter panel is hinged at its base, and can be swung forward so as to give easy access to both valves and components.

# BOOK REVIEWS

**Worked Radio Examples.** By A. T. Witts, A.M.I.E.E. Pp. 126; 60 figures. Published by Sir Isaac Pitman and Sons, Ltd., Parker St., Kingsway, London, W.C.2. Price 6s. 6d.

THE author has produced in this book an excellent little volume to accompany a standard text-book. It is intended to help those wireless operators, service-men or students of radio (and they are many) who find difficulty in memorising and using formulæ to solve the problems they are likely to encounter. To this end the book contains no text in the usual sense, but consists of a total of 302 numerical problems on radio matters, each very carefully worked out, the various steps in each calculation being given in full. The problems, which are supplemented by occasional notes to explain subtle points or indicate alternative methods of procedure, all depend for their solution on well-known formulæ, and several problems are devoted to each, so that every formula is encountered in several of the possible forms in which it can be applied in practice.

The first chapter is devoted to Ohm's law, the problems being concerned with series and parallel resistances, meter shunts and power in DC circuits. The internal resistance of cells, series and parallel arrangements and the capacity and charging of accumulators are dealt with in the second chapter, and in the next the problems are on electromagnetism, the calculation of inductance and transformers. Chapter IV is concerned with condensers and capacitance; the problems here are mainly on series and parallel connections and the calculation of capacitance and leakage current in electrolytic condensers.

In his next chapter on the calculation of inductive and capacitative reactance and resonant frequencies the author quite rightly avoids the *j*-notation and calculates the answers directly from the Pythagorean relationship. Similarly in the next chapter, on AC and impedance, omegas are omitted and the general expression used for an alternating current is $I = I_{max} \sin 2\pi ft$. Chapter VII deals with the graphical determination of and the relationship between the impedance, amplification factor and mutual conductance of a valve and also the method of calculating the power output and harmonic distortion content, while the final chapter discusses the calculation of stage gain and output valve matching.

The book should serve its purpose well and can be confidently recommended. S. W. A.

**Basic Calculations for R.A.F. Ground Duties,** by A. E. Druett, B.Sc., A.M.I.Mech.E. Pp. 80. Published by Sir Isaac Pitman and Sons, Ltd., Parker St., Kingsway, London, W.C.2. Price 3s. 6d.

THE war has produced a large crop of small books of the "cram" variety, all at popular prices and designed to present the man in the Services with an easily understood exposition of his subject, thus enabling him to learn with the least effort and to pass his examinations in the minimum time. This book is of this type.

Beginning with the most elementary processes, such as the addition, subtraction and multiplication of fractions and decimals, this little book gives a brief account of the fundamentals of arithmetic, mensuration and graphical representation in so far as they are involved in the work of airmen engaged in the Radio, Wireless and Electrical trades of the RAF and Cadets training for ground duties, for whose benefit the book has been prepared.

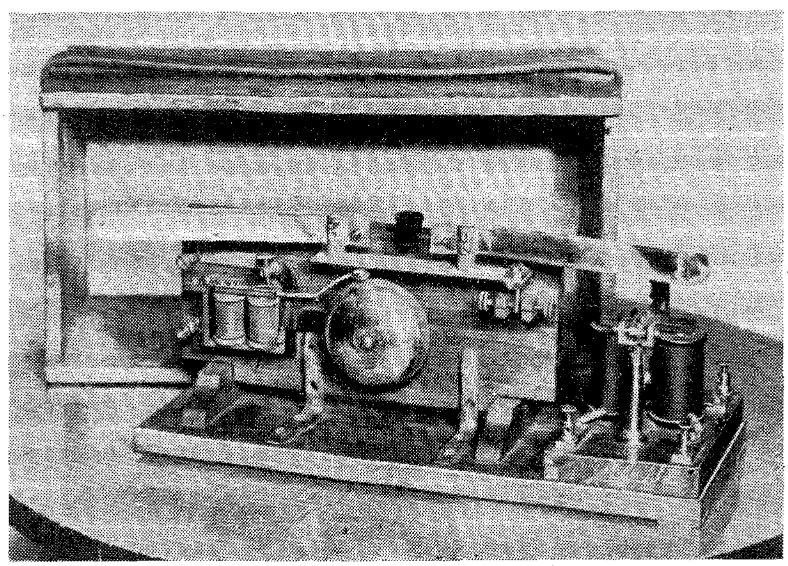
Fractions and their addition and subtraction are dealt with in Chapter I, decimal notation in Chapter II and indices in Chapter III. Further arithmetical subjects such as the relationship between British and Metric units, ratio and proportion, and averages and percentages are next encountered, and algebra is introduced in the seventh chapter on formulæ and equations. The remaining four chapters deal respectively with the measurement of angles, mensuration of the circle, right-angled triangles and graphs.

Each chapter concludes with a set of examples, all of which are of an essentially practical nature. Solutions worked out in full are given.

The short instructional sections which begin each chapter are, in view of the brevity of the book as a whole, necessarily somewhat condensed, but there is no doubt that the most attractive feature of the volume is to be found in the many numerical problems it contains and in the full solutions to them given at the end. S. W. A.

## MUSEUM PIECE

AN accompanying illustration shows a rather unusual demonstration wireless receiver used by the late Richard Kerr, lecturer on experimental physics, *circa* 1900. It has now been presented to the Science Museum, South Kensington, by his daughter, Mrs. Christmas, who assisted him in his lectures. Mrs. Christmas believed that this set had been made for her father by the Marconi Company, but the design, and particularly the ebonite coherer cup which contains a few fine nickel filings, when compared with a contemporary photograph, suggests that it was made by Leslie Miller, manufacturing electrician, who took out a number of patents between 1897 and 1915. These included a description in 1897 of an ebonite box coherer, similar to that shown in this photograph. If Marconi's had supplied the instrument, it would almost certainly have included the Marconi glass tube coherer.



**LAST-CENTURY WIRELESS. This coherer detector unit, believed to have been made in about 1899, has recently been presented to the Science Museum, South Kensington.**

# WORLD OF WIRELESS

### UNIVERSITY RADIO

CONCLUDING his recent review of the progress of broadcasting during the life of the B.B.C., Stuart Hibberd made a plea for a post-war University of the Air. "As I see it," he said, "there will be a huge demand for courses and training in all sorts and kinds of subjects by men who have been, and are about to be, demobilised, all of them about to return to civil life, many of them about to start in a profession or trade, and we know already that there will be an acute shortage of teachers and lecturers. Such a situation will surely be a great opportunity for broadcasting—we should go ahead now with plans to help the nation to meet this need.

"Broadcasting can place would-be students in touch with the greatest authorities on their subjects in the land." He pointed out the main essential would be the setting aside of one wavelength, which could be heard throughout the country, for educational purposes.

### "MUCH ADO . . ."

THE lay Press recently carried banner headlines such as "90,000 utility sets for Christmas;" "85,000 new sets soon." On enquiry it is learned that, whilst there is no justification for undue optimism on the part of besieged dealers and would-be purchasers, there is a movement afoot to expedite the production of the 75,000 unfinished receivers in the possession of manufacturers at the end of September. These have to be completed before "standard" sets are put into production. Moreover, the 10,000 American sets which recently arrived under Lend-lease arrangements have yet to be released.

It has been stated by the R.M.A. that "standard" receivers will be produced by various manufacturers, but will *not* be sold under trade names. Substantial quantities are not expected to be available until June.

