Wireless World

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Uses of Metre-wave Broadcasting

THIS journal is concerned with the means and not the end of radio communication. To us, the urgent messages of life and death, the outpourings of contraltos, comedians or symphony orchestras are, like the impassioned oratory of politicians and the gyrations of ballet dancers, just "signals" or "modulation." Their interest lies not in their information or æsthetic content, but in the way they can be transmitted and reproduced by loudspeaker or on the television receiver screen.

But perhaps all this can be carried too far. Of late there has been much discussion on the technical means for a proposed metre-wave broadcasting system for this country, but practically nothing has been said in our pages, and very little elsewhere, on the way in which such a service would be used. Though it is not strictly our concern, it is essential to know what kind of audiences would be served if the best possible technical decisions are to be reached.

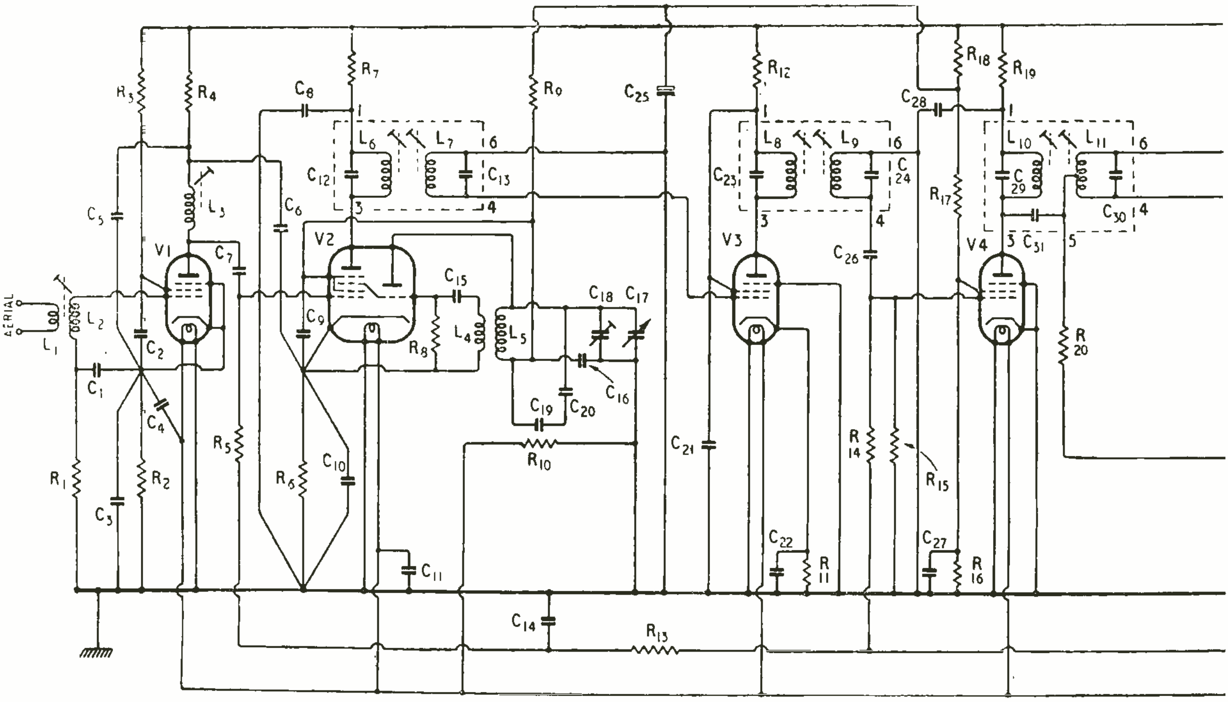
So far as the proposed extension of the B.B.C. service is concerned, the matter is relatively simple. In all probability the new service would be used very largely to fill in the gaps and to give better signals to the very large number of listeners who at present stand in need of them. There would also be the opportunity of providing signals of wider audio-frequency range. We doubt very much if the B.B.C. would decide to use the new channels for programmes different to those radiated on medium and long waves.

In considering the "independent" (non-B.B.C.) stations envisaged in the Beveridge Report and tentatively accepted in the Government White Paper, we move into much more controversial realms. It has been suggested that a multiplicity of small local stations conducted by public bodies would prove widely acceptable to listeners, and so would stimulate general interest in broadcasting; in addition, a valuable element of competition with the B.B.C. service would be introduced. Those who hold these views point to the success of small local stations in America. But can we accept American experience as a guide? We believe in that country local patriotism or the community spirit is much more highly developed than here; even so, the small stations independent of national networks do not seem to be on the increase.

Coming to more materialistic considerations, who in Great Britain could afford to pay for the running of such stations? We must assume, of course, that the present ban on advertising will be maintained. No doubt, certain "pressure groups" with wealthy supporters will apply for licences, but would the propaganda programmes certain to be sponsored by such societies be likely to have a wide acceptance among listeners? Similarly, we may guess that some of the richer educational foundations would enter the field, but probably none of them could afford full national coverage, and anything much less would probably be thought unattractive. However, a group of educational bodies might well set up a network of stations, with a system of time-sharing for individual members.

In the present age of austerity we cannot visualize a stampede on the part of municipalities and the like to set up stations, nor that the ratepayers would approve of the use of their money for running them. And, even if this view is wrong, would there be a steady supply of acceptable programme material? In fact, is there any real future for "parish pump" broadcasting? No doubt, the average citizen would like to have a ready source of information on important local happenings and also on minor local disasters such as interrupted train services, gale and frost warnings, and the like. But, to derive full benefit from such a service, he would need an elaborate receiver with a calling device—a relatively expensive matter.

So we come back to the question of economics, which, in this matter at least, seems to outweigh most technical considerations. Much as we want to see independent stations licensed, if only experimentally, we must not be blind to the difficulties.



DESIGN FOR AN

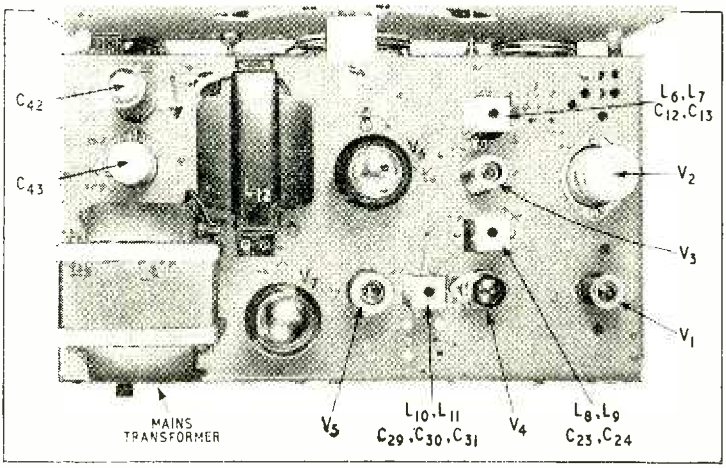
F. M. Receiver

1.—Simple, Inexpensive Set for the 90 Mc/s Band

By J. G. SPENCER
(Research Department, B.B.C.

ONE of the points which has often been discussed when comparing amplitude modulation and frequency modulation for v.h.f. sound broadcasting is the relative cost of receivers for the two systems. It has been suggested that f.m. receivers will be more costly to manufacture, and that tuning is more difficult to achieve and maintain than for the corresponding a.m. receiver. On the other hand it is generally accepted that a wide-deviation f.m. system will result in a much better signal-to-noise ratio than a.m.

The design of the receiver described in this article was undertaken in order to find out whether it is practicable to obtain satisfactory performance from a receiver employing simple circuits and inexpensive components. It was designed for v.h.f. reception only and was intended to be comparable in cost and complexity with a medium priced domestic broadcast superheterodyne, but to realize the improvement in audio bandwidth which is possible at v.h.f. and the reduction in background noise of a wideband f.m. system. A total of seven valves is employed, their functions being, r.f. amplifier, frequency changer, i.f. amplifier, limiter, combined discriminator and first audio amplifier, output valve and rectifier. This is rather more than the medium-wave counterpart, but is largely offset by the absence of a ganged tuning



This top view of the receiver shows the position of the valves, mains equipment and controls. The chassis used measures 14 in x 8 in x 2½ in and the panel 14 in x 8 in. There is a ⅝-in spacing between panel and chassis to accommodate the cord drive for the tuning capacitor.

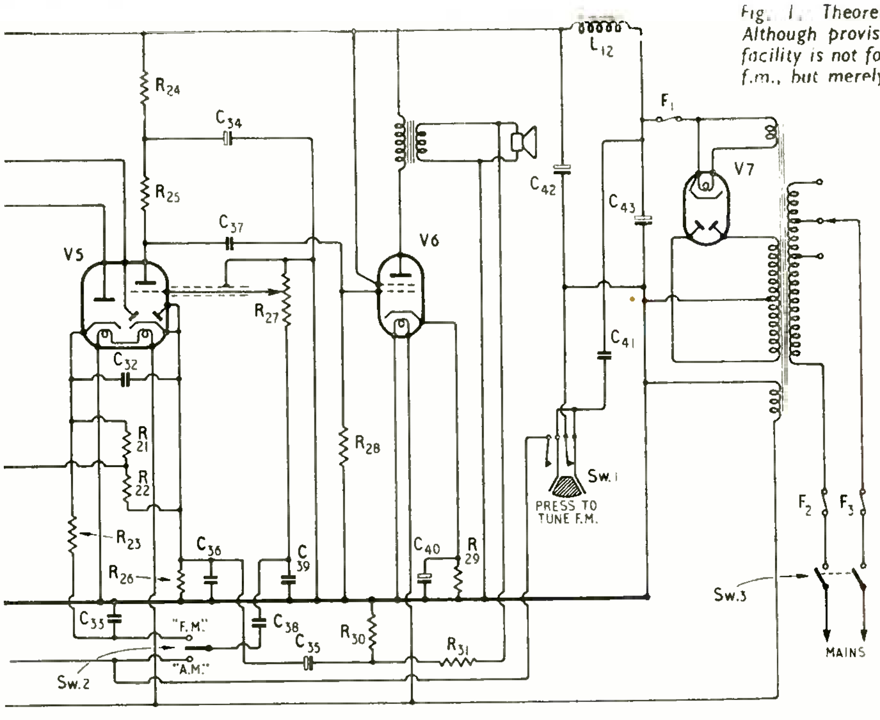


Fig. 1. Theoretical circuit diagram of the receiver. Although provision is made for a.m. reception, this facility is not for direct comparison between a.m. and f.m., but merely because an a.m. signal will appear on the limiter (V_4) grid when receiving an a.m. transmission.

assembly and the simple construction of the r.f. and i.f. coils.

Circuit.—The receiver is designed for an f.m. system employing ± 75-kc/s deviation and 50-μsec pre- and de-emphasis and covers a frequency band of 87.5 Mc/s to 95 Mc/s. The circuit is given in Fig. 1.

The first stage is a pentode r.f. amplifier (V_1), which is followed by a triode-hexode oscillator and mixer (V_2.) The r.f. circuits are not continuously tuneable as the frequency coverage of the receiver is only some 8 per cent of the mid-band frequency and the increased sensitivity at the ends of the band which could be obtained by employing continuous tuning would not justify the difficulties involved in ganging. No lumped capacitance is used in these circuits, since by tuning with stray capacitances only, the L to C ratio is kept high, thus reducing the Q and giving a sufficiently uniform pass-band response while maintaining a high tuned impedance.

A.G.C. is applied to the mixer stage, the control voltage being derived from the limiter grid, to prevent the limiter being over-run by large carrier inputs.

The oscillator is a conventional tuned anode circuit, one point of interest being the frequency drift compensating device R_{10} and C_{19}. This is a high negative temperature coefficient ceramic capacitor which is heated by a resistor connected across the valve heater supply. Its function is to correct for the rapid initial drift of local oscillator frequency which occurs immediately after switching on due to heating in the oscillator valve.

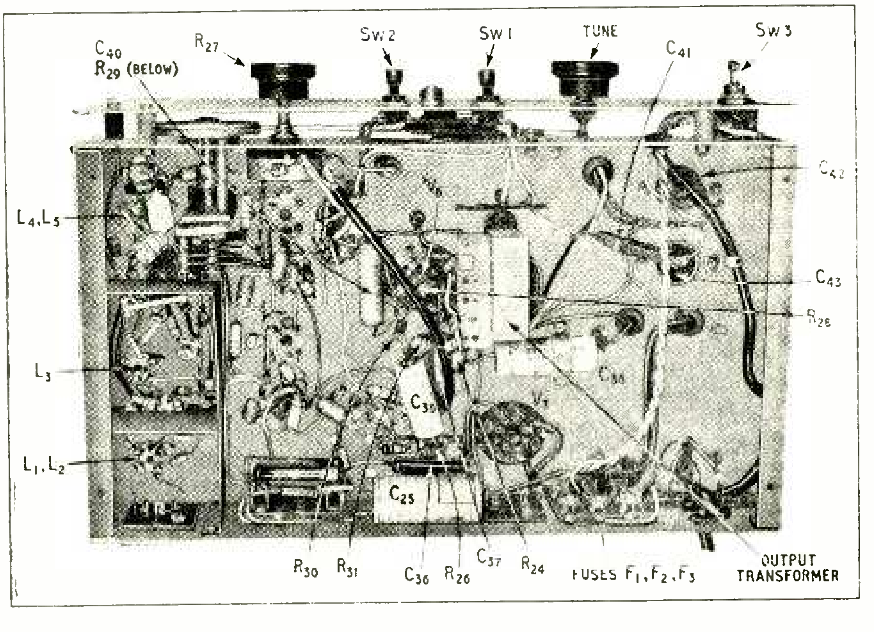
The i.f. amplifier is a single high slope pentode (V_3) and is followed by a pentode limiter stage (V_4).

Provision for a.m. reception is made by utilizing the limiter grid as a detector, and the audio output is fed to V_5 through the i.f. filter R_{11}, C_{39}, and the a.m./f.m. switch SW_2.

To facilitate accurate tuning on f.m., a spring-loaded push-button switch SW_1 is provided, which when pressed, injects into the limiter grid circuit an a.c. voltage derived from the cathode of the rectifier V_7. This amplitude modulates the carrier and if the receiver is incorrectly tuned gives an audible hum in the output. When the receiver is correctly tuned however and the i.f. carrier is at the mid-frequency of the discriminator, the latter does not respond to amplitude modulation and the hum is at a minimum.

V_5 is a triple-diode-triode, functioning as a Foster-

View of the underside of the chassis showing the general layout and the annotation will enable most of the visible components to be identified.



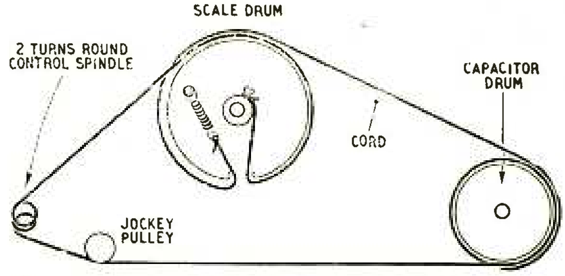
Seeley phase discriminator and first audio amplifier. Only two of the diodes are employed but a normal double-diode-triode cannot be used as the two diodes must have separate cathodes.

The output stage is a single tetrode with negative feedback from the output transformer secondary applied to the cathode of V_5.

Construction.—Winding data and diagrams for the coils are given in Table 1 and Fig. 2. All the i.f. coils should be lightly brushed with polystyrene varnish after winding, to prevent any subsequent movement of slack turns.

TABLE 1.

COIL	WINDING DETAILS
L_1	1 turn 20 s.w.g. insulated wire interwound with L_2.
L_2	6 turns 20 s.w.g. spaced to occupy $\frac{3}{8}$in on Neosid former Dwg. 351/8BA with Dwg. 500 dust core grade 901.
L_3	6 turns 20 s.w.g. spaced to occupy $\frac{3}{8}$in Former and core as L_2.
L_4	2 turns 20 s.w.g. insulated wire interwound with L_5.
L_5	3 turns 20 s.w.g. spaced to occupy $\frac{5}{16}$in on former as L_2. No core.
L_6 L_7	Each consists of 40 turns 38 s.w.g. enamelled wire close wound with 10-mm spacing between adjacent ends of coils. Both coils to be wound in same direction and connections made to pin numbers shown in Fig. 2. Aladdin former Type PP5937 and PP5939 with cores grade "A," Type PP5839. Can, John Dale Ltd. Type DTV1.
L_8 L_9	Each consists of 35 turns 32 s.w.g. enamelled wire close wound with 6-mm spacing between adjacent ends of coils. Former, cores, can and winding direction as L_6 and L_7 with similar pin connections.
L_{10}	22 turns 32 s.w.g. enamelled close wound.
L_{11}	26 turns 32 s.w.g. enamelled close wound in two layers of 13 turns each, one layer outside the other, and centre-tapped (see text). Spacing between adjacent ends of L_{10} and L_{11} is 5 mm Former, cores and can as L_6 and L_7. Connections as in Fig. 2.



Schematic layout of the cord drive located behind the panel. A $2\frac{1}{8}$-in drum is used for the capacitor and one of $2\frac{3}{4}$-in, running loose on a spindle fixed to the panel, carries the pointer. The driving head is the J.B. Type A.

Insulated sleeving is called for in the grid coil of the oscillator assembly, as there is a potential difference of 100 V between the two windings. The overall diameter of the sleeving used should not be too large in order that it may be interwound with the anode coil when the latter is wound with turns equally spaced and filling the specified winding length.

The i.f. transformers are quite straightforward, to facilitate adjustments of coupling, should they be necessary, the primaries are not wound directly on the former, one turn of adhesive cellulose tape is put on first, adhesive side outward, and the primary is wound over this. Provided the coil is not wound on too tightly it will then slide quite easily along the former.

