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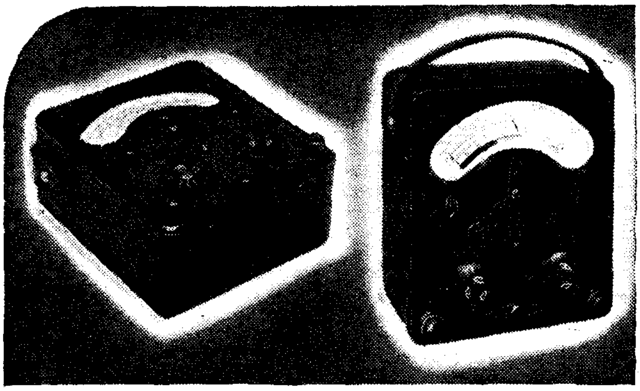

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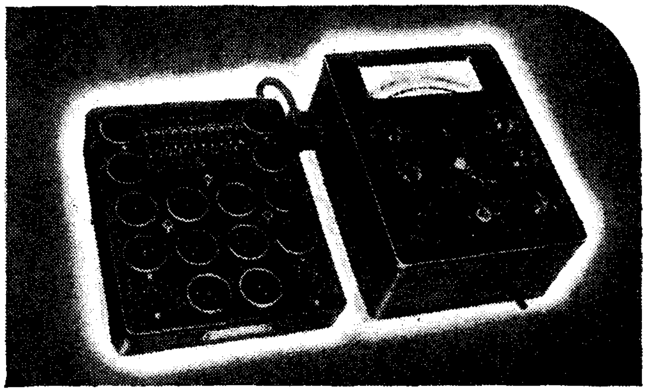

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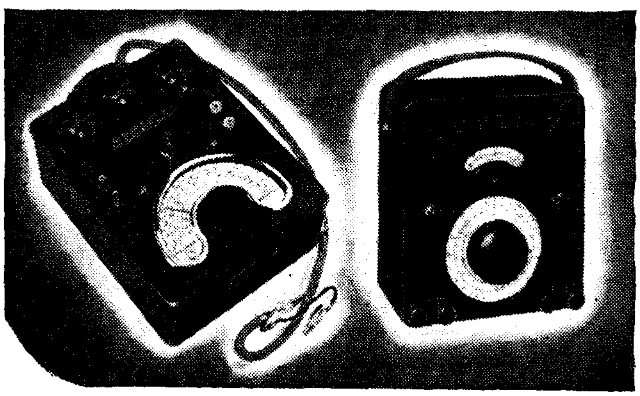

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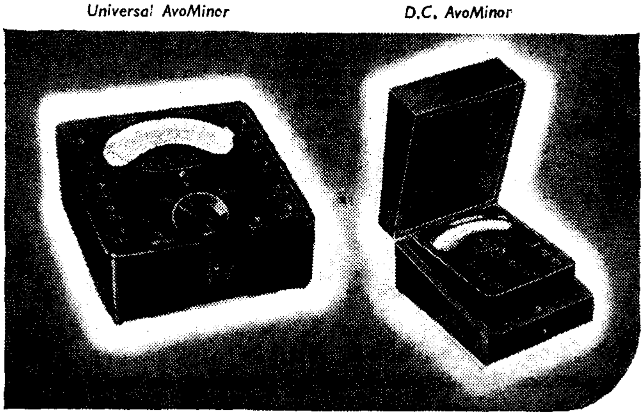

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SEPTEMBER, 1940

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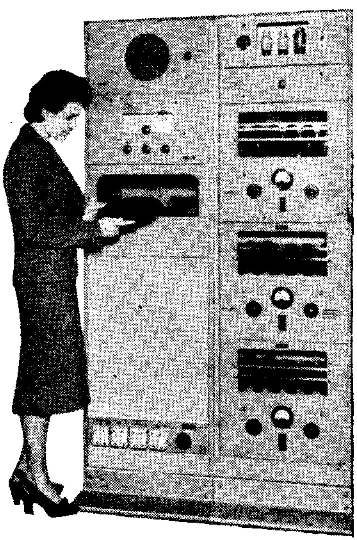

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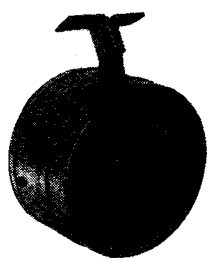

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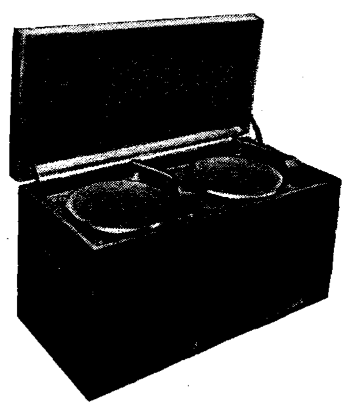

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Editorial Comment

Frequency Modulation and Interference

WE must not dismiss the present stampede in the U.S.A. to exploit frequency modulation—described by a New York contemporary as "radio's new bonanza"—as merely another instance of the supposed tendency of our American friends, like the Athenians of old, to run after any new thing. True, responsible American engineers have urged that broadcasting of equally good quality, or at least of as good quality as is commercially usable, can be obtained more simply by the use of amplitude-modulated short waves. That may be correct enough, but it ignores the fact that the chief claim of frequency modulation to our attention is the immunity it confers from the effects of man-made interference. That immunity is not complete—for instance, FM is apt to be affected by motor car ignition interference—but, according to the most conservative reports from across the Atlantic, it has proved itself in actual working to be vastly superior to AM.

Now in this country it seems too late, as a contributor points out elsewhere, for us to do anything to abate the production of man-made interference; the most that we can hope for is that its increase may be curbed after the war. When *The Wireless World* first instituted its campaign for compulsory suppression, the need for speed was urged, as every day saw a step towards the complete electrification of Britain. Unfortunately, it was found impossible to devise generally acceptable standards of permissible interference and to have these standards given the effect of law before the outbreak of war. Regrets are now useless, and we must face the fact that, if high-fidelity broadcasting is to be open to the majority of the population after the war, it will only be obtained by the use of frequency modulation. Thus it is hardly an exaggeration to say that the new system is likely to be more or less forced on us, and so its development in America must be carefully watched. It is also hoped the B.B.C. may be able to fall in with the R.M.A. suggestion that an experimental FM station should be set up.

Most of the difficulties associated with the establishment of FM services in America seem to be linked up with the commercial system of broadcasting in force there, and the elaborate rules governing allocations of channels by the Federal Communications Commission are necessary to safeguard the interests of both the public and the broadcasters from the effects of uncontrolled competition. Here no such difficulties would arise, and it would be relatively easy and cheap to ensure a "high-fidelity" service to most centres of population, even though the useful range of the stations does not exceed some 50 to 70 miles.

Of course, it is not suggested that the elaborate amplitude modulated system that the B.B.C. has built up should be ruthlessly scrapped. So far as one can see at present, it will always be needed for serving sparsely populated areas, to say nothing of its uses during the transition period. There is no reason why a parallel FM service should not be built up gradually, starting with one or two stations. The linking of widely separate stations by landlines seems to be inconceivable when very high modulation frequencies are in question, and this problem will probably be solved by the use of wireless links, as in America.

Attention is drawn to this matter because we consider that those who demand high-quality reproduction form the backbone of the listening public. There is no incentive to strive after quality unless immunity from interference is in sight.

Reducing Interference

METHODS APPLICABLE TO THE RECEIVER

By R. I. KINROSS

A discussion, backed up by the results of practical tests, of the various circuit arrangements for reducing man-made electrical interference that can be incorporated in the receiver itself. Readers are reminded that these schemes generally operate by "punching a hole of silence" in the received signal at the instant corresponding to peaks of interference.

IT will be assumed in this article that the offending source of interference is inaccessible and that all the well-known expedients (as applied to domestic broadcast receivers), such as the usual type of anti-interference aerial, screened mains transformer and so on are all already incorporated at the receiving station, but reception is still being marred.

In carrying out the experiments to be described it was decided to start by trying the simplest methods first. No very great hopes were held out for these methods, but articles and patents have appeared from time to time claiming useful results for devices requiring only the addition of very few components to an ordinary receiver. These seemed worth a trial before getting too deeply involved in some of the more complicated systems. This work was carried out more in the interest of broadcast reception than that of communication engineering. The reader should bear this in mind if he finds devices which give appreciable improvement in signal/noise ratio nevertheless severely criticised on the score of quality.

Aural impressions of improvements obtainable in static suppression are difficult to form and still more difficult to memorise. It was therefore decided that some rough method of measurement must be evolved before proceeding any further. The following system is crude but sufficiently accurate for the purpose.

A standard calibrated high-frequency signal generator was modified so that it could be modulated at 1,000 cycles per second to a known depth of modulation, ranging from 100 per cent. to 1/100th of 1 per cent. A signal from this source at a strength of 1 millivolt and modulated at 40 per cent. was fed through a dummy aerial into the receiver. At the same time a voltage from whatever source of interference was under investigation was also fed to the dummy aerial and adjusted in strength so that the 1,000-cycle note was just audible through it. The device under test for reducing interference was then connected to the receiver and the percentage modulation of the standard signal generator reduced until again it was only just audible. The ratio of these two percentage modulations gives a figure of merit of at any rate one sort.

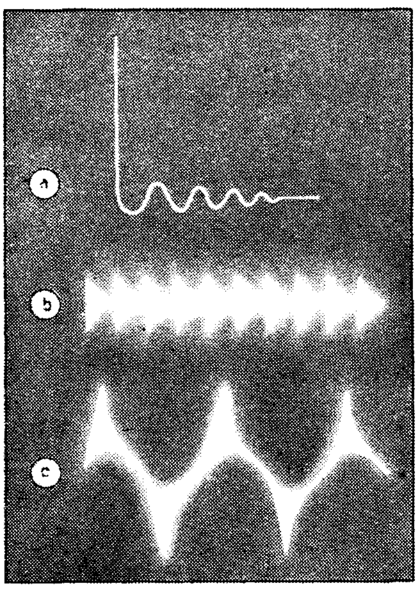


Fig. 1.—Nature of interference set up by (a) motor ignition system; (b) DC motor commutator; (c) neon sign.

It was essential that all measurements should start with a constant percentage modulation of (say) 40 per cent. because most of the simple interference reducing arrangements, especially of the type that relied on limiting, reduced large amounts of interference to small amounts but left small amounts practically unchanged, so that completely different figures of merit would be obtained for different strengths of interference. A different kind of figure of merit was obviously required to take care of this property, and it was found that quite a satisfactory way of expressing this was simply in terms of the lowest equivalent percentage modulation to which any strength of interference of a given kind was reduceable. In taking these measurements, care had to be taken to work at the same acoustic level and with the same characteristics for the AF amplifier and loud speaker throughout the experiments.

The four forms of interference investigated were an arcing contact, a high-voltage spark, DC motor commutator and neon discharge tube. The first was obtained from an ordinary poor quality electric light switch, the second from a car coil ignition system and the third from a DC motor. The neon sign used was that of a well-known trade mark about two yards long.

Most of the interference suppression schemes put forward rely on the fact that interference is usually of considerably greater amplitude than the desired signal but is made up of bursts of comparatively short duration, separated by intervals of silence. A car ignition system is one of the best examples of this, and a neon sign one of the worst.

The voltage set up in a conductor placed near a coil ignition system looks something like figure 1 (a) when viewed on an ordinary monitoring cathode-ray tube.

Reducing Interference—
Obviously there must be an upward stroke, but it is quite impossible to see it or tell how high it rises by this method. The comparatively low-frequency oscillations are due to the resonance of the coil winding (in the particular case under consideration equivalent to a frequency of about 3,500 c/s), but including this LF oscillation, the whole wave-train only lasts about

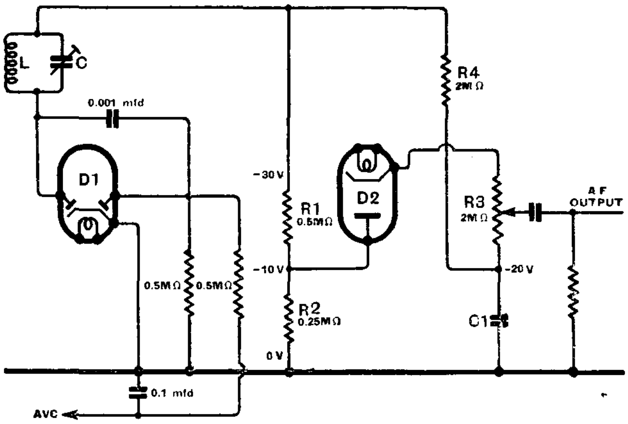


Fig. 2.—A system of suppression which momentarily silences the receiver by cutting off the signal from the AF amplifier during peaks of interference.

1½ milliseconds. Assume an engine speed of 3,000 r.p.m., that is, 100 sparks per second on a four-cylinder engine, the wave-train only takes up 15 per cent. of the total time; and actually the LF component does not cause much trouble, so that it is an even lower proportion still. The first part of this wave-train, which is the one that causes the trouble, will be dealt with more fully later on.

Cummutator spark on a DC motor induces a voltage of the general appearance indicated in figure 1 (b), the main low frequency being that of the commutation periodicity.

Neon Interference

With the neon sign, the wave form is as indicated in figure 1 (c). The purely low frequency component which is, of course, at the periodicity of the mains would not be radiated far, but showed up on the oscillograph, as, in order to obtain sufficient voltage to operate the latter, a conductor was placed close to the neon sign.

Of the simpler schemes, let us consider those providing self-adjustable "gapping" or interruption of the AF feed. One of the first systems of this nature to be tried was an ingenious arrangement developed by the General Electric Company. The circuit arrangement is shown in Fig. 2. LC constitutes the last IF tuned circuit of a superheterodyne receiver. The diode, D1, is used for speech and AVC in a conventional manner, and the diode D2 is used for cutting off the signal from the AF valve during peaks of interference. R1 and R2 constitute the speech diode load, and it is assumed that an unmodulated carrier produces a DC voltage of 30V across this load, and the voltages set up as a consequence of this in the rest of the system are indicated.

As R4 and R3 are equal, it is obvious that the voltage at their junction will be halfway between −30 and −10, that is −20 when D2 is conducting. The condenser C1 is large (2μfd.) so this value of −20 will only vary for mean variations of carrier amplitude, but will not be able to do so for variations of short duration. Under these conditions, D2 will conduct comfortably to the AF amplifying valve. Now assume 100 per cent. modulation. The anode of D2 will rise on peaks of modulation to −20, the same voltage as its cathode. In other words, it will only just be conducting, and at anything over 100 per cent. modulation, it will be definitely non-conducting.

Automatic Limitation

The ingenuity of this device lies in the fact that it is self-adjusting for any strength of carrier. You can see that it is possible to multiply the figure of IF amplitude by anything one likes, and the diode D2 will only pass up to 100 per cent. modulation, and nothing over.

In practice, results were poor. That is to say, if a signal were completely drowned by ignition noise, the addition of this gadget would certainly make speech intelligible, but as, at the time, the author was principally interested in receivers for broadcast reception, the real question he wanted answered was . . . "Does it provide programme value?" and the answer is that it does not. If you cheat with it—that is to say, if you apply a bias to the lower diode so that it starts cutting at a lower percentage modulation—considerably better results are possible, but you can imagine the effect that this will have on quality. For instance, measurements for loud spark gave an improvement of 12:1 in signal/noise ratio under normal conditions, and 35:1 if bias were added and adjusted so that speech was still just intelligible. Subsequent measure of harmonic distortion with the bias left like that showed

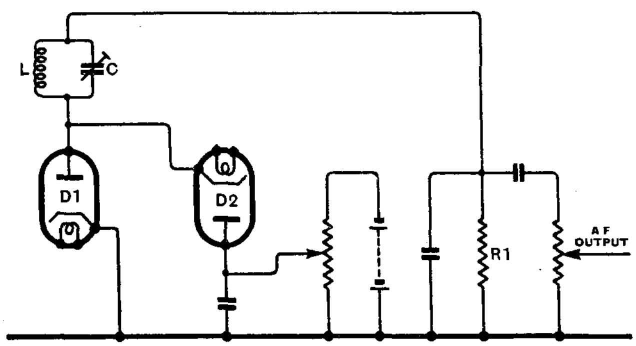


Fig. 3.—A simplified version of the suppressor shown in Fig. 1.

10 per cent. 3rd harmonic, starting at 10 per cent. modulation instead of about 80 per cent.

There are several other disadvantages to the scheme as a whole: (1) There is a 3:1 loss of signal sensitivity due to the "potentiometering" of the diode load.

Reducing Interference—

(2) The cathode of the lower diode introduces hum on the AF amplifier. (3) The capacity of this diode allows a certain amount of the higher components of interference to get through. (4) Results are extremely disappointing on commutator noise, the measured result being only 3 : 1 improvement. (5) The minimum level to which it would reduce either high or low levels of interference was considerably too high for programme value, in the author's opinion.

If it were considered practical to introduce a manual adjustment, a much simpler arrangement, like that

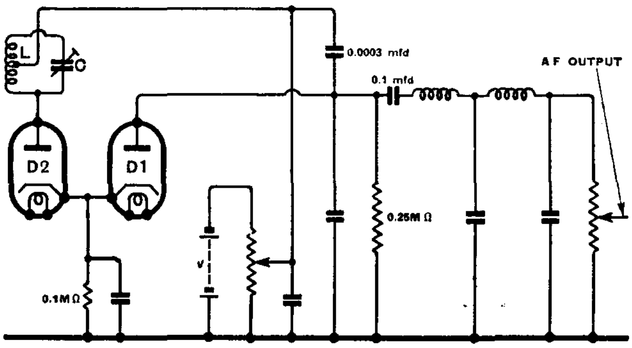


Fig. 4.—In this suppressor the control diode D2 paralyses the signal diode D1 on peaks of interference.

shown in Fig. 3, could be used. Here again, LC constitutes the last IF tuned circuit of a superhet, and D1 is the speech and AVC diode. D2 is simply a limiting diode, and R1 is the diode load. D2, however, is more cunning than it looks at first sight, because on peaks of interference it virtually short-circuits not only the IF tuned circuits, but the diode load as well.

Incidentally, the classic method of reducing interference by limiting across a tuned circuit by means of a couple of diodes, one the right way up, and one upside down, and both suitably biased, really affords extraordinary little relief, even if it is tried in a part of the receiver where large voltages are appearing. The reason for this is probably that in the average radio receiver there is already plenty of limiting going on accidentally due to RF valves running off the linear parts of their characteristics during peaks of interference.

Results of Tests

This particular arrangement we are discussing, although it only needs one extra diode, works better than a conventional limiting device. If it is only connected across the diode load, for instance, an improvement in 12 : 1 in signal/noise ratio is possible on loud spark, but if it is connected as shown, improvements of the order of 40 : 1 are possible, the exact amount being dependent on the degree of distortion tolerable. 40 : 1 may sound quite a lot, but it must be remembered that this figure is only obtainable on spark noise equivalent initially to about 60 per cent. modulation, which is consequently reduced to 1½ per cent. modulation. If we had started with the equivalent of only 10 per cent. modulation of spark noise initially, this would still not have been reduced to below 1½ per cent. This latter figure, therefore, constitutes the second figure of merit (as explained when discussing methods of measurement). These results are about the same as were obtained for the previous arrangement manually controlled.

Right at the beginning of this work some tests were carried out to try and find the highest levels of interference of different types which could be tolerated without detracting from programme value. The figure obtained for the spark was equivalent to 0.1 per cent. modulation, and for commutator was 0.25 per cent. These figures represent a purely personal opinion, and even though other people may hold other views on this point, it is obvious that we are still a long way from our ultimate goal.

An RCA Circuit

Another scheme tried out is shown in Fig. 4; this was developed by the Radio Corporation of America. Here again, LC is the last IF tuned circuit, D1 is the signal and AVC diode, and D2 is a diode added so as to cut off the signal diode on peaks of interference.

Under normal conditions of reception, D2 is biased out of action by the voltage V which applies a negative voltage to its anode via the IF tuned circuit. On peaks of interference, however, it comes into action and applies a positive voltage to the cathode of the signal diode and so momentarily paralyses it. It seemed desirable to try out this arrangement because it appeared to have a few advantages over the first scheme tried out. (1) Capacity of the noise-reducing diode will not let through the higher LF frequencies. (2) There should be practically no loss of sensitivity. The only loss that can occur is due to the LF voltage wasted across the

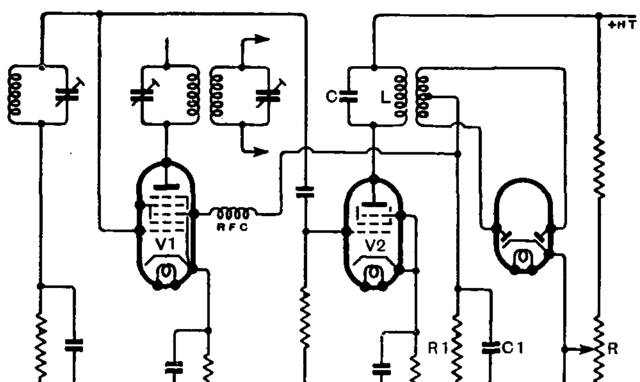


Fig. 5.—The Lamb circuit, in which the IF amplifier is blocked during noise pulses.

100,000 ohm resistance, but that only amounts to about 30 per cent.

In practice it worked just about as well as the second arrangement (Fig. 3), but was not quite so easy to get working. It will be noticed, for instance, that there is rather more IF filtering than is usual in domestic re-

Reducing Interference—

ceivers. The reason was, that without it, it was found that the AF amplifier was acting quite happily as an anode bend detector on peaks of interference, while the detector was supposed to be paralysed.

The three arrangements just described seemed to be the most promising of the many suggested for application at the second detector. There was some slight method in the choice of these particular three, because each one of them was representative of its own individual method of stopping the signal during a peak of interference. For instance, the first arrangement, it will be remembered, worked by introducing a high series impedance to AF. The second worked by introducing a low shunt impedance to AF, and IF as well incidentally. The third worked by paralysing the speech diode.

These are about the only simple ways in which you can shut off your signal quietly in this part of the receiver, and although dozens of different methods for doing so have been brought out, these are often extremely clumsy and expensive by comparison. One of them, for instance, uses a pentode as a diode—just using the anode and cathode for rectification—and paralyses it by applying negative pulses to its grid. Another one actually applied negative pulses to the grid of the AF amplifying valve, but the change in anode current would probably make as much noise as the original interference.

Lamb's IF "Gapper"

There is one more arrangement of interest which still comes under the category of simple. This is due to Lamb, who introduced it in America. The circuit is shown in Fig. 5. V1 is the amplifying valve of a superheterodyne receiver, but a 6L7 type was used instead of an ordinary RF pentode, so that the gain could be cut off by applying a negative voltage to the third grid.

A portion of the IF voltage is taken off to the grid of another valve V2, where it is amplified and rectified. By correctly setting R, which biases both the valve V2 and the diode, matters can be so arranged so that only the peaks—in other words interference of a peaky nature—will be rectified. This produces negative pulses across the resistance R1, which are fed by the RF choke back to the third grid of the IF amplifying valve. The object, of course, is to block the amplifier during the noise pulses. The detector is arranged in push-pull, so as to reduce the risk of IF getting back into the IF amplifier.

This arrangement, it is regretted, did not work any better than the best of the simple arrangements described so far . . . despite its slightly greater elaboration. The reason is not very far to seek.

Though the originator stated that the negative pulse arrives at the third grid of V1 at the same time as the corresponding pulse of interference arrives at the first grid, in actual fact, this cannot be the case: it is bound to arrive there slightly later, the actual time difference being accounted for by the time taken for a sufficiently large voltage to build up across the tuned circuit LC, and sufficiently large DC voltage across C1: and although this time may only be of the order of a few microseconds, this will be sufficient to allow the first part of the interference pulse to reach the anode of the IF amplifier valve, and so to set it ringing.

An attempt was made to speed up the passage of the negative pulse through the parallel amplifier as much as feasible by reducing the Q of the circuit LC as much as possible, consistent with leaving sufficient gain, and also by reducing the time constant of R1 C1, but the improvement was not appreciable.

Delaying the interference pulse through the normal channels was then tried by adding another stage of IF amplification and taking the negative pulses to this later stage of the receiver, so that these negative pulses should get there, if anything, slightly before the arrival of their corresponding pulses of interference. This certainly did give an improvement. Signal/noise ratios were improved now by about 25: 1 by means of the device as a whole on bad spark interference—the sort that almost completely masks the original signal—but the resultant signal was still not of programme value.

The trouble was that there was still an appreciable background of interference, and there was also a new form of background noise, a kind of dull thudding sound. Furthermore, music, especially singing, was badly chopped up; it was in fact being modulated by the mains spark frequency about 100 times per second.