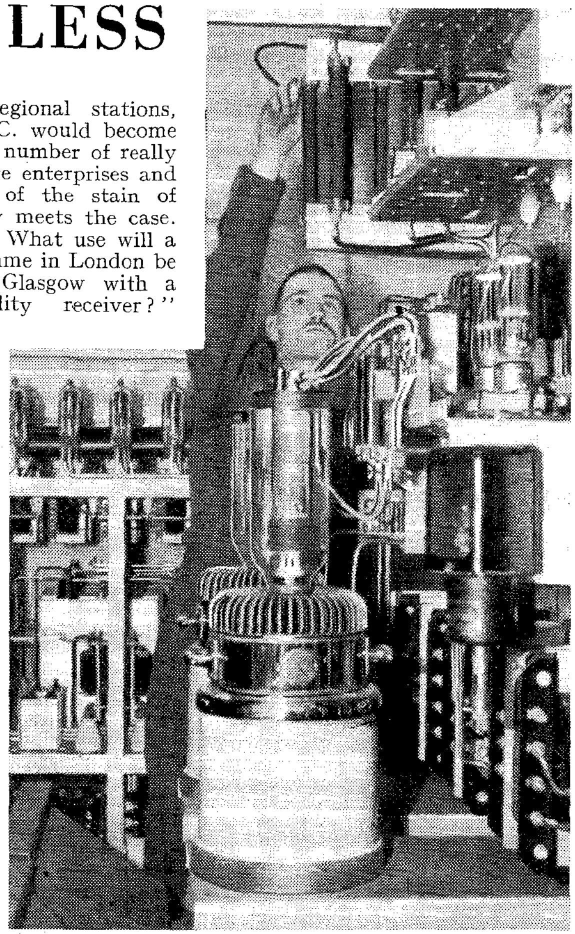
The sets, which will be for AC and battery operation, will be distributed through the normal trade channels, preference being given to those areas most urgently in need of them.

### COMPETITIVE BROADCASTING

IT was encouraging to hear from the Minister of Information at the B.B.C.'s twenty-first birthday luncheon that he approved of the introduction of competitive broadcasting in this country.

His idea, however, of granting "a measure of broadcasting Home Rule" to the regional stations, whereby the B.B.C. would become "the mother of a number of really healthy competitive enterprises and get rid of some of the stain of monopoly" hardly meets the case. One might ask: "What use will a competing programme in London be to a listener in Glasgow with a local-station quality receiver?"

The criticism of the regional scheme of competitive broadcasting is that it savours of parochialism and runs counter to the true spirit of broadcasting, which is not the proper medium for serving local audiences or sectional interests. Some drastic proposals for putting into practice the competitive principle in British broadcasting were considered Editorially in *Wireless World* last month.



**HIGH-POWERED ARMY RADIO.—A section of the new transmitter for high-speed working with the various theatres of war. The station, which is voice-frequency operated over land lines from London, is maintained by Royal Signals.**

### WIRELESS COLLEGES

AS the result of a recent meeting of the principals of the privately owned British wireless schools, "The National Association of Wireless Colleges" has been formed. The chairman is B. G. Moran, of the Manchester Wireless College, while Gordon S. Whale, of The Wireless College, Colwyn Bay, N. Wales, is honorary secretary.

As regular readers know, many questions relating to the post-war qualifications and training of Merchant Navy radio officers have recently come up for discussion. It is now understood that the authorities concerned wish the training schools, as well as other interested bodies, to be represented at any future meetings in connection with these matters. As reported in our last issue, plans are already on foot for setting up a Radio Officers' Training Board.

### U.S. "FREEDOM" STATION

IT can now be stated that the landing of Allied Forces on the North coast of Africa was materially helped by the broadcasts to the inhabitants of Morocco from a transmitter on an American warship.

The broadcasts, appealing to the people to lay down their arms and help the liberators, came from a 5-kW transmitter which was originally destined for a broadcasting station in New Jersey.

The story behind these broadcasts is perhaps of interest. It started about six weeks before the invasion when the U.S. Amphibian Command ordered from Western Electric (on "Triple A" priority) a 5-kW medium-wave transmitter. Owing to the suspension of the manufacture of transmitters except under Government contract, the company had not the apparatus in stock and there was not sufficient time in which to construct it. It was therefore decided to ask for the return of a transmitter which had been delivered to station WHOM, New Jersey, but had not yet been installed. This was procured and the transmitter installed in a battleship

**World of Wireless—**

in time to take part in the successful landings.

## RADIO ENGINEERING COURSE

A FULL-TIME course in radio engineering, conducted under the Hankey Scheme and lasting six months, is to start at the Borough Polytechnic (Borough Road, London, S.E.1) early in the New Year.

Students should possess qualifications equivalent to the ordinary national certificate in radio or electrical engineering, and in any case must have some knowledge of radio communications. Would-be entrants will be considered on their merits. At the end of the course students will sit for the higher national certificate in radio engineering.

Tuition is free and a maintenance allowance is paid to students, who are "reserved" from call-up during training. Prospective students must obtain a release from their employment; it is hoped that wireless firms will support the scheme, which gives a good opportunity for increasing the technical knowledge, usefulness and status of their staffs.

## WHAT THEY SAY

WE [Sperry Gyroscope Co.] never entered the electronic business as a distinct field. Electronics, on the other hand, entered our business, and our products have

# NEWS IN ENGLISH FROM ABROAD

| Country : Station | Mc/s | Metres | Daily Bulletins (BST) |
|---|---|---|---|
| **Algeria** | | | |
| Algiers .. .. | 8.965 | 33.46 | 1600, 1700, 1800, 1900, 2100, 2200 |
| | 12.110 | 24.77 | 1700, 1800, 1900, 2100 |
| **America** | | | |
| WRUW (Boston) .. | 6.040 | 49.67 | 0800 |
| WLWK (Cincinnati) | 6.080 | 49.34 | 0600, 0700, 0800, 0900 |
| WCRC (Brentwood) .. | 6.120 | 49.03 | 0600 |
| WKTS (New York) .. | 6.120 | 49.03 | 0100, 0200, 0300, 0400, 0900 |
| WBOS (Boston) .. | 6.140 | 48.86 | 0900, 1000 |
| WCBX (Brentwood) | 6.170 | 48.62 | 0500 |
| WGEO (Schenectady) | 6.190 | 48.47 | 0615, 0815 |
| WKTM (New York) .. | 6.370 | 47.10 | 0100, 0200, 0300, 0400, 0500, 0800, 2300 |
| WLWO (Cincinnati) .. | 7.575 | 39.61 | 0600, 0700 |
| WKRD (New York) | 7.820 | 38.36 | 0100, 0200, 0300, 0400, 0500, 0700, 0800, 0900, 2200 |
| WGEA (Schenectady) | 9.530 | 31.48 | 1000, 2100 |
| WCDA (New York) .. | 9.590 | 31.28 | 1100, 1200 |
| WKRD (New York) .. | 9.897 | 30.31 | 1000, 1100 |
| WLWO (Cincinnati) .. | 11.710 | 25.62 | 1200, 1300, 2000, 2100, 2200 |
| WRUW (Boston) .. | 11.730 | 25.57 | 1300, 1400 |
| WCRC (Brentwood) .. | 11.830 | 25.36 | 1530, 1630, 2045 |
| WGEA (Schenectady) | 11.847 | 25.32 | 1300, 1400, 1500, 1600, 1700 |
| WBOS (Boston) .. | 11.870 | 25.27 | 1100 |
| WBOS (Boston) .. | 15.210 | 19.75 | 1400 |
| WLWK (Cincinnati) .. | 15.250 | 19.67 | 1400, 1500, 1600, 1700, 1800, 1900, 2000, 2100, 2200 |
| WCBX (Brentwood) .. | 15.270 | 19.65 | 1530, 1630, 2045 |
| WGEO (Schenectady) | 15.330 | 19.57 | 1200, 1300, 1400, 1700 |
| WRUL (Boston) .. | 15.350 | 19.54 | 1500, 1700 |
| WRUW (Boston) .. | 17.750 | 16.90 | 1600, 1700 |
| WLWO (Cincinnati) .. | 17.800 | 16.85 | 1500, 1600, 1700, 1800, 1900 |
| WCDA (New York) .. | 17.830 | 16.83 | 1530, 1630 |
| **Australia** | | | |
| VLI10 (Sydney) .. | 9.580 | 31.32 | 1515 |
| VLG3 (Melbourne) .. | 11.710 | 25.62 | 0800 |
| VLI2 (Sydney) .. | 11.872 | 25.27 | 0800 |
| VLG9 (Melbourne) .. | 11.900 | 25.21 | 1515 |
| VLI3 (Sydney) .. | 15.320 | 19.58 | 1030 |
| **Brazil** | | | |
| PRL8 (Rio de Janeiro) | 11.715 | 25.61 | 2030‡ |
| **China** | | | |
| XGOY (Chungking) .. | 9.635 | 31.14 | 1500, 1700, 2130 |
| **Ecuador** | | | |
| HCJB (Quito) .. | 12.455 | 24.09 | 0000, 2030 |
| **Egypt** | | | |
| Cairo .. .. .. | 7.510 | 39.94 | 1840, 2100 |