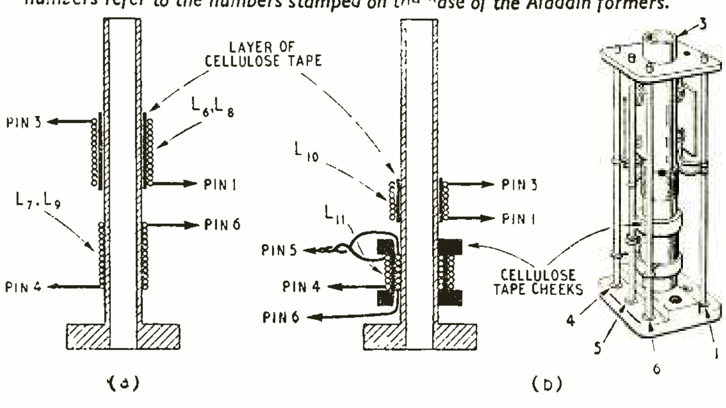
The i.f. tuning capacitors C_{12}, C_{13}, C_{23} and C_{24} are mounted inside their respective cans.

The secondary of the discriminator transformer, L_{11}, is centre-tapped. In order to minimize leakage inductance and to ensure symmetry of the two halves about the centre tap, which is essential for correct operation, it is wound in two layer form. The suggested winding procedure is as follows:—Start the first layer about $\frac{1}{4}$ in up from the base of the former, wind on 13 turns and cut off the wire, leaving an inch or so for connecting and securing the two ends of the coil temporarily with cellulose tape. Next wind on a few turns of cellulose tape cut down to a width of $\frac{1}{8}$ in, hard against each end of the coil. This will provide two end cheeks between which to wind the second layer and will prevent the end turns of the latter from "spilling" over. Put one turn of cellulose tape, cut to the required width, over the first section to provide a smooth base for the second layer and then wind on the second section, starting again at the base end of the former and winding this time in the *reverse* direction. Finally connect together the ends of the two sections remote from the base of the former to make the centre tap. Great care should be taken that both halves are identical, with no loose turns or gaps in the winding, to ensure that the coil is symmetrical about the centre tap.

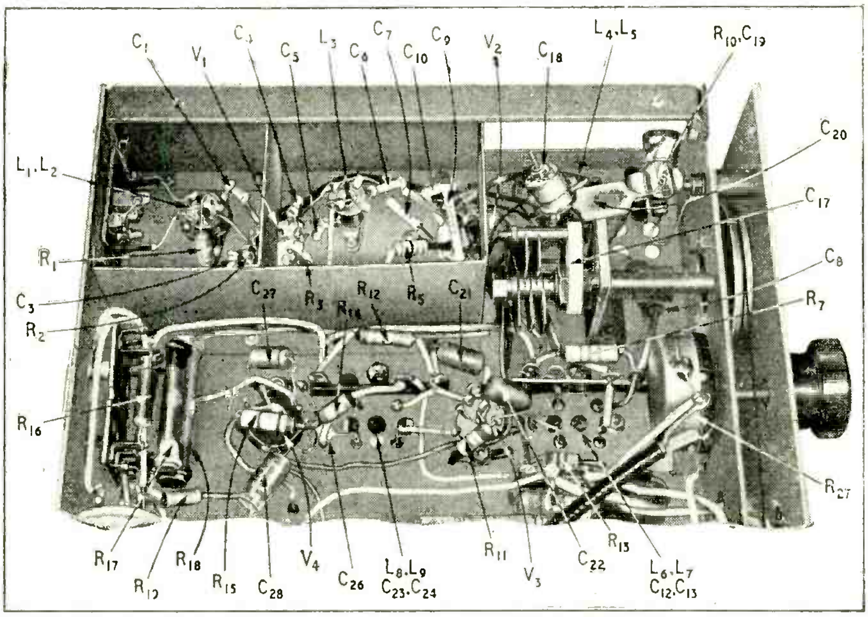
The discriminator primary, L_{10} is wound in the same way as those of the i.f. transformers to allow for coupling adjustment. Capacitors C_{29}, C_{30} and C_{31} are mounted inside the discriminator can.

If the specified chassis layout is adhered to, little difficulty should be experienced with the construction of the receiver.

Fig. 2. Sketch of i.f. (a) and discriminator (b) transformers. The pin numbers refer to the numbers stamped on the base of the Aladdin formers.



Enlarged view of the r.f. and oscillator portion of the receiver. The majority of the components are annotated and can be identified by reference to the circuit diagram.



All decoupling circuits should be returned to the same earth point for each valve to avoid the possibility of coupling through common chassis paths. In the case of the r.f. circuits the decoupling point is the cathode pin of the valve holder, as shown in the circuit diagram. This is particularly important because the impedance of even a short length of wire is appreciable at the signal frequencies involved.

For the same reason all wiring in the r.f. section of the receiver must be as short and direct as possible; C_{16}, for example, is connected directly between the moving vane contact of the tuning condenser and the low potential end of the oscillator anode coil. Any lead of excessive length here will appreciably lower the oscillator frequency, and may make it impossible to tune to the top end of the band.

An earthing clip must be provided at the socket

LIST OF PARTS

Capacitors:

C_1—C_6, C_{11}	= 1,000 pF (Ceramic)
C_7, C_{33}, C_{39}	= 100 pF (Ceramic)
C_8, C_{28}	= 0.01μF
C_9, C_{10}	= 2,200 pF (Ceramic)
C_{12}, C_{13}	= 20 pF (Ceramic)
C_{14}	= 0.1 μF
C_{15}	= 20 pF + 10 per cent (T.C.C. Type SCT7)
C_{16}	= 680 pF (T.C.C. Mica Type 101SMP)
C_{17}	= 5–15pF (see text)
C_{18}	= 2–8pF (Pre-set)
C_{19}	= 20 pF $\pm$ 10 per cent (T.C.C. Type SCD4)
C_{20}	= 18 pF $\pm$ 10 per cent (T.C.C. Type 101SMP)
C_{21}, C_{22}, C_{27}	= 0.03μF
C_{23}, C_{24}, C_{30}, C_{31}, C_{32}	= 50pF
C_{25}	= 32μF (100 V wkg.)
C_{26}	= 30pF
C_{29}	= 70pF
C_{34}, C_{43}	= 8μF (450 V wkg.)
C_{35}	= 25μF (12 V wkg.)
C_{36}	= 0.003μF
C_{37}	= 0.02μF
C_{38}	= 0.05μF
C_{40}	= 50μF (12 V wkg.)
C_{41}	= 1,000 pF (Mica)
C_{42}	= 16μF (450 V wkg.)

Resistors:

R_1, R_{19}	= 39kΩ
R_2, R_{11}	= 180Ω
R_3, R_7	= 4.7kΩ
R_4, R_9	= 1kΩ
R_5, R_{14}	= 47kΩ
R_6	= 220Ω
R_8, R_{15}, R_{21}, R_{2}	= 100kΩ
R_{10}	= 68Ω (Erie Type 8)
R_{12}	= 2.2kΩ
R_{13}	= 1.5MΩ
R_{16}	= 5.6kΩ
R_{17}	= 10kΩ (1 W)
R_{18}	= 10kΩ (2 W)
R_{20}	= 10kΩ
R_{23}	= 470kΩ
R_{24}	= 27kΩ
R_{25}	= 270kΩ
R_{26}	= 3.3kΩ
R_{27}	= 500kΩ (Pot)
R_{28}	= 1MΩ
R_{29}	= 90Ω
R_{30}	= 5Ω
R_{31}	= 100Ω

Switches:

SW1 Spring loaded push switch, contacts one make one break.
SW2 Single pole change-over.
SW3 Double pole on-off 230 V 1A pattern.

Choke L_{12}, 15–20H, 100 mA.

1 Cord drive drum, 2⅛ in	Jackson Bros.
1 Cord drive drum, 2¾ in	Jackson Bros.
1 Cord drive head Type A	Jackson Bros.
1 Pully ½ in dia and pivot	Jackson Bros.
1 Cord suspension spring	Jackson Bros.

Valves:

V_1, V_3	= Mazda 6F12
V_2	= Marconi-Osram X81
V_4	= Mullard EF42
V_5	= Brimar 6T8
V_6	= Marconi-Osram KT61
V_7	= Brimar 5Z4G

Mains transformer.
250-0-250 V r.m.s. 100 mA; 6.3 V 3A; 5 V 2A

Note. All capacitors 350 V wkg. unless otherwise stated. All over 1 μF electrolytic. Miniature types preferable but only essential in r.f. and oscillator sections. All resistors ½ W unless otherwise stated.

of the frequency changer to earth the metal can of the X81. Any of the retaining devices which grip the base of the valve are satisfactory.

For the frequency drift compensating network, C_{19} and R_{10} are mounted in physical contact with each other in a small spring clip of the type used for mounting vitreous wire-wound resistors. The construction of this assembly is shown in Fig. 3.

To minimize oscillator frequency drift it is important that the components in the oscillator circuit should be of the types specified in the list of parts.

Small changes of wiring in this part of the circuit may alter the effect of the drift compensating network. This can be adjusted by changing the capacitance of C_{20}. Increasing this capacitance will increase the upward movement of frequency during the warming-up period and vice versa.

Ventilating holes should be provided in the chassis deck above the oscillator section and in the cabinet base below it to facilitate ventilation.

The tuning condenser C_{17} used in the prototype receiver was a Raymart type MC15DX, nominal capacitance 5 to 15 pF, with one stator vane removed. Thus modified it gives a range of 3 pF to 11.5 pF and any component of similar physical size and with this capacitance range can be used. The tuning range obtained with this variation of capacitance is from 86.5 Mc/s to 96.0 Mc/s, which is somewhat wider than the normal requirements for this band.

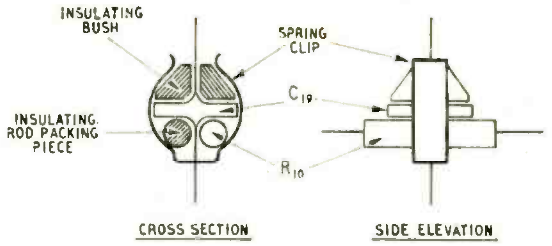


Fig. 3. Details of the frequency drift compensating unit which is described in the text.

Screened wire is used for the lead from the gain control R_{27} to the grid of V_5 to avoid hum pickup and low capacity cable should be used to prevent attenuation of the upper audio frequencies. Coaxial r.f. cable is ideal for the purpose.

The values of the resistors R_{30} and R_{31} are chosen for an output transformer designed for a 3-Ω load. Should a transformer with a different ratio be used these values should be adjusted for the correct voltage feedback.

(To be concluded)

Ringing-Choke E.H.T. Systems

Part 1—Half-wave Rectifier

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

IT has now become almost standard practice to derive the e.h.t. supply for a television receiver from the line flyback. There are, however, cases where it may be desirable to use some other system and one of the most convenient of these is the so-called ringing-choke method. It is, in fact basically the same as the ordinary flyback method but because the e.h.t. and scanning circuits are quite separate each can be of optimum design for its own needs and, in particular, a simple voltage-regulating system can be provided.

Like the flyback system, the ringing-choke circuit depends on the interruption of current in an inductance or, rather, since capacitance is never negligible, in a tuned circuit. The circuit oscillates as a result and the voltage waveform is a damped oscillation. In the scanning circuit such oscillations cannot be permitted or must be confined to a single half-cycle within the flyback period. In the e.h.t. system they can be allowed.

The basic circuit is shown in Fig. 1, where R represents the circuit losses and C the total stray capacitance. If the Q ($= R\sqrt{C/L}$) is reasonably high the natural frequency of oscillation is very nearly $f = 1/2\pi\sqrt{LC}$.

If the valve is suitably biased and a large saw-tooth voltage is applied to the grid, its anode current will remain cut-off for a considerable part of the cycle. This grid voltage is shown in Fig. 2 (a), in which the cut-off voltage is indicated by AB, and the resulting anode current has the form (b). The current rises more-or-less linearly to a maximum value i_p in the period τ_r and is then suddenly cut-off. This kicks the tuned circuit into oscillation and the resulting anode-voltage waveform is like Fig. 2 (c).

It is not difficult to show that the magnitude of the first positive peak of voltage is, very nearly,

$$V_m = i_p\sqrt{xL/C} \quad .. \quad .. \quad .. \quad .. \quad (1)$$

where x is the fractional *current* overshoot in L and is equal to $\epsilon^{-\pi/2Q}$. The first negative half-cycle has the value $-i_p\sqrt{x^3L/C} = -xV_m$. Thereafter each positive half-cycle has a peak value x^2 times its previous positive peak and each negative peak is x^2 times the previous negative peak. The number of cycles which occur before the train of oscillations becomes negligibly small depends on the damping. In practice, when the valve starts to conduct, its a.c. resistance damps the circuit and the oscillations do not usually persist for more than a cycle or so after it has started to conduct. Although the valve is a pentode, the type normally used has quite a low a.c. resistance for a pentode—of the order of 20,000 Ω only. The valve can, therefore, damp the circuit quite heavily.

The e.h.t. supply is obtained from these oscillations by applying them to a rectifier which can be a half-wave type or a voltage-multiplier. For a half-wave rectifier, the output cannot exceed V_m and will usually be some 10% less.

The foregoing relation between the amplitudes of successive peaks holds only in the absence of rectifiers. When these are present they extract energy from the circuit and the following cycle is consequently of smaller amplitude. An exact analysis is quite difficult. A fairly exact one has been made for a half-wave rectifier,[1] however.

Consider a train of damped oscillations as shown in Fig. 3. They are produced by the sudden interruption in the supply of a current i_p to L—the current being supplied by the valve of Fig. 1. The initial energy stored in L is $Li_p^2/2$. With no rectifier, the energy is transferred to the capacitance when the current has fallen to zero and the amount stored in it is then $CV_m^2/2$. This energy is less than that originally stored in L because some has been lost as heat in the circuit. From (1) $CV_m^2/2 = xi_p^2L/2$ and so the lost energy is $(1 - x)\ Li_p^2/2$; it is from this relation that equation (1) is obtained.

Now with a half-wave rectifier the circuit becomes Fig. 4. For simplicity we assume a perfect rectifier which is an open circuit when the voltage across C_1 is less then the voltage on the tuned circuit and a short circuit when it is greater. We assume also that C_1 is so large that the voltage across it cannot change appreciably in any time interval under consideration. Let C_1 be charged to a voltage V_1 less than V_m. When the voltage across C reaches V_1 the rectifier conducts and C and C_1 become in parallel. The voltage across both is then held at V_1 and the current in L flows into C_1, except for some, V_1/R, in the shunt damping resistance. When the total current in L has fallen to V_1/R the voltage can no longer be maintained and falls, so that the rectifier open-circuits to disconnect C_1. This capacitance has gained energy during the conductive period of the diode and it gives this out again in its turn to the load circuit.

The circuit is left with energy $CV_1^2/2$ in C and the voltage V_1 across it. The difference, $Li_p^2/2 - CV_1^2/2$, has been partly expended as heat in the circuit resistance and partly passed to C_1. In effect, a new cycle of oscillation now commences with initial energy $CV_1^2/2$. The second positive peak can have an amplitude of only x^2V_1 and must always be less than V_1. The rectifier thus cannot become conductive again on any positive half cycle after the first. The rectifier action is entirely confined to the first positive half cycle.

Basic Energy Relations

Precise relations for finite damping were given in the article already referred to. If the circuit losses are low enough to be ignored, however, it is very easy to derive some simple relations which, if only approximate, have the great merit of showing the important factors. If losses are negligible, the initial energy $Li_p^2/2$ in L and the energy stored in C at the peak, $CV_m^2/2$ are equal.

When the diode conducts the energy in C is $CV_1^2/2$, the difference $Li_p^2/2 - CV_1^2/2$ is passed into C_1. Now during the whole time C_1 is delivering a constant current i_0 to the load circuit; it delivers an output power i_0V_1 and so during one complete cycle of duration τ (the interval between successive interruptions of i_p) it loses energy $i_0V_1\tau$. In the equilibrium condition the energy gains must equal the energy lost and so

$$i_0V_1\tau = C(V_m^2 - V_1^2)/2 \quad \ldots \quad \ldots \quad \ldots \quad (2)$$

If the output energy $i_0V_1\tau = W_0$ and the energy initially stored in the tuned circuit $\frac{1}{2}Li_p^2 = \frac{1}{2}CV_m^2 = W_s$ the above equation can be written in the very simple form

$$\frac{V_1}{V_m} = \sqrt{\left[1 - \frac{W_0}{W_s}\right]} \quad \ldots \quad \ldots \quad \ldots \quad (3)$$

$$\approx 1 - \frac{W_0}{2W_s} \text{ when } 1 \gg W_0/W_s.$$

For constant stored energy, V_m is also constant, and so we find that the output voltage V_1 falls as the output energy increases. The mean current taken by a cathode-ray tube varies with the mean picture

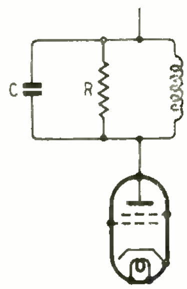


Fig. 1. Basic circuit of ringing-choke e.h.t. supply unit without the rectifier system.

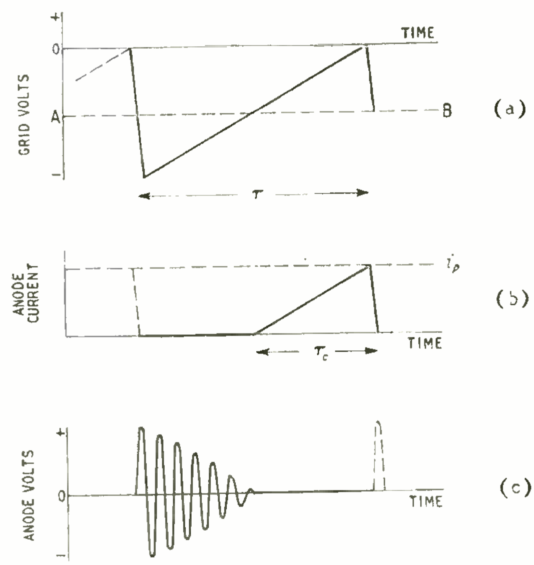
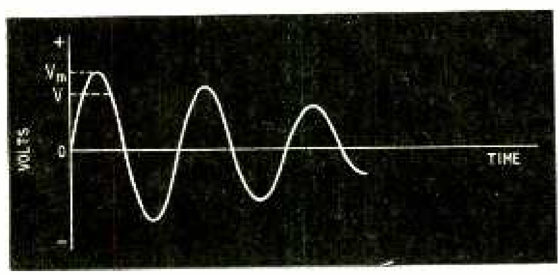


Fig. 2. Waveforms in the circuit of Fig. 1; (a) grid voltage, (b) anode current and (c) anode voltage.