This figure of 25: 1 reduction was obtained from the fact that 40 per cent .modulation was just audible without the arrangement, and 1.6 per cent. with the arrangement through spark. The trouble was, however, that whenever one started with the equivalent of 100 per cent. modulation of noise or only 10 per cent. without the arrangement, the answer with the arrangement connected was always over 1½ per cent. for spark and 10 per cent. for commutator.

(To be continued.)

Henry Farrad's Problem Corner

No. 50—Mains Hum

An extract from Henry Farrad's correspondence, published to give readers an opportunity of testing their own powers of deduction:—

2, Tanner Road,
Shillingsworth.

My dear Henry,

My receiver has recently developed a decided hum. The curious thing is that a high-impedance permanent-magnet speaker connected as an extension is much less affected although it gives quite as good volume. The one built into the set is not a permanent magnet, and that is the one that is giving the trouble. It isn't a violent hum, but I dislike any at all, and it used to be *very* quiet. Can you advise me where to look for the cause?

Yours ever,
Bob.

How might hum have developed? *Turn to page 397 for Henry Farrad's solution.*

Sound on Film

PHOTOGRAPHIC METHODS OF RECORDING

By R. F. E. MILLER
(*B.B.C. Technical Recording Section,*)

An outline of the principal methods employed in recording sound on photographic film. Variable area and variable density systems are discussed, and it is shown how background noises are reduced

WHEN, in 1927, or thereabouts, the cinema finally found its voice, the idea of sound recording on film was already many years old. In 1900, Ruhmer, a German, was photographing sound on film, the sound track, occupying almost the whole available width of the film, being produced by modulating the intensity of a "singing" arc. Reproduction was effected by passing a beam of light through the film and thence on to a light-sensitive selenium cell.

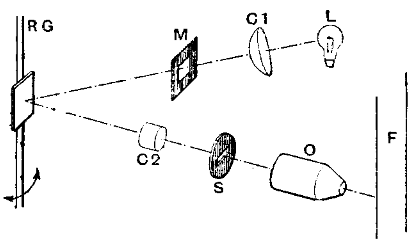


Fig. 1.—"Variable area" sound recording on film by means of a galvanometer. L, recording lamp; C1, C2, condenser lenses; M, mask with rectangular aperture; RG, recording galvanometer; S, optical slit; O, objective lens; F, film.

In 1918-19, Petersen and Poulsen, of Denmark, were recording sound on film, using mirror oscillographs, while in 1923-24 the Germans, Engl, Vogt, and Masolle, and the American, de Forest, were producing variable density records by means of a process using gas discharge tubes.

To-day the mirror oscillograph and the gas discharge tube, together with a variable density system using a "light valve," form the basis of photographic recording of sound on film.

In the photographic recording of sound a track is formed in which the modulation is represented by the variations in the amount of light that will pass through a given area of this track at any instant. This area, in practice, is the full width of the track, approximately 0.001 inch deep, and is technically known as the light slit.

Now it will be obvious that we can vary the track in two different ways to produce the same effect. Either we can have a uniformly transparent track of varying width, or we can vary the general opacity of the track, keeping its width constant. Both these systems are used, the former being known as the variable area, and the latter as the variable density system.

In making a record of the variable area type, a rectangle of light from a recording lamp is projected on to the mirror of a recording galvanometer. This galvanometer consists of a loop of wire stretched over two ivory bridges and kept under tension by a spring attached to the closed end of the loop. To the two arms of the loop where they pass over the bridge a tiny mirror is attached.

This loop is placed in the field of a permanent magnet so that the wires lie across the plane of the magnetic flux. A current passing through the loop will therefore tend to make the two arms rotate about each other, the direction of rotation being determined by the direction of the current. The application of speech currents will cause the arms (and therefore the mirror attached to them) to vibrate in sympathy.

Moving Iron Galvanometer

A later type of galvanometer developed for recording purposes is of the moving iron type, the mirror being mechanically coupled to the armature. The virtual image formed in the mirror is in turn projected on to a narrow slit in an opaque mask, and an objective lens in turn projects an image of this slit on to the photographic film. A schematic diagram of the system is shown in Fig. 1.

Matters are so arranged that when no voltage is being applied across the galvanometer one edge of the rectangle of light bisects the optical slit—that is, we have an optical slit illuminated along half its length.

The application of a voltage across the galvanometer

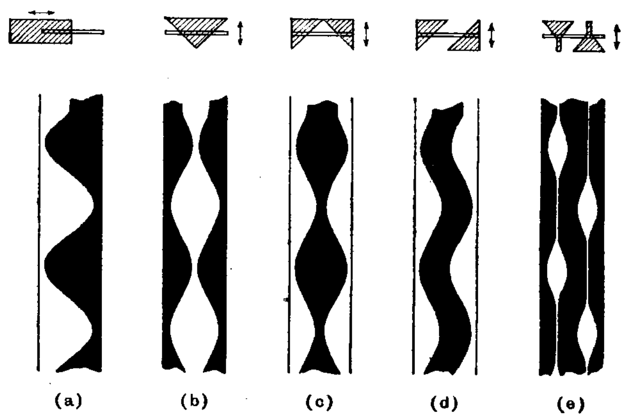


Fig. 2.—Five types of variable area sound track, without noise reduction: (a) unilateral; (b) bilateral, using light wedge; (c) duplex, using "M" shutter; (d) push-pull, class A; (e) push-pull, class B.

Sound on Film—

will rotate the mirror and cause the rectangle of light to embrace more or less of the optical slit, according to the direction of the applied voltage.

This optical slit, with its varying length of illumination, being projected as a sharply defined image on to the photographic film, which is moving at a steady rate of 18 inches per second in a direction at right angles to the length of the projected slit, produces on development a sound track negative of the type shown in Fig. 2(a).

Whilst this system as it stood gave fair results, it had many defects. One of the most noticeable and objectionable shortcomings was an excessive amount of background noise, which, unfortunately, became progressively worse with each "playing," until low levels of modulation were lost in an excess of "mush."

The cause was modulation of the photoelectric cell by scratches and abrasions on the clear portion of the sound track. This problem was solved by rectifying a portion of the speech currents, thus obtaining a voltage to bias back the recording galvanometer, or actuate a shutter, so that the amount of clear film in the positive copy got progressively less as the modulation decreased.

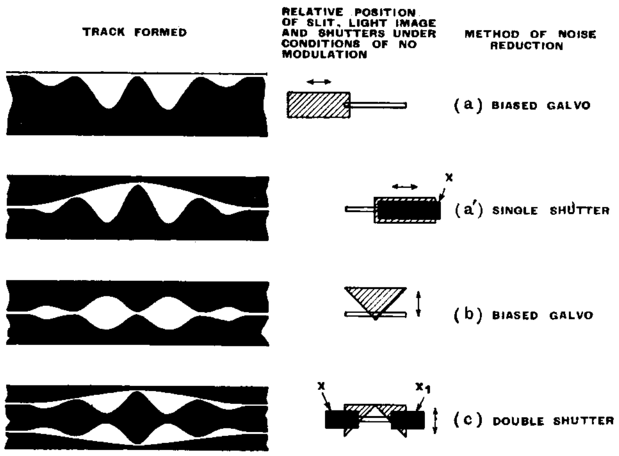


Fig. 3.—Tracks resulting from various methods of noise reduction.

Another trouble experienced was distortion of the higher frequencies, especially at high modulation levels, due to the excessively steep wave face, the spaces or valleys between the waves becoming clogged during the subsequent developing and printing processes.

One can liken this trouble to the clogging by dust, etc., of the spaces between the teeth of a fine tooth comb—the higher the frequency the more teeth per inch, and consequently the smaller the clearance between them.

By projecting a triangular "wedge" of light on to the optical slit, instead of a rectangle, and causing this to oscillate across it a sound track of the form shown in Fig. 2(b) is produced, in which it will be seen that for a given frequency and depth of modulation an increase in the angle between adjacent wave faces is obtained.

A modified form of this light "wedge" now extensively used is the "M" type aperture, producing a track of the form shown in Figs. 2(c) and 3(c).

A double noise reduction shutter *x*, *x*1 (see Fig. 3) is used, the two portions of which close towards the centre of the track during periods of low modulation, occupying the position shown in the diagram during periods of no modulation, and opening out from each other as the modulation increases.

The production of a variable density record necessitates that the optical slit will, at all times, be illuminated along its whole length, but that the intensity of the illumination should be variable.

In practice two methods are employed. In one system a gas discharge tube is used as the source of light. A steady striking voltage is applied across this, and superimposed upon it are the speech voltages, which vary the amount of light about its mean value. The modulation voltages must not, of course, swing the voltage across the tube beyond the quenching or overload values. No optical system is necessary, as the film is drawn past an optical slit in contact with the tube.

The other system of variable density recording employs a light valve, the intensity of the light source remaining constant. In its essentials the light valve consists of a loop of duralumin tape, stretched tight under spring tension, the central portion being held by insulation to form a slit 0.001 inch wide.

This loop is placed in a magnetic field in a plane at right angles to the flux. A current passing through the loop will cause it to open or close, according to the direction of the current. It will be realised that we have, in effect, a shutter whose opening and closing we can vary in sympathy with applied speech currents.

By mounting the ribbons in slightly separated planes, clashing together at periods of over-modulation with attendant risk of mechanical damage will not occur.

The light from the recording lamp is focused by the condenser on to the slit of the light valve, an image of this illuminated slit being focused on to the film by an objective lens.

Sound Reproduction

To reproduce either type of recording, a light image the full width of the track and 0.0013 inch wide is focused on the film, and this light, passing through the film, impinges on to a photo-electric cell.

As the film is moving at a uniform velocity past the projected light slit, the variations in the opacity of the track will cause variations in the amount of light falling on the photo-electric cell, the voltages thus produced being amplified and finally fed to the loud speakers.

The principles of push-pull have been applied to both variable area and variable density film recording with the object of minimising or eliminating certain distortions in the same manner as it has been applied to valve amplifiers.

Although space does not permit this type of recording to be gone into very deeply, we might note the main points. Push-pull film recording is classified under three headings—Class A, Class B, and Class AB. In Class A the signal energy is divided to form two identical

Sound on Film—

tracks 180° out of phase. In Class B one track records the positive half-cycles, whilst the other track records the negative half-cycles. In Class AB, which is of an experimental nature, the recorder is so adjusted that low levels are recorded as Class A and high levels as Class B. Reproduction of either class requires an amplifier with a push-pull input using two photo-electric cells, or a photo-electric cell having two anodes and two cathodes.

As photographic considerations play such an important part in these recordings it will not be out of place to touch upon them here. The light transmission of a variable area type of recording at any point is directly related to the ratio between the dark and light portion of the track, consisting as it does of a combination of opaque image and clear film. It does not, therefore, depend upon gradations of exposure for either output or quality, and, provided that the density of the exposed portion is constant and of sufficient opacity, a satisfactory recording from the photographic standpoint is obtained.

This state of affairs is fairly easily realised in practice,

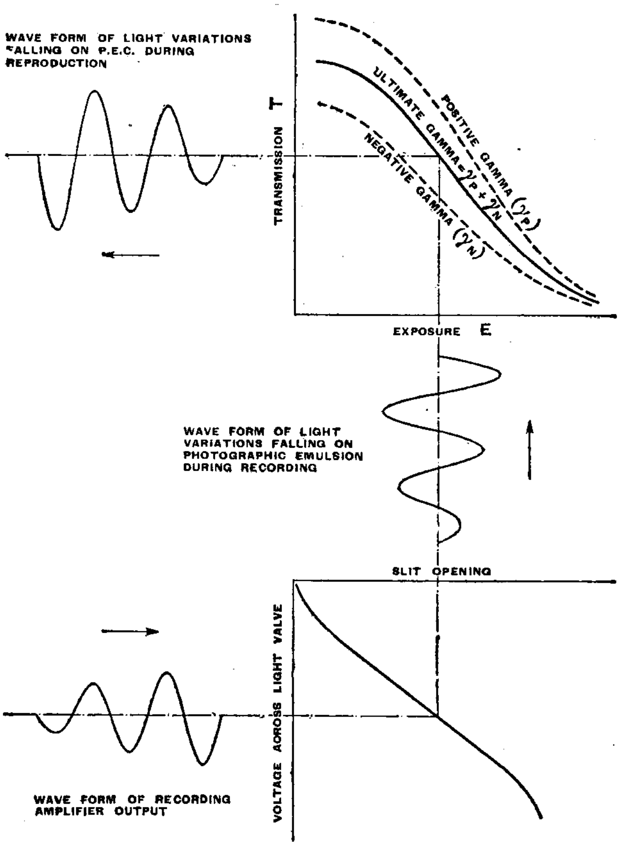


Fig. 4.—Recording sequence in the production of a variable density track by means of a light valve.

as the only two factors governing the exposure are the light intensity and the speed of the film. Variable density recording, however, depends for its modulation upon variations in the densities or transmission values of the track. The photographic requirements for this type of recording are therefore somewhat more exacting.

If we plot the log of the relative exposure of the sensitive film to light against the log of the reciprocal of the light transmission

$$\log E \text{ against } \log \frac{1}{T}$$

we get the well-known Hurter and Driffield (H and D) curve—a standard curve used in photographic calculations, forming a basis from which many other factors are derived.

One of the most important of these factors derived from the curve is the value of "gamma," which is the tangent of the angle formed by the straight portion of the curve with the log E axis. This "gamma" is actually a contrast factor and is an expression of variations in density against variations in exposure. It will be seen that the higher the value of "gamma" the greater will be the contrast for a given variation in exposure.

As an increase in contrast means an increase in the variations of the transmission value T, it follows that the greater the value of "gamma" the greater is the effective volume for a given variation in exposure. A limit, however, is set to the value of "gamma" by the fact that, as it increases in value, the effective length of the log E axis decreases. In sound recording an ultimate "gamma" of 1 is considered the ideal, but in actual practice this is often exceeded, a value of 1.3 or more being used without noticeable depreciation.

It must be realised, of course, that the original recording is a "negative" from which a positive is printed for reproduction purposes. The ultimate "gamma" is the product of the negative and positive "gammas," and if the negative "gamma" is low, then the positive "gamma" must be correspondingly high.

As we are primarily concerned in our recording with the relation between exposure and transmission, we can replot the H and D curve in terms of Transmission T against Exposure E, this curve being known as the ET curve.

The toe, or under-exposed portion of the H and D curve, becomes in this curve practically straight except for the region of extreme under-exposure. Due to the small intrinsic brilliancy of the gaseous discharge tube, it is the under-exposed portion of the ET curve that is used for this system of recording, and an almost linear relationship between exposure and transmission is obtained.

In the production of a variable density recording using a light valve, however, we are not confined to this portion of the ET curve, and can use the central straight portion, which corresponds to the central straight portion of the H and D curve, representing normal exposure.

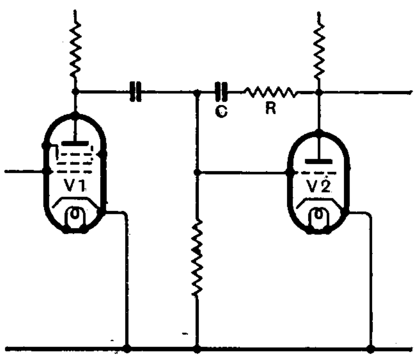
The main application of photographic sound recording is perhaps in connection with the cinema, but it has many other applications. The G.P.O. talking clock (or TIM) uses a photographic sound track on circular glass discs, while there is at least one commercial radio-gramophone designed to use film records instead of the more familiar disc.

Negative Feedback Amplifiers

PROBLEMS OF STABILISATION

THE merits of amplifiers which make use of negative feedback are now widely known, and the improvement in the matter of harmonic distortion is probably the one that is first thought of by all those who are interested in the problems of amplification—undoubtedly because negative feedback is now so much used in ordinary AF amplifiers, and the most immediate problem there is that of curved valve characteristics. Negative feedback, however, has other uses, and one is that of levelling up the response of an amplifier over a considerable range of frequencies; in fact, in telephone technique this use is of the greatest value, for it enables a large number of modulated carrier-speech channels, covering a very wide total range of frequencies, to receive equal amplification, and all by the same amplifier. In the absence of negative feedback stray capacities in the amplifier make it difficult to realise the wide and level characteristic needed—at least in any simple manner. The same difficulty can be surmounted in the same way in television vision-signal amplifiers where an even greater frequency range is met with.

It must not be thought that feedback methods never give rise to any problems of their own; they do, and especially in the wideband type of circuit just referred to. To achieve the greatest benefit from negative feedback it is necessary to use an amplifier of very large amplification. In this way the flattest characteristics and the least non-linear distortion are obtained. At the same time many amplifier stages are needed, and this is of significance when the presence of stray and coupling reactances is remembered.



Auxiliary circuit for feedback stabilisation.

Causes of Self Oscillation

Suppose we consider a single amplifying stage in which the anode circuit contains simply a resistance. In calculating the gain of the stage quite generally we cannot think of the anode-load impedance as just this resistance; we must think of it as this resistance shunted by whatever stray capacities there may exist, for instance, the stray anode-to-earth capacity. At sufficiently high frequencies the reactance of the shunt capacity will be of less magnitude than the resistance of the nominal load element. This, of course, means that the amplification of the stage will be less; but, more important, it means also that signals will be retarded in phase as compared with their transit through the amplifier at lower frequencies. The maximum retardation at the highest frequencies is 90 degrees. Thus if three stages operate in cascade it is clear that at some sufficiently high frequency the effect of "negative" feedback will be the return to the input side of the amplifier of an "in-phase" signal of appreciable amplitude. If this signal is too large the amplifier will not, in fact, be an amplifier, but a self-excited oscillator.

To prevent multi-stage negative feedback amplifiers from becoming unstable it is thus essential that the amplification should have fallen sufficiently before the phase rotation in the amplifier has increased to 180 degrees. Methods to this end that have been used include the insertion of coupling networks in the amplifier or in the feedback path itself, and even an auxiliary path connected in shunt to the main feedback path which comes into operation at the higher frequencies to reduce the amplitude of signals fed back. Another method lies in the use of a special form of feedback applied to operate upon one or more stages separately in the amplifier.

An example of the latter method is shown in the diagram. The stage V2 having the special feedback applied to it is driven from an earlier stage V1, which appears to the driven stage as a constant-current source and may simply consist of a pentode-type amplifier. The feedback is of the current variety, and is brought about by the connection of an impedance R, complex or otherwise, between the output circuits of the two stages; it has the effect of reducing the gain of the driving stage V1 as currents are fed back in phase opposition into the output circuit of this stage, but the gain of the driven stage V2 remains almost unaltered. The feedback impedance in a simple case may be constituted by a fairly high-resistance R, namely, one fairly large compared with an anode-load resistance, and by a condenser C connected in series with it. The condenser C is of small value so as to prevent the feedback functioning appreciably in the normal operating range of the amplifier, but at higher frequencies its reactance becomes small and feedback occurs through the feedback resistance. Thus although the phase rotation through the whole amplifier still occurs as before, yet the reduction of the gain by means of the auxiliary current feedback reduces the amplitude of the signal components which are subject to the rotation sufficiently to prevent any danger of self-oscillation.

Advantage may be taken of the increased stability of the amplifier to obtain a higher amplification or with increased overall feedback a more level characteristic. In order to increase the rapidity with which the auxiliary feedback is brought into action at the higher frequencies an inductance can be connected across the series resistance in the feedback impedance.

Versatile Oscillator

THE NUMANS CIRCUIT : RF, AF AND SAW-TOOTH GENERATOR

By W. T. COCKING, A.M.I.E.E.

A simple single-coil oscillator circuit that at one time enjoyed a considerable vogue is here discussed in the light of modern knowledge—and valves—particularly with regard to its use as a saw-tooth generator.

AN exceedingly interesting form of oscillator was described in *Experimental Wireless* (now *The Wireless Engineer*) for December, 1924, under the title of the Numans Oscillator. In the form then developed a tetrode was used to provide a negative mutual conductance between two electrodes and so a two-terminal tuned circuit could be made to oscillate. In other words, no reaction coil nor tappings on the tuned circuit were required. In this respect the circuit was the equivalent of the dynatron.

The circuit has lately been revived under the name Transitron, [1, 2] but now using a pentode instead of a tetrode. It forms a very useful RF or AF oscillator, and it can also be employed for generating saw-tooth waveforms. It then forms a convenient hard-valve saw-tooth oscillator which does not need coils and which uses only one valve.

Principle of Operation

Theoretically a tetrode is not essential to the Numans oscillator—a triode can be used. Consider a triode with a positive grid potential and start with zero or a very small positive anode potential. Electrons emitted by the cathode are attracted by the positive grid. Some of them land directly on the grid wires, others fly through its meshes. These come within the grid-anode space and are attracted very slightly by the anode some distance in front of them and strongly by the highly positive grid just behind them. Nearly all the electrons consequently fall back to the grid and very few reach the anode. Thus the grid current is large and the anode current very small indeed.

Now suppose that the anode voltage is raised. The attractive force of the anode on the electrons which initially pass the grid is increased and a greater number pass to the anode, so that the anode current is greater. The grid, however, substantially shields the cathode from the anode, consequently the increased anode potential does not result in any appreciable increase in the number of electrons drawn from the cathode. As the number of electrons from the cathode is unchanged and more reach the anode there must be fewer finally landing on the grid. Therefore, increasing the anode voltage *reduces* the grid current.

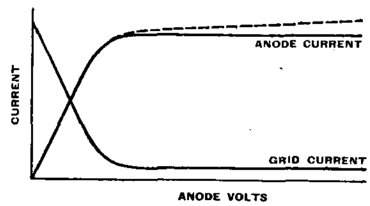


Fig. 1.—Characteristics of a triode valve used as a Numans oscillator.

As the anode voltage is raised from zero the anode current rises and the grid current falls. At length, however, the anode voltage gets high enough to attract nearly all the electrons which pass the grid wires in the first instance. As the total number of electrons leaving the cathode is constant and all that pass the grid go to the anode, both anode and screen currents become independent of further increases in anode voltage. The valve curves become of the form shown in Fig. 1.

These curves represent an idealised case. In practice, the screening effect of the grid is not perfect, so an increase in anode potential does result in an increase in the number of electrons leaving the cathode. This is especially so at high anode voltages and results in a continual increase of anode current with voltage and possibly in a slight increase of grid current. This is indicated by the dotted curve of Fig. 1.

Secondary Emission

In practice, too, matters are complicated by secondary emission at the anode. The action goes on as described until the anode voltage is high enough for the electrons reaching it to have sufficient velocity to knock secondary electrons from it. On the average there are more secondary electrons knocked out of the anode than there are primaries reaching it. Some of them fall back on to the anode, others are attracted by the more positive grid and pass to it. Consequently, the anode current is less and the grid current is greater than it should be. As the anode voltage is raised the anode current falls and the grid current rises.

Referring to Fig. 2, the action is normal over the region *a b* and secondary emission is beginning to show up at *b*. Over the region *b c* secondary emission is playing an important part. At *c* the anode voltage is nearly as high as the grid voltage

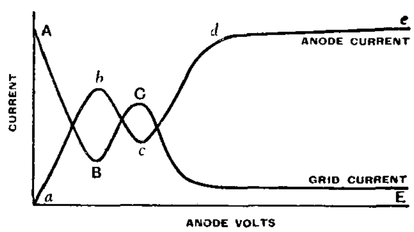


Fig. 2.—Grid and anode current relationship in a dynatron oscillator.

and it is much nearer the secondary electrons. Consequently, the secondary emission no longer goes to the grid to any great extent and the electrons fall back on to the anode. The

[1] Proceedings of the Institute of Radio Engineers, October, 1935.
[2] *Electronics*, August, 1939.

Versatile Oscillator—

anode current consequently rises rapidly with a further increase in anode voltage (*c d*) and the grid current falls. Beyond *d* conditions revert to the idealised case; secondary emission only affects matters over the range *b c d*.

Now the anode AC resistance of a valve at any anode voltage is equal to a change of anode voltage divided by the resulting change of anode current, infinitesimally small changes being assumed. It is, in fact, a measure of the slope of the curve. In Fig. 2 over the range *a b* the curve is nearly straight and the anode AC resistance is nearly constant; an increase of voltage is accompanied by an increase of current so that the resistance is positive. In a practical case it might be of the order of 10,000 ohms.

Approaching *b*, however, the change of current for a given anode voltage change falls off rapidly and becomes zero at *b*. The resistance consequently rises rapidly to infinity at *b*. Beyond *b* the change of current is in the opposite direction and is consequently reckoned as negative. Between *b* and *c*, therefore, the resistance is negative and is at its lowest roughly half-way between, where the slope of the curve is the steepest. The resistance rises again approaching *c* and is infinite at *c*. Beyond *c* it again falls but is now positive. At *d* the resistance rises again and beyond *d* settles down to a fairly constant high value.

In a practical case the resistance might well be 5,000 to 10,000Ω over the ranges *a b* and *c d*; 5,000 to −10,000Ω over *b c*, and 0.1 to 0.2 M Ω beyond *d*. If a tuned circuit is connected in the anode lead of the valve and its dynamic resistance is greater than the anode AC resistance over the range *b c* and the valve is given an anode voltage between *b* and *c*, then the valve will oscillate. This is, in fact, the dynatron oscillator.