| Country : Station | Mc/s | Metres | Daily Bulletins (BST) |
|---|---|---|---|
| **French Equatorial Africa** | | | |
| FZI (Brazzaville) .. | 11.970 | 25.06 | 1945, 2145 |
| **India** | | | |
| VUD3 (Delhi) .. | 7.290 | 41.15 | 0800, 1300, 1550 |
| VUD4 .. .. .. | 9.590 | 31.28 | 0800, 1300, 1550 |
| VUD3 .. .. .. | 15.290 | 19.62 | 0800, 1300 |
| **Mozambique** | | | |
| CR7BE (Lourenco Marques) .. .. | 9.830 | 30.52 | 1155, 1712, 1915 |
| **Newfoundland** | | | |
| VONH (St. John's) .. | 5.970 | 50.25 | 2315 |
| **Palestine** | | | |
| Jerusalem .. .. | 11.750 | 25.53 | 1615 |
| **Portugal** | | | |
| CSW6 (Lisbon) .. | 11.040 | 27.17 | 2000 |
| **Spain** | | | |
| EAQ (Aranjuez) .. | 9.860 | 30.43 | 1915‡ |
| **Sweden** | | | |
| SBU (Motala) .. | 9.535 | 31.46 | 2220‡ |
| SBP .. .. .. | 11.705 | 25.63 | 1700 |
| **Switzerland** | | | |
| HER3 (Schwarzenburg) | 6.165 | 48.66 | 2150 |
| HER4 .. .. | 9.535 | 31.46 | 2150 |
| **Syria** | | | |
| Beirut .. .. | 8.035 | 37.34 | 1820 |
| **Turkey** | | | |
| TAP (Ankara) .. | 9.465 | 31.70 | 1800 |
| **U.S.S.R.** | | | |
| Moscow .. .. | 5.890 | 50.93 | 2200, 2300 |
| | 6.980 | 42.98 | 1700, 2100 |
| | 7.300 | 41.10 | 1100, 1700, 1800, 2000, 2100, 2200, 2300, 2347 |
| | 7.332 | 40.92 | 2000, 2100, 2200, 2300 |
| | 7.560 | 39.68 | 1100 |
| | 9.545 | 31.43 | 1240 |
| | 10.445 | 28.72 | 1240 |
| | 11.830 | 25.36 | 1600 |
| | 15.230 | 19.70 | 1240, 1320, 2200, 2300, 2347 |
| | 15.750 | 19.05 | (as above) |
| **Vatican City** | | | |
| HVJ .. .. .. | 5.970 | 50.25 | 2015 |
| | **kc/s** | **Metres** | |
| **Algiers** .. .. .. | 1176 | 255 | 0100, 1400, 1800, 1900, 2000, 2200 |
| **Athlone** .. .. .. | 565 | 531 | 1340‡, 1845, 2210 |
| **Tunis** .. .. .. | 868 | 345.6 | 0000, 0100, 1900, 2000, 2100, 2200, 2300 |

It should be noted that the times are BST—**one hour** ahead of GMT.

‡ Sundays excepted.

been vastly improved by its applications. We see no end in sight of utilising more and more applications of this new tool, and our research laboratory is now well equipped for electronics research, as it has been for gyroscopics, hydraulics, and many other older fields.—*R. E. Gillmor, President of Sperry Gyroscope Co., in "Electronics."*

Withing five years after peace FM stations will supplant all local, most of the regional, and some of the high-power standard broadcast stations [in the U.S.].—*W. T. David, of the General Electric Company of America.*

FM makes a fair signal perfect, a poor signal good, and a useless signal inaudible.—*K. I. Jones, at the I.E.E.*

### FM CALL SIGNS

SOME months ago a system of allocating call signs to FM broadcasting stations based on their location and the frequency employed was introduced in the United States. It has now been foreseen that the post-war growth of FM will necessitate a change in the system of allocation, and it has, therefore, been decided to use standard four-letter calls as for all other transmitters. The exception to this new ruling is that owners of medium-wave stations who also operate FM transmitters may add the suffix "FM" to the call sign for the medium-wave stations.

According to the latest figures there are 45 licensed FM transmitters in the States.

### DEATH RAY AGAIN

THE "death ray" became headline news again a few weeks ago when two men were accused and fined £50 each at Lancaster for unlawfully possessing a wireless transmitter designed to be used as a navigational beacon, and other apparatus capable of being assembled into a transmitter.

The accused stated that they had the backing of the War Cabinet Scientific Committee for the apparatus with which, it was claimed, they had destroyed electric apparatus at Horsham, Sussex, 230 miles away.

### LONDON RADIO SOCIETY

THE St. Pancras Radio Society has recently been formed; meetings and classes will be held at the L.C.C. Men's Institute, Holmes Road, Kentish Town. A course in wireless servicing is proposed. The secretary is G. F. Kittson, 111, Messina Avenue, West Hampstead, London, N.W.6.

### *IN BRIEF*

**Radar in the Navy.**—A recent Fleet Order announces the formation of a Radar Branch in the Royal Navy. It also states that there will be increases of pay for radar ratings ranging from 2s. a day for instructors to 3d. a day for new ratings. It is understood it is not intended to issue special badges to officers and ratings in the new branch.

**Marconi's Yacht.** — According to broadcasts from Paris, all the apparatus has been removed from Marconi's famous yacht, *Elettra*, and the vessel taken to a place of safety. It will be remembered that it was on this yacht that Marconi carried out some of his most useful experiments in the realm of ultra-short waves.

**Maj. Gladstone Murray,** until recently general manager of the Canadian Broadcasting Corporation, has stated that during the week which elapsed between Britain's declaration of war and the entry of Canada into the war he was asked by "a group of left-wing politicians" to give, in the interests of neutrality, equal prominence to news bulletins from Britain and Germany. His resistance to these efforts is stated to have contributed largely to the defeat of the attempt to keep Canada neutral.

**Radio, Eireann.**—The Minister for Posts and Telegraphs, speaking in the Dáil recently, stated that the number of licence holders in Eire for the past year had decreased by about four per cent. At March 31st this year there were 167,671 licences—nearly 7,000 fewer than the year previous.

**Radio at War.**—Approximately 90 per cent. of the U.S. Army Signal Corps' allocation of $5,000,000,000 for communication equipment for the year is to be spent on radio apparatus.

**Berlin's Broadcasting House.**—It is reported that the Funkhaus, Germany's Broadcasting House, was destroyed in a recent R.A.F. raid on Berlin.

**Institution of Electrical Engineers.**—A Wireless Section Meeting will be held at the I.E.E., Savoy Place, Victoria Embankment, W.C.2, at 5.30 p.m. on Tuesday, January 18th, when J. A. Smale, B.Sc., will open a discussion on "Comparative Merits of Different Types of Directive Aerials for Communications."