Below: Fig. 3. Damped oscillation forming the anode potential of the driving valve.



[1]"Flyback E.H.T.," by W. T. Cocking, *Wireless World*, August and September 1950.

brightness and unless the voltage stays constant both focus and deflection sensitivity vary in some degree. The voltage regulation of the supply is, therefore, an important matter.

It may be expressed in several ways. One is to take the ratio of the voltage change from full load to no load to either the full-load or the no-load voltages [that is, $(V_m - V_1)/V_1$ or $(V_m - V_1)/V_m$]; the figure is the fractional voltage regulation or, if multiplied by 100, the percentage voltage regulation. Another method is to express it as an equivalent resistance by dividing the change of output voltage by the change of output current which causes it [that is, $R_i = (V_m - V_1)/i_0$]; it is in some ways a good method, but means little unless the voltage is stated also. However, the other way also means little unless the change of current is stated.

In this article the change of current used is always 100μA, and is from zero to that figure. The regulation is then $(V_m - V_1)/V_m = 1 - V_1/V_m$ and can be obtained directly from equation (3). As long as W_0/W_s is small compared with unity

$$\frac{V_m - V_1}{V_m} = \frac{\Delta V_1}{V_m} = \frac{1}{2} \cdot \frac{W_0}{W_s} \quad \ldots \quad (4)$$

If it is desired to express the regulation in the form of an internal resistance, this is readily done, for

$$R_i = \frac{V_1}{i_0} \approx \frac{V_m}{i_0} \cdot \frac{1}{2} \frac{W_0}{W} = \frac{V_1/i_0}{2W_s/W_0 - 1}$$

Here V_1/i_0 is, of course, the resistance of the external load circuit.

This expresses the regulation of the system due to the LC circuit and assumes a perfect rectifier. With any practical rectifier the regulation will be poorer. The relation is very important for it shows that, apart from the rectifier, the regulation depends only on the ratio of the output to the stored energy and that good regulation requires a large stored energy which, in its turn, naturally means a large power input to the stage.

Required Voltage Regulation

Since the deflectional sensitivity of a magnetic c.r. tube is proportional to $1/\sqrt{V_1}$ it is necessary for the regulation to be 2% if the picture width and height are to change by only 1% for a change of beam current of 100 μA. On a 10-in picture this means a change of 0.1 inch. In practice a bigger change is often tolerable because changes of picture brightness from black to peak white are rare. Normal brightness changes are probably no more than 25% of the maximum possible, and then a regulation of 8% will not alter the picture size more than 1%. Because of this, a regulation of 8-10% is often considered satisfactory and one of 4-5% is thought to be good. Since the effect of the rectifiers is not included in the present discussion it is desirable to make the computed regulation around 2%.

As equation (4) shows, this demands $W_0/W_s = 0.04$; that is, the stored energy must be 25 times the energy supplied to the load. If the circuit of Fig 4 is driven at line-scan frequency the period τ is nearly 100 μsec. If the output voltage of V_1 is 10 kV and the current i_0 is 100 μA, the output power P_0 is 1 watt and the output energy is 10^{-4} joule. The stored energy must then be 0.0025 joule, and as it must be supplied afresh every scanning cycle (10,000 c/s), the power needed is 25 watts. This is apart from losses, such as the anode dissipation of the valve.

Referring to Fig 2 (b) the anode current of the valve is of triangular waveform and rises more or less linearly to i_p in the period τ_c. Assuming the rise to be actually a linear one, the mean anode current of the valve and the back e.m.f. across L are

$$i_a = \frac{i_p}{2} \cdot \frac{\tau_c}{\tau} \quad \ldots \quad (5)$$

$$E_L = L i_p/\tau_c \quad \ldots \quad (6)$$

In practice it is necessary for the h.t. supply voltage to be greater than E_L by the minimum permissible anode voltage V_a of the valve, usually 60-100 V.

Turns Ratio

One minor difficulty arises. Any practical valve has a peak anode voltage rating which must not be exceeded. In the circuit of Fig 4, V_m must not exceed this figure, and so the output is limited. This is easily overcome, however, by tapping the anode down the coil, as shown in Fig 5. If the ratio (turns 1-3)/(turns 1-2) is n, then the equations already given still apply if all currents and voltages pertaining to the valve are multiplied and divided respectively by n. That is, design is carried out for a unity ratio and then the ratio is chosen to bring the conditions within the limits of the valve and to the most convenient values.

Because of leakage inductance and stray capacitance, the performance is affected in other ways, and if it is to be reasonably close to calculation n must be restricted. It is inadvisable to make n more than about 1.5 for an air-core coil or about 2.5 for an iron-core component. Greater ratios can be used, but more experimental work in the determination of final values will be needed.

As an example of the procedure, let us now consider the example which has already been taken; that is, of a supply of 10 kV at 100 μA with a regulation of 2%. As we have seen, the stored energy W_s is 0.0025 joule.

It is hardly safe to take the self-capacitance of the coil as less than 10 pF and a metal rectifier for e.h.t. will add about 15 pF, so 25 pF is about the minimum safe value to take for C. A valve rectifier would add less, in itself only about 1 pF. The filament winding would increase it considerably above this, however, and it is a very troublesome matter for the experimenter to adjust a filament winding correctly.

Now since $W_s = \frac{1}{2}CV_m^2$ and for 2% regulation $V_m = 10.2$ kV, we find $C = 2 \times 0.0025/1.02^2 \times 10^8 = 4.8 \times 10^{-11}$ F = 48 pF. This is the capacitance required to store the necessary energy at 10.2 kV. It is greater than our assessment of the minimum practical value, and so capacitance sets no limit and we can proceed on the basis of C = 48 pF.

The value of L required depends on the peak current which the valve can provide, and we need to know the turns ratio n. A valve such as the PL81 is rated for a peak voltage of 7 kV positive or 5 kV negative. It is necessary to take the lower value because the anode voltage does swing negative on the second half cycle of oscillation. For this valve, n must be 2, at least. With an EL 38, the peak rating is 8 kV and no restriction is placed on the sign of the voltage. With this valve n need be 1.3 only. Assume this; then i_p for the valve is 150 mA and in the circuit is 150/1.3 = 115 mA.

Since $W_s = \frac{1}{2}L i_p^2$ we have $L = 2 \times 0{\cdot}0025/0{\cdot}115^2$

$= 3.76 \times 10^{-1}$ H = 376 mH. The natural frequency of oscillation is $1/6.28\sqrt{0.376 \times 48 \times 10^{-12}} = 10^6/26.5 = 3.78 \times 10^4 = 37.8$ kc/s. The time of one cycle is 26.5 μsec. This frequency is rather low, for if τ_c is made 50 μsec there is time for something less than two cycles of oscillation only during the non-conductive period of the valve. If we arbitrarily take τ_c as 50 μsec, the back e.m.f. across L is $E_L = 0.376 \times 0.115/50 \times 10^{-6} = 870$ volts. On the valve this becomes 870/1.3 = 670 V. The h.t supply must, therefore, be around 750 V The mean anode current is $i_a = \frac{150}{2} \cdot \frac{50}{100} = 37.5$ mA and the power drawn from the h.t. supply is 760 × 0.0375 = 28.5 W. The anode dissipation of the valve is 28.5 − 25 = 3.5 W.

There are two features about this design which are unsatisfactory, apart from the large total input power; they are the low frequency of oscillation and the very high voltage needed for h.t. The latter can be reduced only by increasing the current, and this may entail the use of valves in parallel.

If poorer regulation can be tolerated the power can be reduced by operating with less stored energy. This entails a reduction of capacitance, and so there is a limit to the amount by which the stored energy can be reduced, a limit set by what it is practicable to achieve in capacitance.

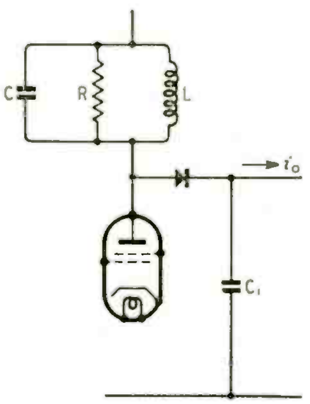
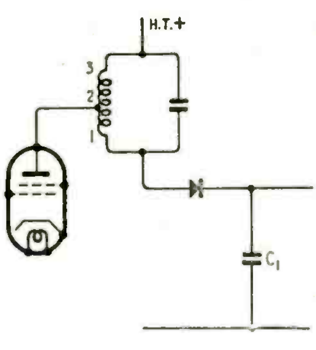


Fig. 4. Basic e.h.t. supply circuit; a rectifier and reservoir capacitor have been added to Fig. 1.

Fig. 5. When the voltage across the inductance exceeds the peak voltage rating of the valve the anode can be tapped down the coil.



It was earlier estimated that the capacitance was likely to be 25 pF as a minimum. Taking it as 24 pF for convenience (one-half of 48 pF), the stored energy is halved and so the regulation becomes 4%. The inductance is halved and becomes 188 mH for the same current. The natural frequency is four times as great (151.2 kc/s) and the number of cycles permissible for $\tau_c = 50$ μsec is nearly eight. The tapping point on the coil, being set by the peak voltages remains unchanged. Since L is halved and the current is unaltered, E_L is halved and becomes 355 V so that the h.t. supply drops to about 425 V. The valve currents are unaltered and the input power falls to 425 × 0.0375 = 16 W.

This is a considerable improvement, but the power is still high. If we could again halve the capacitance the regulation would become 8% and the back e.m.f. on the valve would drop to 167.5 V, so that an h.t. supply of 257.5 V would suffice. The power input would become 9.75 W. This is a reasonable condition and by varying the tapping point on the coil to change the ratio of valve voltage to current we could modify the conditions over a small range to suit a particular h.t. supply voltage.

It is almost certainly possible to achieve a capacitance of only 12.5 pF by careful design when a valve rectifier is used. It is very doubtful if it is possible with existing types of metal rectifier. A regulation of 8% would be tolerable for some purposes, and a system of this basic regulation or worse can be made to have any required improvement by the addition of a voltage regulator. It is possible in this way to obtain an improvement of the order of 5 : 1.

Repetition Frequency

So far no mention has been made of the effect of varying the repetition frequency of the saw-tooth driving waveform, and it has been assumed that it will be at line-scan frequency, some 10 kc/s. This is usually the most convenient frequency, since the e.h.t. supply unit can then be driven from the line timebase.

If τ is increased, by lowering the frequency, the output energy W_0 required per cycle is increased in proportion. For the same voltage regulation the stored energy W_s must also be increased in proportion. This stored energy has to be supplied anew only $f(= 1/\tau)$ times as often, so that the input power remains unchanged. If the conductive period of the driving valve is increased in proportion, so that τ_c/τ is constant, E_L will be inversely and i_a directly proportional to τ. The voltage/current ratio in the driving valve will change, which may or may not be convenient. Generally speaking, therefore, the frequency of the driving wave is not very important, and there is usually no point in departing from the time-base frequency.

For the same regulation, therefore, there is usually no point in making the driving frequency different from the scanning frequency. Generally it is a disadvantage to make it different because a special generator of the driving waveform becomes necessary whereas, if operation is at line-scan frequency, the valve can be driven from the line time base. Moreover, if the frequency is appreciably reduced, a larger reservoir capacitance must be used.

If the regulation is not kept unchanged, however, conditions are different. If W_s is kept constant while τ is increased the regulation varies as $1/\tau$ and as W_s has to be supplied $1/\tau$ times a second, the input power varies as $1/\tau$ and falls as τ is increased.

The whole point of using a regulator with a circuit of this type is to enable the input power to be reduced without affecting the regulation. Now at a driving frequency of 10 kc/s it does frequently happen that it is impossible to make C small enough for the regulation to be worse than 5% or so. The input power is then still large and cannot be reduced by adding a regulator. However, by increasing τ (lowering the frequency) the regulation is made worse and the input power reduced and the regulator is worth while. Because of this there are cases where a lower driving frequency is an advantage and frequencies down to 1 kc/s are used commercially; e.g., in the Mullard 25-kV e.h.t. unit for projection television. As will appear later, the use of a voltage-multiplying rectifier offers an alternative and more convenient solution, and for the rest of this article a 10-kc/s driving wave will be assumed.

Aircraft Radio on Show

Suppressed Aerials, Latest Radio, Radar and Navigational Aids

THE higher speeds now attained by passenger aircraft has given the radio engineer a new set of problems to tackle and not the least of these is the installation of aerials. Even if it carries only a portion of the many radio aids to navigation now available a modern airliner may require up to a dozen different aerial systems, for on long distance routes, m.f. and h.f. communications, d.f., v.h.f. and some of the many homing and position finding systems, and possibly a radio altimeter, will be essential equipment.

In very few cases can one aerial be used for more than one service and the problem is how to fit all those required on a thoroughly streamlined aircraft without introducing "drag" and so impairing its flying efficiency.

The latest technique is to build the aerials into the body of the aircraft and this is a matter that must be decided at a very early stage in the construction of the 'plane, and preferably at the drawing-board stage. Some examples of this practice were seen at the recent flying display and exhibition held by the Society of British Aircraft Constructors at Farnborough, Hants. The installations designed for the English Electric Canberra and the De Havilland Comet and Ambassador were shown by the Marconi Company and a few other examples were seen elsewhere. An account of some measurements made on various types of these "suppressed" aerials, as they are called, was given in *Wireless World* of December, 1949.

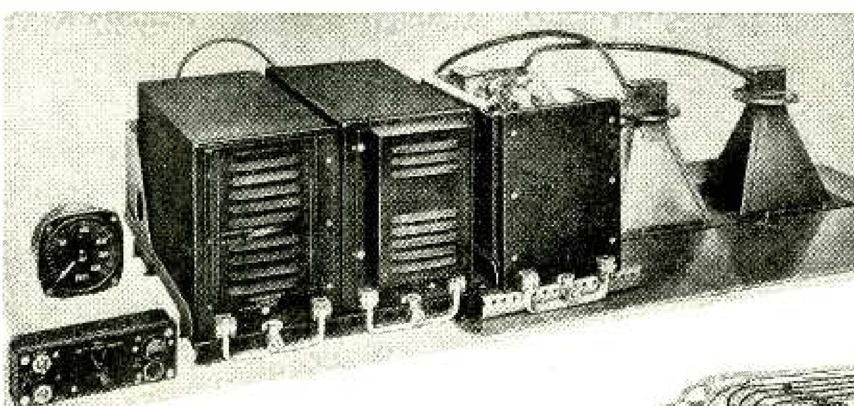
Typical of the way in which the actual structure of the aircraft is being used as a radio aerial is that of the tail fin of the Comet. This is a metallic structure and is insulated from the body of the aircraft by a 4-in section of insulation (fibreglass is used in this case). The metal skin of this fin is used as an aerial for h.f. and m.f. communications and in the top part, under a dome of fibreglass, is a wide-band v.h.f. aerial designed to cover the aircraft band of 118 to 132 Mc/s.

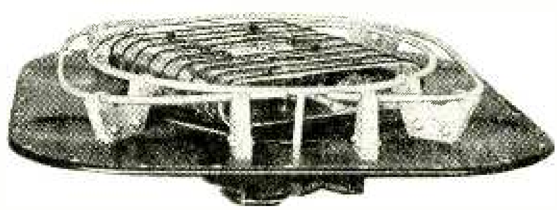
Doors enclosing retractable landing gear; body inspection covers and so on are also pressed into use to accommodate some form of radio aerial.

A new type of radio altimeter, or terrain clearance meter, made its appearance this year. Two firms were showing it and both employ the same basic principle. It is a frequency-modulated system and in the case of the Standard Telephones design, the Type STR30, operates in the 4,300-Mc/s band. A klystron-type oscillator is used for the transmitter, the output circuit being a section of waveguide two wavelengths long. Inside this is a tuning device resembling the vane of a variable capacitor and it is rotated by a small motor giving a sweep of 100 Mc/s or of 10 Mc/s as required, the former being used for the low altitude range covering 0-500 ft and the latter for the high, covering 0-5,000 ft. Separate indicating instruments are used for each range with the view to preventing ambiguity in reading and also to enable the most suitable type of scales to be employed, in this case logarithmic for the low and linear for the high. The lowest height marking is 5 ft and the accuracy is said to be ±2 ft or ±3 per cent, whichever is the greater.

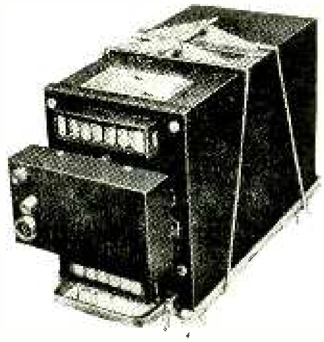
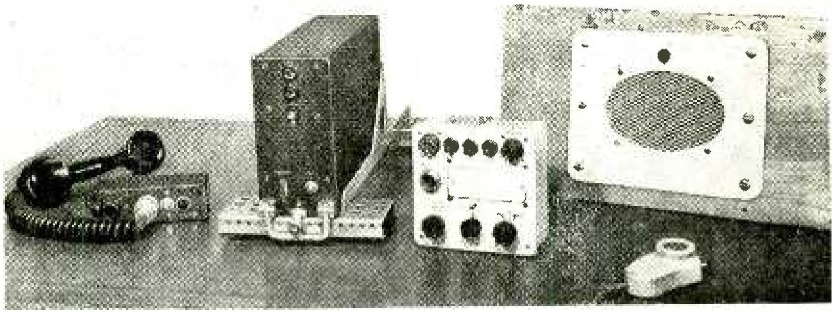
Separate aerials taking the form of small horns for recessed mounting in the aircraft are used for transmitter and receiver and these can be mounted as close as 1 ft apart, measured centre to centre.