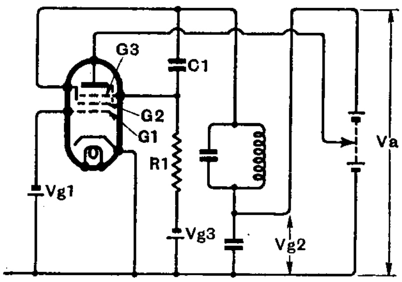


Fig. 3.—Use of a pentode valve; conditions for oscillation are given in the text.

It is not popular because valves are not designed for good dynatron characteristics. To obtain a low negative resistance, necessary for poor circuits and on short waves, a high grid voltage is needed and the grid dissipation may be too heavy to obtain a reasonable life from the valve. Moreover, different specimens of the same type of valve often have widely different negative resistance characteristics. Certain types are quite good, however.

Of course, in practice a triode is not used, but a tetrode. This is because few modern triodes would stand being worked with a highly positive grid potential; the cathode surface would almost certainly be destroyed by the enormous current which the grid would try to draw. Instead a tetrode is used. The control grid then plays no major action but that of limiting the current. It is normally kept at zero or a slightly negative potential. The function of the screen grid is then exactly that of the grid in the foregoing description.

A normal screen-grid tetrode when used as an amplifier may need 200 volts for the anode and 80 volts for the screen. The working point is then well to the right of *d* in Fig. 2. The point *d* corresponds to an anode potential about equal to the screen potential and the mid-point between *b* and *c* corresponds to an anode voltage of about one-half the screen voltage or some 40 volts. The screen current is then abnormally large and it is kinder to the valve to operate with some 40-60 volts on the screen and 20-30 volts on the anode. The negative resistance is higher, however, so that oscillation is not so readily obtained.

In the case of the Numans oscillator or Transitron, use is made of the sloping portion of the anode-volts-grid-current curve of Fig. 1. This amounts to a negative mutual conductance between anode and grid.

Reverting a moment to the triode, the basic idea for its use as an oscillator is to couple the grid and anode together through a condenser so that they are at the same potential to alternating voltages and to join them to cathode through a tuned circuit. The idea is that an increase in anode potential causes a decrease in grid current and hence a lower voltage drop across the tuned circuit. This means a higher voltage applied to the anode and hence still lower grid current. The action is cumulative.

Triode Limitations

In practice, it is upset by the fact that the anode current increases. The increase in anode potential increases the anode current at the same time as it reduces the grid current. Both currents flow through the tuned circuit and oppose one another. To put it another way, the valve is acting as a triode with a negative mutual conductance between anode and grid, but the input circuit is shunted by the low positive anode AC resistance. This makes the circuit oscillate much less readily, and in some cases may prevent it from doing so.

In the ideal case the control electrode, the anode, would draw no current. This may be approached with a pentode, and the modern form of the oscillator with such a valve is a great advance on its predecessors.

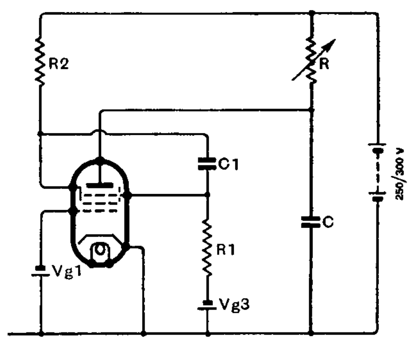


Fig. 4.—Circuit for the production of saw-tooth oscillations.

The arrangement is shown in Fig. 3, and in comparing it with the triode description the cathode proper and G1 correspond to the triode cathode, G2 to the triode grid, and G3 and anode to the triode anode.

Versatile Oscillator—

G1 is kept at a suitable potential to give the required electron flow to G2. It is usually biased by V_{g1} to about -3 volts. G2 is the output electrode, with a mean positive potential V_{g2} of up to 200 volts. G3 is the control electrode and is at zero or a slightly negative bias V_{g3}. The anode is kept positive by V_a at some 20-60 volts.

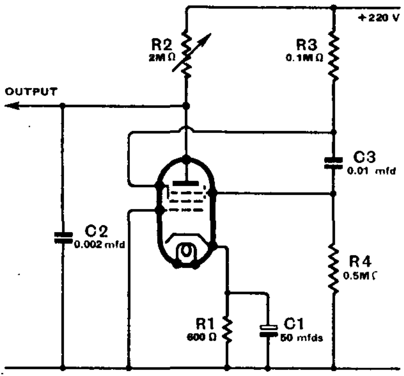


Fig. 5.—A practical form of saw-tooth oscillator.

The action is as follows: G2 is highly positive and draws electrons from the cathode through G1. The number of electrons drawn depends only on V_{g1} and V_{g2}. Some of them strike the wires of G2, others pass through its meshes. These come within the composite field of G3, anode, and G2. The electrons which have only just succeeded in passing G2 and are at low velocity are so strongly attracted by it that they fall back to it. Some of the higher velocity electrons succeed in escaping it, however, and come within the combined field of G3 and anode. This field is positive and attracts them. The electrons do not land on G3, however, because it is negative; they pass through its meshes to the anode.

Now if G3 is made less negative the combined field of G3 and anode becomes more positive, and more electrons are rescued from G2 and pass to the anode. Consequently, the G2 current decreases. The action is, in fact, identical with that described for the tetrode, but the anode is in two parts—an anode proper and a negative control electrode. Instead of varying the attractive power of the anode itself it is kept at a fixed potential, and its attractive power is varied by altering the negative bias applied to G3.

This effectively overcomes the difficulty of the anode AC resistance. G3 draws no current and has an infinite AC resistance (ideally).

The usual application of the circuit is as an RF or AF oscillator with the basic circuit of Fig. 3. For radio-frequency C1 and R1 can be 0.0005 μF. and 0.5 MΩ respectively, while the various voltages must be found by trial to suit the valve selected. Usually V_{g1} can be 0 to -3 volts and V_{g3} about the same; V_{g2} can well be 100 volts or thereabouts and V_a adjusted for satisfactory oscillation. None of the voltages is very critical, but as suitable valve curves are rarely available all must be chosen experimentally.

Most RF pentodes work well, but some of the high-g television types are more ready oscillators than ordinary valves. G1 is of course the "control grid," G2 the "screen grid," and G3 the "suppressor grid."

Saw-tooth Generator

The circuit can also be used as a saw-tooth oscillator, and this arrangement is shown in Fig. 4. G2 is fed from positive HT through R2 of some 50,000 ohms, while G3 is biased through R1 (0.5 MΩ) by V_{g3} (0 to -3 volts). V_{g1} is kept at about the same value. G2 and G3 are coupled by C1; for very low frequencies this may be 1 μF, but for the higher frequencies it can be smaller. It is in no way critical, however.

The operation is quite simple. When first switching on, C is uncharged and the anode potential is zero. The G2 voltage is determined by the drop across R2. The condenser C charges exponentially from the HT supply through R, and at length the anode voltage becomes large enough to draw some anode current. The G2 current then decreases and also the voltage drop across R2, thus increasing the potential of G2. This change of potential is communicated to G3 through C1 and makes G3 less negative, thus increasing the anode current and further reducing the G2 current.

The action is cumulative and C is rapidly discharged through the valve. When C is nearly discharged the anode current naturally falls, because the voltage across C is no longer sufficient to maintain the current. The drop in current means an increase in G2 current and hence a decrease in G2 potential. This drives G3 negative, anode current is rapidly cut off, and the valve returns to its initial state and C commences to charge again.

The circuit is very easy to get working and the writer has used the Mullard TSP4, the Mazda AC/SP3, SP41 and SP42, and the Osram MSP4 types successfully. With V_a of 250 volts and the values given, V_{g3} can be zero for all valves and V_{g1} can be zero for the TSP4 and MSP4 but about -1.5 volts for the AC/SP3 and SP41. In the case of the MSP4, the resistance R2 should be returned to a point of rather lower potential than 250 volts; $+150$ volts is better.

The operation of the circuit is seriously affected by the inclusion of resistance in the G1 lead. A few hundred ohms makes little difference with some valves, but with others it is sufficient to upset the operation. The fly-back time is lengthened and the amplitude reduced; with too much resistance the valve will not oscillate.

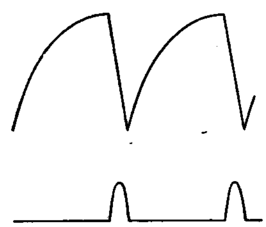


Fig. 6.—Output and pulse waveform of the oscillator shown in Fig. 5.

The resistance that can be tolerated depends on V_{g1}, but is usually too small for G1 to be used for any purpose, such as the injection of sync pulses. Grid current varies considerably with the operating conditions and with $V_{g1}=0$ can be as high as 1 mA. Even when it is less than 10μA., however, resistance in the grid circuit still upsets the performance.

An arrangement which the writer has found very satisfactory is shown in Fig. 5. Using a Mazda SP42 valve an output of some 80 volts (peak potential) is obtained across C2 at about 10,000 c/s. The fly-

Versatile Oscillator—
back time is about 5.5 per cent. of the time of one cycle. The scan stroke is, of course, non-linear, for the output is some 36 per cent. of the HT voltage. With R2 returned to a higher voltage, a more linear output can be secured, or a correcting circuit may be used.

Under the conditions given the G1 current was 10 μA., G2 current 1.6 mA., G3 current 30 μA., and anode current 0.6 mA. This gives a total of nearly 2.25 mA. The voltage across C2 is of the form shown in Fig. 6 (a), while the waveform on G2 and G3 takes the form of pulses (b).

Letters to the Editor

THE EDITOR DOES NOT NECESSARILY ENDORSE THE OPINIONS OF HIS CORRESPONDENTS

Thoughts on Morse Operating

OUT of an experience of the matter both extensive and peculiar, I beg to offer a few remarks.

Those who learn to read the clicks of a sounder have no difficulty in proceeding to the buzz or musical note of wireless telegraphy, but the opposite process is very tough indeed. Telegraph operators accustomed to the single-needle system can usually copy dots and dashes readily enough, but when they first essay sending on the normal key their dots and dashes tend to be too equal to each other, and the unfortunate operator at the other end is hard put to it to make sense of it all. There used to be an operator at Ushant whose cramped style suggested an earlier experience on the railway. Operators with much experience of wireless, which is our concern here, all agree that it is most important to get the dashes clear and distinct, if necessary spinning them out beyond their precise three-dot length. *Never* clip the dashes; when interference or atmospherics are bad, the good operator instinctively sits on his dashes a little more, and is grateful if the other fellow reciprocates; or, at any rate, is vocally ungrateful if he doesn't!

"Machine" sending is only really suitable for machine reception: anyone who has copied much press, as distinct from scrappy messages with breaks between, has experienced that maddening feeling that comes from the monotony of the machine—or the soulless, machine-like hand telegraphist. Personally, I dislike the "bug" for this reason; as a multitude of ordinary Post Office operators used to have no difficulty in working at a steady 30 without fatigue or cramp, with a burst up to 40 if required, one fails to see any reason for using a bug at all, when the normal key will take anything one can give it. This is not to say that I don't like the American style of sending, as taught by the Candler system, where the character is formed as a whole, and the sheer speed is more a matter of spacing between characters than of spinning out dots, dashes and pauses to fill all the available time.

Old-timers will perhaps remember a weather report that the Air Ministry used to transmit in the early 1920's, supposed to be for the benefit of beginners in telegraphy; this consisted apparently of a normal perforation on Wheatstone tape run through slowly, thus dragging out all the components of the message. Operators of many years' experience found it most difficult to read! When I was a learner myself, one of our instructors sent his stuff in the American style, and we beginners could always take him at several words per minute faster than another who insisted that his was perfect telegraphy. His fast stuff, when we had progressed a bit, was indeed pretty good, but he drew out his characters when sending slowly so that one forgot the beginning of a letter before the end was reached.

Holding the key is ruled by the size and shape of the knob and by the set and length of the operator's fingers. My own handwriting was ruined in early life by a schoolmaster who insisted (with a stick) on our resting two fingers on the pen: that suited his own hand all right, but he could not see that most of us had a middle finger appreciably longer than the index, and so needed to rest it at the side of the pen for comfort, the essential factor for good writing as for good telegraphy. And writing is an important matter to the telegraphist, whether or not a typewriter is normally used. A good style to practice resembles the favoured American style of sending, in that each letter is made in a narrow space, and joined to the next by a long, sweeping line. As fluency is developed, the spacing is shortened, while keeping the letters clear and distinct. L. J. VOSS.

Plympton, Devon.

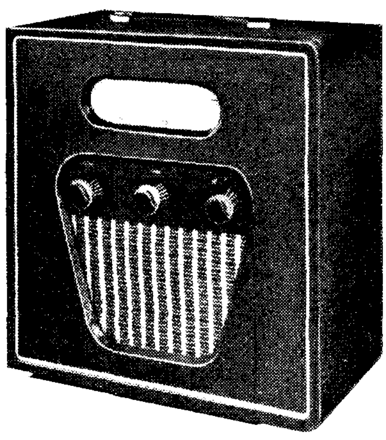
Interval Signals

IF the B.B.C. *must* use its initials as an interval signal, surely it would be better to send them in slow morse rather than as musical notes, and to add H or F to distinguish the Home and Forces programmes. As a compromise, the dots and dashes representing the letters could be attuned to the respective musical notes, although, for obvious reasons, H would be barred as a prefix. I would suggest D (Domum) and C (Copiae).

Teddington, Middx. H. WEST.

Two New Murphy Sets

A BATTERY PORTABLE AND AN AC CONSOLE



The new B93 battery portable.

IN the general design of its circuit the new B93 ("Service") portable follows the lines of its predecessor, the B81. It is intended for high-quality reproduction, and has a QPP output stage powered from a 120-volt HT battery.

A feature of the new model is the generous space allowed for the 2-volt accumulator. When used at home a really large glass-cell can be installed if desired. The new cabinet is finished in black and white throughout.

The range of the B93 should be comparable with that of a four-valve battery set working from an external aerial, for not only is there a stage of RF amplification, but the frame area has been increased relative to the earlier model. The price, less batteries, is £10.

Murphy A90C console receiver for AC mains.

The new console is an adaptation of the A90 receiver reviewed in our May issue this year. It costs £18, and is available for AC mains only. Special attention has been given to the acoustic design. The large diameter loud speaker has an improved field magnet and a reduced air gap, the latter being completely dustproof. The cabinet is shallow from back to front, and the loud-speaker is off-set to minimise air column resonance and baffle interference effects. Wood resonances in the cabinet are prevented by a system of interval struts.

Book Review

The Amateur Radio Handbook. Second Edition. Published by the Incorporated Radio Society of Great Britain, 16, Ashridge Gardens, London, N.13. Price 4s. 2d. post free. Overseas 5s.

IN the second edition of this handbook which is now available, several chapters of only peacetime interest, such as that dealing with the obtaining of a transmitting licence, have been omitted. A very generous amount of space is, however, still devoted to the technical side of transmitting, as it is quite rightly thought that the amateur cannot do better than prepare himself for the eventual return of peacetime conditions.

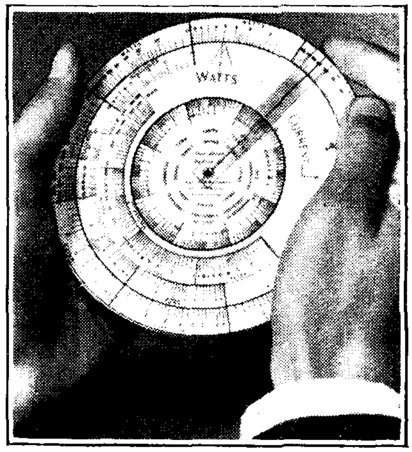
At the same time a goodly number of the book's twenty-four chapters are devoted to non-transmitting aspects of radio, including television technique. The whole of the book has been very drastically revised, and a considerable amount of new matter has been included. There are two new chapters dealing with workshop practice and with crystal band-pass filters. It is noted that the lucidity of style which characterised the first edition has been retained in the present one.

From the World's Journals

"THE Abstracts and References section of *The Wireless Engineer* is in itself worth the half-a-crown a month." This testimonial to a regular monthly feature of our sister journal, offered by a wireless engineer some months ago, is still more to the point to-day when it is becoming increasingly difficult to obtain journals from abroad. In the August issue, which was published on the first of the month, the Abstracts and References section includes references to and abstracts from over 400 recently published articles on wireless and allied subjects.

The issue, which is obtainable through newsagents or direct from the publishers, Dorset House, Stamford Street, London, S.E.1, at 2s. 8d. post free, also contains an article giving a comprehensive survey of the application of feedback to receiver circuits. Another article describes a method of neutralising the grid-anode capacitance coupling in screened grid valves.

"Flik-o-Disk" Resistance Calculator

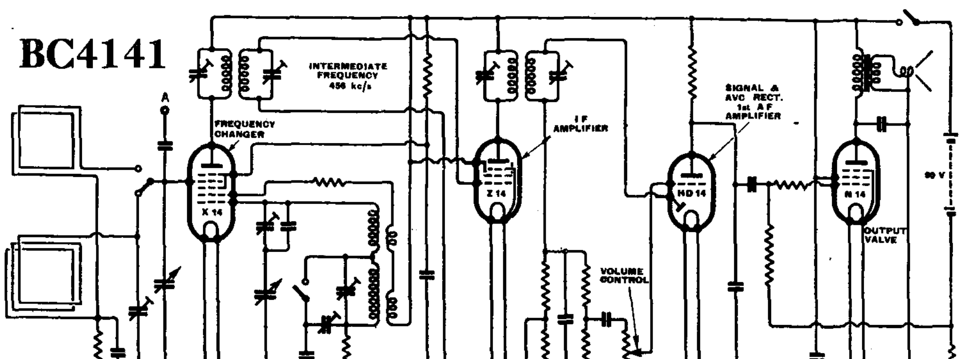


ALL the problems relating to Ohm's Law can be quickly solved with the aid of the "Flik-o-Disk" calculator made by Ionic Laboratories, 514, Ipswich Road, Trading Estate, Slough, Bucks. Not only are resistance, current and voltage relationships simplified, but wattage calculations—often a source of trouble to the beginner—can be worked out with speed and certainty. The scales are direct-reading for most values met with in servicing work, and the accuracy of graduation is sufficient for all practical purposes. The price is 4s. 6d.

G.E.C. Portable BC4141

A Correction

IN the circuit diagram which accompanied our test report on this receiver on page 367 of last month's issue, the AVC was shown connected only to the first valve. The control is actually applied to the IF as well as the frequency-changer stage. Unfortunately, there was also a draughtsman's error in the lettering of the valve types. To make matters quite clear, we take this opportunity of reproducing the corrected circuit.



Short-wave Broadcasting Stations

ARRANGED IN ORDER OF FREQUENCY

Station	Call Sign	Mc/s	Metres	kW
49 - Metre Band (6.000 - 6.200 Mc/s)				
Moscow (U.S.S.R.)	RNE	6.000	50.00	20–100
Pretoria (South Africa)	ZRH	6.007	49.94	5
Moscow (U.S.S.R.)	RW96	6.030	49.75	20–100
Boston (U.S.A.)	WRUL	6.040	49.67	20
British Oversea Service	GSA	6.050	49.59	10–50
Philadelphia (U.S.A.)	WCAB	6.060	49.50	10
Motala (Sweden)	SBO	6.065	49.46	12
Toronto (Canada)	CFRX	6.070	49.42	—
Lima (Peru)	OAX4Z	6.080	49.34	15
Nairobi (Kenya)	VQ7LO	6.083	49.31	1
Cape Town (South Africa)	ZRK	6.097	49.20	5
Belgrade (Yugoslavia)	YUA	6.100	49.18	10
British Oversea Service	GSL	6.110	49.10	10–50
Wayne (U.S.A.)	WCBX	6.120	49.02	10
Lahti (Finland)	OFD	6.120	49.02	1
Hsinking (Manchukuo)	MTCY	6.125	48.98	20
Pittsburgh (U.S.A.)	WPIT	6.140	48.86	40
Winnipeg (Canada)	CJRO	6.150	48.78	2
Wayne (U.S.A.)	WCBX	6.170	48.62	10
Schenectady (U.S.A.)	WGEO	6.190	48.47	100
Vatican City	HVJ	6.190	48.47	25
Athlone (Ireland)	—	6.190	48.47	—
Ica (Peru)	OAX1A	6.335	47.33	—
Radio Nations (Switzerland)	HBQ	6.675	44.94	20
Bandoeng (Dutch E. Ind.)	PMH	6.720	44.64	1.5
Valladolid (Spain)	FET1	7.070	42.43	—
41 - Metre Band (7.200 - 7.300 Mc/s)				
British Oversea Service	GSW	7.230	41.49	10–50
Tokio (Japan)	JVW	7.257	41.34	50
British Oversea Service	GSU	7.260	41.32	10–50
Lisbon (Portugal)	CSW8	7.260	41.32	10
Moscow (U.S.S.R.)	RWG	7.360	40.76	20–100
Moscow (U.S.S.R.)	RKI	7.520	39.89	20–100
Moscow (U.S.S.R.)	—	7.545	39.76	20–100
Cairo (Egypt)	SUX	7.865	38.14	10
Bangkok (Thailand)	HSP6	7.968	37.65	10
Moscow (U.S.S.R.)	RIA	8.070	37.17	20–100
Budapest (Hungary)	HAT4	9.125	32.88	5
Bucharest (Rumania)	—	9.280	32.33	—
Lima (Peru)	OAX4J	9.340	32.12	—
Radio Nations (Switzerland)	HBL	9.345	32.10	20
Moscow (U.S.S.R.)	—	9.465	31.70	20–100
Ankara (Turkey)	TAP	9.465	31.70	20
St. John's (Newfoundland)	VONG	9.482	31.64	—
31 - Metre Band (9.500 - 9.700 Mc/s)				
Chungking (China)	XGOY	9.500	31.58	35
Bangkok (Thailand)	HS8PJ	9.500	31.58	10
Lahti (Finland)	OFD	9.500	31.58	1
Mexico City	XEWW	9.503	31.57	10
Belgrade (Yugoslavia)	YUC	9.505	31.56	10
British Oversea Service	GSB	9.510	31.55	10–50
Moscow (U.S.S.R.)	RW96	9.520	31.51	20–100
Pretoria (South Africa)	ZRG	9.523	31.50	5
Hong Kong (China)	ZBW3	9.525	31.49	2.5
Schenectady (U.S.A.)	WGEO	9.530	31.48	100
Moscow (U.S.S.R.)	—	9.530	31.48	20–100
Treasure Island (U.S.A.)	KGEI	9.530	31.48	20
Calcutta (India)	VUC2	9.530	31.48	10
Tokio (Japan)	JZI	9.535	31.46	50
Motala (Sweden)	SBU	9.535	31.46	12
Suva (Fiji)	VPD2	9.535	31.46	—
Schenectady (U.S.A.)	WGEA	9.550	31.41	25
Vatican City	HVJ	9.550	31.41	25
Bombay (India)	VUB2	9.550	31.41	10
Pittsburgh (U.S.A.)	WPIT	9.570	31.35	40
Millis (U.S.A.)	WBOS	9.570	31.35	10
Madras (India)	VUM2	9.570	31.35	10
Montevideo (Uruguay)	CXA2	9.570	31.35	5
British Oversea Service	GSC	9.580	31.32	10–50
Melbourne (Australia)	VLR	9.580	31.32	2
Cincinnati (U.S.A.)	WLWO	9.590	31.28	50
Delhi (India)	VUD2/3	9.590	31.28	10
Philadelphia (U.S.A.)	WCAB	9.590	31.28	10
British Oversea Service	GRY	9.600	31.25	10–50
Moscow (U.S.S.R.)	RAL	9.600	31.25	20–100
Cape Town (South Africa)	ZRL	9.606	31.23	5
Sydney (Australia)	VLQ	9.615	31.20	—
Budapest (Hungary)	HAT5	9.625	31.17	5
Taihoku (Formosa)	JFO	9.636	31.13	—
Wayne (U.S.A.)	WCBX	9.650	31.09	10
Perth (Australia)	VLW2	9.650	31.09	—
Vatican City	HVJ	9.660	31.06	25
Manila (Philippine Islands)	KZRH	9.660	31.06	—
Buenos Aires (Argentine)	LRX	9.660	31.06	7
Radio-Teheran (Iran)	EQC	9.680	30.99	14
Mexico City	XEQQ	9.680	30.99	10
Sydney (Australia)	VLQ5	9.680	30.99	—
Moscow (U.S.S.R.)	RW96	9.684	30.98	20–100
British Oversea Service	GRX	9.690	30.96	10–50
Buenos Aires (Argentine)	LRA1	9.690	30.96	10
Singapore (Malaya)	ZHP	9.700	30.93	2.5
Lisbon (Portugal)	CSW7	9.740	30.80	10
Madrid (Spain)	EAJ7	9.860	30.43	10
Bandoeng (Java)	PMN	10.260	29.24	1.5
Sofia (Bulgaria)	—	10.310	29.10	—
Buenos Aires (Argentine)	LSX	10.350	28.99	12
Lisbon (Portugal)	CSW6	11.040	27.17	10
Radio Nations (Switzerland)	HBO	11.402	26.31	20
Moscow (U.S.S.R.)	RIC	11.640	25.77	20–100
Canton (China)	XGOK	11.650	25.75	—
25-Metre Band (11.700-11.900 Mc/s)				
Motala (Sweden)	SBP	11.705	25.63	12
Moscow (U.S.S.R.)	—	11.710	25.62	20–100
Winnipeg (Canada)	CJRX	11.720	25.60	2
Vatican City	HVJ	11.740	25.55	25
British Oversea Service	GSD	11.750	25.53	10–50
Hsinking (Manchukuo)	MTCY	11.775	25.48	20
Boston (U.S.A.)	WRUL	11.790	25.45	20
Tokio (Japan)	JZJ	11.800	25.42	50
British Oversea Service	GSN	11.820	25.38	10–50
Wayne (U.S.A.)	WCBX	11.830	25.36	10
Perth (Australia)	VLW3	11.830	25.36	—
Lisbon (Portugal)	CSW5	11.840	25.34	10
Melbourne (Australia)	VLR3	11.850	25.32	2
British Oversea Service	GSE	11.860	25.29	10–50
Cincinnati (U.S.A.)	WLWO	11.870	25.27	50
Sydney (Australia)	VLQ2	11.870	25.27	—
Pittsburgh (U.S.A.)	WPIT	11.876	25.26	40
Sydney (Australia)	VLQ7	11.880	25.25	—
Chungking (China)	XGOY	11.900	25.21	35
Moscow (U.S.S.R.)	—	11.900	25.21	20–100
Moscow (U.S.S.R.)	—	11.920	25.17	20–100
Moscow (U.S.S.R.)	RNE	12.000	25.00	20–100
Shanghai (China)	FFZ	12.050	24.90	—
Moscow (U.S.S.R.)	—	12.145	24.70	20–100
Quito (Ecuador)	HCJB	12.460	24.08	—
Radio Nations (Switzerland)	HBJ	14.535	20.64	20
19-Metre Band (15.100-15.350 Mc/s)				
Moscow (U.S.S.R.)	RKI	15.040	19.95	20–100
Vatican City	HVJ	15.120	19.84	25
Boston (U.S.A.)	WRUL	15.130	19.83	20
British Oversea Service	GSF	15.140	19.82	10–50
Motala (Sweden)	SBT	15.155	19.80	12
Tokio (Japan)	JZK	15.160	19.79	50
Moscow (U.S.S.R.)	RW96	15.180	19.76	20–100
British Oversea Service	GSO	15.180	19.76	10–50
Lahti (Finland)	OIE	15.190	19.75	1
Ankara (Turkey)	TAQ	15.195	19.74	20
Chungking (China)	XGOX	15.200	19.74	35
Pittsburgh (U.S.A.)	WPIT	15.210	19.72	40
Lisbon (Portugal)	CSW4	15.215	19.72	10
Belgrade (Yugoslavia)	YUG	15.240	19.68	10
Boston (U.S.A.)	WRUL	15.250	19.67	20
British Oversea Service	GSI	15.260	19.66	10–50
Cincinnati (U.S.A.)	WLWO	15.270	19.65	50
Wayne (U.S.A.)	WCBX	15.270	19.65	10
Delhi (India)	VUD3	15.290	19.62	10
Buenos Aires (Argentine)	LRU	15.290	19.62	7
British Oversea Service	GSP	15.310	19.60	10–50
Schenectady (U.S.A.)	WGEA	15.330	19.57	25
Budapest (Hungary)	HAS3	15.370	19.52	5