**"Vibrations and Waves"** is the subject of a series of six lectures to be given by Prof. E. N. da C. Andrade, D.Sc., F.R.S., at the Royal Institution, 21, Albemarle Street, London, W.1, during the Christmas vacation. The lectures, which are adapted to a juvenile audience, will be given at 2.30 p.m. on December 28th, 30th, January 1st, 4th, 6th and 8th, when the subjects will be Vibrations, Wave Properties in General, Sound Waves, Visible Light, Short Electromagnetic Waves and Long Electromagnetic Waves, respectively. The subscription is 10s. 6d. for juveniles aged 10-17 and £1 1s. for adult non-members.

**Institute of Physics, Electronics Group.**—A discussion on "Space-Charge and Noise in Radio Valves" will be opened by Drs. P. B. Moon and R. R. Nimmo at a meeting of the Institute of Physics to be held at 2.30 p.m. on January 22nd at the University, Edmund Street, Birmingham.

# "SUPERHET-STRAIGHT" SWITCHING

## *Cathode Follower Method Calling for Few Circuit Alterations*

By P. A. SHEARS

HIGH-QUALITY reproduction from a receiver demands among other things, low distortion and a wide frequency range. The music-lover will of necessity employ a superheterodyne in order to be able to take advantage of the many excellent concerts from abroad, and, with variable selectivity, he will be able to obtain in most cases quite good results from astonishing distances. When, however, he moves to the Home programme he is apt to feel that there is room for improvement. Those who have space and means will employ a separate straight receiver for local reception, but by a little judicious switching a superhet with an RF stage can give excellent results as a straight set with "cathode follower" or negative feedback detector, no extra valves being required, and—an important point—no switching in RF leads.

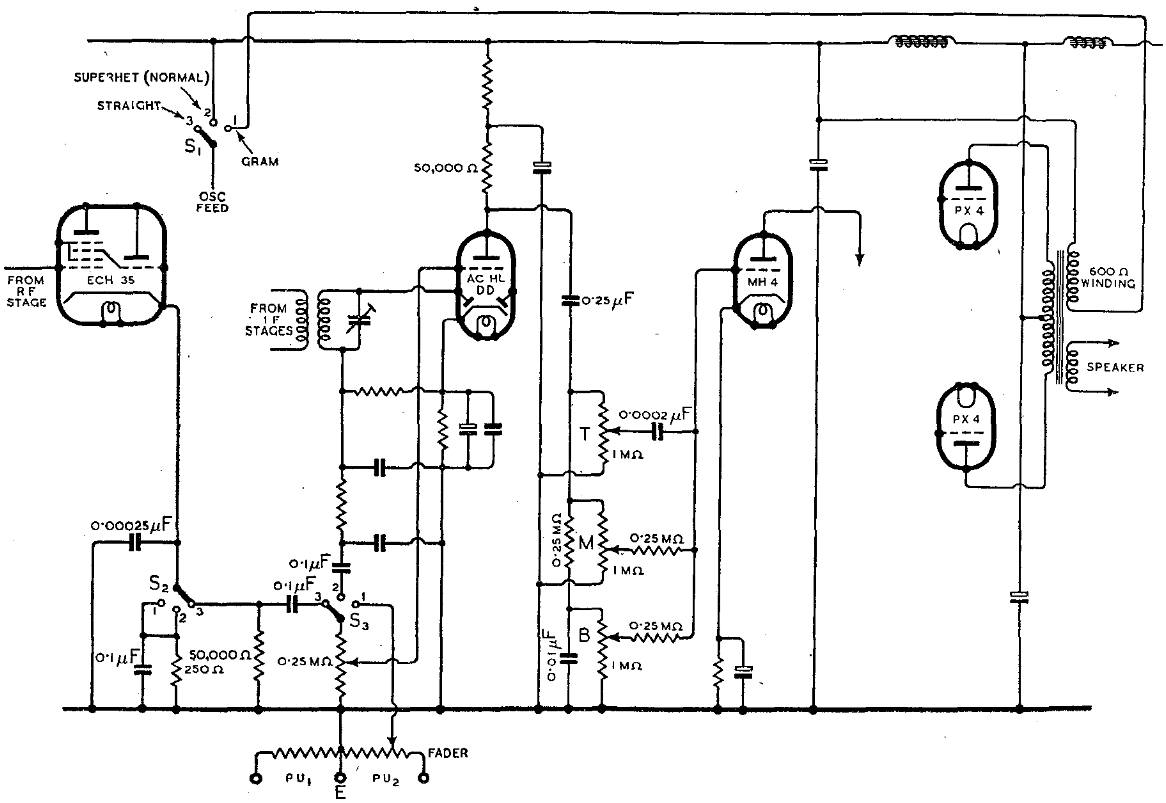
The method will be clear from the diagram, which shows the circuit applied to the writer's receiver. The frequency changer operates as the cathode follower detector with the oscillator anode feed disconnected; the audio section is switched through to the frequency-changer cathode.

Looking at the frequency changer in a little more detail, it will be seen that the amount of switching required is very small. The control grid is already connected and the anode circuit can be regarded as a short circuit to frequencies in the broadcast band; in any case, the screen will act as an anode for the purposes of cathode follower detection. The oscillator grid may be left connected.

The current in the cathode load resistor is straight from the HT line and many contain hum frequencies and necessitate some extra filtering in the anode and screen feeds to the valve. This filtering may be left permanently in circuit.

The variable-mu characteristic of the frequency changer does not appear to have any deleterious effect on the performance as cathode follower detector. Operation will be in the region of cut-off as in all cathode follower detectors, the 100 per cent. negative feedback causing cancellation of distortion.

There are, therefore, only three circuits to be switched (*a*) oscillator anode, (*b*) cathode from bias circuit to a suitable load resistor




Skeleton diagram showing alterations required in a superheterodyne to convert it to a straight receiver with cathode follower detector. A tone control system favoured by the author is also shown.

(*c*) audio section from diode detector to cathode follower detector load resistor. In the writer's case a 3-pole, 3-position midget Yaxley type switch was available, and one of the positions was utilised instead of the existing Gram/Radio switch, so that the three positions of the new switch became "Gram"-"Superhet" "Straight."

Demands from the household for a system whereby gramophone concerts could be relayed to other receivers suggested a use for the blank contact, on which the oscillator anode feed wiper rested in the "Gram" position of the switch. Those who have operated several superhets on one aerial system will appreciate that sufficient of the oscillator voltage finds its way along the aerial to give quite a substantial signal strength on another receiver. Thus by modulating the oscillator output, programmes can be easily conveyed, hum free, throughout the building. This is a superior method to that of long screened leads; it employs no more radiated power than when the set is operating as a receiver and thus cannot infringe transmitting regulations.

A point arises regarding the depth of modulation of the oscillator output. It will be advantageous to keep the depth of modulation low—say below 50 per cent. on the average—in order (*a*) to keep the total distortion as low as possible, (*b*) to minimise frequency modulation, which is bound to occur to some extent with a modulated oscillator, (*c*) to leave ample margin for handling peaks when using volume expansion.

The oscillator anode voltage in a superhet is usually of the order of 150 v.; thus 75 V peak audio, or about 50 V RMS, will give 50 per cent. modulation. This may be obtained from the output stage or from the driver of a push-pull stage. In any case, the exact arrangement will depend on the output required from the set for monitoring the transmission. If the full output of several watts is required, the RMS anode voltage will be far too great and will over-modulate the oscillator. The power dissipated in the load on the output valve is $\frac{E^2}{Z}$ where Z is the load impedance and E the voltage across it. Thus it will be seen that for a typical pentode with load impedance 5000Ω the power corresponding to 50 V is $50^2/5000 =$ 0.5 watt. Thus in most cases, unless it is permissible to operate at this low level, it will be necessary to employ another transformer of ratio approx. 4 : 1 step-down in parallel with the speaker transformer. A better arrangement would be to find two tappings on the primary of a multi-ratio output transformer between which the requisite voltage is developed. At any rate, the matter is not critical and trial and error cannot fail to yield the desired result.