The other radio altimeter was shown by Salford Electrical. It has been produced to Ministry of Supply requirements and is a single-range instrument covering 50-5,000 ft with a required accuracy of 3 ft ±3 per cent. Present indications are that readings below 50 ft will be quite reliable and the upper limit probably better than the specification. It also embodies a frequency modulated system employing a mechanical means of sweeping the frequency





Above: Standard Telephones radio altimeter Type STR30; the two horn "aerials" are on the right and the remote control unit with one height indicator on the left. Right: Recessed iron cored loop (inner) and sense aerial (outer) of the Marconi Type AD7092A automatic direction-finding equipment.

Left: Plessey Type PTR61, v.h.f. transmitter-receiver fitted with remote control attachment. The equipment provides 6 channels send and receive, for immediate operation. Right: Redifon Type A145 airborne passenger announcement system showing pilot's control (left), amplifier unit, steward's control and microphone and one of the 13 loudspeakers.

over a band of 50 Mc/s and it operates at a mean carrier frequently of 1,630 Mc/s. Slot aerials are used and mounted in weatherproof boxes designed for fitting flush with the skin of the aircraft.

The most up-to-date types of v.h.f. airborne radio-telephone equipment can be divided into two main categories. In the one are those sets capable of providing, at the turn of a switch, any one of the full number of radio channels available in the 118- to 132-Mc/s band and in the other sets which provide immediate selection of a limited number of channels and facilities for changing to any of the others by fitting the appropriate crystals.

Two firms, Marconi and Standard Telephones, have multi-channel sets of the first kind and both provide a complete coverage of the available channels with 24 crystals only and this includes both send and receive.

Basically, the principle of operation is the same in both sets but there are many differences in carrying out the idea. Two oscillators are used in the Marconi AD115 equipment, one, the major oscillator, has 14 switchable crystals whose frequencies are adjusted so that after a pre-determined multiplication a carrier output on each of the whole numbers of the working frequencies is obtained; e.g., 118, 119, 120 and so on to 132 Mc/s.

The other, or minor, oscillator is also crystal controlled and provides an output which when mixed with the major oscillator's output adds the required decimal portion of the frequency, for example, 0.1, 0.2, 0.3 Mc/s and so on.

At present the band 118 to 132 Mc/s is operated with 200-kc/s channel spacing and so 70 channels only are usable but future requirements will be for 100-kc/s spacing and then the 140 channels will be required. This equipment gives 15-20 watts output, has full remote control and operates on telephony or m.c.w.

In the Standard Telephones STR12C equipment 70 channels with 200-kc/s spacing are provided, but it is a simple matter to double this number when the need arises. A small remote control unit contains 24 miniature crystals and three oscillators, but two only are in use at any one time. It carries also two frequency selecting switches, one for whole numbers the other for the decimals, on-off switch and telephony or m.c.w. telegraphy switch. The carrier output is 15 watts.

Typical of the sets in the second category are the two Ekco models CE40, 11 channels, and CE58, 22 channels; Murphy MR60 and MR80, 5 and 23 channels respectively and Plessey PTR61 with six channels. The majority of the equipments in this category are low power sets being intended mainly for privately owned and light aircraft, where the requirements are a limited number of channels immediately available and facilities for changing to others, if necessary, in the air.

Some of the larger passenger aircraft now have several cabins, each seating 12 or more people and, although interconnected, dividing bulkheads isolate them to some extent. In these aircraft are now being fitted passenger announcement loudspeaker systems, generally under the control of the steward or stewardess but with over-riding control from the pilot's or navigator's positions.

An amplifier for an installation of this kind is made by Redifon; it is the Type A145, gives 15 to 20 watts audio output and is capable of operating 13 loudspeakers distributed throughout the aircraft. It fits the standard aircraft racking and has all cabling brought in at the back via plugs and sockets to simplify servicing.

Wide-band aerial amplifiers designed to do away with the forest of aerials which distinguish most ground stations working long-distance point-to-point and ground-to-air communication services were seen at the S.B.A.C. show. Plessey has developed one, the Type PV14, covering 2-25 Mc/s and which will operate up to ten communications receivers from a single aerial without mutual interference. The amplifier consists of two identical sections each having two EF91 valves in parallel and feeding five ECC91 valves operated as cathode followers. Each supplies a separate receiver. A modification of this amplifier is available for dual diversity reception, each half operating up to five receivers from two separate aerials.

Another example of a wide-band amplifier is the Redifon Type MCU1. It is designed to operate up to eight receivers from a single aerial. The input from the aerial is taken through a band-pass filter which accepts all signals within the band 2-20 Mc/s but heavily attenuates those outside this band. Following the filter are eight EC91 triodes operating as cathode followers and each feeding into a separate output for the eight receivers.

One of the latest secondary radar navaids, the interrogator-responder system known as DME (Distance Measuring Equipment) was shown by Ferranti. This operates in the 1,000-Mc/s band and provides the pilot of an aircraft with continuous visual information of the distance, and any deviation from the direct line of flight, to a selected ground beacon. Its effective range is about 200 nautical miles. Both ground and airborne equipments were on view.

Another navigational system well represented was Decca, which firm had a model of an anti-static aerial for aircraft consisting of a vertical streamlined and insulated mast with its leading edge cased in metal and acting as a shield for the aerial fitted in the centre of the mast. It is claimed that the earthed metal shield protects the aerial from charged rain and other static effects and provides a better signal-to-noise ratio than the usual unprotected aerial. This firm also included the latest Mark VII airborne Decca receiver designed for use in fast flying civil aircraft. It operates on a wider "lane" spacing than hitherto and includes a local oscillator which is locked to the master station's signals so that the operation of the set is not dependent entirely on the continuous reception of the master station. Complete interruption of several seconds' duration does not affect the operation or reliability of the system as a navigational aid. Including the control unit it weighs under 40lb.

SHORT-WAVE CONDITIONS

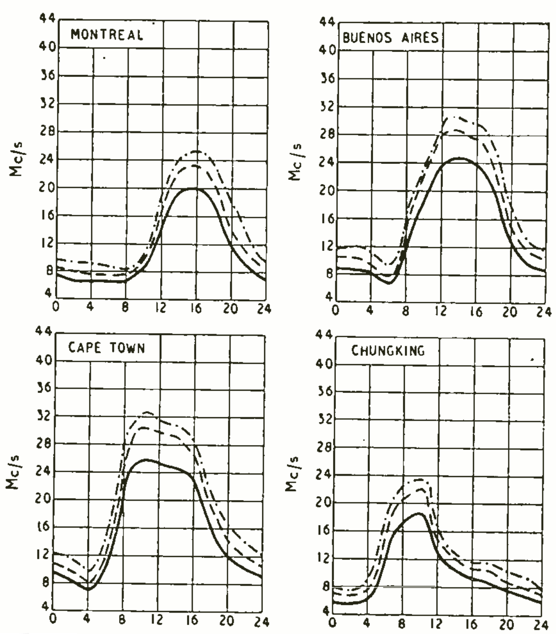
September in Retrospect : Forecast for November

By T. W. BENNINGTON*

DURING September the average maximum usable frequencies for these latitudes increased by day and decreased by night, which variations were in accordance with the normal seasonal trend. Daytime working frequencies did not, however, appear to increase, and 17 M/cs remained about the highest regularly usable frequency for east/west paths, though those up to 22 Mc/s were sometimes usable. Over north/south paths 24 Mc/s remained about the highest regularly usable daytime frequency. At night only the lower short-wave frequencies (6—7 M/cs) were generally usable, due mainly to the disturbed conditions which generally prevailed.

There was a sharp decrease in the amount of Sporadic E recorded. Dutch and German stations on frequencies around 94 Mc/s were frequently received during the first half of the month, and on isolated days towards the end, their signals being presumably heard due to tropospheric propagation.

* Engineering Division, B.B.C.



——— FREQUENCY BELOW WHICH COMMUNICATION SHOULD BE POSSIBLE ON ALL UNDISTURBED DAYS
– – – – PREDICTED AVERAGE MAXIMUM USABLE FREQUENCY
–·–·–· FREQUENCY BELOW WHICH COMMUNICATION SHOULD BE POSSIBLE FOR 25% OF THE TOTAL TIME

The average sunspot activity was considerably higher than during the previous month.

The month was notable for the very large amount of ionospheric storminess which occurred. Although the equinoctial months of March and September are generally badly disturbed, this September was exceptional for the long duration of the disturbed periods. In fact the whole period from the 9th to 28th was more or less severely disturbed, this being probably due to several different ionospheric storms following each other in quick succession, and possibly connected with the central meridian passages of sunspots on the 9th, 15th and 20th. There were accompanying magnetic disturbances of severe intensity and on several occasions aurora was observed in this country. The height of the disturbance occurred on the 25th, when the aurora was widespread and the magnetic disturbance reached the intensity of a "great magnetic storm." In the afternoon and evening of this day short wave reception was very poor and there was severe flutter fading with a "rumbling" background on nearly all stations. Both the rapid fading and the "rumble" were noticed even on medium wave reception later in the evening.

Five Dellinger fadeouts were reported during the month, those at 1057-1230 on 7th and 1500-1700 on 15th being of severe intensity.

Forecast: During November the daytime m.u.f. for these latitudes should continue to increase, whilst that for the night-time should continue to decrease. Working frequencies should, therefore, be relatively high by day, and on east/west circuits those up to 20 Mc/s should be regularly usable. It is unlikely, though, that those above 26 Mc/s will become usable over such circuits, except, perhaps, on one or two isolated occasions. Over north/south circuits frequencies up to 26 Mc/s should remain regularly usable, and those up to 32 Mc/s occasionally so, during the daytime. Medium-high frequencies will have to be used for an increasingly large proportion of the daily time, owing to the continued decrease in the hours of daylight. At night very low frequencies will have to be employed, and 6 Mc/s should be about the highest regularly usable frequency over most circuits.

Sporadic E capable of propagating very high frequencies is unlikely to be prevalent. Medium-distance communication will be controlled by the F_2 layer, and should therefore be possible on medium-high frequencies during the day, and only on the lowest short-wave frequencies at night.

The curves indicate the highest frequencies likely to be usable over four long-distance circuits from this country during the month.

Ignition Interference Suppressor

Suggestion for an Improved Television Limiter Circuit

By RONALD G. YOUNG

ONE of the difficulties encountered in receiving televised images is that of removing the "blobs" produced by unsuppressed car ignition systems. These are due to spot defocusing caused by intense positive or negative interference pulses (depending on whether grid or cathode modulation is used) being applied to the cathode ray tube.

There are two kinds of suppression systems in use and each depends on a clipping action on the waveform. The first, shown in Fig. 1, is a limiter with manual adjustment (applied to a cathode-drive modulator). If adjusted correctly this undoubtedly gives the better overall results, but it has the disadvantage that adjustment of the contrast control alters the threshold of clipping. At first sight this may seem irrational until it is realized that every adjustment of contrast requires a corresponding adjustment of brightness—which means a change of black level and peak white level.

Unless one resigns oneself to a constant contrast setting this can become a nuisance, so various attempts have been made to devise self-setting suppressors. A simple circuit used by home constructors and in certain commercial receivers is shown in Fig. 2. It gives extremely efficient suppression as the effect is augmented by instantaneous negative feedback from anode to grid. Although in theory the 0.1-μF capacitor should charge to a value equivalent to peak white, it actually reaches a value somewhat below this level and tends to clip highlights. Images above a certain brightness therefore lack detail and this is particularly noticeable when the relevant object is against a dark background.

The writer has attempted to devise a simple circuit (Fig. 3) which will combine the merits of both these methods and at the same time minimize their disadvantages as far as possible. It will be seen that a manual control is supplied, which can be set for optimum results on a normal picture. If, however, the contrast level is reduced (and brightness increased) the circuit self-biases itself to highlight level. This works out very well, in the writer's experience, because at low contrast there is little likelihood of a gloomy background, and, what is more important, over a long period of use it has been found that resetting is quite unnecessary under any circumstances. This in spite of repeated trials to see if the setting could be improved.

The method of setting recommended is simple. Choose a programme consisting of a fairly mixed range of contrasts (newsreels are probably as good as anything in this respect). Then reduce the value of the variable resistor until the highlights begin to be affected and lose detail. Finally adjust the setting so that no effect can be detected, just beyond this point.

In fringe areas, where more or less severe variations of signal take place, it may be found preferable to connect the 5-MΩ resistor to h.t.+ rather than to the anode. The connection shown, however, has been found better for normal conditions of steady reception, since the anode connection supplies a small amount of d.c. level to the diode and reduces any tendency for loss of highlight detail when receiving exceptionally dark pictures such as night scenes.

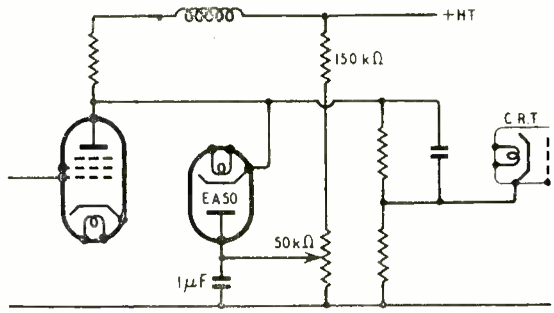


Fig. 1. Simple limiter with manual adjustment.

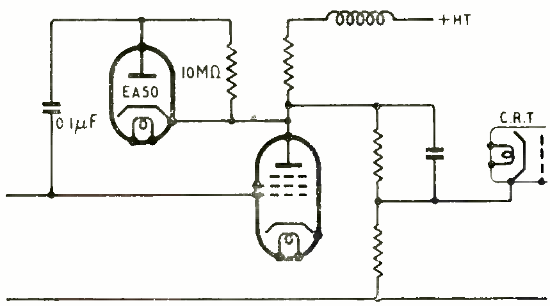


Fig. 2. Self-bias limiter acting by negative feedback.

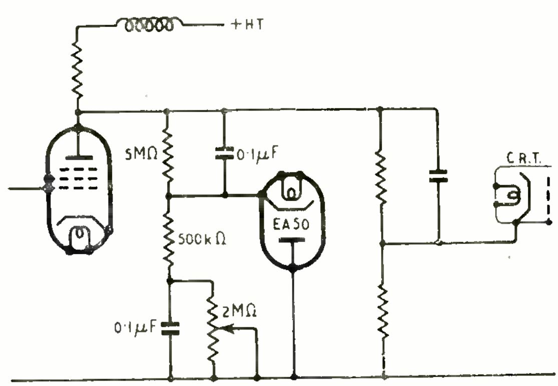


Fig. 3. Limiter combining manual setting with automatic self bias. Note that the 2-MΩ control may be connected by long wires because of the 0.1-μF capacitor acting as a filter.

Sensitive T.R.F. Receiver

3-Valve Circuit with Amplified A.G.C.

By S. W. AMOS,* B.Sc.(Hons) and G. G. JOHNSTONE,* B.Sc.(Hons)

THE 3-valve receiver descibed in this article was designed to use the amplified a.g.c. circuit described in last month's issue. It uses a t.r.f. circuit, chosen because such circuits are easier for home constructors to align than superhets. Nevertheless the perfomance of the receiver compares very favourably with that of a 3-valve superhet with a frequency-changer, i.f. amplifier and double-diode-pentode output; in fact the sensitivity and a.g.c. performance are better than that of the superhet. The selectivity is inferior but permits interference-free reception of 12 medium-wave signals during daylight in London, three of the signals being between the Home Service (908kc/s) and the Light Programme (1214kc/s).

It is unusual to apply a.g.c. to a t.r.f. receiver because the gain is not normally adequate to make its application worthwhile. If the receiver has to operate at maximum gain to give adequate output from an aerial signal of, say, 1mV amplitude, the a.g.c. can do nothing to maintain the output when the signal fades below 1mV; applied to such an insensitive receiver, a.g.c. is only useful in levelling the output from comparatively strong signals, though it may also serve to prevent detector overloading on strong signals. To make the best use of a.g.c. as a means of reducing fading, high sensitivity is essential and is obtained in this receiver by the use of high-slope pentodes as r.f. amplifier, detector and output valve. With such valves it is possible to obtain sensitivity of the order of 10μV as will be seen from the following calculations.

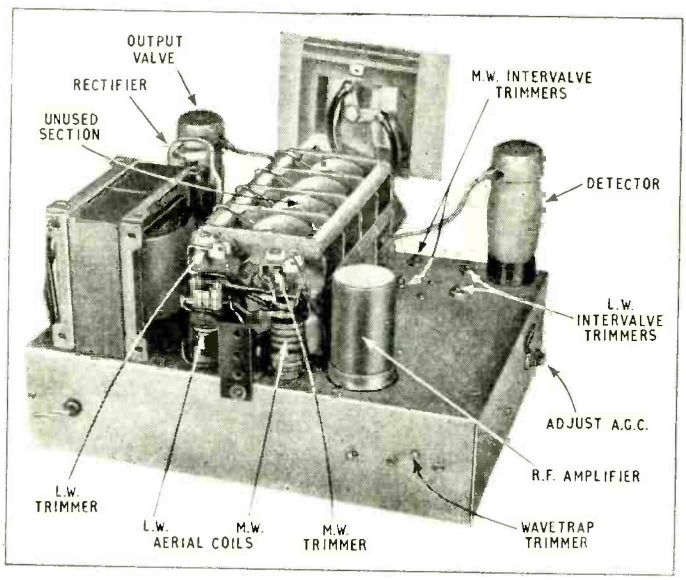
An EF50 or SP61 is used as an output valve with a load of 20 kΩ; with a g_m of 6mA/V (a practical figure) the gain is 120. A similar valve is used as detector with an anode load of 300kΩ; the working mutual conductance is much lower but the gain is still approximately 100. In the r.f. stage a dynamic anode load of 30kΩ or higher is used giving a gain in the region of 200. With an aerial circuit gain of 5 (a conservative figure) the overall r.f. gain is 10^3 or better, and the total receiver gain from equivalent aerial generator to final anode is in the region of 10^7. With the output-valve anode load assumed, the anode voltage swing is 31.6 volts r.m.s. for the standard 50mW output, and the r.f. aerial generator output necessary (at 30 per cent. modulation) to produce this output is approximately 10μV. The sensitivity realized in practice is slightly less than this calculated value and is approximately 20μV.