Station	Call Sign	Mc/s	Metres	kW
Moscow (U.S.S.R.)	—	15.390	19.49	20–100
Moscow (U.S.S.R.)	RW96	15.410	19.47	20–100
Moscow (U.S.S.R.)	—	15.500	19.35	20–100
Moscow (U.S.S.R.) .. .	—	15.715	19.09	20–100
Moscow (U.S.S.R.)	—	15.735	19.07	20–100
Moscow (U.S.S.R.)	—	16.090	18.61	20–100
16-Metre Band (17.750-17.850 Mc/s)				
Pittsburgh (U.S.A.)	WPIT	17.780	16.87	40
Bound Brook (U.S.A.)	WNBI	17.780	16.87	25
British Oversea Service ..	GSG	17.790	16.86	10–50
Chungking (China)	XGOX	17.800	16.85	35
British Oversea Service ..	GSV	17.810	16.84	10–50
Wayne (U.S.A.)	WCBX	17.830	16.83	10
Moscow (U.S.S.R.)	—	17.910	16.75	20–100
Radio Nations (Switzerland)	HBF	18.450	16.26	20
Moscow (U.S.S.R.)	—	18.540	16.18	20–100
Bangkok (Thailand)	HS6PJ	19.020	15.77	10
13-Metre Band (21.450-21.750 Mc/s)				
Boston (U.S.A.)..	WRUL	21.460	14.00	20
British Oversea Service ..	GSH	21.470	13.97	10–50
Schenectady (U.S.A.)	WGEA	21.500	13.95	25
Philadelphia (U.S.A.)	WCAB	21.520	13.94	10
British Oversea Service ..	GSJ	21.530	13.93	10–50
Pittsburgh (U.S.A.)	WPIT	21.540	13.93	40
British Oversea Service ..	GST	21.550	13.92	10–50
Wayne (U.S.A.)	WCBX	21.570	13.91	10
Schenectady (U.S.A.)	WGEO	21.590	13.89	100
Cincinnati (U.S.A.)	WLWO	21.650	13.86	50
British Oversea Service ..	GRZ	21.640	13.86	10–50
11-Metre Band (25.600-26.600 Mc/s)				
Boston (U.S.A.)..	WRUW	25.600	11.70	—
St. Louis (U.S.A.)	W9XPD	25.900	11.58	—
Cincinnati (U.S.A.)	W8XNU	25.950	11.56	—
South Bend (U.S.A.)	W9XH	26.050	11.52	—
Superior (U.S.A.)	W9XJL	26.100	11.49	—
Nashville (U.S.A.)	W4XA	26.150	11.47	—

Stations of which the names are "indented" are working outside the regular broadcasting bands.

Short-wave Receiving Conditions

PROSPECTS FOR SEPTEMBER

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

PROPAGATION conditions during the first half of July were somewhat erratic as a result of ionosphere storms on the 3rd, 4th, 5th, 6th, 9th, 10th, 13th, 14th and 15th; thereafter a general improvement set in, storms in the second half of the month being confined to the 22nd, 30th and 31st.

In a review of conditions for May[1] reference was made to the prospects of favourable conditions (low magnetic activity, during the last week of July; in this connection it is of interest to record that for the seven consecutive days, July 23rd to 29th inclusive, the average magnetic activity, on a zero (very quiet) to 9 (extremely disturbed) basis, fell to *1.8*, compared with *2.5* for the remainder of the month.

Only one sudden ionosphere disturbance of the "Dellinger" type was observed during the month; this occurred at approximately 1140 on July 9th and affected simultaneously almost every circuit operating to and from this country at the time. (This and other times given in this report are GMT on the 24-hour clock notation.)

Atmospherics were noted to be above normal on the following dates: July 3rd, 5th, 6th, 10th, 11th, 12th, 13th, 26th and 27th.

Particulars of the broadcast bands which, it is considered, should prove most reliable under normal conditions of propagation during September on five selected routes are given below; these may serve as a guide when considering reception from places other than those mentioned. Considerations of transmitter power and efficiency of aerials at both the transmitting and receiving end may often result in better reception being obtained on other wavelengths, as may also be the case during disturbed conditions.

Tokio: Midt/0200, 25 or 31 m; 0500/0700, 19 or 25 m; 0700/1600, 16 m; 1600/1800, 16 or 19 m; 1800/2000, 19 or 25 m; 2000/midt, 25 or 31 m.

The period 0200/0500 presents difficulty at this season as signals on or below the maximum usable frequency for the London end of the route would be greatly attenuated at the Tokio end.

[1] *The Wireless World*, July, 1940, p. 328.

Towards the end of the month reception may be possible via South America and New Zealand between the hours of 0700 and 1100, giving rise to "backward" echo.

Melbourne: 0500/0800, 25 m Westward (via Pacific); 0800/1000, 25 m Westward or 16 m Eastward (via Calcutta); 1000/1300, 16 or 19 m Eastward; 1300/1500, 19 or 25 m Eastward; 1500/1800, 25 m Eastward; 1800/2100, 25 or 31 m Eastward; 2100/midt, 19 m Westward.

The period midt./0500 is unreliable, due to the conflicting ionosphere conditions at the two terminal points.

Bombay: Midt/0500, 25 or 31 m; 0500/0700, 19 or 25 m; 0700/1300, 16 m; 1300/1800, 16 or 19 m; 1800/midt, 19 or 25 m.

Buenos Aires: Midt/0300, 25 or 31 m; 0300/0600, 31 m; 0600/1000, 19 or 25 m; 1000/2000, 16 m; 2000/midt, 19, 25 or 31 m.

The 13-metre band may prove useful on this route during the early afternoon.

Montreal: Midt/0800, 25 or 31 m; 0800/1000, 25 m; 1000/1200, 19 m; 1200/2000, 16 or 19 m; 2000/midt, 19, 25 or 31 m.

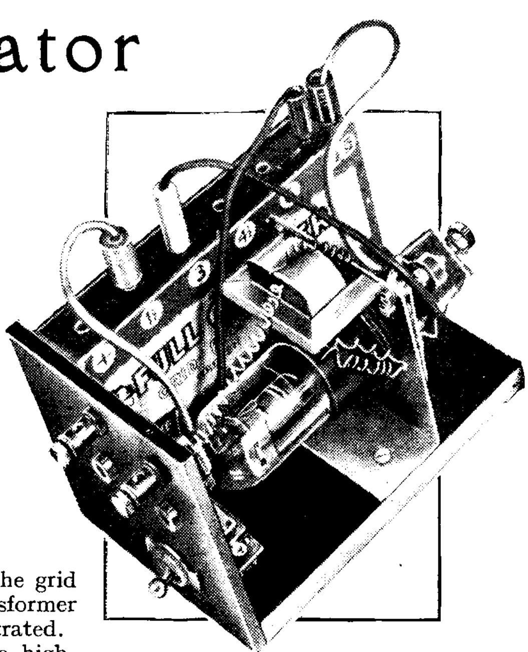
Local atmospherics should be less troublesome than in recent months; it is not uncommon in this country for thunderstorm activity at this period of the year to be some fifty per cent. lower than at the summer solstice.

In spring and autumn propagation conditions usually change more rapidly than at the solstices, with the result that the difference in wavelength requirements for the beginning and end of the month is more apparent at the former periods of the year.

With the approach of the autumnal equinox it is not unusual for ionosphere disturbances to exhibit an increase in both frequency and activity; however, continuance of the present trend would imply favourable conditions centred on one or more of the following approximate dates: September 10th, 18th and 27th.

Simple AF Oscillator

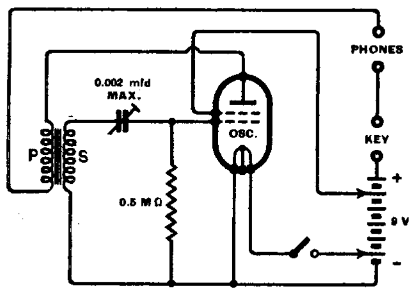
FOR MORSE PRACTICE



The pitch of the note may be controlled to suit the taste of the user by varying the grid condenser capacity; the controlling knob is at the back.

READERS who are studying the morse code will be interested in an inexpensive valve oscillator with a note of the same quality as that usually associated with wireless signals and of which the note frequency can be adjusted within reasonable limits. In the instrument to be described oscillation starts and stops rapidly without chirps or wails, and the shortcomings of the buzzer—harsh note and uncertain action, at any rate in the cheaper forms—are absent.

The essential parts comprise a low-consumption valve, valve holder, LF transformer, 0.002-mfd. semi-variable condenser, 0.5-megohm resistance, 9-volt grid bias battery, on-off switch and terminals for external connections. The most suitable valve at present available is the Brimar dry-battery tetrode Type 3Q5GT, with a filament requiring only 50 mA at 3 volts. It continues to oscillate quite satisfactorily when filament voltage is reduced to 1.5 volts. It can be used as a pentode, or, with its anode and screen strapped, as a triode, but in the former case a wander plug attached to the screen lead forms a convenient volume control.



Circuit diagram of the oscillator. Filament current may be obtained as shown from a tapping on the 9-volt dry battery, but for long periods of continuous use it will be an advantage to provide a separate LT cell.

Any low-consumption filament triode valve can be used as the oscillator, but if it is to be used with a single 9-volt battery its impedance should be low, as otherwise it may be necessary to employ a 16-volt battery, or perhaps two 9-volt batteries in series.

The negative end of the battery is connected to one end of the valve filament, the positive end of which is connected to whatever tapping on the battery provides the required filament voltage, reckoning from the negative end. A 2-volt valve will usually operate satisfactorily from the 1.5-volt tapping, or a 4-volt valve from the 3-volt tapping. If an old 4-volt type happens to be available its use is to be recommended.

The frequency of the note is determined initially by the transformer and the valve used, but it can be adjusted by varying the capacity of the condenser in the grid circuit. A Bulgin LF33 transformer was used in the oscillator illustrated.

Should the frequency be too high, it can be lowered by connecting the condenser in parallel with the transformer secondary, when the frequency will again be increased as the capacity is reduced.

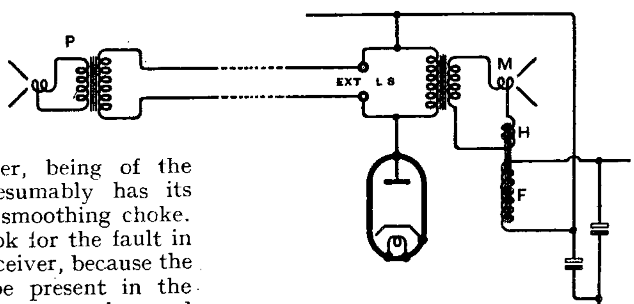
Constructionally, little need be said, except that the "sense" of the transformer windings must be right to produce oscillation. The parts can be made up into a compact little unit, as can be seen in the photograph.

Two pairs of phones connected in series will operate quite satisfactorily, and one pair can be in another room if desired. Also, since the key and phones are in series, a second key could be included in series with the phones at the remote end, so that if provision is made to short-circuit each of the keys in turn, two-way communication can be achieved.

The unit will be found to oscillate very readily, and in one instance, using a very old 4-volt triode valve, oscillations were produced quite positively with the filament and HT voltages tapped down to 1.5 and 4.5 volts respectively. E. S.

Henry Farrad's Solution (See page 385)

THE circuit of the receiver, so far as the loud speaker end is concerned, apparently is somewhat as shown. If the external speaker is high-impedance it will be connected across the primary of the output transformer, through its own transformer. The internal speaker, being of the energised type, presumably has its field coil used as a smoothing choke.



It is useless to look for the fault in other parts of the receiver, because the hum would then be present in the anode circuit of the output valve, and would affect both speakers equally. That not being so, one looks for a cause in the internal speaker itself; and a probable one is a short-circuit or other defect in the "hum-bucking" coil H, which consists of a few turns of wire in series with the moving coil M and arranged to couple closely with the field coil F, which induces in it a hum voltage equal and opposite to that which it induces in M. As the unbalanced hum voltage resulting from a defect in H is only very indirectly coupled to the extension speaker coil P, the hum produced therein may well be considerably less.

Current Topics

RECENT EVENTS IN THE WORLD OF WIRELESS

R.A.F. WIRELESS PERSONNEL

Radio Mechanics and Operators Wanted

THE rapid expansion of the Royal Air Force has resulted in an increased demand for men for ground duties in maintaining the Force's radio apparatus. During the past few weeks there has been a drive made by the R.A.F. to recruit men between the ages of 18 and 50 who have a good theoretical and sound practical knowledge of wireless. The appeal is especially addressed to men who are on the servicing side of the radio industry and qualified as wireless engineers, testers or repairers. It is not necessary that applicants should know morse. The rate of pay is 3s. 9d. to 5s. 6d. per day according to proficiency.

This recruitment is made possible by the recent ruling of the Ministry of Labour announcing that servicemen over 30 were now free to volunteer for duty as radio mechanics in the R.A.F., although not in any other Service. This ruling materially changes the situation so far as the servicing of domestic receivers is concerned, for it will be remembered that the revised schedule of reserved occupations issued in June reserved servicemen from serving in their trade capacity from 30.

Our contemporary, *The Wireless and Electrical Trader*, states that the combined effect of conscription and such special calls for volunteers as the present one may easily reduce the servicing side of the industry to one-tenth of the normal. In an endeavour, therefore, to meet the demand for domestic servicing, *The Trader* has suggested a nation-wide co-operative scheme whereby the services of the remaining engineers should be pooled for the period of the war.

Recruits between the ages of 18 and 38 are also needed by the R.A.F. to be trained as wireless operators, the pay being 2s. a day on enlistment, increasing to 3s. 6d. when qualified. Trainees are given the opportunity of volunteering for additional training as air gunners. Upon qualification as a wireless operator-air gunner, the pay will be 7s. 9d. a day with the rank of sergeant.

PURCHASE TAX ON RECEIVERS

IN the full list of goods that will be subject to the Purchase Tax which was issued on August 1st, Section 12 includes the following, which are chargeable at the basic rate of one-third of the wholesale value: Wireless receiving sets of the domestic or portable type, radio gramophones and valves, batteries and accumulators suitable for use therewith. Gramophone records, with the exception of those for the reproduction of speech, and specially adapted for the use of the blind, are also included in this section.

INDIAN WAVELENGTH CHANGES

ALL-INDIA RADIO has changed the wavelengths used for the morning transmissions from the Delhi, Madras, Bombay and Calcutta short-wave stations, from the 31- to the 41-metre band. This has been done in an endeavour to give better reception within a three hundred mile radius. Although the 31-metre band has been found satisfactory in past years, the present gradual transition from maximum to minimum sunspot activity makes it necessary to use lower frequencies to ensure better reception.

MORE POWER FOR U.S. STATIONS

TWO more American international short-wave stations are seeking permission from the U.S. Federal Communications Commission to have their power increased to 50 kW. They are the National Broadcasting Company's 25-kW stations WRCA and WNBI at Bound Brook, New Jersey. Application has also been made to reconstruct the aerial array of WRCA, which is beamed continuously on Latin America. The two stations are at present simultaneously operating a continuous sixteen-hour service from noon until 1 a.m. E.S.T. Station WNBI's transmissions on 17.780 Mc/s are beamed on Europe from 1 p.m.-6 p.m. G.M.T.

The reason prompting these applications is to be found in a recent notice issued by the F.C.C. to all licensees of international stations. This calls attention to the proviso that no international station would be licensed for operation with a power of less than 50 kW after July 1st. It is also provided that aerials must be designed and operated so that the signal toward the region served is at least 3.16 times the average effective signal from the station (power gain of 10).

AN AMERICAN TENDENCY

Plug-in Components

IN order to facilitate the job of testing and servicing radio receivers, there is a tendency in America to design components that can readily be removed from the chassis and replaced without the aid of tools. The latest illustration of this tendency is given in the July issue of *Radio*, where it is stated that plug-in electrolytic condensers, originally designed for the United States Signal Corps, are now available to the American amateur.

Fitted with four pins and a centre locator, similar to that used on the octal-type valve base, these condensers, which are of standard dimensions, are produced by the Aerovox Corporation, of New Bedford, Massachusetts.

PHOTOTELEGRAPHY

Success of Long-distance Transmissions

THE clarity of the reception, at a distance of 12,000 miles, of photographs transmitted from the West Base of the U.S. Navy Antarctic Expedition, is attributed to the use of a recently developed phototelegraphic technique to counteract selective fading of the carrier frequency. It is described by the engineers of Press Wireless Inc., who originated the scheme, as a "sweep circuit" which was inserted between the scanning apparatus and the 500-W transmitter.

The transmissions were received at the Press Wireless station at Baldwin, Long Island, whence they were transmitted automatically by telephone line to New York. The first photographs of what is to be a regular service between the Expedition and New York were published in the *New York Times* of July 8th.

GERMAN FM

DID Germany use frequency modulation for field communications during the *blitzkrieg*? Our American contemporary, *Electronics*, commenting on this subject in the July issue, says, "American newspapers, speculating on the ease with which German military units keep in touch with each other and with headquarters, have given some of the credit for this feat to Hans Roder, who took to Germany all he had learned about American practice, especially the virtues of FM. It is supposed that u-h-f technique,

Current Topics—

probably including FM because of its ability to get around noise, has been worked to the fullest extent between mobile units on the battlefield."

NEW COLOUR CODES

For Condensers and Resistors

"RECOMMENDED War Standards" for the colour coding of resistors and fixed condensers have recently been issued by the Radio Manufacturers' Association. The resistor code now covers a wider range of values, and, in addition, includes markings to indicate percentage tolerances above and below the previously accepted standard of 10 per cent.

INDUSTRIAL REGISTRATION

UNDER the first industrial registration Order issued by the Minister of Labour, male wireless instrument makers and assemblers between the ages of 21 and 65, unless wholly engaged on Government work, are required to register during the period August 19th to 23rd, at their local Labour Exchanges. The Order also requires the registration of those under 65 who at any time during the past 12 years were engaged for not less than 12 months in the specified occupation.

R.A.F. CALL ON WIRELESS STUDENTS

ACCORDING to a G.P.O. statement, all students under training for marine operator's certificates born between 1913 and 1920, and who are registered under the National Services Act, will be enlisted in the Signals Branch of the R.A.F. on qualifying. Students of other ages will be available for the Merchant Navy, for which there are now vacancies, but may volunteer for the Armed Forces. Men of 35 or over may volunteer as civilian operators at R A.F. stations.

FROM ALL QUARTERS

Alas, a "Lakh"!

Do you know what a "lakh" is? Apparently our contributor who supplied the item entitled "Indian Listeners" in last month's notes does not. A lakh is a term used in India for one hundred thousand, and is written 1,00,000. This number was misread by our contributor to be 1,000,000, hence the erroneous statement that the number of licensed listeners in India had "*passed* the six-figure mark;" whereas it had only just *reached* it. The actual number of licences issued up to the end of April was 100,388.

Broadcasting in South Africa

TECHNICALLY, the outstanding feature of the recently issued report of the South African Broadcasting Corporation is the successful inauguration of the diversity receiving station which is now being used continuously for the relay of outstanding transmissions from oversea. The cost of the equipment for this station is given in the report as £3,328. An increase in the Union of more than 36,000 licence holders during 1939 is reported.

Amateur Award

IT was recently announced by the Columbia Broadcasting System that the William S. Paley amateur award, which is given annually to the amateur who has the best record for research and proficiency during the year, will not be made for 1939. It is understood that the A.R.R.L. stated that no award was justified last year. Because of this, it is proposed to broaden the scope of the requirements so that past achievements will also be taken into account.

FM Studio

WHAT is claimed to be the first studio built expressly for FM transmission was used when station W2XOR commenced operation on August 1st from its new home in Madison Avenue, New York. The studio, which was originally used by the 50-kW parent station WOR, has been equipped with Western Electric audio apparatus to give a flat frequency response from 30 to 15,000 cycles with a total harmonic distortion of less than 0.5 per cent. The 1-kW transmitter radiates on a frequency of 43.4 Mc/s.

B.B.C. Short-wave News

THE call signs and frequencies to be used during this month by the B.B.C. for the transmission of news in English in the European short-wave service remain unchanged. For easy reference, however, they are again given: GSA, 6.050 Mc/s (49.59 m); GSL, 6.110 Mc/s (49.10 m); GSW, 7.230 Mc/s (41.49 m); GSB, 9.510 Mc/s (31.55 m); GRX, 9.690 Mc/s (30.96 m); GSN, 11.820 Mc/s (25.38 m); and GSE, 11.860 Mc/s (25.29 m).