In the author's own arrangement a "600-ohm" winding was available on the output transformer; with 6 watts output, 60 volts are developed.

### Improved Tone Control

Often when listening to a programme the critical listener feels that the reproduction could do with "just a little more bass" or "a bit more extreme treble," and he may wish for separate volume controls for treble, middle and bass. The arrangement used by the writer is shown on the circuit diagram. The treble is separated out by a 0.0002μF condenser in the slider of the treble control, and the bass filter consists of a 0.25MΩ resistor and 0.01μF condenser.

Resistors of 0.25MΩ are incorporated in series with the sliders of the middle and bass controls to prevent mutual short-circuiting.

To obtain a satisfactory boost of either end of the frequency spectrum a considerable reserve of gain is required. Two triodes feeding transformer coupled PX4's are just sufficient. With a pentode or tetrode output stage and two triodes in the earlier stages, as shown, there would be ample reserve.

## THE WIRELESS INDUSTRY

THE firm of Vacuum Science Products has now changed its name to Radio-Electronics, Limited. (Address: Merton Road, Norwood Junction, London, S.E.25.) This concern is at the moment devoting itself chiefly to the manufacture of photocells and various types of caesium and rubidium photo-electric multipliers.

The temporary head office of the British Aluminium Co., Ltd., is now at Salisbury House, London Wall, London, E.C.2. Tel.: Clerkenwell 3494.

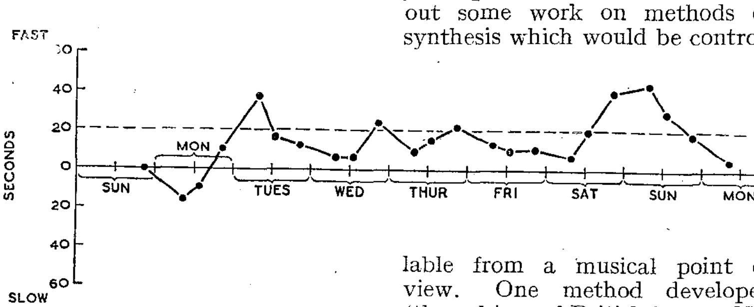
# Letters to the Editor

## Synchronising Electric Clocks : Synthetic Sound : Pick-up "Arms"

### *Time Signals*

I AGREE with Evan W. Davies, who writes in your December issue, that it would be convenient if it could be known in advance when "mains time" would be in agreement with Greenwich time, but the very existence of fluctuations (not so wide, perhaps, as those he implies) suggests that the regulation would not be equal to the task of holding the clocks in step if there were an unexpected change of load just before the pre-arranged time signal.

It is a case of Mahomet and the mountain, and, fortunately, there is quite a simple method of getting on to "mean mains time" without calling for extra exertions on the part of the "grid." By keeping one's own clock under observation for, say, a week or ten days and plotting the error at each B.B.C. time signal in the form of a graph, it is possible to strike an average (dotted line in the accompanying example) which will show how much the mains had drifted from their own datum line when the clock was first started. It is then possible at any time, with the aid of a watch with seconds hand to stop the clock for long enough to remove this standing error. If the local clock is slow on "mean mains time" by, say, 20 seconds, all that is necessary is to advance the hands by one minute and stop the clock for 60 − 20 = 40 seconds. The error will now coincide with that shown on the master clock at the grid control system.




H. MORGAN.

London, S.E.

### *Synthetic Sound*

YOUR contributor, Free Grid, in his paragraph, "Ersatz Run Riot," has, with his usual blend of fact and fancy, touched on a subject which should be of some interest to musically minded technicians, since it offers a wide field for experiment.

The idea of synthetic sound is not particularly new, the idea having occurred to physicists of the last century, but one of the first suggestions that a new musical technique might be evolved thereby came from the Hungarian artist, Moholy-Nagy, in about 1924; his idea was that a record might be made using some sort of engraving machine, but it was not found possible to put this into practice. Since then, as is fairly well known, quite a number of film technicians have produced sound tracks from drawings, but the chief difficulty seems to be that unless there is some relatively simple method of producing and combining any required waveforms, however complex, the whole thing becomes too laborious and cumbersome to have much practical use. Some years prior to the war I carried out some work on methods of synthesis which would be controllable from a musical point of view. One method developed (the subject of British Patent No. 527818) has given promising results; disc records only have been made, although the system can be applied to any type of sound track.

Although it is possible to produce, as well as many other effects, the exaggerated vocal imitations apparently suffered by your contributor, I believe the chief importance of synthetic music is the fact that it will offer the composer the means of creating his work in pure sound, without reference to existing instrumental limitations, and of presenting it to his audience without the intervention of any interpreting artists. It is obvious that before many composers are going to venture into this new medium they will have to be convinced that electrical reproduction of music can practically equal an original performance; how long this will take may depend on the activities of some of the high-fidelity enthusiasts among your readers. In addition, there seems a possibility that the production of special synthetic records, for example, for concert hall reproduction, may give the opportunity to introduce new and improved record ng and reproducing techniques which may give the impetus needed to break away from the limitations imposed by present-day standard methods.

C. C. BUCKLE.

Winterbourne Monkton,
Wilts.

### *Pick-up "Arms"*

I SHOULD like to add my remarks to those of your other correspondents regarding the correct term to use when referring to "that which carries the pick-up."

Of the two suggestions made, tracking arm by Mr. Robb; carrying arm by Mr. Aldous; I much prefer the former, as it is surely the arm which assists the pick-up to track the record.

However, I am not at all certain that either expression is necessary, or even desirable; both are unwieldy when used with the word "Pick-up" in front, as they must be to give the complete meaning.

I would suggest the term "pick-up arm," which is short, complete, and conveys immediately what one means. It does not suggest recording, as Mr. Aldous fears "tracking arm" might, although I would say here that the word "arm" in connection with a cutter head for recording is rather out of place with modern equipment where the cutter is mounted on a carriage, which is part of the traverse mechanism, thus doing away with the older type of long, counterbalanced arm which was never really a satisfactory method of mounting.

I quite agree with Mr. Aldous's desire to cut out that awful misnomer "tone arm," and also that it is desirable to standardise terms used in recording, particularly when one considers its rapid advancement during the last few years, and the great strides forward which have been made since the start of the war, particularly in this country, which has been very slow in the past.

R. W. LOWDEN.

Camberley, Surrey.

### *Musical Taste*

I WAS very interested in "Diallist's" reply (your December issue) to my challenge on the subject of top cutting, and would like to make some further comments.

In the first place, I agree that valve hiss can hardly be a problem in a crowded and presumably fairly noisy mess, but it was not my intention to imply that all three of my suggested reasons for top cutting were necessarily applicable to any one case. In the average home, I think that they do all apply, but in a mess one of them predominates; namely, the fact that music is being used as a background, and is anything but really listened to.

Secondly, I must confess that my letter was not entirely concerned with the technical problem. My musical taste appears to be similar to "Diallist's," except that I happen to like jazz. There is so little real jazz to be heard to-day that I was prepared to forgive him for confusing it with dance music, but I did feel that he was allowing musical questions to confuse the issue. I agree that there is a connection between popular taste in music and in reproduction, but I do not think that it is as simple as "Diallist" suggests. For if dance music and jazz are really intended to be heard only in a "topless" condition, why is it that people will go to great trouble to hear their favourite bands in the flesh? It seems to me that the connection between popular music and "mellow tone" is that both are intended to be half-listened to by people who have never made the effort necessary to obtain real musical experience.

Finally, I would like to say that I do, in fact, both tolerate and like jazz without top cut, and from a reasonably high-quality receiver, though whether I should do so if my receiver were an "ordinary domestic set" is, perhaps, another matter.

P. B. FELLGETT.

Cambridge.