The provision of such high gain introduces a number of design difficulties. One, already mentioned, is that of detector overloading and is most effectively overcome by the a.g.c system. Overloading is also possible at the grid of the r.f. amplifier since "straight" pentodes of the EF50 type overload with signal inputs greater than approximately 1 volt. To prevent this, provision is made for the introduction of a wavetrap tuned to the strongest signal. Further, and most important, high gain is an embarrassment unless the receiver has high selectivity; this point is illustrated by the following calculation. Assume that it is intended to receive a relatively weak signal (100μV amplitude) displaced by 50kc/s from a powerful neighbour operating at 1Mc/s with a signal amplitude of 10mV. From universal selectivity curves[1], the rejection of the strong signal given by a single LC circuit with a Q of 100 tuned to the weak signal is 20 db. Thus to give a signal/interference ratio of 20 db, three tuned circuits are necessary.

In practice conditions even more difficult than this may easily be encountered. To cope with such conditions a wavetrap tuned to the Home Service frequency and providing a further degree of selectivity, is necessary. This not only helps station separation, but also prevents overloading of the r.f. stage. Such a wavetrap is incorporated in the receiver described (which is used in the London Area) but it should be realized

[1] See for example "Radio Receiver Design," by K. R. Sturley Part I, p. 124 (Chapman & Hall).

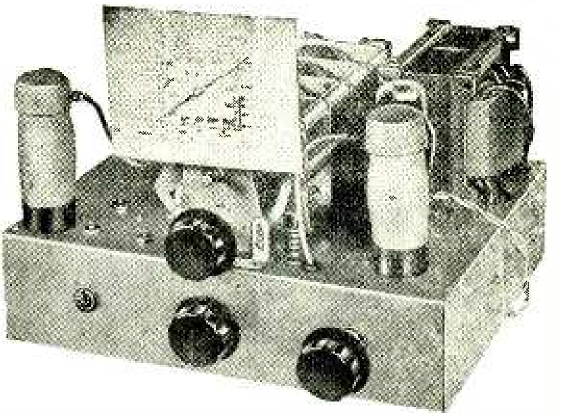
Top of chassis viewed from the back, showing trimming adjustments.



*B.B.C. Engineering Training Department.

that it will not be necessary in areas of generally low field strength, and should not in every region be tuned to the Home Service for the best results. For example in the Daventry area, it may be most advantageous to tune the wavetrap to the Third Programme on 647kc/s. Some idea of the value of the wavetrap can be gathered from the fact that the receiver in Central London and without interference receives clearly three stations, Hilversum (1007kc/s), West of England Home Service (1052kc/s), and Midland Home Service (1088kc/s) between the London Home Service and the Light Programme ; it certainly cannot do this without the wavetrap.

The three tuned circuits are best arranged as a single circuit and two coupled circuits acting as a bandpass filter. Experiments showed that best results are obtained when the single circuit is connected between aerial and r.f. valve and the coupled circuits between r.f. valve and detector.



The Circuit

The full circuit diagram of the receiver is given in Fig. 1. V1 is the r.f. amplifier (an EF50) with a.g.c. voltage applied to the suppressor grid, V2 is an anode bend detector (SP61 or EF50) and V3 is an audio output stage (SP61 or EF50).

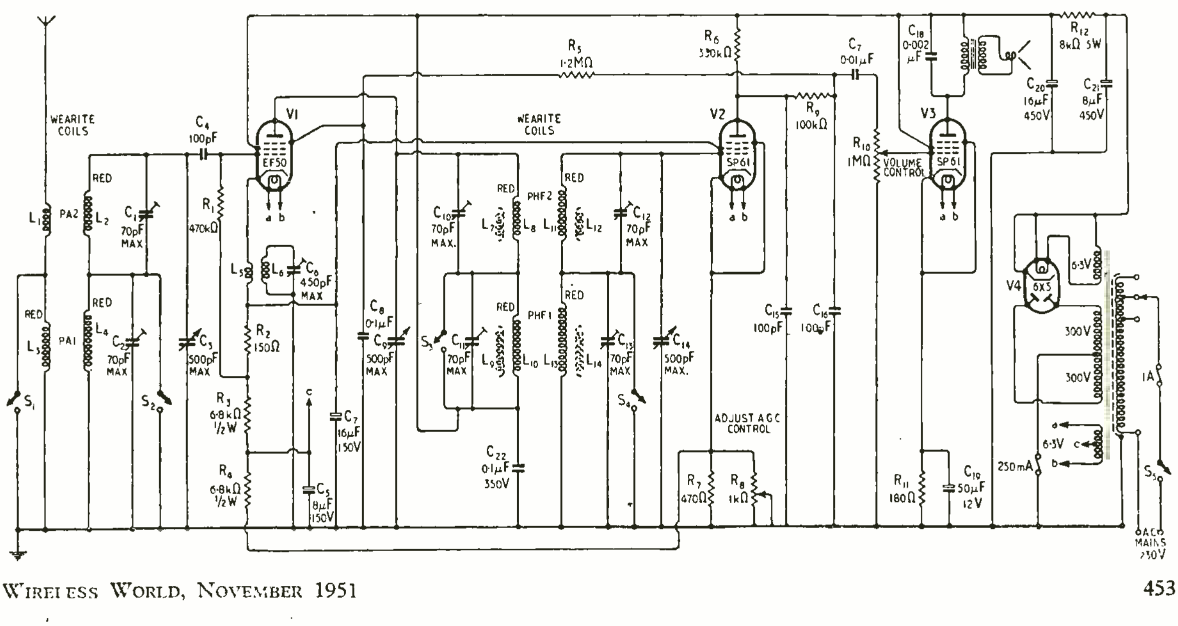
The aerial input circuit is quite conventional and uses Wearite PA1 and PA2 coils. The cathode of V1 is maintained at a potential of 100 volts (approximately) above earth by high-value cathode resistors, R_3 and R_4. This cathode provides the screen potential for V2 and for this reason it is decoupled by a 16μF capacitor C_7. The grid leak of V1 is returned to a tapping point on the cathode resistor chain, R_2 acting as the bias resistor. The wavetrap previously mentioned is also included in the cathode circuit and provides negative current feedback at the rejection frequency. It was decided to place the wavetrap in the cathode rather than the aerial circuit for two reasons ; first, it avoids the mistuning effect of aerial wavetraps ; secondly, it avoids the marked changes in receiver sensitivity over the waveband caused by aerial wavetraps. This latter effect has been discussed in an earlier article[2]. The design of the wavetrap in this set depends on local conditions, and is described later.

The intervalve circuit is a bandpass filter, used to provide the necessary selectivity. Several methods of coupling were tried, and coupling by mutual inductance was adopted, because performance is quite satisfactory, and is simple to achieve. Wearite coils were again used, the coupling being obtained by adjustment of the spacing between coils. The filter consists of two PHF1 and two PHF2 coils for long and medium waves respectively ; unmodified PA2 coils are not suitable for this position because the large primary coil is self-resonant at the high-frequency end of the medium waveband causing a pronounced fall in Q and receiver sensitivity at these frequencies. If PA2 coils must be used, this difficulty can be overcome by connecting a fixed capacitor of 200pF (approximately) across the primary coil to shift the resonant point out of the medium-wave band.

Mutual-inductance coupling gives a pass band directly proportional to frequency ; therefore for a

[2] " Wavetraps," by S. W. Amos, *Wireless World*, January 1945

Fig. 1. Complete circuit diagram of the receiver. The primary windings L_7, L_9, L_{12} and L_{14} of the Wearite coupling coils are left unconnected. All resistors are ½-watt unless otherwise indicated.



given degree of coupling the required pass band can be achieved at one frequency only. Best results were obtained by spacing the coils to give optimum coupling (i.e., maximum gain) at 800kc/s approximately in the medium waveband. Overcoupling is used on the long-wave band, to preserve a reasonable bandwidth. The spacings necessary with PHF coils are indicated in Fig. 2.

An approximately constant pass band can be obtained by using a suitable combination of two forms of coupling, e.g. shunt capacitance and mutual inductance, and readers interested in using such mixed couplings can find design details in most standard textbooks[3].

The anode-bend detector bias is provided by R_7 and R_8 in parallel, which carry the cathode current of V1 in addition to that of V2. This arrangement was adopted to enable a low value of cathode resistor to be used; this is necessary to preserve high d.c. gain. R_8 is variable to enable the quiescent anode potential of V2 to be adjusted to equal the cathode potential of V1, i.e. to give zero quiescent suppressor-cathode potential at V1. The screen of V2 is fed from the cathode of V1, so that in effect the screen voltage is stabilized. As mentioned in last month's article, this condition is also necessary for high d.c. gain. On receipt of a signal the average anode current of V2 increases and the anode potential falls, thereby applying negative bias to the suppressor grid of V1.

C_{15}, R_9 and C_{16} form an r.f. filter, and R_{10} is the volume control. It is permissible to control volume at this point because overloading of V2 is prevented by the operation of the a.g.c. circuit. V3 is the output stage, and is of conventional design, but uses an SP61 for high gain. The anode load required is 20kΩ, and the maximum power output is approximately 1 watt.

[3] See for example "Radio Receiver Design," by K. R. Sturley. Part I, Chapter 4, Section 4.5 (Chapman & Hall).

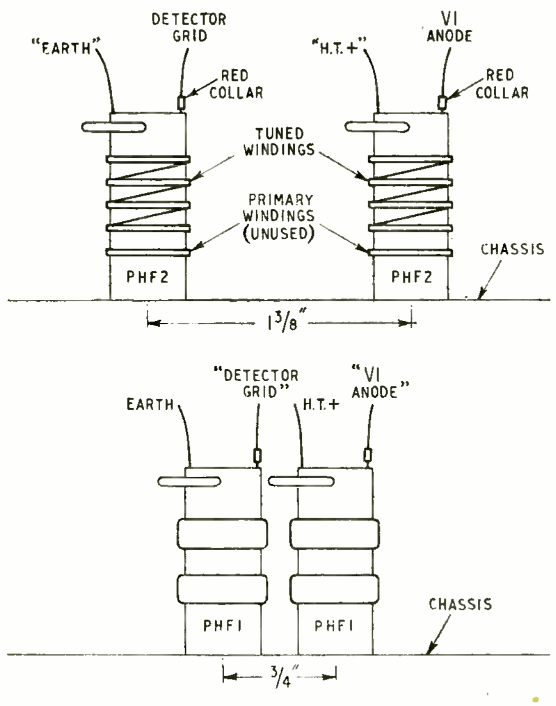


Fig. 2. Medium- and long-wave coil spacing in bandpass filter.

The power pack is also of conventional design, resistance-capacitance smoothing being used as the total h.t. current consumption is relatively low (20mA approx.).

If greater power output is required, an output valve of the 6V6 type may be used, but an output transformer of different ratio will be necessary to provide the output valve with the correct load. The smoothing resistor will need to be reduced or preferably replaced by a smoothing choke to provide the additional h.t. current whilst maintaining the h.t. voltage at the correct value of 230 volts.

The cathode of V1 is 100 volts positive (approximately) with respect to earth, and to reduce the heater-cathode potential to a reasonable figure, the centre-tap of the heater winding is returned to the junction of R_3 and R_4. The heaters are thus approximately 50 volts positive with respect to earth; this is advantageous because the resulting positive heater-cathode bias reduces considerably the hum in the audio-frequency stages. Capacitor C_5 is essential to prevent ripple voltages being fed to the cathode of V2. If the mains transformer has no heater centre tap, one side of the heater supply may be connected to the point *c* in the cathode circuit of V1.

The layout of the receiver is illustrated in the photographs, and prospective constructors are advised not to depart radically from the arrangement of the r.f. section shown, as with such gain instability may occur.

In spite of the fact that the r.f. amplifier grid is under the chassis and the detector grid above the chassis, it was found essential to mount the aerial coils above the chassis, and the bandpass filter below. With the coil positions reversed, instability occurred due to coupling between the aerial and the bandpass filter.

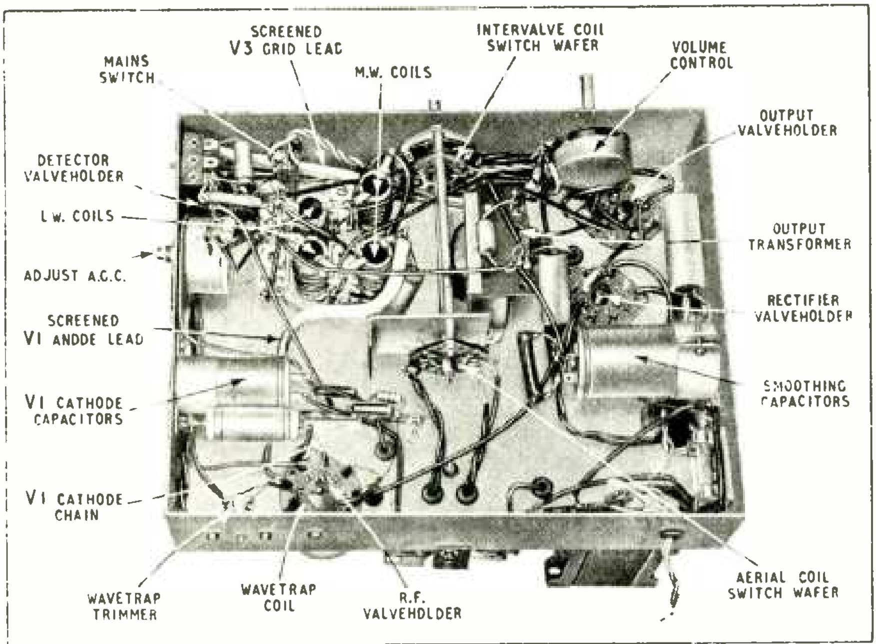
It was found necessary to shield the aerial circuit switch wafer from the bandpass filter wafer, to avoid slight instability on long waves; only a small screen was required, actually a mounting bracket for a Yaxley-type switch.

A four-gang tuning capacitor was used, as these could be obtained relatively cheaply. The unused section separates the aerial section from the bandpass sections, and thus serves to reduce the chance of instability due to proximity coupling effects. A three-gang capacitor could, of course, be used, but there is a risk of instability due to proximity of aerial and bandpass sections.

The aerial circuit trimmers are mounted on top of their respective coils and the intervalve circuit trimmers are mounted alongside the respective coils with the adjusting screws projecting through the chassis. The wavetrap capacitor adjusting screw can be adjusted through a hole in the rear flange of the chassis. Thus all adjustments can be carried out with the receiver standing normally on the bench.

Alignment

First, the suppressor of V1 should be strapped to the junction of L_5 and R_2, to render the a.g.c. inoperative. This may give rise to some distortion due to detector overload during alignment, but such distortion should be ignored. Tune to a signal at the 550-metre end of the medium band, and set the dial pointer on the capacitor shaft so that it indicates the wavelength correctly. Swing the tuning capacitors



Underside of chassis. Note screening bracket adjacent to aerial coil switch wafer.

to the 200-metre end of the band, and, using a relatively weak signal, adjust C_1, C_{10} and C_{12} for maximum output from the receiver, with the dial pointer indicating the correct wavelength. This adjustment may upset the calibration at the other end of the band, and it may be necessary to repeat the adjustments.

On long waves tune to a relatively weak signal near 1,000 metres and adjust C_2, C_{11} and C_{13} for maximum receiver output, with the dial pointer indicating the correct wavelength.

It may be necessary to adjust R_8 initially to obtain signals, but in general this should not be so. After alignment has been completed the suppressor-cathode strap on V1 should be removed.

Adjustment of A.G.C.

The quiescent anode potential of V2 must be adjusted to equal the cathode potential of V1, and the receiver should be switched on for at least ten minutes before this is done. The best method of making this adjustment is by the use of a high-impedance d.c. meter which is connected in turn to measure the anode-earth and cathode-earth potentials, whilst R_8 is adjusted to give equality of readings. The meter impedance must be high, preferably several megohms, because the anode potential of V2 is affected by the meter resistance.

Two alternative methods are available. A meter (0–10mA) may be connected in series with the screen feed of V1, a 0.1-μF capacitor being connected from earth to the screen side of the meter to avoid instability, and adjustment made in the absence of a signal. It will be found that at one extreme setting of R_8, the meter reading is a minimum of approximately 2.5mA and at the opposite extreme a maximum of approximately 8mA. R_8 should be adjusted to the point at which the meter reading just begins to increase from its minimum value. Such a meter may be incorporated permanently in the receiver as an "S" meter, since its readings vary with received signal strength.

The third method does not require any meters. It will be found that the receiver is "dead" at one extreme setting of R_8 and "lively" at the other extreme setting. With R_8 set to the latter position, the receiver is tuned to a very weak signal, or noise. R_8 should then be rotated until it is at the point where the output of the receiver just begins to fall.

Once R_8 has been correctly adjusted it should not require readjustment unless V1 or V2 is replaced. The receiver has been in continuous use over a period of several weeks, including periods when the mains voltage was low, and there has been no need to readjust R_8.

The frequency to which the wavetrap, if required, should be tuned depends on local conditions. Details of the inductor used for rejection of the London Home Service are given in Fig. 3; the capacitor has a maximum capacitance of 450 pF. The number of turns required on the secondary winding L_6 depends on the rejection required and many be calculated as follows. The rejection of the wavetrap is given by

$$\text{Number of decibels} = 20 \log_{10} (1 + g_m Z)$$

where g_m is the working mutual conductance of V1 and Z is the impedance across L_6 at resonance. For 20 db rejection, which was considered adequate, $\log_{10} (1 + g_m Z) = 1$, from which $1 + g_m Z = 10$, therefore

$$Z = \frac{9}{g_m}$$

With the screen-cathode voltage applied to V1, the working mutual conductance is approximately 4mA volt. Therefore $Z = \frac{9}{0.004} = 2{,}250$ ohms. The

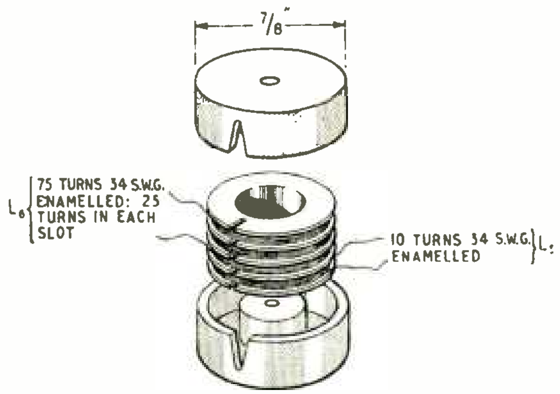


Fig. 3. Details of the wavetrap inductor used to reject London Home Service.