The times (B.S.T.) of the transmission of news and the calls used are:—

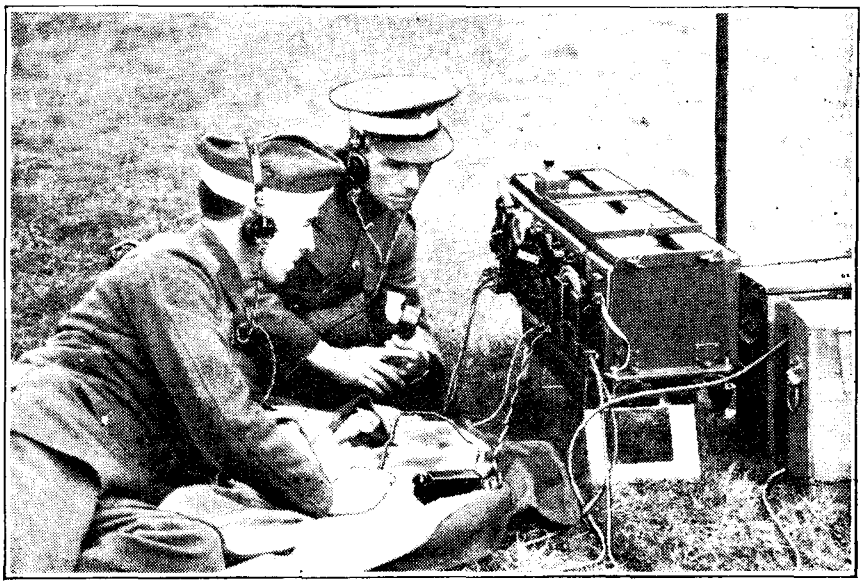
00.30, 07.15, 09.00 } GSA, GSW, GRX.
12.45, 14.15 } GSA, GSL, GSW, GSN, GSE.
17.00—GSA, GSW, GSE.
19.00—GSA, GSL, GSW, GSB, GRX.
23.00—GSA, GSW, GRX.

B.B.C. Interval Signal

THE B.B.C.'s ticking-clock interval signal, originally introduced in 1930 and reintroduced after a lapse of some years a few months ago when the ban on the ringing of church bells prohibited the use of the Bow Bells interval signal, gave place on August 11th to the present signal based on the musical notes B, B, C.

Obituary

IT was with regret that we learned after we had gone to press with the August issue, that Mr. Peter W. Willans, M.A., M.I.E.E., had passed away a fortnight before, on June 28th. Readers of *The Wireless World* will remember him as a frequent contributor to its pages in the past under the nom de plume



ROYAL SIGNALS OFFICERS in the making. Men chosen from the ranks of the Royal Corps of Signals are shown operating a field transmitter-receiver during their course of intensive training in wireless telegraphy and telephony for commissions in the Corps. All Army signalling arrangements are under the control of the Royal Signals, which was formed in 1920 after the Great War.

Current Topics—

"Empiricist." Mr. Willans was successively with Marconi's W.T. Co. and H.M.V. prior to acting in the capacity of a consulting radio engineer.

The death in July of Mr. J. B. Garlick, of Freshwater, Isle of Wight, recalls the part he played in assisting Marconi in his early experiments in the island. Mr. Garlick was then postmaster at Totland Bay, a position from which he retired in 1936. It was near the site originally occupied by the Royal Needles Hotel, Alum Bay, in which Mr. Garlick assisted Marconi soon after he came to England in 1896 that a memorial stone was recently erected.

American B.B.C. Relays

MR. GERALD COCK, B.B.C. North American representative, states that the arrangement with 34 individual American stations whereby they are granted permission to regularly rebroadcast B.B.C. news bulletins and talks by leading individuals, stipulates that the relays must not be directly associated with advertisements, or sponsored in any form.

Brit. I.R.E. Exams.

WE learn from the British Institution of Radio Engineers that sufficient applications have been received to justify the holding of examinations for associate membership and the radio servicing certificates at London, Manchester, Birmingham and Bristol, in November.

Short-wave Reception Guide

A MEANS of readily selecting the best wavelength for receiving in Australia transmissions from the major capitals of the world at any given hour is provided by a vest pocket short-wave log card issued by the Amalgamated Wireless Valve Company of Sydney.

Varley Dry Accumulators

MR. J. M. G. REES, director of Oliver Pell Control, Ltd., and Tok Switches, Ltd., has been elected to the Board of Directors of Varley Dry Accumulators.

NEWS IN ENGLISH FROM ABROAD

REGULAR SHORT-WAVE TRANSMISSIONS

Country : Station	Mc/s	Metres	Daily Bulletins (B.S.T.)
America			
WNBI (Bound Brook)	17.780	16.87	5.0, 6.0.
WCAB (Philadelphia) ..	6.060	49.50	11.45 (Tu., Wed. and Fri.), 12.0 midnight†.
WCAB	9.590	31.28	11.45 (Mon., Th. and Sat.).
WBOS (Millis)	9.570	31.35	11.45.
WCBX (Wayne) ..	15.270	19.65	8.30‡, 10.50§‡.
WCBX	17.830	16.83	1.0, 2.0†, 3.0†, 3.15§‡, 4.0*†, 4.30§‡, 6.0, 6.30§‡, 7.55†.
WGEO (Schenectady).	9.530	31.48	8.30†, 9.55§‡, 11.25‡.
WGEA (Schenectady).	15.330	19.57	1.0, 2.0‡, 9.55§‡.
WPIT (Pittsburgh) ..	15.210	19.72	6.0.
WRUL (Boston) ..	6.040	49.67	12.15 a.m.‡, 12.0 midnight*.
WRUL	15.250	19.67	12.15 a.m.‡, 8.30§‡, 9.30§‡, 12.0 midnight*.
WLWO (Cincinnati) ..	9.590	31.28	7.25 a.m.‡.
WLWO	11.870	25.27	7.25 a.m.†, 1.15.‡.
Australia			
VLQ (Sydney)	9.615	31.20	9.15 a.m.
VLQ2	11.870	25.27	9.15 a.m.
VLQ7	11.880	25.25	9.50.
VLR (Melbourne) ..	9.580	31.32	10.0 a.m., 2.50 (2.15 Sun.).
VLR3	11.850	25.32	9.50.
China			
XGOY (Chungking) ..	9.500	31.58	10.30.
XGOY	11.900	25.21	11.30 a.m., 12.10, 10.30.
Finland			
OFD (Lahti)	6.120	49.02	} 12.15 a.m., 8.55 a.m., 7.15, 10.15.
OFD	9.500	31.58	}
Hungary			
HAT4 (Budapest) ..	9.125	32.88	1.30 a.m.§.
HAT5	9.625	31.17	12.15 a.m.‡, 12.30 a.m.†.
HAS3	15.370	19.52	3.55†.
India			
VUD2/3 (Delhi) ..	9.590	31.28	9.0 a.m., 1.30, 4.50, 6.30.
VUD3 (Delhi) ..	15.290	19.62	9.0 a.m.

Country : Station	Mc/s	Metres	Daily Bulletins (B.S.T.)
Japan			
JZJ (Tokio)	11.800	25.42	9.5.
JZK	15.160	19.79	9.5.
Manchukuo			
MTCY (Hsinking) ..	11.775	25.48	7.30, 10.0.
Rumania			
Bucharest	9.280	32.33	11.0.
Spain			
FET1 (Valladolid) ..	7.070	42.43	8.50.
EAJ7 (Madrid) ..	9.860	30.43	12.30 a.m.
Sweden			
SBO (Motala)	6.065	49.46	10.45.
Turkey			
TAP (Ankara) ..	9.465	31.70	7.15.
TAQ	15.195	19.74	12.15.
U.S.S.R.			
—— (Moscow) ..	7.545	39.76	10.30, 11.30.
RW96	9.520	31.51	7.33 a.m., 7.30, 9.0, 10.30, 11.30.
RAL	9.600	31.25	1.0 a.m.
——	11.710	25.62	9.0, 10.30.
RNE	12.000	25.00	1.0 a.m., 10.30.
——	12.145	24.70	12.0 noon.
RKI	15.040	19.95	1.0 a.m.
RW96	15.180	19.76	1.0 a.m., 7.33 a.m., 9.0 a.m., 7.30, 9.0, 10.30, 11.30.
——	15.735	19.07	5.0.
——	18.540	16.18	12.0 noon.
Vatican City			
HVJ	6.190	48.47	8.0 (Tu. and Fri.).
Yugoslavia			
YUA (Belgrade) ..	6.100	49.18	8.30, 10.30.

The times of the transmission of news in English for Europe from the B.B.C. short-wave station are given on page 399.

REGULAR LONG- AND MEDIUM-WAVE TRANSMISSIONS

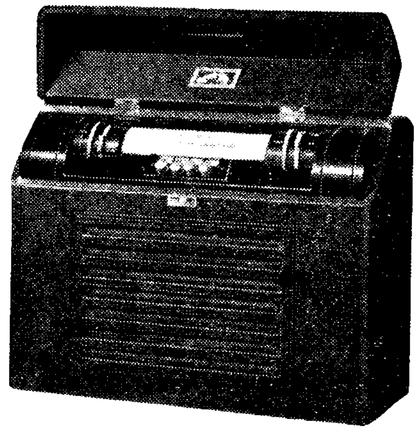
Country : Station	kc/s	Metres	Daily Bulletins (B.S.T.)
Hungary			
Budapest 1	546	549.5	11.10.
Ireland			
Radio-Eireann	565	531	6.45‡, 10.10 (10.5 Sun.).
Latvia			
Madona	583	514.6	10.0 (Tu. and Fri.).
Kuldiga	1,104	271.7	10.0 (Tu. and Fri.).

Country : Station	kc/s	Metres	Daily Bulletins (B.S.T.)
Sweden			
Motala	216	1,389	10.45.
Stockholm	704	426.1	10.45.
Göteborg	941	318.8	10.45.
Falun	1,086	276.2	10.45.
U.S.S.R.			
Moscow 1	172	1,744	11.30.

All times are p.m. unless otherwise stated. * Saturdays only. § Saturdays excepted. † Sundays only. ‡ Sundays excepted.

H.M.V. Model 1406

A HIGH - GRADE BATTERY PORTABLE WITH PUSH - BUTTON TUNING. Price : 11 Gns.



EVERYTHING of the best has been put into the specification and finish of this receiver. From the special frame aerial winding to the push-pull output valves, the circuit is designed to give the highest possible performance from a set of reasonable size, and although this has called for the use of a lead accumulator for LT supply, the H.T. consumption has been conserved by a battery economy circuit of unusual type, which does not restrict the volume available on local stations.

Mechanical push-button tuning in addition to the usual manual control assists in changing rapidly from one programme to another, and the workmanship and finish throughout the instrument are of a very high order.

Circuit.—The importance of an efficient frame aerial in giving improved signal-to-noise ratio as well as higher sensitivity has not been overlooked by the designers. The voltage available at the grid of the first valve can be increased in two ways: (1) by increasing the area of the frame, (2) by raising the Q-factor of the coil. Since the frame size is limited by considerations of portability, improvement over standard performance can only be effected by concentrating on the "goodness" of the coil, and this course has been pursued to its logical conclusion in the Model 1406.

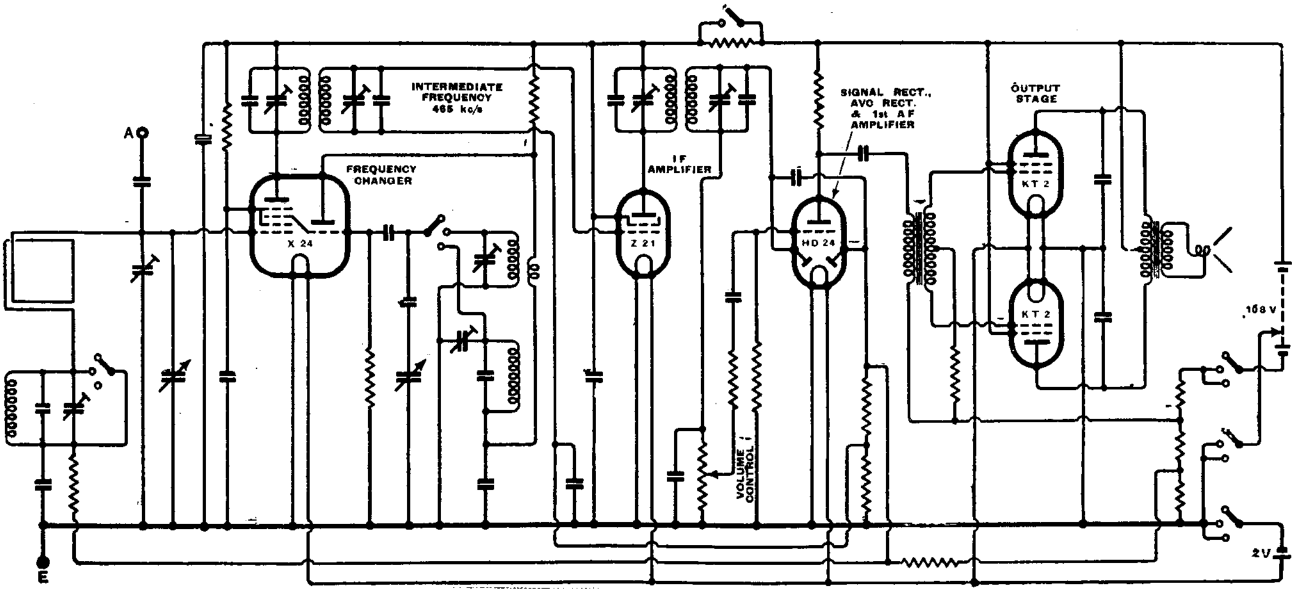
In the first place, the frame aerial has been mounted on the back panel of the set well clear of the metal-work in the set, and it is wound in the form of a helix, i.e., with edge-on turns. Sharp corners have been avoided and the turns are spaced by woven insulating sleeving, having good dielectric properties, which is finally treated with special varnish to render it rigid and moisture-proof. It is stated that this form of construction gives a Q-factor of 70 at 1 megacycle, whereas the Q of the average portable frame is of the order of 45. On long waves the aerial inductance is increased by a series loading coil with iron-dust core.

WAVERANGES

Medium	...	*200 - 550 metres*
Long ...	...	*900 - 2,000 metres*

The frequency changer is a triode-hexode and the IF amplifier works at a frequency of 465 kc/s. Both valves are controlled, the IF stage receiving a lower AVC voltage than the frequency changer. Delay bias is derived from a potentiometer across the last six cells of the HT battery. The resistance across these cells ensures that their rate of discharge shall be consistent with the life of the main HT battery.

Battery economy is effected by introducing a resistance in the HT lead to the frequency changer and IF stages. The consequent reduction in voltage considerably reduces the current consumed without preventing the oscillator section from functioning. There is, of course, a falling-off in the RF gain of the receiver, but the power-handling capacity of the AF



Circuit diagram of the H.M.V. Model 1406. Push-pull output valves are employed and HT current may be conserved by reducing the voltage applied to the frequency changer and IF stages.

H.M.V. Model 1406—

stages remains unaffected on strong signals.

Separate tetrode valves in push-pull are used in the output stage and are coupled by a parallel-fed intervalve transformer. The maximum undistorted power output available is 800 milliwatts and the circuit is so designed that this power is reached without using specially matched valves.

Performance.—The care which has been taken in the design of the frame aerial and its associated circuits is reflected in the general liveliness of the performance. Even with the battery economy control in operation a good selection of foreign stations is available, and one or more B.B.C. transmitters should be available at full volume in most parts of the country. In fact, the maximum performance of which the set is capable is likely to be called upon only on rare occasions, or in a few isolated positions where reception is difficult.

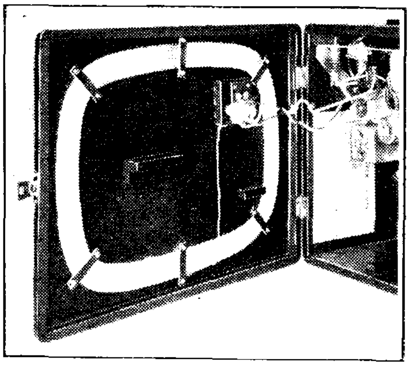
If further evidence were required of the efficiency of the frame aerial, the excellence of the long-wave performance with inductance loading and the sharpness of the directional minimum might be cited. The latter property is useful in cutting out unwanted transmissions, but is not really necessary as the inherent selectivity of the set is well up to the standard demanded of superheterodyne circuits for broadcast reception.

Quality of reproduction is admirably suited to speech, and the volume available is suitable for outdoor listening to news bulletins when circumstances permit. Music sounds best at intermediate volume. This seems to give the best tonal balance and avoids any suggestion of thinness due to lack of bass at low levels of predominance of lower middle and high frequencies at full volume. In the ordinary course of indoor listening to programmes of all types one will instinctively work well within the power-handling capacity of the output valves, and overload distortion will not enter into the picture.

The edgewise tuning controls handle smoothly and enable stations to be found quickly and without effort. They are supplemented by the mechanical push - button tuning mechanism which moves the condenser quickly from one setting to another.

Measurements of HT consumption confirmed the makers' figures of 9 mA and 6 mA for the "Maximum" and "Economy" switch positions. These are standing currents for no signal; a strong unmodulated carrier reduces the values by about 1.5 mA and 0.2 mA respectively, but deep modulation may cause an average increase of 3 to 5 mA on these figures.

Constructional Features.—The chassis is built on the so-called triplane system with two sides parallel to the top and front of the cabinet and the middle section sloping at 45 degrees. A horizontal drum with a spiral red line provides the tuning indication and is driven by a cord coupled to the condenser spindle. The push-button drive is of the pivoted plate type, the stops on the push-button stems being adjustable from the front of the set. The rotation is transferred to the condenser spindle through a quadrant and double pinion, the latter being spring-loaded to avoid backlash.



The frame aerial is wound edge-on in the form of a helix and is insulated by special woven sleeving of low dielectric loss.

The cabinet work is exceptionally neat and the detail fittings are of very good quality. Both batteries are carefully chocked to prevent movement and the set hangs vertically from the centrally disposed carrying handle.

"Learning Morse"

NEW REVISED EDITION

A HEAVY demand on the part of those expecting to join the wireless branches of one or other of the Services has been responsible for the rapid exhaustion of the third edition of our booklet "Learning Morse," and a fourth edition has now become necessary. Advantage has been taken of this opportunity to make extensive revision, deleting material that was mainly of interest to the amateur and replacing it by information of more direct concern to the would-be Service or professional operator.

Differences of opinion still exist with regard to the best method of learning morse, and, even more important, with regard to operating technique. These differences have been well ventilated in the columns of *The Wireless World* since the outbreak of war concentrated attention on the subject. The majority opinions of the many experts who have contributed to the discussion have been taken into account in carrying out the revision. The booklet, which covers not only the mere learning of the code, but the technique of using it in wireless operating, will, it is hoped, prove of real value to those who are attempting to increase their usefulness in the National cause—and, incidentally, to speed up their own promotion.

"Learning Morse" costs 6d., or 7½d., post free, from our Publishers, Iliffe and Sons Ltd., Dorset House, Stamford Street, London, S.E.1.

Club News

Ashton-under-Lyne and District Amateur Radio Society

Headquarters: 17a, Oldham Road, Ashton-under-Lyne, Lancs.

Meetings: Wednesdays, 7.30 p.m., and Sundays, 2.30 p.m.

Hon. Sec.: Mr. K. Gooding, 7, Broadbent Avenue, Ashton-under-Lyne, Lancs.

Several letters, which were received from members serving with H.M. Forces, have been handed to various members for reply after being read at a recent meeting.

Messrs. H. Hattersley and W. Taylor presented their report regarding the Social held on August 7th.

British Short Wave Correspondence Club

Headquarters: The Watering, Parham, Woodbridge, Suffolk.

Hon. Pub. Manager: Mr. T. Knight, 37, Hartington Street, Barrow-in-Furness, Lancs.

Will readers please note that the present Hon. Sec. is Mr. A. Richardson, whose address is at headquarters.

A branch of the B.S.W.C.C. has been formed in Pembroke, where meetings are held on alternate Thursday evenings. Readers are welcome to attend, and should request details from the Hon. Sec., enclosing a stamped addressed envelope for reply.

It has also been suggested that a branch be formed in Barrow-in-Furness. All persons interested should communicate with the Hon. Pub. Manager.

Edgware Short Wave Society

Headquarters: 4, Gainsborough Gardens, Edgware, Middx.

Meetings: Wednesdays at 8 p.m.

Hon. Sec.: Mr. E. R. Radford, 1, Gibbs Green, Edgware, Middx.

Will those interested please note that for the duration of the war headquarters have been shifted to 4, Gainsborough Gardens. The annual subscription to the Society is 2s. 6d.

Telephone Broadcasting

LINE DISTRIBUTION AT RADIO FREQUENCY

By T. WALMSLEY, Ph.D., M.Inst.C.E. (Post Office Engineering Department)

Although the G.P.O. "wired wireless" broadcast distribution scheme has been shelved for the duration of the war, it is of interest to put on record a description of the means whereby distribution was to be effected. This article is contributed by a member of the Post Office staff who took a prominent part in the development of the system.

THE attractiveness of any wire broadcasting service depends largely upon the difficulties of radio reception, and is at its greatest in areas where field strengths are weak or subject to large variations, or where interference from industrial plant is considerable. On the cost side, to compensate for the additional charges incurred in providing a service such as that under consideration is the fact that a receiver capable of receiving several strong carrier signal programmes can be manufactured at low cost.

Then there is the question of band-width. The carrier frequencies chosen for the Post Office service had a separation of about 30 kc/s, as compared with the 9 kc/s separation between radio broadcasting stations. These figures give a measure of the potentialities of the carrier system for high-quality reproduction. The proposed width of the audio-frequency band was actually about 7,000 c/s. The carrier frequencies for the initial scheme were to be 172, 216, 252.5 and 280 kc/s, this selection having been made so as to reduce interference from powerful radio stations to a minimum.

It is a fortunate circumstance that the cables of the telephone network have reasonably low capacity and high characteristic impedance. This implies that for a given voltage required at the listener's end of a pair of wires, the energy input into the pair at the exchange end is less than would be needed if the cable pairs had higher capacity and lower characteristic impedance. Furthermore the problem of designing amplifier output circuits for the purpose of feeding many pairs in parallel is simplified when their characteristic impedance is high.

Another advantage obtained by using the telephone network for broadcasting purposes arises from the fact that each telephone subscriber has a separate pair of wires, thus enabling the energy requirements to be easily met as connections are added.

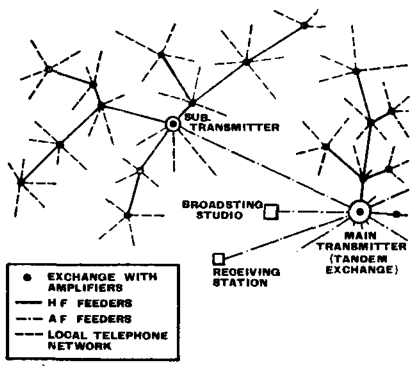


Fig. 1.—Simplified diagram showing a typical layout for carrier distribution. The number of sub-transmitters and local networks would of course be greatly increased in many cases.

Moreover, the average radius of the area served by each telephone exchange is suitable for the distribution of broadcast programmes at carrier frequencies, an amplifier being needed only at each exchange.

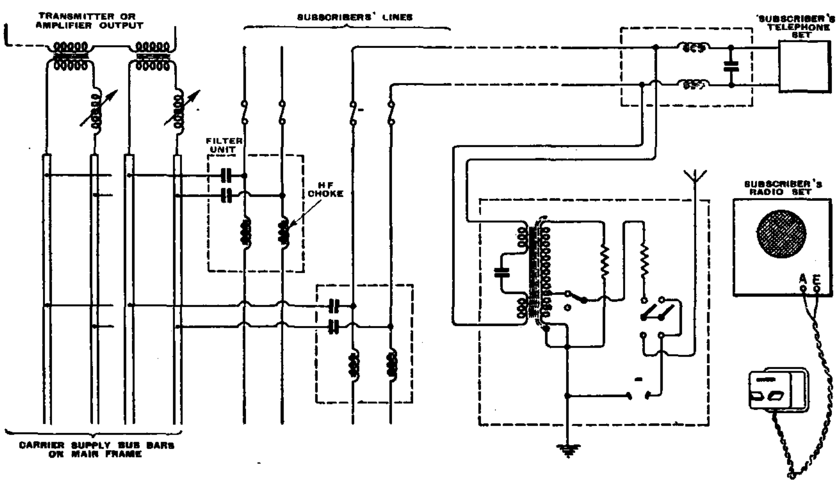


Fig. 2.—How the modulated carrier is fed into the busbars at the telephone exchange and thence to the subscriber's home.

In Fig. 1 a simplified layout of a carrier system over a telephone wire network is given. Of necessity the layout is based upon the existing telephone network. In a large-sized town a main exchange is chosen for the central carrier transmitter. This comprises an audio-frequency amplifier, carrier-frequency generating and modulating equipment, and carrier-frequency amplifiers. By means of telephone pairs the audio-frequency programmes would be fed from the nearest B.B.C. studio and from the nearest G.P.O. receiving station to the central carrier transmitter, thus providing both home and foreign programmes. The central transmitter has two functions: it provides carrier-frequency currents for distribution to the local

Telephone Broadcasting—

subscriber and energises the junction circuits to feed amplifiers located in surrounding subsidiary telephone exchanges. These amplifiers provide programmes for local distribution. It is convenient to arrange for the provision of one receiving station in each radio broadcasting region so that the area covered by the regional radio broadcasting service and the area covered by the wire broadcasting service in a fully-developed system would roughly coincide.