### A VALUABLE INDEX

SOME 300 abstracts from, and references to, recently published articles in the world's technical press are included in each issue of our sister journal, *Wireless Engineer.*

The subject and author indexes to the abstracts and references published during 1943 will be issued as a separate publication early in the New Year. Our Publishers inform us that, as supplies will be limited, readers requiring copies should make early application. The charge for the index, which will occupy some forty pages, will be 2s. 8d., including postage.

# RECENT INVENTIONS

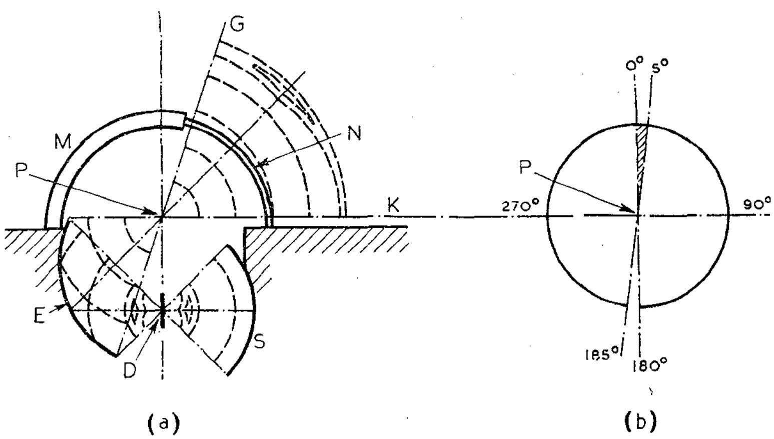
## A Selection of the More Interesting Radio Developments

### RADIO NAVIGATION

IN the diagram (a) is a vertical cross-section through an underground aerial-and-reflector system, which is intended to radiate an approach path, say for an aircraft, without offering any dangerous obstacle to the craft when landing. Energy from the dipole D is focused by an elliptical reflector E, so that it appears to originate from a point P on the surface of the ground. From P the radiation spreads uniformly over an horizontal angle of 180 deg., and vertically through an angle GPK which is determined by the constants of the reflector E. A spherical reflector S serves to reinforce the aerial energy received by the reflector E. The underground installation can be protected, if necessary, by a coverplate M with a portion N which is transparent to the radiated waves.

By arranging two such installations in close proximity, the two radiated fields can be separately modulated and made to provide a narrow overlapping sector of equi-signal strength, forming an approach path of known type, as shown by the shaded part of diagram (b), yet distinguished by the fact that the diametrically opposite sector carries no signal, thus removing the usual 180 deg. ambiguity in direction.

*H. M. Dowsett. Application date April 7th, 1942. No. 553424.*




**Underground beam approach aerial system.**

### AUTOMATIC SELECTIVITY CONTROL

THE selectivity of a receiver for ultra-short waves is kept broad during the operation of searching, but is automatically sharpened as the circuits are brought into tune with a desired station. This result is secured by deriving a control voltage the value of which varies with the deviation of the circuits from resonance.

The radio-frequency stage of the receiver includes a circuit with a comparatively wide bandpass characteristic, whilst the IF stage includes a bandpass circuit of adjustable width. When a signal is tuned-in close enough to fall within the first bandpass, a voltage is produced in the IF stage and is fed to an associated frequency discriminating circuit to shift the frequency of the local oscillator, so that the resulting frequency is brought to the centre of the second bandpass. This, in turn, causes the AVC unit to apply a negative bias to a valve which serves, in known manner, to reduce the effective width of the second bandpass as the incoming signal increases in strength, i.e., as the point of resonance is approached. The arrangement described is preferably combined with the known type of control which serves automatically to sharpen the selectivity of the set in the presence of an interfering signal.

*Hazeltine Corporation (assignees of H. A. Wheeler and R. L. Freeman). Convention date (U.S.A.) January 23rd, 1941. No. 554668.*

### MODULATING AN ELECTRON STREAM

THE electrons flowing through a discharge tube of the cathode-ray type are passed, under the control of an axial magnetic field, through a pair of semi-cylindrical electrodes carrying an alternating voltage. This imposes different velocities upon the electrons, which next pass through a hollow metal cylinder or "drift space," where they "sort themselves out" into a spaced series of bunches. The stream is then said to be velocity-modulated, and in this form will deliver energy to a second pair of semi-cylindrical electrodes similar to the first. In this type of modulating tube the electrons usually travel in a straight line from the cathode through the various control electrodes.

In order to prolong the period of time during which the electrons are subjected to the modulating action, an auxiliary electrode is arranged to deflect the stream so that it enters the "bunching" device at an angle to the main axis of the tube. The magnetic control field then causes each electron to travel in a spiral path through that device, whereupon a second deflecting electrode restores the straight-line path through the "drift space." Similar deflectors are mounted at each end of the "collectors" or output electrode. The net effect is to intensify the degree of modulation, thus increasing the efficiency of the arrangement as a generator or amplifier at ultra-high frequencies.

*Philips Lamps, Ltd. (communicated by N. V. Philips Gloeilampenfabrieken). Application date December 18th, 1941. No. 554202.*

### RADIO COMPASSES

RELATES to direction finders of the kind in which the direction of signals received on a constantly rotating aerial system is indicated on the screen of a cathode-ray tube by an electron beam which is rotated synchronously with the aerials. The aerial system is driven by a motor, which is also geared to a two-phase generator for imparting the required circular movement to the electron beam.

As the aerial rotates, the signal strength will vary from maximum to minimum in accordance with the well-known directional effect. This low-frequency voltage can be applied to control the cathode-ray indicator in various ways. It may, for instance, produce a single bright spot at the appropriate point on the periphery of the fluorescent screen; or it may create a dark gap in a brightly illuminated circular trace; alternatively, the rotating beam may be deflected radially so as to produce an elliptical trace or "finger" pointing in the required direction.

In all cases, the clearness of the indication given will depend upon the effective intensity-control exerted by the low-frequency aerial voltage upon the electron beam.

The invention describes various arrangements for increasing the sensitivity of the device in this respect, more particularly by using a cathode-ray tube in which two controlling anodes are inserted in the path of the beam between the gun and the ordinary deflecting plates.

*Standard Telephones and Cables, Ltd. (communicated by International Standard Electric Corporation). Application date January 9th, 1942. No. 554251.*

### PERMEABILITY TUNING

A CONSTANT frequency-difference is maintained between the incoming signal and the local oscillator, in a superhet receiver with permeability tuning, by making the oscillator core and coils longer than the core and coils of the signal circuits, and by initially setting the oscillator core so that it enters its coil before the others.

It is usually easy to gang the moving cores to give the required beat frequency at the beginning and end of the tuning range, but it is a more difficult matter to maintain the difference frequency constant at all the intermediate settings on the scale.

The inventors have plotted the frequency (1) of the signal circuits and (2) of the local oscillator circuit, against the different positions of their respective cores, and have discovered that the slopes of these two curves begin to develop a marked difference at a certain point. The object of the arrangement described above is to throw this point beyond the limits of the tuning range without restricting the band-width to be covered.

*Philips Lamps, Ltd. (Communicated by N. V. Philips' Gloeilampenfabrieken.) Application date January 30th, 1942. No.* 555150.

## RADIO BEACONS

WHEN the vertical dipoles of a radio-beam transmitter are mounted on the top of a building or motor vehicle, a certain amount of horizontally polarised energy is liable to be reradiated from the screening-mesh that is laid below the aerials. Such secondary radiation is objectionable, because its polar diagram does not coincide with that of the primary overlapping beams, and may therefore cause the navigator, say of an aircraft, to get false guiding signals when his machine is banking and the receiving aerials are inclined to the vertical.

By way of remedy an auxiliary screen or network is mounted horizontally above the point on the transmitting dipoles at which the aerial current reverses. The secondary currents induced in this screen are therefore in phase-opposition with those flowing in the lower screen. The upper screen is also so arranged that both the currents are of equal magnitude, whereby undesired radiation from them is substantially neutralised.