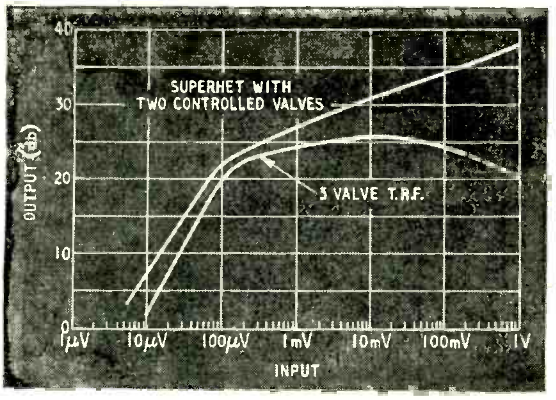


Fig. 4. Comparative a.g.c. curves illustrating the performance of a superhet with two controlled valves and the t.r.f. receiver described in this article.

inductance of L_6 is approximately $160\mu H$ and the Q-value 150. The dynamic impedance at 907kc/s is thus given by

$$Z_0 = L\omega Q = 160 \times 10^{-6} \times 6.284 \times 10^3 \times 150 = 137{,}000 \text{ ohms}$$

The impedance measured across L_5 is related to the dynamic impedance thus

$$\frac{n_1^2}{n_2^2} = \frac{Z}{Z_0}, \text{ from which } n_1 = n_2\sqrt{\frac{Z}{Z_0}}$$

where n_1 is the number of turns on L_5 and n_2 is the number on L_6.

$$\text{Therefore } n_1 = 75 \times \sqrt{\frac{2{,}250}{137{,}000}} = 9.6$$

In fact 10 turns were used as shown in Fig. 3.

To reject signals at the high-frequency end of the medium waveband, it may be necessary to reduce the number of turns on both coils and/or the capacitance of the trimmer. To reject signals at the low-frequency end of the medium waveband, it may be necessary to increase the turns on both coils, but it should not be necessary to increase the capacitance.

The tuning of the wavetrap is best carried out after the receiver has been aligned, and before the suppressor cathode strap on V1 is removed.

Valves

An EF50 was used as r.f. amplifier, and cannot be replaced in this position by an SP61 because the SP61 has a long " tail " to its anode-current suppressor-bias characteristic, and gives poor a.g.c. performance for this reason. EF50's could be used throughout, without change of circuit values.

Constructors proposing to redesign the receiver using a valve other than an EF50 as r.f. amplifier, are advised to consult the valve characteristics, to ensure that the anode-current/suppressor-volts characteristic has reasonably early cut-off, not greater than 60-70 volts at the most.

Performance

As mentioned before, the measured sensitivity is $20\mu V$ on medium waves, and this does not vary appreciably over the whole band. On long waves the sensitivity is higher. The selectivity is good, but is masked by the a.g.c. action, which causes signals to " spread " over a relatively wide band. The a.g.c. is better than that of a superhet with two controlled valves, as shown by the curves in Fig. 4. The a.g.c. circuit arrangement used in this receiver is the subject of a patent application.

LIMITS OF RADIO INTERFERENCE

New British Standards Specification

A RECENTLY published revision of the British Standards Institution B.S.800 defining new tolerable limits of radio interference, specifies the magnitude, duration and frequency of occurrence of radio interference which may be generated by various types of electrical appliances over the frequency band 200 kc/s to 1,605 kc/s. The limits laid down are considered adequate for the protection from such interference of the majority of radio broadcast receivers operating within this band of frequencies.

The specification does not apply to the ignition systems of motor cars, nor to industrial, scientific and medical r.f. equipment, which are covered by other British Standards and Codes of Practice, nor to interference arising from defective domestic apparatus.

The principal amendments in the new edition of B.S.800 are :—

(a) Simplification of the technique of measurement of the noise voltage at the terminals of the interfering appliance.

(b) An increase in the permissible upper limit of the terminal noise voltage from 500 to 1,500 microvolts.

(c) Revision of the limits for the duration and frequency of occurrence of radio interference.

(d) Use of the "radio interference free mark," which was introduced in the 1939 edition of B.S.800 but not brought into use owing to wartime conditions, is further postponed until the specification can be extended to cover television frequencies. This is necessary because electrical appliances which could satisfy the requirements in the 200-1,605-kc/s band might still cause intolerable interference in the television bands.

Copies of this new publication, B.S.800 : 1951 can be obtained from the British Standards Institution, Sales Department, 24, Victoria Street, London, S.W.1, and the price is 3s by post.

RECORD PLAYER

Design for the Home Constructor

IN response to requests for particulars of equipment suitable for use with " Goldring " gramophone pick-ups, the makers, Erwin Scharf, 49-51A, De Beauvoir Road, London, N.1, have issued a booklet (price 2s) which gives constructional details of a recommended amplifier and loudspeaker cabinet design.

An interesting feature of the loudspeaker is that the unit is placed horizontally and radiates into a corner of the room, with a spherical diffuser just above the diaphragm which is designed to give an apparent reduction in the size of the source of sound when reproducing speech.

The amplifier is of economical design and gives an output of 3 watts from a single tetrode, using 26db of negative feedback. A tone-compensated volume control is included and also a variable top-cut control.

LETTERS TO THE EDITOR

The Editor does not necessarily endorse the opinions expressed by his correspondents.

Reactivating Dry Batteries

R. W. HALLOWS, who wrote in the October issue on this subject, may be interested to know that during the war years we supplied many hundreds of trickle chargers for reactivating l.t. batteries.

These were standard commercial 6-volt chargers, and were connected to a 4.5-volt battery for about 30 minutes. The off-charge voltage then rose to about 6.0 and it was important that the battery was not used for a few hours after charging. With the increased supply of l.t. batteries after the war very few chargers remained in use, despite the considerable saving in cost. It appeared that the consideration was the saving of batteries rather than the saving of expense.

The N.P.L. tests quoted revealed results comparable with our own findings, but the advantages of recharging are, of course, considerably less with present-day hearing aids, owing to the low l.t. and h.t. currents of about 30mA and 1mA respectively. A. EDWIN STEVENS.

Amplivox, Ltd.,
London, W.1.

RECHARGING, restoring or reactivating dry cells is not new. The process has been used commercially in U.S.A. and a description of experimental and commercial equipment was given in *Q.S.T.* for June, 1944. Suggested starting currents for charging were given as:—

Size of cell	*Current, mA*
$1\frac{1}{8}$in × $3\frac{1}{2}$in	10-15
$1\frac{1}{8}$in × $1\frac{1}{2}$in	7.5-10
$\frac{3}{4}$in × $1\frac{1}{8}$in	5-10
$\frac{1}{2}$in × $1\frac{1}{2}$in	5-7.5

A fairly standard charging time of 22-24 hours seems to be satisfactory for discharged cells.

These notes may be useful for amateur experiment.

It is stated that with correct treatment 75-90 per cent of all used cells can be restored to give from 10 to 25 times original service. THOMAS G. WARD.

Bideford, N. Devon.

Crystal Menace?

ADMITTEDLY the possibility of harmonic radiation, mentioned by C. Kidd in your October issue, was not one of the factors considered when designing the Modern Crystal Set (*Wireless World*, September, 1951), but the two tuned circuits, one having unusually high capacitance, might be expected to make the effect very small. A test since made confirms this expectation.

The set was tuned to the London Home Service, the crystal current being 100μA, and a sensitive communications receiver on the same bench was connected to an aerial 20 feet away, led in through a screened lead. Completely independent earthing was not feasible, so the sets shared an earth lead from the first floor to ground level. Under these conditions weak harmonics were detected up to the seventh. The strength of the most powerful one, the third, was equivalent to a 2.5-microvolt signal. When the 200-kc/s Light Programme was tuned in with a crystal current of 4μA no harmonics whatever could be detected.

On the indication of these results no further measurements or consideration of redesign seemed necessary. In reaching this opinion I took into account two other points. The first was that in regions of very high signal strength, where incidentally there is nearly always already severe re-radiation from other non-linear elements, listeners will tend to use a small aerial aperiodically coupled to the parallel-tune modification of the set. The other was that any modifications that occurred to me, including the fairly obvious one of substituting bottom capacitance coupling for the present arrangement, have minor disadvantages which make their adoption a pity unless they are really essential.

If anyone in the London area has made tests which show that the matter ought not to be so lightly dismissed I shall be most interested to hear his results.

General Electric Company, B. R. BETTRIDGE.
London, W.C.2.

Diathermy Interference

LIKE R. Cussins (your Sept. issue), I too have observed an objectionable interference pattern on several types of television receivers, both of t.r.f. and superhet designs. The pattern takes the form of a "herring bone" or "oak grain" band across the screen and occupies approximately one third of the height. Its position on the screen is usually fairly stable although pattern design may change slightly.

I have been informed from several unofficial sources that the cause of this interference is diathermy equipment. Having had some experience in the design of such apparatus several things puzzled me concerning the nature and existence of the pattern.

One was that the pattern was not present when the Holme Moss transmissions were off the air, another was the evidence of modulation (a.f.) on the pattern, and a third was the considerable range attributed to the suspect diathermy equipment.

It was while studying a particularly pronounced specimen of this interference that I solved the first two puzzles. The pattern was obviously the result of a beat frequency caused by the harmonic or fundamental of some signal and that of Holme Moss transmission.

By injecting into the aerial sockets of a television receiver a pulse modulated frequency variable about 51-Mc/s and a fixed c.w. signal of 51Mc/s, I managed to reproduce the identical interference pattern.

Further experiments proved, as was expected, that the two signals had to have good stability to maintain the pattern constantly in its position on the screen.

Slight variation in stability caused the inside detail pattern to change without its position being altered.

Knowing the approximate power ratings of diathermy equipment, and also the degree of stability to be expected of its frequency adjustment (the patient forms part of the resonant circuit) I doubt if diathermy is the source of the interference.

Reports of this type of interference are being received from places twenty miles away from the nearest hospital.

It would appear that attention should be paid to other possible sources such as radar stations, aircraft beacons and navigation installations. I would hasten to add, however, that before an onslaught be made upon the "authorities" demanding the elimination of such stations, a little further analysis of the pattern should be made.

H. WILLAN CRITCHLEY.

Scarborough, Yorks.

Automatic Monitoring

R. DANZIGER, writing in your August issue, seems to think that the general principles used in the B.B.C. automatic monitors, discussed in a recent I.E.E. paper, are those described by him in your June, 1948 issue.

He has evidently missed the main reasons for the successful application of Automatic Monitoring to the B.B.C. system.

First, it is not practicable to balance out programme signals which are derived from the two ends of even a relatively short (electrically) system. Phase distortion (or delay) on the connecting transmission line and its asso-

D

ciated apparatus, although it may be inaudible to the listener, prohibits this unless a very rough degree of balance is acceptable. We have used a rectified output arrangement to overcome this trouble and obtain balances which permit the detection of noise components 40-50db below programme peaks.

Secondly, we have provided the facility in the circuits, not only to give the proper relative aural sensitivity at both high and low levels, but to render the monitor properly proportioned to other forms of distortion such as frequency response, overload and transmission equivalent changes.

I would like to make it quite clear that any claim to success in our automatic monitors is not that we were the first to wish that programmes could be so monitored, but, as far as I know, we were the first to attain a reliable monitor that would on the average be at least as good as the man it replaced.

Actually, work on circuits basically similar to that suggested by Mr. Danziger was attempted in the B.B.C. considerably before 1948, but no claim was published as successful application of the design was regarded as the criterion of its value.

It is relevant to note that by early 1948 our final laboratory models had worked successfully and the first provisional patents were filed in June of the same year.

London, W.1. F. A. PEACHEY.
B.B.C. Designs Department.

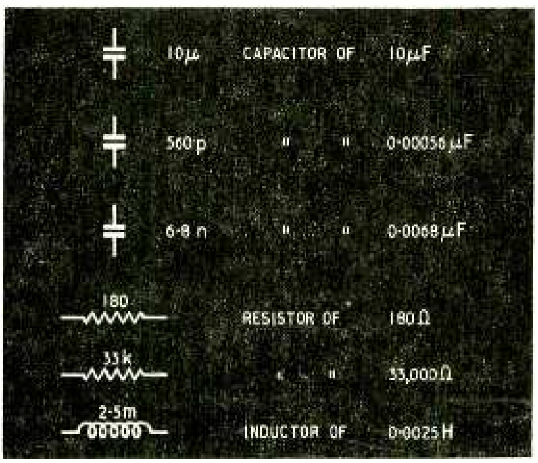
Units in Indonesia

IN your August issue A. C. Kay suggests a new unit of capacitance.

In my personal opinion this is undesirable and even unnecessary if another metric value, the nF (nano-farad) could be accepted for one-milliardth of a farad, in addition to the μF for one-millionth of a farad and the pF for one-billionth of a farad, already adopted in most countries. Thus 0.001 μF = 1 nF = 1,000 pF.

Originally introduced—so far as I know—in Germany and also used in other Continental countries before the war, this *nano* abbreviation is now, in the Indonesian PTT, as normal as *km* for length of wire. Of course, it took a few months before everyone was used to this *n* and there was some confusion with μ, but now we just don't understand why anybody still writes 0.015 μF if he actually means 15 nF.

In circuit diagrams one can leave out F, Ω and H, since it is obvious that a resistor is Ω and not F or H. For example:



Still one step further is the use of a code in which no dot appears; this is quite convenient since some countries use commas instead of dots. In this system, which is used by some manufacturers to indicate their parts, 1m5 means 0.0015 H and 2n2 means 0.0022 μF and M47 means 0.47 MΩ, etc.

Radio Division, PTT, V. J. de GRIJS.
Bandung, Indonesia.

"The Modulation Battle"

MR. BEAUMONT'S letter in your October issue fills me with amazement. Being already biased in favour of a.m., perhaps I got the wrong impression, but I thought the matter was solely one of economics and politics. The engineer may grant a small advantage to f.m., but his business is to provide the cheapest equipment to do a given job.

With regard to politics: the B.B.C. would prefer f.m.; it saves them money, even if relatively a small amount. The Government would also prefer f.m.; the higher cost of receivers means more purchase tax.

London, N.W.5. W. M. DALTON.

Recording Studios

I READ with interest the excellent article by P. A. Shears on acoustic treatment of small recording studios (*W.W.*, September, 1951). Perhaps it will stimulate many home recordists to embark upon the oft-neglected art of studio treatment. The reverberation formula Mr. Shears gives as Eyring's is actually that due to Millington. Eyring's formula is

$$T = 0.05V\ S \log_e (1 - X_{av})$$

where X_{av} is the average value of absorption coefficient for the room. This formula gives less tedious calculations than Millington's.

Mr. Shears does not mention that preferred dimension ratios exist for room proportions. This is important in order to prevent several low-frequency eigentones occurring at nearly the same frequency. Height, width, length ratios of 1 : 1.26 : 1.6 are considered satisfactory for small studios.

The eigentone formula given is only exact for rectangular flat-walled rooms with completely rigid boundaries, but gives a useful approximation in many practical cases.

Panel absorbers of the type described have to be rather carefully designed and erected, as there is a risk that if their "Q" is too high they will continue to emit sound after being acoustically excited and thus give reverberant sound "coloration" at their resonant frequency. Unless carefully mounted, panels may also produce buzzing or rattling noises when strongly excited. Similar enclosed resonant absorbers consisting of a volume covered with lino or roofing felt in place of a semi-rigid panel are now claimed to give similar absorption coefficients without the above disadvantages of panels.

A useful and low-priced book which might be added to the references is "Applied Architectural Acoustics" by M. Rettinger (Chemical Publishing Coy., Inc., Brooklyn, New York) M. L. GAYFORD.
London, S.E.18.

Redundant Word?

ON page 422 of the October issue of *Wireless World* appears a concocted word which I submit should not exist in a journal generally accepted to be of value in the education of technical people. This obnoxious word "wattage" is natural to the ignorant who do not appreciate that the watt is a *unit* of power, or rate of working.

It is unfortunate, I know, that the word "voltage" is perforce in common use since with alternating quantities the usual unidirectional terms tend to be meaningless, but this exception is no excuse for replacing a perfectly good word "power" by "wattage," any more than for the common mistake made by the uninitiated in referring to "amperage" (ugh!) when the correct term is "current." R. L. HACKWORTH.
London, N.8.

Paris Television Show

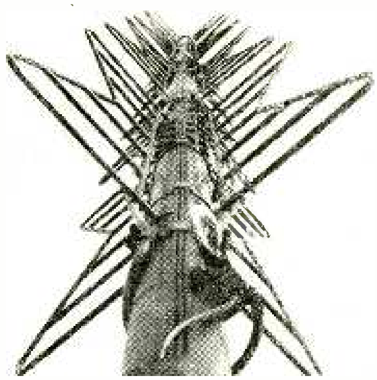
Domestic Receivers for Two Standards

By A. V. J. MARTIN*

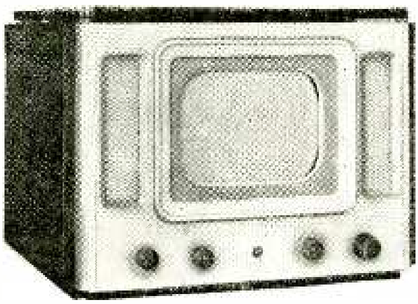
THE first specialized television exhibition in the world was held in Paris at the Musée des Travaux Publics from September 28th to October 10th, under the name Premier Salon de la Télévision. It met with great success and at the week-ends the crowds of visitors were such that the organizers had to limit the number of admissions. The possibility of prolonging the exhibition for a few days was considered, but other arrangements had been made and it proved impossible.