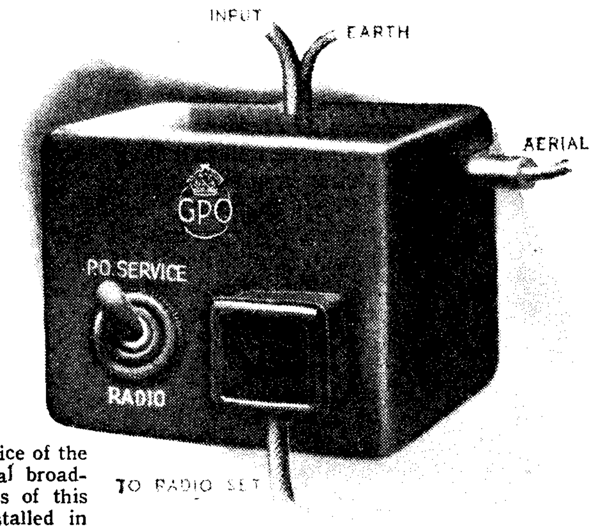


Fig. 3.—According to the proposed G.P.O. carrier distribution scheme, those subscribers who wished to do so could have the choice of the carrier service or normal broadcast reception by means of this change-over switch, installed in conjunction with an aerial and a suitable receiver.

The reasons for using carrier-frequency circuits as much as possible instead of audio-frequency circuits to provide programmes to the local centres (as well as for distributing the programmes from the local centres to the subscribers) are chiefly economic: a saving in physical pairs is made since junctions can be used simultaneously for ordinary telephone purposes and for carrier-frequency working, and only comparatively cheap amplifiers are needed at the local centres instead of costly transmitters.

The manner in which carrier currents may be introduced into telephone pairs at the telephone exchange and thence into the receiver at the subscriber's premises is shown in diagrammatic form in Fig. 2. The transmitter or amplifier output circuit is connected to the primary of a multiple transformer (or the primaries of several separate transformers) the secondaries of which are joined to small vertical copper bus bars located on the main telephone cable frame. Adjustable inductances may be provided in the secondaries to neutralise the capacitative effects of the load of the subscribers' lines. When it is desired to provide service to a subscriber, a feeding and filter unit is fixed across the bus bar, and connections are made so as to insert the small chokes of the unit in series with the subscriber's line and to arrange for condensers to be joined up for the purpose of supplying the carrier currents to the line. The purpose of the chokes is to reduce to a minimum any noise in the carrier frequency spectrum emanating from exchange equipment. At the same time, appreciable loss in the audio-frequency spectrum must be avoided in order not to entail degradation of the telephone service. Tests have shown that by correct design of the filter and associated equipment the quality of the telephone service can be slightly improved. A reduction in noise of 30 db. can readily be obtained by the use of chokes of very small size.

The ideal system of feeding subscribers with carrier would be obtained by grouping on each pair of bus bars cable pairs having about the same total attenuation, and energising the various bus bars at appropriate voltages. In practice this is not possible since near and far subscribers might have adjacent lines on the main distribution frame. Arrangements are therefore made to provide condensers of different values in the filter unit. Three values have been found convenient: 0.01 μf for subscribers located between 2 and 3 miles from the amplifying station, 0.003 μf for those about 1-2 miles away, and 0.001 μf for subscribers within about a mile of the station.

Reference to Fig. 2 will explain the arrangements at the subscriber's end of the cable pair. Here again chokes are used for the dual purpose of reducing noise from the subscriber's telephone set and preventing the carrier currents from being introduced into the telephone set at appreciable volumes. The necessity for the latter precaution arises from the fact that it would otherwise be possible for the telephone transmitter to act as a modulator of the carrier currents when the subscriber is conducting a telephone conversation.

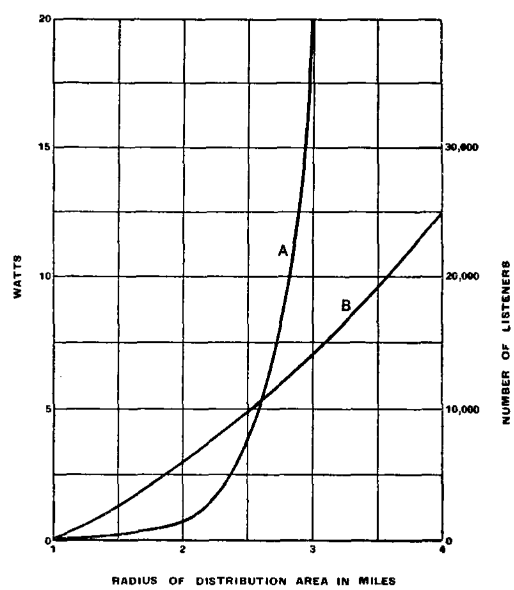


Fig. 4.—Power requirements of a carrier distribution system. Curve A represents number of listeners in the area served; curve B is the total carrier power required at the exchange end to provide each receiver with 1 micro-watt. Density of listeners is assumed to be 500 per square mile and attenuation 13 db. per mile.

The subscriber's filter is a necessary part of the equipment, and its dimensions are such that it can be housed in a box approximately 4in. × $1\frac{1}{2}$in. × $1\frac{3}{4}$in.

Telephone Broadcasting—

A change-over switch, shown diagrammatically in Fig. 2 and in perspective in Fig. 3, is provided. This switch enables a change-over to be made from radio to wire reception, and thus caters for those listeners who either do not wish to be burdened with the expense of a new receiver designed for carrier reception only, or who wish to have the benefits of carrier reception for normal use with the added advantage of being able to receive other stations not provided by the wire service.

Associated with the change-over switch is a screened transformer. The necessity for this transformer arises primarily from the fact that the receiver has an unbalanced input circuit, one terminal being earthed.

The introduction of the transformer, fixed as close as possible to the receiver, reduces the length of the unbalanced connections to a minimum. Thus the harmful effects of interference currents induced into leads from electric supply circuits are reduced, usually to negligible amounts.

Owing to the fact that the noise introduced in pairs is considerably less in underground circuits than in overhead circuits the power required at the receiver is appreciably smaller with the former system of distribution.

On the other hand, attenuation is greater in underground telephone circuits than in overhead. Thus the voltage required at the exchange end of the line is dependent upon the make-up of the line, as well as the actual length. To indicate the order of magnitudes involved, the curves of Fig. 4 have been prepared.

The values are based upon theoretical consideration and have assumed a line attenuation of 1.5 neper (13.0 db.) per mile, which is roughly the attenuation of a 10 lb. per mile telephone pair at the higher carrier frequencies chosen for the service. It is further assumed that the density of listeners is 500 per square mile.

The most noticeable feature of the curves is the small amount of power needed when the radius of the distribution area is only one or two miles, but the extremely rapid rate of increase when the radius extends beyond a certain value. This increase is due not so much to the greater number of listeners supplied as to the increase in total attenuation. Thus when the radius extends from 2 to 3 miles the number of listeners increases in the ratio of 2.25 to 1 approx., whilst the power requirement increases in the ratio of 30 to 1 approx. These features impose an economic limit to the size of the local distribution areas.

The Wireless Industry

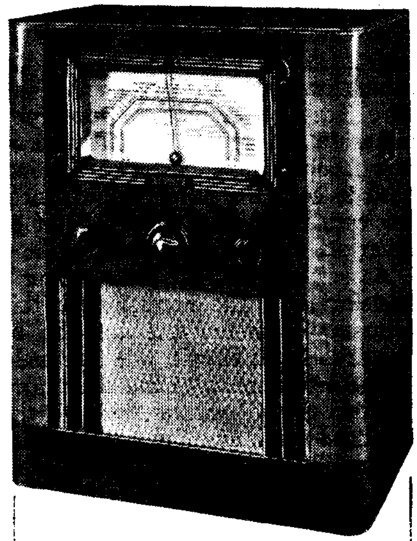
THE GRAMOPHONE CO., LTD., have announced provisional plans for set production during the forthcoming winter. There will be six H.M.V. receivers and two radio-gramophones—the latter in the popular price category. With this reduction in the number of different models, it is expected that in spite of the prior claims of war work and the export trade, a satisfactory supply of receivers for the home market will be maintained.

◇ ◇ ◇ ◇

A leaflet describing the Latem lamp for emergency lighting has been received from the Latem Electrical Co., Eastwood Street, Hall Lane, Bradford. The body is of heavy enamelled iron construction and is fitted with a Tucker tumbler switch or alternatively a secret switch. A Varley dry accumulator supplies current to the M.E.S. 1.5 watt bulb. The price complete is 41s. 6d.

Cossor Model 55

"ALL-DRY" TRANSPORTABLE SUPERHET (4 VALVES). PRICE £9 17s. 6d.



WAVERANGES

Medium	..	*190-560 metres*
Long	..	*830-2,000 metres*

A RECEIVER which is completely independent of mains, even to the extent of battery charging, has many advantages, but not everyone requires the purely portable types which usually make use of the combined HT and LT dry battery. The Cossor Model 55 has a cabinet which would not disgrace the more expensive class of table model mains receiver, yet it is light in weight and is equipped with self-contained aerials so that it can be moved and set up in any situation with the minimum of trouble.

Circuit.—The whole of the tuning inductance on both medium and long waves is provided by the frame aerials which are of about twice the area of those of the normal portable. When an external aerial is used the coupling is aperiodic and the EMF is developed across the by-pass condenser in the AVC feed to the frequency changer valve. The condenser is of rather lower capacity than usual in order to present the required impedance.

The frequency changer is of the pentagrid type and is coupled to the IF amplifier through an iron-cored transformer with fixed tuning capacities. A single-diode-triode is used for signal and AVC rectification and first stage AF amplification, and tone control is incorporated in the coupling between the AF stage and the output valve. Bias for the latter valve is derived from the volt drop in a resistance between −HT and −LT and a lamp fuse is incorporated with this part of the circuit.

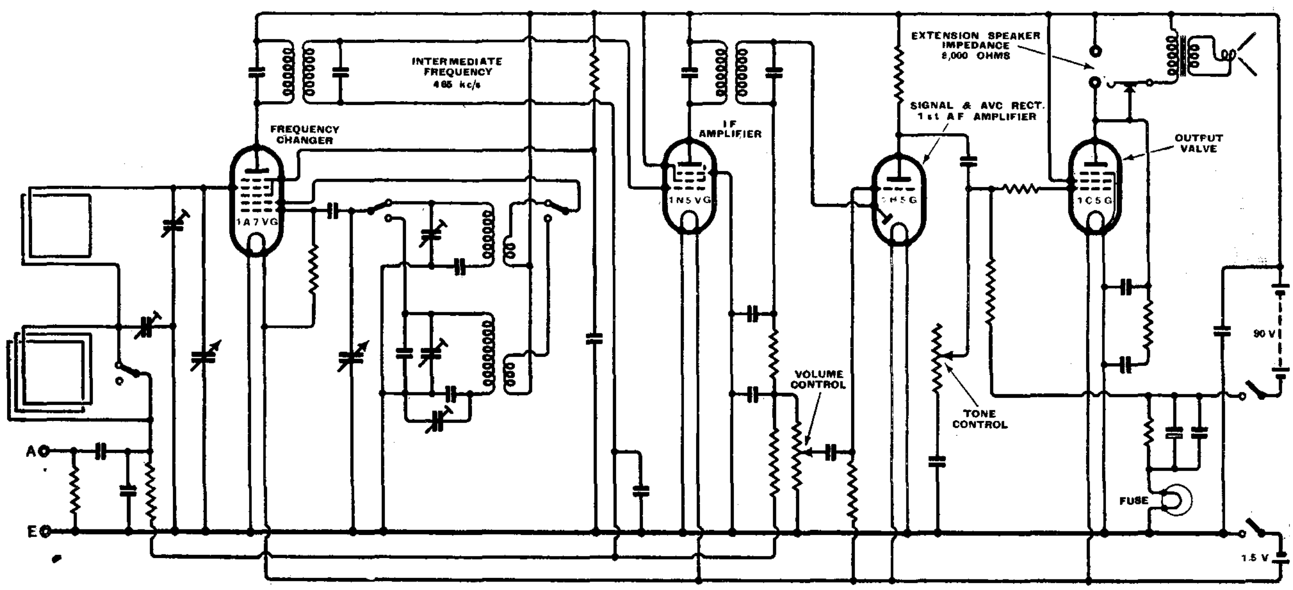
A switch plug is provided for the external loud speaker, which can be used separately or in conjunction with the internal loud speaker. The external unit, if of the moving coil type, must include a transformer presenting a load of 8,000 ohms.

Performance.—Taking as a standard of comparison, the average small all-dry portable, the Cossor Model 55 with a similar circuit, excels in two main directions, (1) range, (2) quality of reproduction.

As regards range, we may attribute this partly to the efficiency of the valves used, but principally to the unusually large area of the frame aerials. The combination of these two factors gives a sensitivity which ensures a wide choice of stations without the use of an external aerial.

Inside a steel-framed building the performance was such that no need was felt for any additional pick-up, but as a matter of interest the outdoor aerial was connected. It was found that unlike most portables, the ganging and selectivity remained unaffected, the sole difference being an improvement in the volume of some distant stations.

Besides allowing the use of large frames, the cabinet also provides an effective baffle area for the loud



Circuit diagram of Cossor Model 55. The coupling for an external aerial is unusual, and is designed to cause the minimum disturbance of circuit alignment.

Cossor Model 55—
speaker, which is of an even higher efficiency than the type used in standard Cossor sets. The undistorted output available from the final stage in the set is of the order of 200 milliwatts, but the loud speaker makes it sound like 1 watt or more. There is an excellent bass response, and the high magnet flux gives exceptionally good transient response. The distribution of sound from the diaphragm is also good and the instruments of the orchestra seem to stand out in perspective instead of being concentrated at some point inside the cabinet.

In the particular set tested we noticed a tendency to microphony which was traced to the 1H5G valve. It was found that the acoustic pick-up was mainly on the glass bulb so the trouble was quickly cured by a rubber band.

To house a dry battery set in a cabinet 20in. by 16in. by 10in. was a bold move, but the designers have undoubtedly produced a performance of a character in keeping with the appearance.

Constructional Features — The roomy cabinet permits the use of a wide and deep receiver chassis, thus giving the designer plenty of space for the most effective disposition of his components. Simplicity is the keynote of the construction and it should be possible to produce the set with much less than the usual quota of special tool-making or fitting.

The loud speaker, frame aerial and battery units are connected by readily detachable plugs and sockets and the screws fixing the chassis to its shelf are accessible.

An unusual feature is the provision of a cream-coloured moulded bakelite plate as the background to the tuning scale. This gives freedom from warping troubles, which often cause the pointer to foul, and the colour should be retained indefinitely.

The weight distribution has been well arranged and the set stands firmly on its ball-bearing turntable.

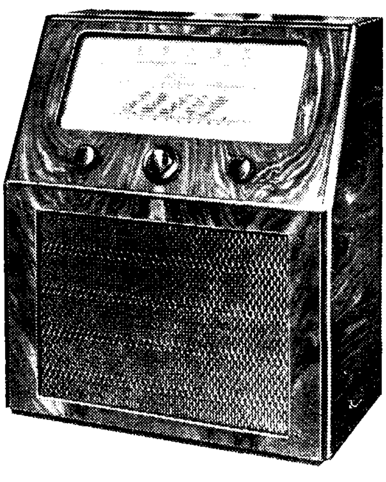
Additions to the Cossor Range

TABLE MODELS FOR AC, AC/DC AND BATTERY OPERATION

THE new Model 34 is a battery-operated receiver designed to provide "mains volume" for those in country districts who cannot make use of the supply mains. It covers short waves (16-50 metres) as well as the usual medium- and long-wave ranges, and the four-valve superheterodyne circuit terminates in a QPP output stage. Special attention has been given to the efficiency of the permanent magnet loud speaker, which is 10 inches in diameter. The price, including 120-volt double capacity HT battery and 60 AH accumulator, is 11 guineas.

The same cabinet is used for the Cossor Models 47 and 77.

Model 77 is a three-waveband superhet with a triode output valve. There are four valves plus a rectifier in the circuit, and the frequency changer is a triode-hexode. A similar circuit is employed in the Model 47, which operates from either AC or DC mains. In this receiver, however, the output valve is a tetrode. Designed to give all the essential characteristics of good performance at a reasonable price, these instruments are housed in simple but well-proportioned cabinets with indirectly illuminated tuning dial. The price of the AC model is £11 7s. 6d., and of the AC/DC version 11½ guineas.



Cossor Model 34 for battery operation.

Straight Line Calibration

—FOR WAVEMETERS AND OSCILLATORS

By W. A. ROBERTS

This article shows how calibration can be improved by the use of series "padding" condensers in conjunction with parallel trimmers.

THERE always seems to be a certain excitement in calibrating a newly completed wavemeter or radio frequency oscillator. Provided that the instrument has been carefully and stably constructed, its whole value will depend upon the curve which results from those lists of frequencies and dial readings. If the curve is straight, open, and of sufficient range, then the work of construction is adequately rewarded.

Very often, though—and perhaps more often than not—the curve is not quite all that may be desired. It may be good, but it could be better, and one of the most frequent annoyances is that the plotted line bends seriously. As a result, the overall range of the instrument is less than it could have been with straight-line calibration, and the useful range is restricted. The cramped portion at the end of the scale is unreliable and difficult to read and the next range must overlap to a considerable degree to cover the unsatisfactory portion of the calibration.

Simplifying the Problem

The cause of this trouble lies in the tuning condenser and in the circuit capacities which are in shunt across the main tuning capacity. For the purpose of investigating this point, the wavemeter or oscillator circuit, however complicated it may be, can be "boiled down" to the simple tuned circuit shown in Fig. 1. Here, L is the coil, C the tuning condenser, and C1 represents any incidental capacities occurring across the circuit.

Fig. 2 is a curve of dial readings plotted against frequency for each of the four main types of tuning condenser which are available. In the order of the diagram the types are: straight line capacity, straight line wavelength,

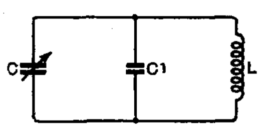


Fig. 1.—Typical tuned circuit; C1 represents the stray capacities.

straight line frequency and log law or midline.

These curves show that the first two condensers are quite unsuitable for our purpose; the high frequencies are cramped in relation to the low frequencies. These two types are, in any case, more or less obsolete, though there are still plenty to be found in junk boxes. The third type, straight

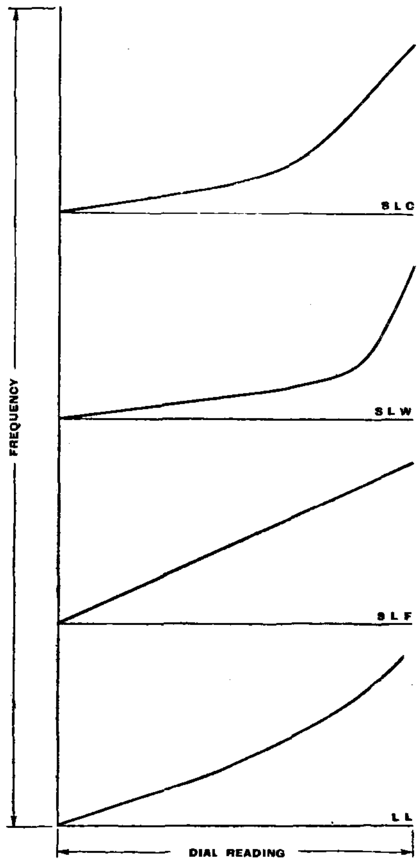


Fig. 2.—Characteristics of the four main types of tuning condenser.

line frequency, is the best for our immediate purpose, while the fourth type—the log law—will also serve quite well.

Considering the straight line frequency design, it might appear that with one of these condensers connected across a coil straight line calibration is certain. In practice, curve A of Fig. 3 will almost invariably result: it will tip up at the high frequencies and compression will result at the low capacity end of the scale.

The design of any modern variable condenser takes into account the stray capacities which will be placed across it in practical use. Suppose a tuned circuit is to be arranged to give a 2 to 1 frequency variation from minimum to maximum of the condenser, with a straight line frequency law. Then the condenser design must be arranged so that the *total* maximum capacity is four times the *total* minimum capacity (since frequency is proportional to $1/\sqrt{C}$). Any trimmers which are in the circuit will be taken into consideration.

Unsuitable "Strays"

If, now, that condenser is removed from the circuit for which it has been designed and put into another circuit without the same trimmer and incidental capacities, then the straight line effect will no longer be obtained. Suppose, as is most likely, that the new circuit has lower inherent shunt capacity than that with which the condenser is intended to work. With the plates near the full mesh position the capacity of the tuning condenser is large, and the effect of any minor shunt capacity is small. A straight line frequency/dial reading curve may be obtained for about half the rotation from maximum to minimum capacity. When the condenser rotation has reached such a position that the plates are well out of mesh, the capacity is decreasing to a very low value, and the effect produced by the absence of the fixed shunt capacity gets relatively greater and greater. The total capacity towards minimum is less than it should be; the frequency to which the circuit tunes is correspondingly higher; the

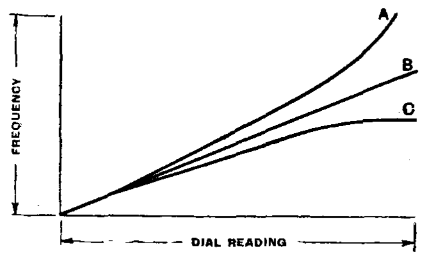


Fig. 3.—Tuning characteristics obtained by variation of shunt capacity.

Straight Line Calibration—

curve bends upwards at an increasing angle, and A of Fig. 3 is the result.

If, for some reason, too much shunt capacity is present then the curve will bend downwards at the upper end, for the total capacity there will be higher by a considerable percentage than the capacity required for straight line results, and the highest frequency reached will be lowered accordingly (see curve C). This is the condition which obtains when a tuned circuit has been overloaded with fixed shunt capacity to obtain higher stability.

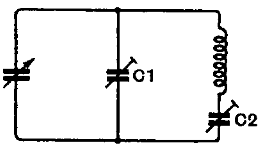


Fig. 4.—Arrangement for obtaining straight line calibration with log law condenser.

It is plain that somewhere there lies a happy medium for the value of shunt capacity and, in fact, a little trial and error with a variable trimmer or with different fixed condensers will produce the desired straight line for a curve of frequency against dial reading—as shown by B in Fig. 3.

Improving the Curve

Turning to consideration of the log law or midline condenser, the same remarks regarding design apply. The theoretical curve (the bottom one of Fig. 2) will not necessarily be obtained by simply connecting the condenser across a coil and calibrating the circuit. However, using the circuit of Fig. 4, where C_1 and C_2 are trimmers, it is possible not only to obtain the theoretical curve, but to go beyond this and obtain something very close to a straight line result. Increasing the shunt capacity C_1 will lower the highest frequency obtained, and increasing the series capacity C_2 will lower the lowest frequency. The effect of these condensers is, of course, interlocked to some extent The dotted corrections of Fig. 5 can be obtained, and the resultant is virtually a straight line. It will be noticed that this circuit is the same as that used in a superheterodyne to "track" the oscillator portion of the ganged condenser.

Because the unknowns are so prominent it is not possible to give specific values for the parallel and series trimmers. One can, however, give an idea of the values which will be required, and after that, "trial and error" is advised.

First take the calibration curve without trimmers of any sort, and see where correction is needed. Choose your correction circuit as described previously. Now remember that with the parallel connection the larger the correction required, the larger must be the capacity; with the series connection, the larger the correction required the smaller must be the capacity. Then start connecting some trial values.

With a 0.0005 mfd. main tuning condenser, used at wavelengths between 200 and 2,000 metres, a parallel trimmer of 50 m-mfds. maximum will usually meet the case. With 0.00025 mfd. as main tuning, a condenser half that size will be better. Indeed, a 25-m-mfd. trimmer will be suitable for use with most small tuning condensers. The "postage stamp" type, of indeterminate capacity, often turns out to be just about right.

The Series Padding Condenser

In the case of the series condenser, we have said that the smaller the capacity, the larger the correction. At the same time, there must be an early limit to the smallness of the capacity, or the resultant total capacity present may not be anything like the nominal value of the tuning condenser—with adverse effect on the expected range. The series capacity must be large relative to the tuning capacity, and on the frequencies previously mentioned, a suitable arrangement is a 0.002 mfd. fixed condenser having a 300 or 500 m-mfd. trimmer in parallel with it. For the smaller tuning condensers, the fixed capacity may be reduced to 1,000 m-mfd., with the same trimmer for providing a range of adjustment.

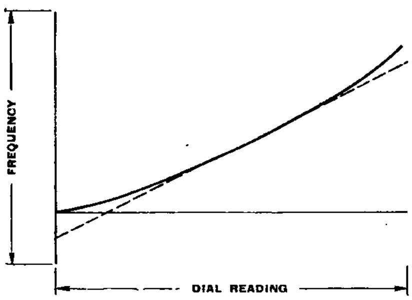


Fig. 5.—Corrections obtained by adjustment of C_1 and C_2 in Fig. 4.