*Standard Telephones and Cables, Ltd., and A. J. Maddock. Application date December 9th, 1941. No.* 553970.

## FREQUENCY MODULATION

THE frequency of the carrier wave is made to respond flexibly to the applied signal, without having to use any special correcting circuits to stabilise the transmitter about the mean or unmodulated frequency.

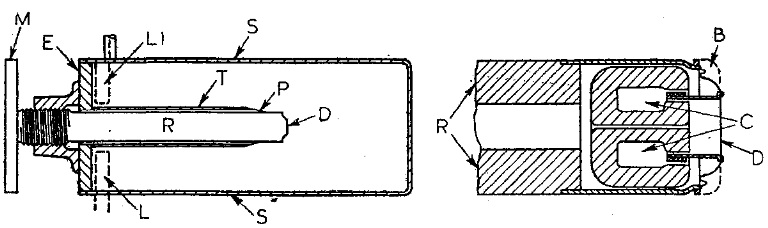
For this purpose a quarter-wave resonator of the concentric-line type serves as the main oscillator, and the desired signal variations are secured by varying the effective length of the centre core or "stub."

As shown at (a) in the diagram, a quarter-wave rod R is mounted inside a closed screen S to form a resonant system which is tuned to the carrier frequency by adjusting the length of the rod through a micrometer screw M.

As shown enlarged at (b), the inner end of the rod is fitted with a flexible diaphragm D. This is driven by a moving-coil system C, to which signal currents are applied by leads passing through a central aperture. The resulting piston-like vibrations of the diaphragm vary the effective length of the rod R, and therefore the instantaneous frequency of the resonator.

Oscillations at carrier frequency are fed to the resonator by a loop L, and the modulated output is coupled by a second loop L1 to the transmitting aerial. The outer conductor or screen S is connected to the rod R by a metal sleeve T, which makes sliding contact at the point P where the current density is less than it is near the end-plate E.

*A. D. Blumlein. Application date November 16th, 1939. No.* 554715.




(a) (b)

Concentric-line frequency modulator.

## SHORT-WAVE TUNING DEVICES

A SECTION of concentric transmission line, short-circuited at one end, forms an inductance which can be tuned by a variable condenser branched across the other ends of the inner and outer conductors. If, however, such a device is used to effect a frequency change greater than three to one, it is found that the "Q" of the circuit falls off rapidly towards the lower end of the scale. This can be overcome by using two separate sections of transmission line in series, one section covering the higher part of the tuning range and the second the lower, with the necessary "overlap" required to give a continuous variation over the entire range.

The invention provides means for switching the two sections in and out of circuit with each other, utilising the fact that at the "shorted" end of each section the current flows from the inner to the outer conductor of the line through multiple paths which are radial. The switch consists of a rotatable disc or plate, which in one position connects the two sections in series, and in another position short-circuits the inner and outer conductors of one of the sections.

*Marconi's Wireless Telegraph Co., Ltd. (assignees of W. H. Conron and B. W. Suckle). Convention date (U.S.A.) March 1st, 1941. No.* 554350.

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

# RANDOM RADIATIONS

*By "DIALLIST"*

## Interference

SEVERAL letters from readers on the subject of interference with short-wave reception have reached me; and doubtless others will eventually catch me up. I mean that I have been out on a tour of inspection; letters follow from address to address. One such reached me recently after an adventurous journey in the course of which it had been re-addressed no fewer than five times. On short-wave interference the general consensus of opinion is much what I expected: trouble from motor car ignition systems has decreased, since there are fewer motor cars on the roads; that from domestic appliances has lessened somewhat owing to the casualties amongst them and the impossibility of obtaining replacements. But interference from commercial electrical machinery has become a great deal worse than it was, for much more of such machinery is in use now than was the case in 1939. No steps seem to have been taken to compel those who install electrical appliances to render them non-radiating. That is a thousand pities, for much of the machinery now in service will remain in use when the war is over, though employed on different tasks. And its owners will be able to put up pleas for leniency; no doubt they'll ask and obtain leave to use the offending appliances till they wear out. Hence if we ever do get effective legisation against the radiation of interference with wireless reception it is likely to be years before it comes properly into force.

## Do It Now!

One thing that we could do without hurting anybody is to prohibit right away the manufacture or sale of any kind of domestic electrical appliances that cause interference. Practically none are being made now, so far as I know, and an immediate enactment on the lines suggested would give manufacturers plenty of time to put their houses in order. To give one example: certain electric shavers are amongst the worst of offenders, interference from them extending over a surprisingly large area. None, I believe, are being made now either here or in the United States. The proposed regulations would ensure that, when production restarts, fresh designs or modifications of those existing would render all electric razors offered for sale here innocuous, so far as radiated interference is concerned. It would be sheer folly to allow manufacture and sales to continue on the old unrestricted lines—but I sadly fear that that is exactly what will happen.

## Not Sauce for the Gander

One correspondent puts up a very reasonable grouse. He installed a short-wave transmitter, not just for the fun of the thing, but because certain of the powers that be had intimated that he could give valuable voluntary help in certain ways. It was found to cause interference with the reception of his neighbours. Complaints were made and he had what was necessary done at his own expense. But when he complained mildly that his work was being hampered by interference with his reception from the said neighhour's vaccum cleaners and so on he was told that nothing could be done about it. That's a bit hard, when you come to think of it. What's sauce for the goose should be sauce for the gander, too.

□ □ □

## Post-war Television

IN one or other of the lay papers I came across a scare headline the other day: "Present Television Sets No Use After the War," or something of that kind. First of all I don't believe that that will be so; but would it matter very much if it was? Most of the television receivers sold were combination instruments, capable of being used for the reception of sound only on the medium-wave band. Doubtless sets of that kind have been thoroughly used for broadcast reception during the war. They have given their owners their money's worth in that way alone. Very few receivers can have been laid up, so to speak in lavender and not used at all. It wouldn't, then, be any great hardship if, after the war, the authorities decided to scrap right away the present transmitting installation at Alexandra Palace and to make a fresh start with apparatus incorporating all the improvements made in the intervening years. But, as I've suggested, I don't think that that will happen. The "Ally Pally" plant served only Greater London and its environs; hence it's only in that area that pre-war television receivers in private ownership are to be found. Very well; let the Alexandra Palace outfit continue for the time being to serve this area and give those living in it full opportunities for making use of their existing receivers. Meantime develop television broadcasting further afield by installing, as was suggested in the *Wireless World* Editorial last month, transmitting plants that are bang up to date to serve the most thickly populated parts of the Provinces. London's modern plant can come either with the others or a little later; but the old one should in either event be kept at work for some little time, so that there may be no recriminations about a breach of faith.

□ □ □

## Locating a Break

WHAT at first appeared to be rather a tricky problem cropped up the other day. Two of the many insulated leads in a stout multi-cored cable some 200 yards in length were found to be broken, and the problem was to make a repair as soon as might be, destroying as little as possible of the expensive cable in the process. No cable-test ing instruments were available; i. fact, we weren't too well off for instruments generally, having none by us but an Avo and an accurate wavemeter. Strenuous efforts to locate the break by feeling for it as the cable was moved gently to and fro or to detect the grating of broken ends by ear did not appear to promise results, so we sought to improvise some kind of testing device. An idea that seemed to have possibilities was to measure the capacity of an unbroken pair, then to measure that of the broken pair. By comparing the two capacities we might be able to calculate the approximate position of the break. As we had inductances of known value, the suggestion was to rig up an oscillator, using first an unbroken pair and then the broken pair as the tuning condenser; we could then measure the frequency and obtain the capacity from a *Wireless World* Abac. But we did not try the experiment after all, for a radio mechanic was lucky enough, on making a last attempt, to spot the place c the breakage by feel. I wonder-i. it would have worked out. Perhaps some reader can suggest a simpler and better method, bearing in mind the limited instrument equipment that we had at hand.