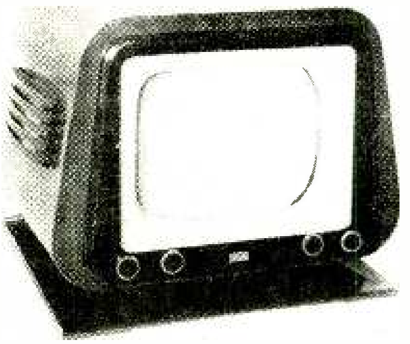
The organizers were the Télévision Française authorities and the Syndicat National de la Construction Radioélectrique. Excluding the Press, there were 23 exhibitors. Three of them were aerial makers, two were valve and c.r.t. manufacturers, and the remaining 18 were television set makers. The Télévision Française had made a big effort and put up a complete studio comprising a semi-circular stage, about 21 yards in diameter, surrounded by 800 seats for the public. Four dual-standard cameras (441/819 lines) were in use and the scene was lit by projectors with a total power consumption of 300kW. The "live" cameras were supplemented by films run from a film-scanner, which could be seen by the visitors through a glass panel. Programme material, either direct or from films, was available to the exhibitors continuously from opening till closing time.

* Editor. *Télévision,* Paris.



The 185-Mc/s turnstile vision aerial on top of the Eiffel Tower.





Model for 819 lines by Radio-Industrie. It has a 10-in flat-faced tube and 22 valves. Below: Receiver with 12-in tube by Ducretet-Thomson. Available for 441 lines with 16 valves or 819 lines with 19 valves.

The v.f. signals originating in the Salon were sent by coaxial cable to outside-broadcasting vans packed in the street and thence by 30-cm microwave link to the studios of the Télévision Française. There they were demodulated, controlled and amplified, and sent to the Eiffel Tower transmitters through the usual coaxial cable. Depending on the standard in use, they went either to the old 441-line transmitter at the foot of the Tower and by coaxial cable to the aerials on top (46Mc/s vision), or to the new 819-line transmitter on the fourth floor of the Tower and by a very short coaxial link to the 4-bay turnstile aerial (185.25Mc/s vision). The accompanying sound was radiated on 42Mc/s for the 414 lines and on 174.1Mc/s for the 819 lines.

Thus in both cases the programmes were received at the Salon in the usual way through the standard transmitters, and the televisors were shown under actual working conditions. The three aerial makers exhibiting had supplied and installed on the roof of the building the necessary banks of aerials for both the standards, and the signal was distributed to the stands by ordinary coaxial feeders.

On the Stands

Altogether 81 different receivers were shown. Most exhibitors had a standard chassis in different cabinets—some of these incorporated a broadcast receiver or a record changer, and others were for long-distance reception with one or two r.f. pre-amplifier valves. Seventy per cent of the sets were for the high-definition 819-line standard and included six dual-standard 441/819-line receivers. The number of valves varied between 15 and 22 for 441 lines and between 14 and 23 for 819 lines.

There were remarkably few projection receivers. Fifty per cent of the sets had 12-in tubes, ten per cent had 14-in tubes, and the other sizes, varying from 6in to 24in, were each under five per cent of the total. Table models were in a majority and were followed second and third by consoles and large-size combination models. Sensitivities ranged from 10μV (long-distance) to 500μV (local). There were frequently two versions of the same receiver, one for 441 lines (46Mc/s), generally of the t.r.f. type, and one for 819 ing on frequencies in the 3,700-4,200 Mc/s band, although initially only one is in use. To avoid interference due to "skip transmissions" two frequencies separated by 40 Mc/s are used alternately on each channel along the route.

It is reported that 94 of the country's 107 television transmitters were linked to the "circuit" for the initial transmission.

International Acoustics

THE first issue of *Acustica*, the international journal on acoustics, sponsored by the Acoustics Group of the Physical Society in this country and similar organizations in France and Germany, has now made its appearance.

The aim of the journal is "to cover the science of acoustics in all its aspects — theoretical and experimental, purely scientific and applied." Articles are in English, German or French with summaries in the alternative languages. *Acustica* will be issued six times a year, for which the subscription is 36 Swiss francs. The British representative on the Editorial Board is Dr. E. G. Richardson, of Kings College, Newcastle-on-Tyne, and the publisher, S. Hirzel, Claridenhof, Gotthardstrasse 6, Zurich, Switzerland.

Fire Risks

FIRES caused by broadcast and television receivers during the years 1947-49 are analysed in the report of the Fire Research Board of the D.S.I.R. published by H.M.S.O. under the title "Fire Research, 1950." The table showing the rate of incidence of fires reveals that whereas the number of fires per 10,000 licensed broadcast receivers (including radiograms) has increased from 0.21 in 1947 to 0.34 in 1949, the figures for television sets have decreased from 6.4 to 3.7 during the same period.

The facts given in the report are more reassuring than those quoted in our Editorial in January this year, when the figures given by a responsible member of the Home Office indicated that the curve was rising very steeply.

Athlone Fellowships

TO enable Canadian engineering graduates to take post-graduate training in this country, thirty-eight Athlone Fellowships are to be awarded by the Government each year.

These Fellowships, of which 28 will be awarded annually to newly graduated candidates and ten to graduates from industry, will be tenable normally for two years.

Three of this year's holders of Fellowships are taking post-graduate courses in electronics at Imperial College, which, in one case, will be followed by a year's research at T.R.E.

Speed of Light

THE apparatus used by the N.P.L. in the experiments which showed that the figure normally accepted as the speed of light was inaccurate by eleven miles a second, is now on show and will be demonstrated at the I.E.E., Savoy Place, London, W.C.2, until the end of November.

A cavity resonator is used in which a radio wave is reflected backwards and forwards between the two ends. When the time of travel between the ends equals the time interval between successive waves, they build up to an electrical resonance which can be detected with very high precision. The waves follow one another at a frequency of 10 thousand million per second (10 kMc/s) and it is necessary to measure this frequency with an accuracy better than one part in a million.

Radio and Power Cuts

WHILST on the one hand the B.B.C. is co-operating with the British Electricity Authority by broadcasting warnings of impending power cuts, criticism is levelled against it in the electrical press for its inconsistence in its approach to the problem of the power supply position at peak hours. Our associate journal, *Electrical Review*, criticizes the lengthening of the children's hour on television during a period in which the highest peak load occurs in winter. *The Electrician* gives figures of the increased power consumption during the recent broadcast on the Turpin-Robinson fight in New York. During the half an hour of the broadcast 100,000 kWh, requiring about 70 tons of coal, were consumed.

The warnings of impending electricity cuts are to be broadcast by the B.B.C. on 1,500 metres between 7.30 a.m. and 12.30 p.m., and 3 p.m. and 6 p.m. In addition, arrangements have been made with relay organizations to interject warnings in the transmitted programmes.

PERSONALITIES

H.R.H. The Duke of Edinburgh. F.R.S., has accepted the office of President of the City and Guilds of London Institute for the Advancement of Technical Education. As already recorded His Royal Highness has also accepted Honorary Membership of the British Institution of Radio Engineers.

J. T. Marler, who joined the Marconi International Marine Communication Co.'s Dalston Works in 1907, has been appointed manager of the company's Operating Division in succession to S. Stansbridge, who recently retired. He will continue to represent the company on the Radio Officers' Panel of the National Maritime Board.

J. McG. Sowerby, B.A., M.I.E.E., who is a frequent contributor to *Wireless World*, has left Cinema-Television, Ltd., where he has been concerned with the design and development of electronic instruments since 1946, and joined English Electric, Ltd. From 1940 to 1946 he was with the Ministry of Supply and was responsible for the design and development of electronic instruments for Chemical Warfare Research.

OBITUARY

The death occurred on September 7th of **Commander F. G. Loring,** O.B.E., R.N., M.I.E.E., at the age of 82. After his naval career, during which he specialized in wireless telegraphy, he was appointed, in 1908, the first Inspector of Wireless Telegraphy at the Post Office. On his retirement from the Post Office in 1930 he became a director of the International Marine Radio Co.

Dr. Anton Philips, who, with his brother, founded in 1891 the electric lamp factory which has grown into the world-wide Philips organization, died at Eindhoven, Holland, on October 7th at the age of 77.

C. H. G. Hobday, managing director of Hobday Bros., died on September 1st at the age of 52.

IN BRIEF

Receiving Licences.—Approximately 12,443,850 broadcast receiving licences, including 933,050 for television, were current in the U.K. at the end of August, an increase of 8,950 during the month. The month's increase in television licences was 17,850, the lowest since July last year.

Components Exhibition.—Next year's exhibition of components, organized by the Radio & Electronic Component Manufacturers' Federation, will be held from April 7th to 9th at Grosvenor House, Park Lane, London, W.1.

French Decca Chain.—The French Government has ordered from the Société Française Radio-Electrique, licensees of the Decca Navigator Co., a chain of Decca stations.

Dutch Television. — The Netherlands broadcasting authority (a corporate body on which is represented the four major broadcasting organizations) has brought into regular use—although at present only twice a week—its first television station. It is operating on the proposed C.C.I.R. standards—625 lines, negative modulation, vestigial sideband transmission (upper sideband retained) and f.m. sound. The 5-kW Philips vision transmitter operates on 62.25 Mc/s and the sound transmitter on 67.75 Mc/s. Transmissions are horizontally polarized.

S.W. Listeners are invited by the International Short Wave Club to participate in a competition designed to encourage the sending of better reports of short-wave reception. Postcards, giving details of the reception of an amateur or broadcasting s.w. station, should be sent to A. E. Bear, 100, Adams Gardens Estate, London, S.E.16, before January 1st.

"The Old N'Ions," as members of the Northampton Engineering College Past Students' Association are known, will be holding their twenty-fourth annual dinner and reunion on November 30th at the Connaught Rooms, London, W.C.2. Particulars are obtainable from R. W. C. Gilbert, 6, Ella Road, London, N.8.

New B.B.C. Stations.—Two more of the twelve proposed low-power stations to improve reception of the B.B.C. Home Service in certain areas came into operation on October 7th at Whitehaven (692 kc/s) and Barrow (1,484 kc/s). Both transmitters will ultimately have a power of 2 kW, but initially are lower.

Servicing Exam.—The results of this year's Radio Servicing Certificate Examination, held jointly by the Radio Trades Examination Board and the City and Guilds of London Institute, show that of the 290 candidates for the examination held in May, 117 passed in both the written and practical tests. Forty-six candidates passed the written examination but were referred in the practical test, and 19 candidates who were referred in the 1950 practical test completed the examination.

Wharfedale Wireless, the publishers of the book "Pianos, Pianists and Sonics," by G. A. Briggs, which was mentioned in our August issue, are organizing an essay competition on (a) Which in your opinion is the most interesting chapter in the book, and why? and (b) Which chapter do you find the least interesting, and why? Entry forms and details are available from Wharfedale Wireless Works, Idle, Bradford, Yorks.

Sets for Fijians.—In order to encourage the import of cheap broadcast receivers it is proposed to waive the duty on approved sets. An importer, R. O. Sharma, P.O. Box No. 8, Nadi, Fiji, who will be glad to receive information from interested manufacturers, advises us that the sets should cover the short-wave bands (with bandspread tuning) in addition to the m.w. band. As mains supply is not available in the majority of areas, the sets should be of the "all-dry" type.

Correction.—In the review, on page 403 of last issue, of the new book "Magnetic Recording," by S. J. Begun, a printer's error occurred in the name of the company with which the author is associated. It is, of course, the Brush Development Company.

F.M. in Germany.—According to a correspondent, all but the cheapest broadcast receivers on the market in Germany now incorporate both a.m. and f.m. There are some twenty stations operating at present and about as many being built. The agreed i.f. is 10.7Mc/s.

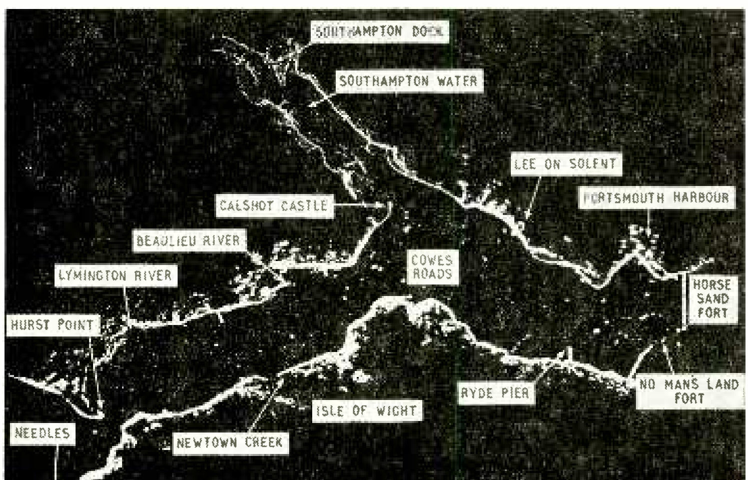
U.S. Radio Chief.—President Truman has appointed Haraden Pratt, who has been secretary of the Institute of Radio Engineers since 1943, as his personal adviser on telecommunications.

World Radio.—According to figures published in the September issue of our New York contemporary, *Tele-Tech*, the western hemisphere, which has approximately 14 per cent of the world's population, has 75 per cent of the world's transmitter power. So far as the United States is concerned, it has, according to *Tele-Tech,* 65 per cent of the world's transmitter power, just over 50 per cent of the broadcast receivers of the world and 98 per cent of its television sets.

Canada's Department of Transport announces the appointment of F. G. Nixon as Assistant Controller of Telecommunications in the Department. Prior to joining the Radio Division of the Transport Department in 1937 he was doing research work with the National Research Council.

School Television. — Experimental transmissions of television for schools is planned by the School Broadcasting Council and the B.B.C. for next summer. During the experimental period selected schools will be equipped with various types of receivers—direct-viewing and projection—and the industry is being asked to co-operate.

City and Guilds.—The new secretary of the City and Guilds of London Institute, in succession to G. C. Stephenson who has filled the post since 1924, is J. W. Voelcker, B.Sc., A.M.I.E.E., who, since returning to this country from the U.S.A. in 1925, has been with English Electric. He is honorary secretary in this country of the Massachusetts Institute of Technology and president of the M.I.T. Club of Great Britain.



RADAR MOSAIC of the Solent, Spithead and Southampton Water composed of twenty-one photographs of the p.p.i. presentation on a Decca Type 159B marine radar set installed in the Company's motor yacht "Navigator."

Danish Television.—Regular one-hourly transmissions on alternate weekdays began from the Danish television station on October 2nd. The experimental transmissions were stopped some months ago. The Copenhagen 625-line 100-watt vision transmitter operates on 62.25Mc/s with negative modulation. Double sideband transmission is employed. The f.m. sound transmitter operates on 67.75Mc/s with a power of 50 watts. Transmissions are horizontally polarized.

Cable & Wireless announce additions to both the Middle East and West Indian radio services. The Cyprus-United Kingdom radio-telephone service, which was opened last May, is now extended to the U.S.A., Canada, Cuba, Mexico and parts of Europe. In Lybia, the company's stations at Tripoli and Benghazi are being equipped for radio-telephone services, which will operate between both these points, and between them and Malta, with extensions to the United Kingdom. A radio-teleprinter circuit is now operating between Bermuda and Montreal, and the Jamaica-Nassau radio-telegraph circuit has been replaced by a similar circuit between Bermuda and Nassau.

E.I.B.A.—The Electrical Industries Ball, organized in aid of the funds of the Electrical Industries Benevolent Association, will be held at Grosvenor House, Park Lane, London, W.1, on November 9th. In the report of the Association for 1950 donations from a number of radio concerns are acknowledged, including £193 collected at the London luncheons of the Radio Industries Club, £160 from the R.I. Club Ball, and £113 from the R.I. Club, Glasgow.

Marconi College, claimed to be the first wireless college in the world, celebrated the fiftieth anniversary of its opening on October 12th. Originally established by Marconi's Wireless Telegraph Co. at Frinton-on-Sea, Essex, it has been at Chelmsford since 1904.

Electro-Acoustics.—A twenty-week course of lectures on electro-acoustical transducers is being held on Monday evenings at Southall Technical College, Beaconsfield Road, Southall, Middx. The fee for the course, which began on October 8th, is £1.

Four-year Course.—Applications for enrolment for the third four-year course in electronic engineering, which commences at E.M.I. Institutes on January 15th, should be received by November 30th. Details of the scholarship scheme, by which the £400 fee is halved, are available from the Institute, 10, Pembridge Square, London, W.2.

"Mechanical Handling," our associate journal, is organizing the Third Mechanical Handling Exhibition and Convention, to be held at Olympia from June 4th to 14th, 1952.

R.D.F. Reunion.—We have been asked by ex-Flt. Sgt. V. H. Wotton to announce that he is endeavouring to organize a reunion of 1941-43 members of No. 31 R.D.F. School, R.A.F., Clinton, Ontario. His address is 216, Vicarage Farm Road, Heston, Middx.

'The Guilds' Engineer.'—The second number of the journal of the Engineering and Radio Societies of the City and Guilds College, South Kensington, which has this title, includes several articles of radio interest; among them a summary by H. Bishop, B.B.C. Chief Engineer, of his presidential address to the College's Radio Society and two student papers; "Frequency Modulation Receivers," by P. M. S. Hedgeland, and "Trends in the Design of Small Power Transformers for use in Communication Equipment," by E. S. Parkes. The journal costs 5s.

INDUSTRIAL NEWS

Tannoy.—Three companies now constitute the Tannoy organization—Tannoy Products, Ltd. (formerly Sound Rentals, Ltd.), Tannoy Rentals, Ltd. (handling the rental of equipment), and Tannoy, Ltd. (handling development work). With the reorganization, W. J. Haines, who has been with Tannoy eighteen years, is appointed general production manager of the main company, and A. E. Dunevein (previously with Standard Telephones & Cables), general commercial manager. Guy R. Fountain and his son Michael are directors.