Finally, it is necessary to point out that if the same tuning condenser is used on several ranges, separately adjusted, trimmers must be used with each coil. There is no particular difficulty in this. If the ranges are switched, then the trimmers can be switched with the coil: no extra switch contacts are necessary. If separate plug-in coils are used, separate trimmers can be incorporated in the construction of each coil.

Random Radiations

By "DIALLIST"

Frequency Modulation

THE Armstrong system of frequency-modulated transmission appears to be attracting more than a little attention on the far side of the Atlantic. Regular broadcasting services are to be run and those behind them believe that once the general public has had a fair taste of the quality of reproduction and the freedom from interference obtainable by this method it won't want to go back to amplitude-modulation. I wouldn't go so far as that. I agree that the man in the street would like to be free from interference, but I'm not at all sure that he appreciates real quality. He still seems to like what he calls a "mellow tone," which means in most instances a cutting of top, combined with false bass of the carpet-beater type. That may, though, be an unduly pessimistic view. I hope that it is! Anyhow, people will undoubtedly be educated up to demanding quality in years to come.

Looking Ahead

A longish time ago I was rash enough to predict that the future of broadcasting lay on the ultra-short waves. I still believe that the bulk of broadcasting will be done at some future date, which may not be so far ahead, on wavelengths below 10 metres. What I foresee is the retention of a certain number of medium-wave (and probably long-wave) stations for reaching people scattered over thinly populated areas, but the greater part of the country being served by high-fidelity ultra-short-wave transmitters. There would, of course, have to be many of these; but they could be of comparatively low power and they would relay both national programmes and those originating in area studios. Possibly each will have its accompanying television transmitter. If the frequency-modulation system lives up to the claims made for it there is the possibility that my dream may be realised by its adoption here, there and everywhere.

Can We Outlaw Radiating Appliances?

One thing is pretty certain, we have failed lamentably to take the action necessary to suppress at its source interference with radio reception. It is now probably too late to do anything in the matter. Apart from the ignition systems of motor vehicles and commercial electric machines, there must be millions of pieces of radiating domestic apparatus installed in the homes of this country. No government would dare to prohibit their use and if the sales of such appliances were made illegal it would be many years before all of those now at work were worn out. It looks, then, as if we must regard radiation by apparatus of countless kinds as a necessary evil. We can't suppress it at its source, for matters have now gone too far for that. We shall have to tackle the problem entirely from the other end by endeavouring to make receivers immune from the effects of unwanted radiation. It may be that this will be accomplished by developments in anti-interference systems combined with better screening of receivers. But it is also possible that frequency-modulation will show the easiest way out of the difficulty.

An Imposing Array

THE number of wireless broadcasting stations collared by the Germans during the past 12 months is staggering. All of the occupied countries had extensive broadcasting systems, including a proportion of high-powered stations. Poland, Denmark, Norway, Holland, Belgium and France were all in the forefront of broadcasting. Add the German and Austrian stations and those in Italy and you have an imposing tale of medium-wave transmitters at the disposal of the unholy Alliance. And then there are the short-wave stations, not a few with extensive wavelength allotments, and with world-wide range. The total at the disposal of the Axis Powers, taking medium-wave and short-wave together, can't fall much short of a couple of hundred. I'd forgotten the long waves because one so seldom uses them nowadays: of these Germany owns or controls now the Deutschlandsender, Radio Paris, Warsaw, Oslo, Kalundborg and Hilversum No. 1. A formidable array! Nor have the aggressors always remained content with the power output of stations as it stood. Your wireless receiver will convince you that the power of a good many has been considerably increased.

Not All Their Own Way

We haven't been exactly idle ourselves. The utmost use is being made of the stations at our disposal for bringing the real news both to Germans and to the peoples whom they are protecting out of existence. But we still need more and more high-powered channels, particularly on the short waves. One reason for this is that Germany now has so many transmitters and so many channels at her disposal that she can afford to use quite a number of stations purely for jamming purposes when she feels so minded. They don't get things all their own way by any manner of means. Our Empire stations are both

Random Radiations—

well equipped and well used. News is going out continually from us in goodness knows how many languages and it is getting to the people who want to know the truth about what is happening. But we could do with further high-powered short-wave transmitters and I'm sure this pressing need is not being neglected.

From the Horse's Mouth

NO doubt you've heard or read statements about the exaggerated claims made in the German news bulletins. I've been rather intimately concerned lately with one part of the country, which has received many visits from raiding planes. It's been more than interesting to observe the difference between the hostile planes seen to be shot down in particular engagements and the number admitted in the German news bulletins. Again, I'm writing this at a very short distance from (and within actual view of) a place reported by the Germans to have been severely damaged by their bombs. If they'd done what they claimed I probably shouldn't be writing! Anyhow, I can assure you that that particular objective was absolutely unscathed. The nearest bomb fell several miles from it and as they dropped on to open land they didn't do anything—except possibly to render a field or two useless as potential landing grounds for their own aircraft in case of invasion! I suppose they think that if they broadcast their ridiculous claims some people will believe them. But it must have been rather a shock to them to hear the eye-witness account of a recent dog-fight in the Straits of Dover broadcast recently by an American over some of the big U.S.A. networks!

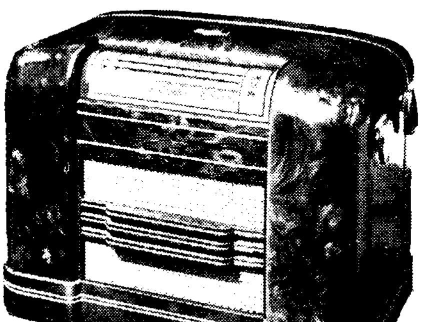
An Opening

THE R.A.F. authorities have announced lately that they require many expert wireless servicemen. I'm not surprised, for all the services now make much use of radio for communications over distances great and small, and there must be a vast amount of repair work and adjustment always to be done. Work with the R.A.F. is bound to be interesting, for this service has always made great use of wireless for many purposes and its technical people don't let the grass grow under their feet. Research and experimental work are constantly going forward in some of the most entrancing branches of wireless. Any serviceman who takes up a job with the Air Force will find that it's a very up-to-date concern.

Marconiphone Model 911

A NEW AC RECEIVER OF UNCONVENTIONAL DESIGN

THE latest product of The Marconiphone Co., Ltd., is a three-waveband superheterodyne selling for 8½ guineas. It makes use of a four-valve plus rectifier circuit with a pentode in the output stage delivering 5 watts to a 5-inch moving coil loud speaker. The short-wave band covers the range 16.5 to 52 metres and is calibrated to megacycles as well as metres.



A moulded cabinet and an unusual chassis layout are features of the new Marconiphone Model 911.

Undoubtedly, the most interesting feature of the design is the use of a moulded cabinet into which the chassis slides on fillets moulded on the sides near the top of the cabinet. The valve bases are on the underside of the chassis and the valves project downwards. This form of construction enables the drum-dial to be mounted with a short cord drive in the top corner of the cabinet where it is most easily seen; most of the trimmers are also made accessible on the underside of the chassis.

The controls are all at the side, and this arrangement, in conjunction with the well-rounded corners of the cabinet, gives the set a neat and compact appearance, while at the same time making for convenience in operation.

Unbiased

Regaling ourselves at a coffee stall.

By FREE GRID

Retrospect

THE other night, or, to be precise, very early the other morning, as the Editor and myself were regaling ourselves at a coffee stall after a heated all-night sitting of a learned scientific body of which we are both fellows, he suddenly seized my arm and remarked in a rather agitated manner that the next issue of *The Wireless World* would be the September one. Using his silk scarf to mop up the coffee which he had caused me to upset, I remarked somewhat acidly that, having regard to the fact that the last issue of the journal was the August one, it did not overmuch surprise me to learn that the next one would be the September issue and that, in my opinion, it was highly probable that the one following would be the October issue.

He pointed out, however, that he had suddenly remembered that it was just ten years since he had asked me to contribute to these columns, and he wondered what ought to be done about it. I replied that if he was hinting that I should celebrate the event by buying him some more coffee there was nothing doing, as, in the first place, I did not approve of junketings in wartime, and, in the second place, all my spare cash was at present going toward the cornering of all the television sets I could lay my hands upon in anticipation of making my fortune when the post-war television boom descended upon us.

I suggested that we should defer our celebrations to next April, when *The Wireless World* would be having its thirtieth birthday, and it was not impossible that by that time the rest of the nation and ourselves might have successfully completed the little job we had on our hands just now.

When I arrived home I hastily looked up the September 1930 issues of *The Wireless World*, and, to my astonishment, I found that the Editor was speaking the truth. What surprised me still more, however, was to find that in those days we were so much in the dark ages that the superheterodyne had not been vulgarised, as I referred in my notes to a rumour which I had heard that this ancient system of reception, dating back to 1917, was about to stage a comeback. Even more astonishing, however, the same old problems of ether congestion which exist to-day were turning our hairs grey then. It set me wondering what things will be like ten years hence.

Asking for Trouble

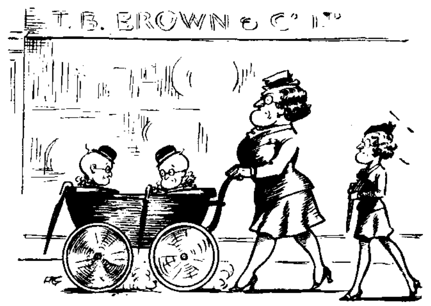
ALTHOUGH we must all put up with it as cheerfully as we can, for the duration, there can be no doubt that this car-radio ban is a great hardship to people like myself who take wireless seriously and do not like to be without it at any time. There is no ban on the carrying of a portable set by pedestrians, but even the modern lightweight instrument gets very burdensome after the first mile or so, and I had been endeavouring to compromise by using roller skates, but I have just learned, to my horror, that I have unwittingly been rendering myself liable to be shot at dawn, as roller skates are a road vehicle within the meaning of the Act.

The situation was soon remedied, of course, by discarding the skates, but now I find that, owing to the pig-headedness of Mrs. Free Grid, I am still liable to be charged with an infringement of the road-radio ban. It appears that, in spite of perambulators cluttering up our pavements in the disgraceful manner that they do, they have no legal right to be there. The proper place for them is on the road, and I think it disgraceful laxity on the part of the police that the law is not enforced. At any rate, they are definitely road vehicles within the meaning of the Act, and here is my trouble.

At the present moment we have staying with us Kilocyclia, one of my elder daughters, who long ago persuaded some unfortunate wretch that two could live as cheaply as one, with the inevitable result that she and her twin offspring spend most of their time staying with Mrs. Free Grid at my expense. The trouble is that Mrs. Free Grid *will* insist on taking a portable set in the children's pram every time she and Kilocyclia go off on a shopping expedition. As in the case of most other women, she allows the set to drool on all day irrespectively of what programme is coming through.

This is bad enough, for at any moment a policeman may wake up to the fact that a pram is a road vehicle and that, therefore, an offence is being committed, but, to make matters worse, the set is switched on full blast all the time, and it is inevitable that, before long, the laws of chance will decree that the pram is being pushed through the town at a time when the B.B.C. are churning out one of their news bulletins in German.

I dread to think what may happen, as the average person knows just enough about the German language to recognise it when he hears it, and not enough to distinguish between a B.B.C. news bulletin and what may well be thought to be a deliberate attempt to disseminate enemy propaganda.



Mrs. Free Grid and Kilocyclia.

A crowd can be very ugly at times, as I learned to my cost on an occasion during the last war when I absentmindedly walked through the streets of Portsmouth to a fancy dress ball dressed as a German submarine commander.

Recent Inventions

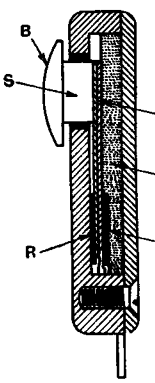
Brief descriptions of the more interesting radio devices and developments disclosed in Patent Specifications will be included in these columns

PIEZO-ELECTRIC CRYSTALS

RELATES to a resilient mounting for a piezo-electric crystal oscillator suitable for use either with a gramophone, in a dictaphone, or as a hearing aid. The crystal P, shown in cross section in the figure, is held resiliently at its lower end between two clamps of rubber R, R1, whilst a third rubber pad R2 lies along one side of its length.

For use as a hearing aid, the upper end of the crystal bears against a button B which presses against the ear or one of the skull bones of the wearer, so as to transmit vibrations from the crystal to the auditory nerve. The button is formed with a square shank S, which passes through a square rubber-lined hole in the casing, so as to prevent the button from being twisted in the course of use, and so losing firm contact with the crystal. At the same time, the crystal is adequately protected from damage should the casing be dropped or receive an accidental blow.

The British Thomson - Houston Co., Ltd.; L. B. Ault; and W. A. Bocock. Application date 8th June, 1938. No. 515636.



Cross section of piezo-crystal bone - conduction hearing aid.

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IMPROVING CATHODE-RAY TUBES

IT has been observed that the centre of the fluorescent screen of a cathode-ray tube tends to develop black markings after it has been in use for some time. These are particularly noticeable when the fluorescence is faint, and are due to the bombardment of the screen by negative ions of the contained gas, and by other charged particles too heavy to be sufficiently deflected by the applied scanning fields.

The defect is overcome, according to the invention, by projecting the heavy particles against a plate which collects and removes them from the normal stream of electrons. The latter is diverted, by the field from an auxiliary solenoid, away from the collecting plate, before it comes under the control of the usual pair of scanning coils which then sweeps it across the fluorescent screen in the ordinary way.

Ferranti, Ltd.; J. L. Miller; and H. Wood. Application date August 12th, 1938. No. 518221.

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ULTRA-SHORT-WAVE AERIALS

A SHORT-WAVE aerial which is substantially non-reactive over a wide range of frequencies, and is therefore particularly suitable for television, consists of a hollow inverted cone with its apex placed near a flat reflecting surface, such as the roof of a house. The feed-line is connected across the point of the apex.

Alternatively two cones, placed apex to apex, can be used to form the two limbs of a dipole, the inner and outer conductors of a coaxial feed-line being connected respectively to the two apices. The points of connection are shifted some way up the sides of the cone, if necessary, to match the impedance of the aerial to the line.

Such an aerial is stated to react substantially as a pure resistance over the band of wavelengths between 1.36 and 1.55 metres, the phase-angle never exceeding 5 deg.

Marconi's Wireless Telegraph Co., Ltd. (assignees of P. S. Carter). Convention date (U.S.A.), June 12th, 1937. No. 515795.

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TRANSMISSION LINES

A COPPER tube, slit along its length, is used as a high-frequency transmission line. Signals are applied at one end by a coil wound outside the tube, and are similarly taken off at the far end. The energy is propagated as a magnetic flux.

The inventor states that the high-frequency flux cannot penetrate the copper, and is therefore constrained to travel along its length, except for the small portion that leaks through the longitudinal slit. The slit is, of course, necessary, as otherwise the tube would form a short-circuited "turn" and so prevent the flux from getting into its interior.

The tube is said to simulate a transmission line having inductance in series with the path of propagation, and capacities in shunt.

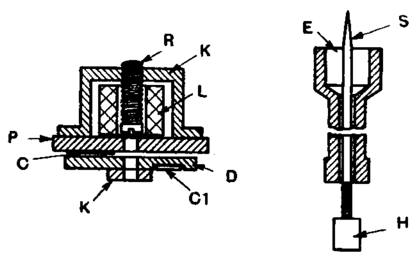
The tube can be used as a radiating aerial by adjusting the width of the longitudinal slit, so as to control the leakage of the flux.

A. D. Blumlein. Application date March 7th, 1938. No. 515684.

TUNING UNITS

A COMPACT coil and condenser unit to which small balancing or trimming adjustments can be made is shown on the left of the diagram. The inductance coil L is mounted inside a metal screening case K, the iron core for the coil taking the form of a screw R. One plate of the balancing condenser consists of a semi-circular coating C mounted on the underside of an insulated plate P. The other condenser plate C1 is of similar shape and is mounted on the lower side of a ceramic disc D which can be rotated through an angle of 180 deg.

In the tool for trimming the tuning of the unit, which is shown on the right, the hollow end E fits over the polygonal knob K and turns it like a spanner. At the same time, a screw driver S is brought into engagement with the slotted end of the iron core R, and can be rotated by the handle H to force the core further in or out of the inductance coil.



Pre-set tuning unit and trimming tool.

Telefunken Ges. für drahtlose Telegraphie m.b.h. Convention date (Germany) 13th July, 1937. No. 516924.

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DIRECTIONAL SYSTEMS

ORDINARY methods of determining the direction of an incoming wave only give accurate results if the wave is polarised in the vertical plane. But in practice, particularly at certain times of the day, the received wave is likely to include horizontally polarised components, produced as the result of the reflection that occurs at the Heaviside layer. It has already been proposed to eliminate this so-called "night effect," by using a system of impulse signalling in which the transmitter sends out a series of "trains" of waves, separated by very short periods.

It is then possible to distinguish, at the receiving end, those signals that travel along the earth from those that reach the receiver after reflection from the Heaviside layer, and to take directional observations only on the earth-bound waves, since these are invariably polarised in the vertical plane. But in such systems, it is necessary to transmit synchronising signals in order to control

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Recent Inventions—

the receiver so that it shall respond only to the earthbound wave, and not to the space wave.

The invention describes a method of impulse signalling in which the use of synchronising impulses is not necessary, the required directional information being obtained by measuring the "slope" of the rising part of the ground-wave impulse, before it is affected by the arrival of the corresponding space wave.

Telefunken Ges. für drahtlose Telegraphie m.b.h. Convention date (Germany) 28th August, 1937. No. 517099.

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SHORT-WAVE AERIALS

A SHORT-WAVE aerial giving a broad frequency response when directly coupled to a standard transmission line, say of 600 ohms, consists of two or more conductors, each half a wave long, arranged in parallel and spaced apart by a small fraction, say one-hundredth, of the working wavelength. Each conductor is connected at both ends to its neighbour, so as to form, in effect, a narrow loop. The transmission line is connected to two terminals at the centre of the nearest dipole.

The arrangement is equivalent to a single-wire half-wave dipole in radiation characteristic, since, owing to the phase reversal at each end, the current flow is in the same direction in both wires. The radiation resistance of a two-wire system is, however, equal to four times that of a single wire, without using any special matching between the aerial and feed-line. This gives an extremely flat impedance when measured against frequency, and makes the aerial particularly suitable for handling television signals.

Marconi's Wireless Telegraph Co., Ltd. (assignees of P. S. Carter). Convention date (U.S.A.), July 24th, 1937. No. 517342.

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VISUAL TUNING INDICATORS

AS a preliminary to tuning, the condenser of the receiver is set into rapid rotation, either by a motor, or by operating a press-button or lever which drives a flywheel mounted on the condenser shaft. A small Neon lamp is mounted on the shaft and rotates past a translucent dial at a speed sufficient to give the persistence of vision effect.

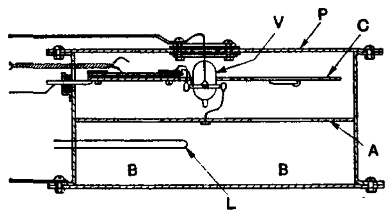
The Neon lamp is included in the anode circuit of one of the amplifier valves, so that it glows more or less intensely at those points where the rotating condenser tunes the set to any signals that are within range. In other words, the listener is able to "search the ether," and to note what stations are in operation, before selecting any particular one. The final choice is effected by adjusting a stop or brake to arrest the condenser at a point coinciding with the appropriate luminous spot on the dial.

Standard Telephones and Cables, Ltd. (assignees of Le Matériel Téléphonique Soc. Anon.). Convention date (France) September 9th, 1937. No. 518031.

MICRO-WAVE OSCILLATORS

THE figure shows an outfit for generating wavelengths of the order of a metre and less. A short-wave valve V of the acorn type is mounted inside a cylindrical resonator chamber, the upper part of which is divided by two discs A, C connected respectively to the anode and cathode of the valve. Owing to the distributed capacity and inductance of the system, a stationary wave is built up between the top plate P and the anode disc A forming the upper part of the resonator.

RF energy passes through perforations in the anode disc A into the lower part B of the resonator, from which it is drawn off by a wire loop L to a load circuit. The size of the resonator chamber is of the same order as the wavelength generated, and the arrangement is such that the current distribution is symmetrical in all the conducting members associated with the valve.



Resonator chamber for micro-wave generation.

The nodes of the standing wave system are so located in the resonator that leakage radiation is prevented. The energy generated can be used, among other things, for inducing an artificial fever in medical treatment.

A. H. Stevens (communicated by the Leland Stanford Junior University). Application date April 21st, 1938. No. 517264.

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NAVIGATIONAL BEACONS

A DIRECTIVE aerial system is used to radiate two wireless beams at a slight angle to each other, both being modulated with interlocking signals, so that the common or overlapping part of the two beams indicates a definite course or guide-way for an aeroplane in flight. It is well known that if a dipole is "backed" by a second aerial wire, of equal or slightly greater length, the latter acts on the radiated waves as a reflector. If, however, the second dipole is made shorter than the main aerial, it serves both to strengthen the waves along their original direction, and also to concentrate them into a narrow beam. It is then called a director, as distinct from a reflector.

According to the invention, a combination of such reflectors and directors is used to produce two overlapping radio beams for navigational purposes. The main or energised aerial is backed by a reflector dipole, whilst a second dipole is placed in front of the main aerial. This second dipole is provided with a section which can be opened or closed by a keying switch, so that the dipole acts alternately as a reflector or director. The result is that each beam is interrupted or reversed in direction by the keying switch, at a frequency which provides the necessary interlocking signals.

Bendix Aviation Corporation. Convention date (U.S.A.) July 2nd, 1937. No. 518714.

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FLYING "BLIND" BY WIRELESS

DIRECTIONAL wireless is utilised to give the pilot of an aeroplane a continuous indication of his position, relative to the surrounding country, even when fog prevents any direct sight of land. The signals received from two course-marking wireless beacons are applied to control a cathode-ray indicator, so that the position of the machine is marked at all times by the inter-section of two lines of light, as seen against a map or chart of the route as background. The map indicator is mounted on the dashboard of the machine where it can conveniently be kept under constant observation by the pilot.

The cathode-ray tube is fitted with two "guns" so that two beams of electrons trace out independent circular paths on a common fluorescent screen. These paths are synchronised with the rotating wireless beams radiated from the land beacons, so that their intersection on the fluorescent screen follows the points of intersection of the beams in space. At any point within the area of overlap of the beacons, the received signals produce two bearing-line traces, which intersect at a point on the chart corresponding to the position of the machine in flight.

Marconi's Wireless Telegraph Co., Ltd. (assignees of V. K. Zworykin). Convention date (U.S.A.), September 24th, 1937. No. 517826.

o o o o

INCANDESCENT TELEVISION SCREENS

THE ordinary fluorescent screen of a cathode-ray television receiver is replaced by one which becomes incandescent under the impact of the scanning stream of electrons. The screen is made by spraying a foundation of fine-wire mesh, having 200 apertures to the square inch, with a solution of thorium nitrate. The nitrate is "held" between the interstices, when dried, and forms, in effect, a mosaic of separate small rods or plugs.

The mosaic is heated to a temperature of 1,000 deg. C., whereupon the plugs of thorium nitrate are converted into the oxide, and swell in size so as substantially to cover the screen, though without touching each other. The heat-sensitive surface so produced can be raised to white incandescence by an electron stream using an anode voltage of less than 10,000 V. Cooling occurs sufficiently rapidly to "localise" the light-and-shade effects of the original picture, so as to produce the necessary persistence-of-vision effect.

Marconi's Wireless Telegraph Co., Ltd. (assignees of W. H. Kaufmann). Convention date (U.S.A.) August 31st, 1937. No. 518588.

Wireless World

CLASSIFIED ADVERTISEMENTS

THE CHARGE for advertisements in these columns is 12 words or less 3/-, 3d. for every additional word. Each paragraph is charged separately.

ADVERTISEMENTS, with remittance, should reach Dorset House, Stamford Street, S.E.1, not later than first post Tuesday, September 10th, for the October issue, or one day earlier at the Branch Offices, 8-10, Corporation Street, Coventry; Guildhall Buildings, Navigation Street, Birmingham, 2; 260, Deansgate, Manchester, 3; 26B, Renfield Street, Glasgow, C.2.

SERIES DISCOUNTS are allowed to trade advertisers on orders for consecutive insertions provided a contract is placed in advance, and in the absence of fresh instructions the entire copy is repeated from the previous issue. 3 insertions, 5 per cent.; 6 ins., 10 per cent.; 12 ins., 15 per cent.

Advertisements received too late for one issue, or crowded out, are published in the first following in which there is space. The Proprietors retain the right to refuse or withdraw advertisements at their discretion.

The Proprietors are not responsible for clerical or printers' errors, although every care is taken to avoid mistakes.