□ □ □

## Certificated Service-men

THE idea behind the proposed examination by the Radio Trades Examination Board for wireless service-men is a good one, provided that the examinations themselves are of the right kind. By that I mean that I hope they won't counterbalance inability to use a soldering iron as it should be used. And theoretical knowledge won't help in the tracing out of faults unless it's backed up by a good ration of common sense. The first test that I would give a budding service-man would be aimed at discovering whether he could use simple tools properly—it's surprising to find how large a proportion of mankind can't use a screwdriver! They may be able to worry screws in and out somehow, but look at the blades of their screwdrivers when they have been in use for a little time—and at the slots of the screws with which they have dealt. My view, for what it is worth, is that there should be practical tests with examinations in elementary theory for newcomers to the ranks of service-men. More difficult tests in both practice and theory should be available to those who had gained experience, and there should be every opportunity for the really good practical man to qualify himself as time goes on in the more advanced aspects of theory.

## CATHODE-RAY PHOTOGRAPHY

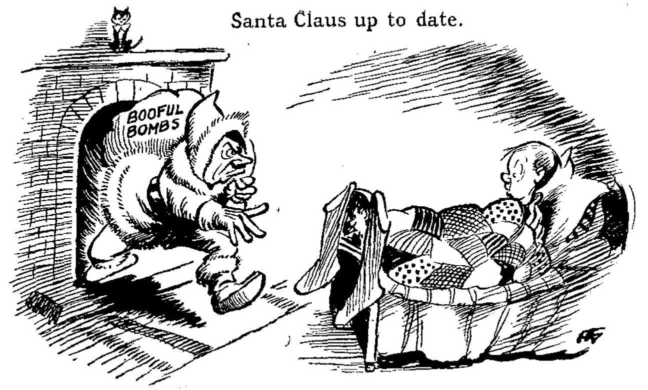
TWO interesting papers dealing with the problems of photographing cathode-ray oscillograph traces were read by W. Nethercot (Electrical Research Association) and N. Hendry (Rotax, Ltd.) at the November meeting of the Association for Scientific Photography.

The recording of single transients with traverse times of less than a microsecond was discussed by Mr. Nethercot, who pointed out that achromatic lenses in the camera are unnecessary, since with the usual blue screen the light emitted is confined to a comparatively narrow band in the blue-violet region. Neither is it necessary to use a high-grade corrected lens for oscillograph recording at a fixed distance. The difficulties usually met with in making lenses of large aperture do not therefore arise, and negatives of useful dimensions have been obtained from a $5\frac{1}{2}$in. tube using a $2\frac{1}{2}$in. focus lens with an aperture of f/1. Best results were obtained with ortho emulsions such as the Kodak R.55 or Ilford 5.G.91, using the Kodak D.19b or Ilford I.D.2 developers. Panchromatic film is frequently fogged by the glow from the tube cathode.

Mr. Hendry pointed out that small changes in the setting of the brilliancy control made large differences in the apparent recording sensitivity due to changes in the spectral emissivity of the screen. Except for the highest speeds, recording paper was as satisfactory as film and more economical. He had found that the usual mercuric iodide intensifier gave good results, and also the uranium nitrate silver intensifier, recently described in the British Journal of Photography, which gave a fivefold increase in density. Extreme cleanliness and the use of distilled water is, however, necessary if staining is to be avoided.

# UNBIASED

By FREE GRID

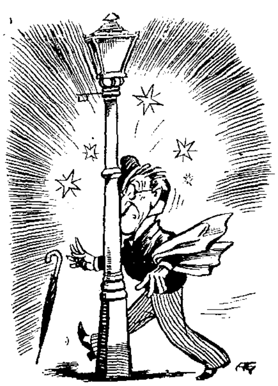


Santa Claus up to date.

## Black-out Blues—and the Cure

NOW that signposts have again appeared on our roads and there is a certain measure of relaxation of other stringent measures which circumstances forced us to accept in 1940, it would not be out of place, I think, if the Government were to make a further gesture in this direction by allowing us to have a little further information about the precise *modus operandi* of radiolocation. So far we have only been told rather vaguely that it operates on the principle of waves being reflected from the object it is desired to locate. I am, of course, perfectly well aware that to people whose basic technical knowledge is sound and whose powers of reasoning are above the average, like readers of *Wireless World*, this tiny scrap of information is more than enough to enable them to figure out precisely how it works.

I am, therefore, addressing this appeal to the Government to relax the regulations to a sufficient degree to enable the ordinary man in the street not only to be informed how it works, but even to be given permission to construct simple locators for himself. My reasons for so doing are that in this final winter of the black-out (*vide* Old Moore) a golden opportunity presents itself for the radio industry to get the great British public really interested in the technical side of radio to the extent that they were in the nineteen-twenties.


Radio can stop this.

As is well known, in 1922 and onwards the home constructor of sets was "motivated" (what a word!) mainly by the fact that he was unable to hear the then new-fangled broadcasting unless he built his own set, and the act of building the set led to the coming into being of a great deal of technical interest in radio.

Anybody who has followed me thus far and has not turned for light relief to the Editorial or to the Recent Inventions pages will be wondering what on earth I am driving at and why anybody should want to build a radiolocator even if permission were given. Anybody whose torso is so covered with black-out blues and other forms of contusion as my own, due to constantly colliding with street lamps and outsize females during these days of renewed No. 8 battery famine, will know the answer to that question. My firm belief is that if permission were given to build and use a low-power radiolocator, the battery-starved public would leap at it.

There is, in other words, as vital a need for building one as there was to build a wireless receiver in 1922. The demand is already there. It only needs Government permission for the idea to come into effect. As a result there would be created such a renewed interest by the masses in radio technology as we have not seen since 1922, and the ground would be all prepared for the radio industry to have a flying start when peace returns. But it must not be forgotten that this is the last winter when it can be done, and there is therefore need of a swift decision, and I trust that the Government will appoint a commission to sit on my idea without further delay.

## Fröhliche Weihnacht

I NOTICE that the Nazi propaganda service has been busy of late trying to make our flesh creep by telling us how occupied their laboratories have been in perfecting the radio-controlled torpedo bomb by which we are all to be wiped off the face of the earth. This new engine of destruction is apparently a sort of flying torpedo which, according to the usual inspired "neutral" sources, can be guided to its ultimate destination by its parent plane up in the stratosphere with such a degree of accuracy tha it can be caused to proceed down a chimney, if need be, like Father Christmas, about whom many of us are thinking at this time of the year.

No doubt the Germans themselves have not forgotten the season of the year, and are planning to give the bombs a delayed-action mechanism and paint them to represent Father Christmas so that they can be successfully "planted" in the nursery on Christmas Eve and joyfully welcomed by the unsuspecting British child. I cannot think, in fact, why this thought did not occur to the writer of the item in the particular London newspaper which I have before me at the moment; he seems to have thought of almost everything else in what amounts to a blood-curdling eulogy of German ingenuity. It would appear that this writer imagines that radio control of any form of aircraft or air-borne device is something entirely new, and I hardly like to disillusion him by referring to our own pre-war "Queen Bees" and other things.

I must do so, however, but will not deal with anything so recent as "Queen Bees," but will take him back over thirty years to the issue of this journal for September, 1913, where he will find mention of miniature radio-controlled aircraft attacking a target with bombs which were themselves released by radio control. No doubt the German research workers have not been idling away their time, but their latest achievements, if indeed they exist, will probably be short-circuited at the source by an R.A.F. raid.

It is time that the venerable antiquity of wireless was better realised. Few people know that next year we celebrate the jubilee of Marconi's arrival in England in 1895, that in 1898 Queen Victoria had the Royal yacht fitted with wireless, and in 1899 wireless was used in the Boer War.