BOX NO. ADVERTISERS should include the words "Box 000 c/o 'The Wireless World'" which must be paid for. An additional 1/- is charged for registration and cost of forwarding replies.

Letters addressed to Box Nos. are simply forwarded to the advertiser. No responsibility is accepted in connection with these advertisements.

DEPOSIT SYSTEM. Readers may deal with advertisers in safety through our Deposit System. Purchase money payable to Iliffe & Sons Ltd. should be deposited with "The Wireless World," when both parties are advised of its receipt.

The time allowed for decision is three days, counting from receipt of goods, after which period, if buyer decides not to retain goods, they must be returned to sender. If a sale is effected, buyer instructs us to remit amount to seller, but if not, seller instructs us to return amount to depositor. Carriage is paid by the buyer, but in the event of no sale, and subject to there being no different arrangement between buyer and seller, each pays carriage one way. The seller takes the risk of loss or damage in transit, for which we take no responsibility. Details of any arrangement made between parties which does not concur with any of the above conditions must be advised to us when the deposit is made. For all transactions whether a sale is effected or not a commission of 1 per cent. is charged on and deducted from the amount deposited (minimum charge 2/-). All correspondence must be sent to Dorset House, Stamford Street, London, S.E.1.

Cheques and Postal Orders sent in payment for deposits or advertisements should be made payable to Iliffe & Sons Ltd., and crossed. Notes cannot be traced if lost in transit. They must therefore be regarded as being despatched at sender's risk. Alternatively, they may be sent per registered post.

NEW RECEIVERS AND AMPLIFIERS

*

CHALLENGER RADIO CORPORATION.—We still lead with best value money can buy; send 2½d. stamp for illustrated catalogues of finest all-wave receivers, handsome cabinets, speakers and valves, firsts only 6/- each; every article fully guaranteed; buy now before prices again rise.

CHALLENGER RADIO CORPORATION, 31, Craven Terrace, Lancaster Gate, London, W.2. [9176

SCOTT Latest Philharmonic, new, complete, £150; McMurdo 15-17 Georgic Autoradiogram, £82.—A. C. S. Radio, 46, Widmore Rd., Bromley. [9198

AMBASSADOR Chassis.—Prompt delivery of latest models from Coulphone Radio, New Longton, Preston. Full discounts. Model Ch. 6779, six-valve, all-wave (12.5-52 metres), R.F. stage, 5.8 watts output, 10in. speaker; £8/5 nett; carriage paid; stamp for catalogue. [9178

BANKRUPT Bargains.—Brand new 1939-40 models, well-known best makes, makers' sealed cartons, with guarantees, at less 30%-40% below listed prices; also Midgets, portables; send 2½d. stamp for lists.—Radio Bargains, Dept. W.W., 261-3, Lichfield Road, Aston, Birmingham. [9150

£11/10 Only.—Usual price £22; *Wireless World* 2 R.F. Receiver with push-pull quality amplifier, 10 valves, including tone control stage, 8 watts triode output, ideal for quality reproduction from radio and gramophone; limited number.—Bakers Selhurst Radio, 75, Sussex Rd., South Croydon. [9191

COMMUNICATION RECEIVERS

NATIONAL NC44 (A.C./D.C.), 7-valve, 4-waveband, 10-500 meters, with speaker, new; £16.—May, 51, Graham Mansions, Hackney, E.8. [9184

HOWARD Communication Receiver 430, with signal strength meter, in perfect condition; £8, or exchange for good quality gram. amplifier in cabinet.—Horsfield, Chemist, Ainslie St., Barrow. [9188

R.M.E.69 Standard, as new, £35; R.M.E. 69, noise silencer model, as new, £38/10; Howard 440, shop soiled, £27/10; Howard 460, with speaker, £26/10; Eddystone E.C.R., with speaker, £29/10.—A. C. S. Radio, 46, Widmore Rd., Bromley. [9197

Wanted

COMMUNICATIONS Receiver, 6-26 M.C.—4, Belvedere Court, Lyttleton Rd., N.2. [9203

SUPER Skyrider, SX16/17, PRO or similar, for cash.—Nunn, 86, Hermitage Rd., S.E.19. [9204

WANTED, good communication receiver; send full-est particulars.—Thompson, 50, Harlestone Rd., Northampton. [9159

FAIR Market Value Cash Offered for Good Communication Sets.—A. C. S. Radio, 46, Widmore Rd., Bromley. [9196

ARMSTRONG

ALMOST UNBELIEVABLE!

In these days of universal shortage of material it is almost unbelievable that we can give **immediate delivery** from stock of our NEW EXPORT Model EXP48, but for some time past we have been carefully conserving a supply of material to give our friends overseas the prompt delivery service normally enjoyed by the Home buyer.

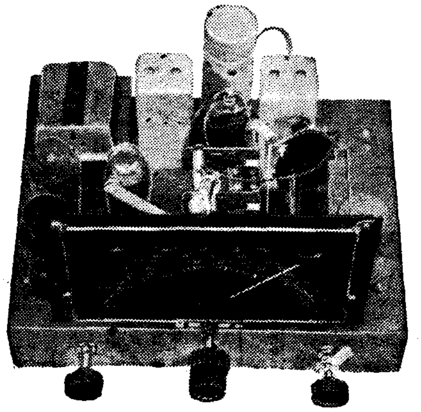
As pointed out in our August announcement we are anxious to co-operate in overcoming any local geographical condition which may present a problem to our Overseas friends and we look forward to hearing from you.

A limited number of these new chassis is available for the Home market.

SPECIAL OVERSEAS MODEL EXP48

8-v. 4-BAND ALL-WAVE SUPERHET CHASSIS

(13-160m. continuous & normal Broadcast bands)



This chassis has been developed on the lines of our Model AW38 which has proved an outstanding success since its introduction at 1939 Radiolympia. Overseas requirements, however, have been given primary consideration. Firstly, an additional short-wave band has been incorporated and the chassis now gives an efficient continuous short-wave coverage from 13 to 160 metres. All coils and I.F. transformers have been specially treated to render them impervious to humidity. Switching is of extra robust construction and contacts heavily plated. The mains transformer is interleaved and has a generous iron content to avoid excessive temperature rise and the steel chassis itself is heavily cadmium plated for tropical use.

International standard base valve-holders are used throughout .... **8 gns.**

With 8" P.P. Speaker £9. 9. 0

With 10" P.P. Speaker £10. 3. 0

Plus 4/6 for part cost of packing and carriage on all orders in the U.K.

OVERSEAS TRADE BUYERS

are invited to get into touch with us.

For our friends at Home

OUR ILLUSTRATED ART CATALOGUE

fully describes the above new model, our well-known AW125 PP (reviewed so favourably by "The Wireless World"), the SS10 and all other chassis in the Armstrong range. Write for your copy to-day—6d. p.f.

ARMSTRONG MANUFACTURING CO.

WARLTERS RD., HOLLOWAY, LONDON, N.7, ENGLAND.

'Phone: NORth 3213

USED SETS FOR SALE

HAYNES

HAYNES Tuner, 2 H.F., 1940 model, perfect; £10, offers.—Pysden, 20, Lansdown Rd., Canterbury. [9177

R.M.E. 69

FOR Sale, one R.M.E.69 Receiver, complete with DP20 preselector unit and one Hallocrafter loud speaker in metal cabinet; best offers to: T. H. Colebourn, 61, Victoria St., Douglas, Isle of Man. [9158

MISCELLANEOUS

H.M. 907 All-wave Radio Televisor, £25; Baird T5C Televisor, £25; Pye Table televisor, £20; McCarthy all-wave chassis with speaker, £6; Crosley 1938-9 console, £12/10; Marconi 346, £9/9.—A. C. S. Radio, 46, Widmore Rd., Bromley. [9199

Wanted

WANTED, R.G.D. Autogram, Model 1015 or 7511; price moderate.—Kilpatrick, 7, Diamond, Londonderry. [9189

PUBLIC ADDRESS

V

VORTEXION P.A. Equipment

IMITATED, but unequalled.

WE Invite You to a Demonstration.

A.C.-20 15-20-watt Amplifier, 38-18,000 cycles, independent mike and gram., inputs and controls, 0.037 volts required to full load, output for 4, 7.5, and 15 ohms speakers, or to specification, inaudible hum level, ready for use; 8½ gns. complete.

C.P. 20 12-volt Battery and A.C. Mains Model, as used by R.A.F., output as above; 12 gns.

A.C.-20, in portable case, with Collard motor, Piezo pick-up, etc., £14; C.P.20 ditto, £17/17.

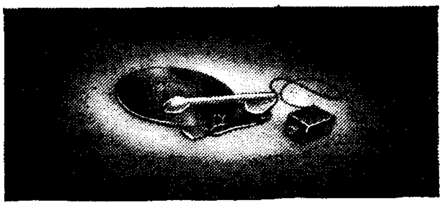
50-WATT Output 6L6s, under 60-watt conditions, with negative feed back, separate rectifiers for anode screen and bias, with better than 4% regulation level response, 20-25,000 cycles, excellent driver, driver transformer, and output transformer matching 2-30 ohms impedance electronic mixing for mike and pick-up, with tone control, complete with valve and plugs; £17/10.

COMPLETE in Case, with turntable, B.T.H. Piezo pick-up and shielded microphone transformer; £22/10.

80-WATT Model, with negative feed back; £25, complete.

120-WATT Model, with negative feed back; £40, complete.

(This advertisement continued on next page.)



by P.G.A.H. Voigt

The Pick-up that does what you thought impossible.

Operating System
moving coil.

Voltage Output (Loud records)
approx. 50 millivolts.

Reproducing Point stiffness and pressure on the Record
less than in any other pick-up.

Raising and lowering
by means of lever.

Patent applied for

Provisional Price Experimental models £6.

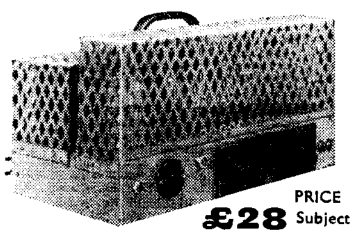
Delivery 8 to 10 weeks. Advance information free upon request. ACT NOW

VOIGT PATENTS LTD.

THE COURTS, SILVERDALE, LONDON, S.E.26.
Tel.: SYDenham 6666. Regd. Office : 22 Castle St., E.C.1.

For Police & Mobile Patrol!

The **ACOUSTICAL**
C25 AMPLIFIER
30 Watts Output
from 12v. Battery or A.C. Mains



PRICE **£28** Subject

Low Battery Consumption

The Output is obtained from a pair of KT 66 valves operating in paraphase Push-Pull under 32 watt conditions. A High Standard of Quality at 30 watts, combined with the fact that the equipment operates direct from a 12-volt car battery or A.C. mains, plus the features detailed below, makes this the ideal instrument for P.A. work under all conditions.

- Dual inputs for high and low impedance lines, electronically mixed at Driver stage.
- Four high gain stages all R.C. coupled.
- Variable output impedance.
- Automatic polarising for low impedance input.
- H.T. and silencing switch for economy in consumption.
- Tone control, portability, etc.

Write for full Specification and Circuit.

The **ACOUSTICAL** MANUFACTURING CO. *Electro-Acoustic Engineers*
201-205, Lever Street, City Road, London, E.C.1.
Tel.: CLErkenwell 5821.

VALVES

ALL Types of American Tubes in Stock of Impex and Arcturus makes at competitive prices.

WE Can Also Supply a Full Range of Guaranteed Replacement Valves for Any British non-ring, American or Continental type at an appreciably lower price.

SEND for Lists of These, and also electrolytic condensers, line cords, resistances, etc.

CHAS. F. WARD, 46, Farringdon St., London, E.C.4. Tel.: Holborn 9703. [0452

METROPOLITAN RADIO SERVICE.—American Valves, in all types, trade supplied.—1021, Finchley Rd., N.W.11. Speedwell 3000. [0436

BRITISH Valves at Less Than One-third Cost (all guaranteed). Battery types, 2v. double diode triode, 2/-; power, 1/6; super power, 1/9; pentodes, 4- and 5-pin, 2/6; Class B, 3/6; mains types, 4v. A.C./H.L., indirectly heated, 2/6; A.C. screen grid, 3/6; S.G. High Gain, 3/6; S.G. Variable-Mu, 3/6; A.C./D.C. types, K.T.30, 3/6; L.13 detectors, 1/6; U.30 rectifiers, Octal, 1/6; all made by well-known British manufacturer; terms, cash with order to S.S.(W.), Radio Service, 20, Upper Duke St., Liverpool. [9167

METERS, ETC.

FERRANTI 2½-inch Moving Coil Flush Meters, as new, 0-15 ma., 0-1½ amps., cost 35/- each; combined 7½ volt, 150 volt and 30 ma., cost 52/6; all half price; other goods, stamp list.—Box 2534, c/o *Wireless World.* [9202

Wanted

WANTED, A.C.-D.C. multi-range meter, any good make; good price.—Fenn, 10, St. George's Rd., E.7. [9186

TEST EQUIPMENT

Wanted

A.C. Avometer or Avominor, good order.—Cameron, 95, Danes Drive, Glasgow, W.4. [9183

MORSE Recorder, Universal Avo, good oscillator, and communications receiver.—Full particulars, Pritchard's Radio, Menai Bridge, Anglesey. [9187

WANTED, accurate instrument for checking inductance 1 micro Henry to 100 Henries.—Send full details to Box 2533, *The Wireless World.* [9170

COMPONENTS

SECOND-HAND, CLEARANCE, SURPLUS

PREMIER RADIO.

PLEASE See Our Displayed Advertisement on page 4. [0488

SOUTHERN RADIO'S Wireless Bargains.

ALL Goods Previously Advertised Still Available.

SOUTHERN RADIO, 46, Lisle St., London, W.C. Gerrard 6653. [9163

VAUXHALL.—All goods previously advertised still available. Send stamp for list.

VAUXHALL UTILITIES, 163a, Strand, W.C.2. [9131

BROWN'S A Headphones, 2 pairs, 8,000 ohms; best offer secures.—23, Byron Rd., Ealing. [9185

5/- Only.—Bargain parcel comprising speaker cabinet, drilled steel chassis, condensers, resistances, and many other useful components, worth 35/-; limited number; postage 1/-.—Bakers Selhurst Radio, 75, Sussex Rd., South Croydon. [9194

COULPHONE RADIO. New Longton, Preston.—Cosmocord Series III Crystal Pick-ups, 18/6; Rola G.12's, energised, 52/6; P.M., 65/-, with transformer; Tungsram valves 33⅓% discount; American, 4/6 to 6/-; Ambassador chassis 33⅓% discount. Stamp for new lists. [9179

COULPHONE Offer Brand New Bargains.—10 guinea Deccas, Pushbutton, 5 gns.; Airmaster 14 gn. 8-valve 4 waveband chassis, with speaker, 8 gns.; Sparton 78 gn. 11-valve automatic radiograms, 35 gns.; 8in. Goodmans P.M. speakers, Universal transformer, list 27/6, at 15/6.—See other advertisements. [9190

No overheating with Solon *Electric* Soldering

Overheated irons need filing and retinning; a laborious or troublesome job—cut it out by using a SOLON. With Solon Electric Soldering, in 4 minutes, the bit gets to the correct heat and stays there—just as long as you need it; 15 hours use takes only 1 unit. No flame—no dirt. The constant heat, at the point, makes the solder run sweetly; sweats it right into the joint; gives you a strong, neat job.

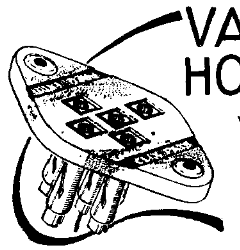
Made for following standard voltages :—200/220 230/250.

SOLON *Electric* **SOLDERING IRON**

Supplied complete with Resin-Cored Solder, Flex and Lamp Adaptor **9/4**

Solon Resin-Cored Solder **6D.** per reel.

W. T. Henley's Telegraph Works Co. Ltd. (Dept. 14/E) Engineering Sales Department, GRAVESEND, KENT



VALVE-HOLDERS

Valve-holders embodying the perfect contact helically slotted CLIX socket built on laminated plastic or Frequentite CERAMIC plates—for all standard valves and all conditions of service.

CLIX

BRITISH MECHANICAL PRODUCTIONS LTD.
1, Church Road, Leatherhead, Surrey.

RADIO UPKEEP AND REPAIRS FOR AMATEURS

by Alfred Witts, A.M.I.E.E.

6/- net. **6/6** by post.

This invaluable handbook enables the average radio receiver owner to diagnose for himself the ordinary troubles of his wireless set and to remedy them successfully. There is a useful chapter on how to fit a gramophone pick-up. Every keen amateur should have a copy.

PITMAN, PARKER ST., KINGSWAY, W.C.2

COMPONENTS—SECOND-HAND CLEARANCE, SURPLUS, ETC.

RADIO CLEARANCE, Ltd.,

63, High Holborn, W.C.1. 'Phone: Holborn 4631.

ALL-WAVE Superhet Chassis, 5-valve A.C., latest Mullard valves, T.H.4B, V.P.4B, T.D.D.4, Pen A4, L.W., 4/350v. Ranges: Short wave, 16-48 metres; medium wave, 200-560 metres; long wave, 800-2,200 metres. Size of chassis, 14½in. long, 7½in. deep, height overall 8½in. Controls, tuning at side, volume on/off at side, wave-change, provision for pick-up. Complete with valves and knobs. £4/17/6 each. Special speaker, 1,500 ohms field; 10/6 each.

LISSEN 2v. Screen-grid Valves, S.G.215 and S.G. 2v.; 4/6 each.

LISSEN 2v. Battery Pentodes, 4-pin, side terminal, P.T.2A. and P.T.225; 4/11 each.

LISSEN Rectifier Valve, U650; 2/11 each.

ULTRA Short and Short Wave Choke, Lissen Hi-Q, inductance, 100 microhenries, boxed, list 2/-; our price 1/- each.

ULTRA Short and Short Wave Double Wound Low-resistance Choke, Lissen Hi-Q, resistance less than 0.05 ohms, boxed, list 2/6; our price 1/3 each.

LOW-LOSS Ceramic Valve Holders, Lissen Hi-Q, baseboard and chassis, 5- and 7-pin; 10d. and 1/- each.

MANSBRIDGE Type Condensers, Lissen Hi-Q, 250 D.C. working, moulded case with feet, 0.1 mfd. and 1 mfd.; 6d. each.

ROTARY Coil Unit, Lissen Hi-Q, 4-band from 4.8-91 metres, can be selected by turn of knob, with circuit, boxed, list 15/6; our price 6/11 each.

LOW-LOSS Short Wave Variable Condensers, Ceramic insulation, brass vanes, Lissen Hi-Q, minimum capacity 5 microfarads, two types, boxed, with knobs, 160 mmfd., list 7/6, our price 3/- each; 20 mmfd., list 5/6, our price 2/6 each.

PUSH-PULL Switches, Lissen; 2-point, 4d. each; 3-point, 6d. each.

AMERICAN Line Cords, with fittings; 3/6 each.

ROLA P.M. Speakers, latest type, 7½in. cone, with power and pentode transformer, boxed; 15/- each.

MAGNAVOX 10in. Energised Speaker, field resistance 3,000 ohms, less transformer; 12/6 each.

CLOCK-FACED Dials, 5in.×3½in., with printed 3-wave scale, ox-copper escutcheon and glass, 3/6 each; ditto less escutcheon, 2/6 each.

MAINS Transformers, Plessey 350-0-350v., 90 m.a., 4v. 2.5 amps, 4v. 6 amps; 8/6 each.

MAINS Transformer, G.E.C., American windings, 350-0-350v., 65 m.a., 5v. 2 amps., 6.3v. 2.5 amps., suitable for replacements in G.E.C. models; 6/6 each.

MAINS Transformers, Wearite.—R.C.1, 250-0-250v., 80 m.a., 4v. 2.5 amps, 4v. 4 amps, 9/11 each; R.C.2, 350-0-350v., 120 m.a., 4v. 2.5 amps., 4v. 4 amps, 12/6 each; R.C.3, 350-0-350v., 150 m.a., 4v. 2.5 amps, 4v. 2 amps, 4v. 5 amps, 15/- each; R.C.4, 500-0-500v., 150 m.a., 4v. 2 amps, 4v. 2 amps, 4v. 2.5 amps, 4v. 5.6 amps, 21/- each; all above are centre-tapped windings; R.C.5 100-watt auto transformer, 100-110v., 200-250v., reversible, 12/6 each; all transformers 200-250v. tapped primaries; R.C.D. drop through type, capped, 350/350v., 100 m.a., 5v. 2 amps., 6.3v. 5 amps., 10/6 each.

CHASSIS Mounting Valve Holders, American 4-5-6-7-pin, 4d. each; Octals, 6d. each; Loctals, 10d. each; 7-pin English type, 3d. each.

1-WATT Resistances, polar N.S.F.; 4d. each, 3/9 per dozen; all sizes up to 2 meg.

VOLUME Controls, American C.T.S., finest made, divided spindles, length 2½in., with switch, 2,000, 5,000, 10,000, 25,000, 100,000, 250,000, 500,000, and 1 meg., 2/11 each; wire wound 5-watt (less switch), 2,000, 10,000, 20,000 ohms, 2/6 each.

SPEAKER Transformers, pentode output 3-4 ohms matching; 3/- each.

B.I. Wire-end Type, bias electrolytics, 50 mfd., 12v., 1/6 each; ditto, 50 mfd., 50v., 2/- each.

TUBULARS, wire-end non-inductive paper condensers, all sizes up to 0.1; 5d. each, 4/9 per dozen.

B.I. 8×8 mfd., 550v. working, cardboard electrolytics, 3/6 each; ditto 16×8 mfd., 4/6 each; ditto 8 mfd. tubulars, 2/- each; ditto 4 mfd. tubulars, 1/9 each.

HUNT'S Cardboard Wire-ends, 8 mfd. × 8 mfd. × 8 mfd., 450v. wkg., 2 negatives, 3/11 each; ditto 16 mfd. × 8 mfd., 350v. wkg., 3/3 each.

RAYTHEON First Grade Valves, largest stockists, all types in stock, including Glass Series, Glass Octal Series, Metal Series, Bantam Series, Single-ended, Metal Series, and Resistances Tubes; all at most competitive prices; send for lists.

ALL Orders Must Include Sufficient Postage to Cover. Hours of business: 9 a.m.-6 p.m. week-days, 9 a.m.-1 p.m. Saturday.

PLEASE Write Your Address in Block Letters.

WE Cannot Undertake to Answer Enquiries Unless Accompanied by Full Postage (2½d.).

RADIO CLEARANCE, Ltd., 63, High Holborn, London, W.C.1. Telephone: Holborn 4631. [9201

GALPINS

ELECTRICAL STORES

75, LEE HIGH ROAD, LEWISHAM, LONDON, S.E.13

Telephone: LEE GREEN 5240

Terms: Cash with Order

MAINS TRANSFORMERS, 220/240 volts input, 100 volts 40 m/a. and 4 v. 1 amp. output, **4/6** each. P.F.

D.C. MOTOR BLOWERS, 2in. inlet and outlet. Aluminium body, laminated field, ideal for dug-out ventilation. 100-volt, **25/-**; 220-volt, **30/-**. Carriage Paid.

MAGNAVOX MOVING COIL SPEAKERS, 7in. cone, 6-volt field, complete with Speaker Transformer, **4/6** each post free.

CRYPTO SHUNT WOUND DYNAMO, 12/18 volts, 8/10 amps., 2,200 r.p.m., in new con., **37/6,** carriage forward.

MET. VIC. ELECTRIC LIGHT SHILLING SLOT METERS for 200/240 volt 50 cy. 1ph. supply, **19/6** each, carriage 1/6.

X-RAY TUBES by well-known makers, 7in. bulb Tungsten Targets, **15/-** each, carriage forward.

MAGNAVOX PM PUBLIC ADDRESS MOVING COIL HORN SPEAKERS, handle 15/20 watts, size of horn 40in., 20in. flare. Price **47/6,** carriage paid.

EX-G.P.O. UNI-SELECTOR SWITCHES, with relay, 3 rows of 25 contacts in new condition, **25/-** each.

TWIN CYLINDER AIR COMPRESSOR, high pressure, in perfect mechanical condition, **95/-,** carriage forward.

HIGH-VOLTAGE TRANSFORMERS, useful for all test work, or television. Input 200/240 volts, output 5,000 and 7,000 volts, **6/6** each, post 1/-.

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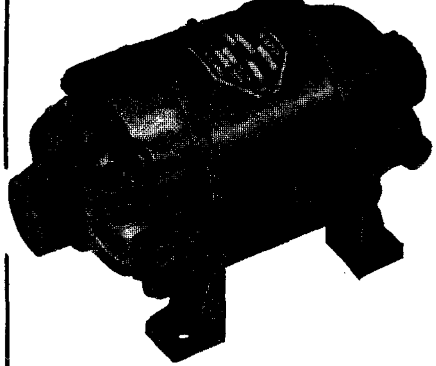

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