Nagard, Ltd., designers and manufacturers of electronic research and industrial equipment, will be transferring their offices and factory from Brixton, London, S.W.9, to 18, Avenue Road, Belmont, Surrey (Tel.: Vigilant 0345), on November 1st.

F. C. Robinson & Partners, Ltd., electronic instrument specialists, of Deansgate, Manchester, announce the appointment of Frank P. McKellen as sales manager. He was, until recently, senior signals officer at the British Military Headquarters in Berlin.

Loudspeaker Diaphragms will be manufactured at the rate of 30,000 per week by the new plant being installed at the works of Fibre Form, Ltd., Garratt Mills, Trewint Street, Earlsfield, London, S.W.18. (Tel.: Wimbledon 6228.) It is expected that production will gradually be increased to 50,000 diaphragms a week.

Sales Department of Astor Boisselier & Lawrence, Ltd., specialist technical wax manufacturers, is now at 9, Savoy Street, London, W.C.2. The telephone numbers remain unchanged—Temple Bar 5927 and 6942. The company's head office and works are at West Drayton, Middx.

MEETINGS

Institution of Electrical Engineers

Ordinary Meeting.—"The London-Birmingham Television-Cable System" by T. Kilvington, B.Sc. (Eng.), F. J. M. Laver, and H. Stanesby on November 8th.

Radio Section.—"The Life of Oxide Cathodes in Modern Receiving Valves" by G. H. Metson, M.C., Ph.D., M.Sc., S. Wagener, Dr. Phil., M. F. Holmes, B.Sc., and M. R. Child on November 14th.

Discussion on "Should Broadcasting be Superseded by Wire Distribution?" on November 26th. Opener, P. P. Eckersley.

The above meetings will be held at 5.30 at the I.E.E., Savoy Place, London, W.C.2.

East Midland Centre.—"The Development and Application of the Vibrator as a Competitor of the Rotary Convertor" by J. H. Mitchell, Ph.D., B.Sc., at 6.30 on November 6th at Loughborough College.

Cambridge Radio Group.—Address by D. C. Espley, O.B.E., D.Eng., chairman of the Radio Section, at 6 on November 6th at the Cambridgeshire Technical College, Cambridge.

Mersey & North Wales Centre.—"The Life and Work of Oliver Heaviside" by Prof. G. H. Rawcliffe, M.A., D.Sc., at 6.30 on November 5th at the Liverpool Royal Institution, Colquitt Street, Liverpool.

North-Eastern Radio Group. — "Crystal Triodes" by T. R. Scott, B.Sc., on November 5th.

"An Electronic Process-Controller" by J. R. Boundy, B.Sc., and S. A. Bergen, M.B.E., on November 19th.

Both meetings will be held at 6.15 at King's College, Newcastle-on-Tyne.

North Midland Centre.—"The Nervous System as a Communication Network" by J. A. V. Bates, M.A., M.B., B.Chir., at 6.30 on November 13th at the Hotel Metropole, Leeds.

North-Western Radio Group.—"An Investigation into the Mechanism of Magnetic Recording" by P. E. Axon, O.B.E., M.Sc., at 6.30 on November 28th at the Engineers' Club, Albert Square, Manchester.

South Midland Radio Group.—"The Life and Reliability of a Radio Valve" by H. G. Metson, Ph.D., M.Sc., at 6 on November 26th at the James Watt Memorial Institute, Great Charles Street, Birmingham.

North Staffordshire Sub-Centre.—"Television" by C. T. Lamping at 7 on November 5th at the P.O. Central Training School, Stone, Staffs.

Rugby Sub-Centre.—"Crystal Diodes" by R. W. Douglas, B.Sc., and E. G. James, Ph.D., and "Crystal Triodes" by T. R. Scott, B.Sc., at 6.30 on November 21st at the Rugby College of Technology and Arts, Rugby.

South-Western Sub-Centre.—"The Operation and Maintenance of Television Outside-Broadcast Equipment" by T. H. Bridgewater at 3 on November 28th at the Rougemont Hotel, Exeter.

Ipswich District Meeting.—Lecture on "Television" at 6.30 on November 12th at the Crown and Anchor Hotel, Ipswich.

London Students' Section.—"The Use of Working Scale Models in the Development of Broadcasting Aerials" by T. R. Boys at 7 on November 27th at Savoy Place, London, W.C.2.

Students' District Meeting.—"Medical and Industrial Uses of Radio Frequency Energy" by H. Burton, B.Eng., at 7 on November 19th at the George Hotel, Reading.

British Institution of Radio Engineers

London Section.—"Developments in High-Frequency Transmitter Cables," by R. C. Mildner (Telcon), at 6.30 on November 21st at the London School of Hygiene & Tropical Medicine, Keppel Street, London, W.C.1.

North-Eastern Section.—"Television Aerial Design," by G. L. Stephens (Belling & Lee), at 6.0 on November 14th at Neville Hall, Newcastle-upon-Tyne.

Scottish Section.—"The Brain as a Piece of Communication Equipment," by H. W. Shipton, on November 6th at University College, Dundee; on November 7th at the University, Edinburgh; and on November 8th at the Institute of Engineers and Shipbuilders, Glasgow. These are joint meetings with the Institute of Physics and each begins at 7.0.

Institution of Electronics

Southern Branch.—"The Technique of Trustworthy Valves," by G. P. Thwaites, B.Sc., A.M.I.E.E., (S.T.C.), at 6.45 on November 14th at University College, Southampton.

Royal Institution

"Radio Astronomy," by Prof. J. A. Ratcliffe, O.B.E., M.A., F.R.S. (Cambridge University), at 9.0 on November 23rd at the Royal Institution, 21, Albemarle Street, London, W.1.

British Sound Recording Association

"Electrical and Mechanical Problems of Record Reproduction," by K. R. McLachlan and R. Yorke, at 7.0 on November 16th at the Royal Society of Arts, John Adam Street, London, W.C.2.

Portsmouth Centre.—"Recording at the B.B.C.," by R. C. Patrick (B.B.C.), on November 1st.

"Microgroove Recording and Reproduction," by E. D. Parchment (Decca), on November 14th.

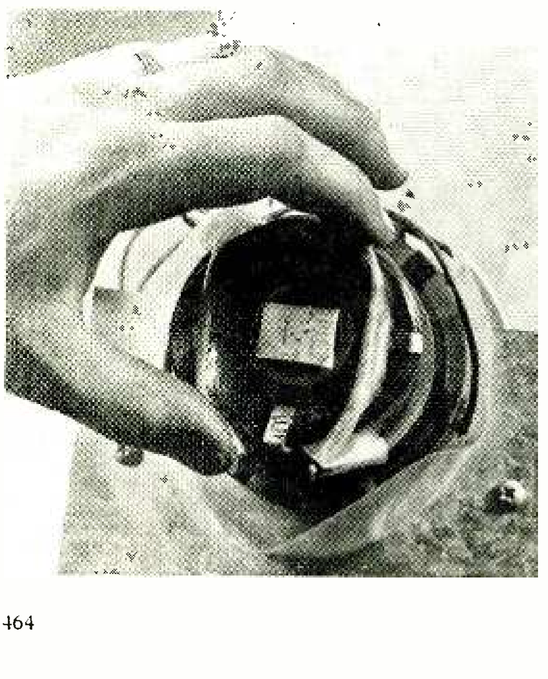
Both meetings will be held at 7.0 at the Central Library, Guildhall, Portsmouth.

Television Society

"The Murphy V200 Television Receiver" by P. Kidd (Murphy Radio) on November 8th.

"Television Distribution by Wire" by K. J. Easton (Central Rediffusion Services) on November 23rd.

Both meetings will be held at 7 at the Cinematograph Exhibitors' Association, 164, Shaftesbury Ave., London, W.C.2.



APID TESTING of deflection coils is facilitated at the Du Mont Laboratories, New Jersey, by the use of a one-inch tube which permits the yoke to be over the face of the tube, thereby obviating the need for disconnecting the tube.

Amateur Radio Developments

A Review of Current Techniques

By J. P. HAWKER*

MORE than 7,000 amateur transmitting licences—double the peak pre-war figure—have been issued in the United Kingdom since the resumption of licensing in 1946. While it is perhaps true that the enthusiastic amateur to-day lacks the facilities necessary for highly original research and usually obtains his licence chiefly for the pleasure to be derived from radio operating as a hobby, he can, and does, play a not unimportant rôle in the practical application of new laboratory techniques to the general field of two-way communication. In this article it is proposed to review briefly a few of the trends noticeable in post-war amateur equipment in order to show a little of what the amateur experimenter is doing, and why.

One of the most serious problems facing the amateur transmitter since the war has been the mutual interference arising from the greatly increased activity. For example, if at any given moment 5 per cent of the licensed amateurs of the world wished to operate in the popular 14-Mc/s band then the 400 kc/s available would have to accommodate no less than 6,000 stations, of which possibly half would be using telephony. But it is not in the nature of the enthusiast to be unduly dismayed by such statistics, and indeed the problem has been tackled, with a fair degree of success, by:—(1) simplifying transmitter frequency changing; (2) increasing receiver selectivity, and (3) reducing the band-width of transmissions.

Transmitter Frequency Changing.—In 1939 probably some 90 per cent of British amateurs used crystal-controlled transmitters and were limited to a few fixed frequencies. Those who anticipated that post-war operation would be along similar lines were soon proved wrong. From 1946 onwards variable frequency control rapidly grew in popularity as more and more amateurs found it essential to be able to pick a "clear" channel in the crowded bands. But in reverting once again to master oscillators, the amateur, perhaps more so than the designer of comparable commercial equipment, has been concerned with obtaining, from relatively simple and cheaply constructed apparatus, a good quality note as free as possible from frequency drift and keying chirp. In practice he has concentrated upon the use of a low-power receiving-type valve as an oscillator, fed from a stabilized power supply and followed by an isolating stage which provides from 1 to 3 watts of r.f. output. By operating the oscillator stage on 1.7 or 3.5 Mc/s with bandspread tuning, the v.f.o. (variable frequency oscillator) unit can be made stable enough for all practical purposes without the complications of temperature compensation and elaborate coil construction found in most commercial equipment of comparable stability. The amateur, incidentally, has done much towards popularizing the series-tuned modified Colpitts, or "Clapp," circuit shown in Fig. 1. The adoption of variable frequency control has led also to an important change in amateur operating technique; the practice of "netting," i.e., the use of the same frequency by two or more stations in communication, is now generally employed on all h.f. bands. While the system possesses many advantages for amateur working, the piling up of transmissions on the frequency of any unusual DX[1] station is at times a severe handicap.

As with the development of broadcast and communication receivers, there has been steady progress towards the simplification of transmitter tuning and band-changing. The amateur possesses a distinct advantage over the commercial designer in that his frequency bands are largely in harmonic relationship and represent only a comparatively small portion of the h.f. spectrum, complete frequency coverage is therefore not required. On the other hand, power efficiency of the final stage is of greater importance than for commercial applications owing to the strict limitation of input power. Much interest has been shown in recent months in the American development of a reasonably high-Q "all-band" power amplifier multiple-tuning system which can tune to any amateur band between 3.5 and 30 Mc/s without switching or coil changing. The basic arrangement of this tuner is shown in Fig. 2, where L_1 is a considerably smaller value inductance than L_2. On lower frequencies

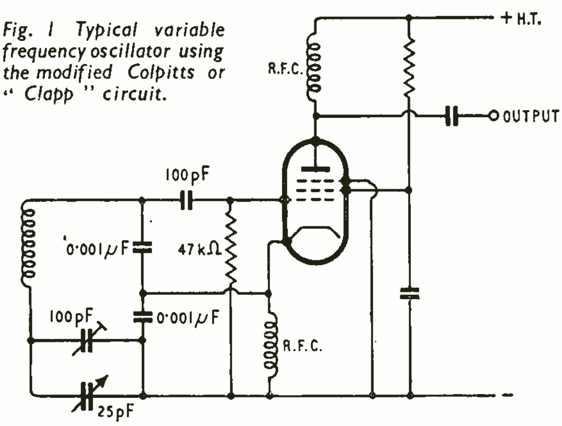


Fig. 1 Typical variable frequency oscillator using the modified Colpitts or "Clapp" circuit.

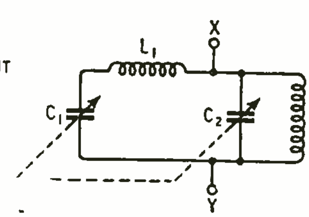


Fig. 2 Basic arrangement of the multiple tuner as used to cover all amateur bands between 3.5 and 30 Mc/s.

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[1] On h.f. bands DX means any foreign station, but on v.h.f. it is often used to denote any station beyond line-of-sight distances.—Ed.

L_1 acts merely as a rather long lead to C_1, which is thus effectively in parallel with C_2, while on higher frequencies L_2 behaves as an r.f. choke. Thus across the points X and Y the circuit tunes simultaneously to two widely different frequencies; by careful selection of the inductances no two amateur bands need appear at identical settings of the ganged tuning capacitors. The design of band-switched exciter units has also been facilitated by the use of wide-band interstage couplers and coil turret assemblies.

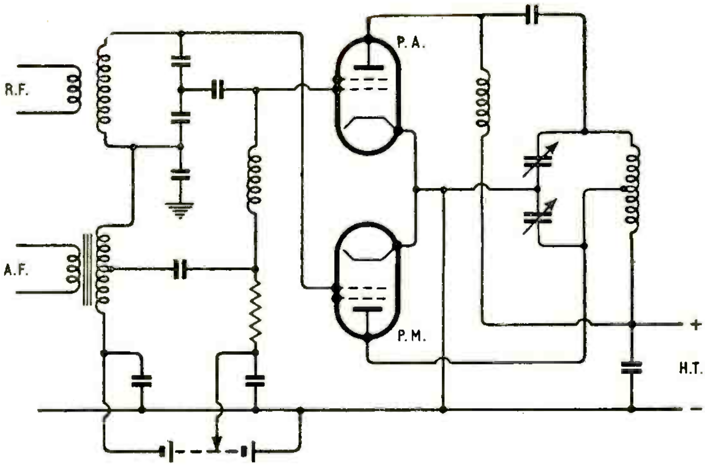


Fig. 3. Skeleton circuit of the "Taylor super modulation system," now being used by a number of British amateur stations.

Receivers.—An interesting development in the search for improved receiver selectivity for telegraphy operation has been the use of a very low second i.f. (50-100 kc/s) in double-conversion superheterodyne circuits. A popular arrangement is to feed the output from a conventional 465- or 1,600-kc/s i.f. stage into an additional unit comprising a mixer and local oscillator, one or more stages of amplification at 85 kc/s, followed by demodulation and audio amplification; such a unit usually being termed a "Q5-er." Peaked audio filters and other audio-selection devices have also become more popular in recent years, though of course these aids to selectivity are not of recent origin. Crystal filter, "Q5-er" and audio filter is a combination whose selectivity, in practice, is usually limited chiefly by the stability of transmissions, the slightest drift of the incoming signals resulting in their sudden disappearance. Receivers for amateur communication with switched side-band selection have also been successfully demonstrated in this country and in the United States. But it should be reported that, compared with the 'thirties, relatively few amateurs now use entirely home-constructed receiving equipment except for v.h.f. working.

Efforts at reducing the band-width of telephony transmissions to permit the operation of more stations in any given band of frequencies, have been made by the more progressive amateurs; techniques used including speech-clipping with cut-off filters and "splatter" suppression. An attenuation at 4,000 c/s of 26 db with reference to the response at 1,000 c/s was recommended at the 25th Anniversary Congress of the International Amateur Radio Union in 1950. Experimental single-sideband suppressed-carrier transmissions are regularly made by a number of stations throughout the world, but the added complications seem likely to restrict the use of this system.

Television Interference.—Increased amateur activity is not the only major problem which has influenced current techniques; television interference (TVI) is also radically affecting the design of amateur transmitters. Although such interference only amounts to a small percentage of the total number of television interference complaints investigated by the G.P.O. it does represent (to the individual amateur) one of the most difficult problems with which he has ever been confronted. Owing to the unfortunate choice (from an amateur viewpoint) of the television frequency in the London area, Alexandra Palace transmissions are most susceptible to interference from the third harmonic of 14-Mc/s amateur transmissions, particularly in areas where the television signals are weak. In addition, the intermediate and image frequencies of several makes of television receivers are such that, through no fault of the amateurs concerned, these sets are liable to suffer interference from amateur transmitters in the immediate neighbourhood. The most successful answer to harmonic interference so far lies in screening and filtering the transmitter to a far greater extent than is normal amateur practice and in careful harmonic monitoring. In fringe areas complete screening of the transmitter is usually necessary, involving precautions to prevent the escape of r.f. power along mains supply leads, keying and power lines or even through meter apertures. The r.f. output is then fed to the aerial, or aerial matching unit, through a screened co-axial line via a multiple-section low-pass filter designed to attenuate the unwanted output above 30 Mc/s. Outstanding work in connection with the cure of amateur TVI has been carried out by a number of amateur investigators here and in the U.S.A., but the problem still remains a serious one in crowded districts where the distance between an amateur transmitting and the nearest television receiving aerial may be only a few feet.

Modulation Systems.—The desire to eliminate costly high-power modulation equipment is reflected in the development of narrow-band frequency-modulation using simple reactance modulation circuits. N.b.f.m. transmitters are designed to operate with a maximum deviation of the order of 2.5 to 3 kc/s and thus occupy no more ether-space than a conventional a.m. transmitter. Another advantage that the system possesses over normal f.m. systems, where the deviation is often of the order of 75 kc/s, is that n.b.f.m. transmissions can be received satisfactorily on an a.m. receiver simply by tuning to one side of the carrier frequency. In the U.K. the terms of the amateur licence prohibit the use of n.b.f.m. on frequencies below 28 Mc/s, but elsewhere the system, which is particularly suitable for mobile work, is proving effective on frequencies down to 3.5 Mc/s. For similar reasons, interest has also been shown in "Taylor super modulation" a high-efficiency grid-modulation (a.m.) system in which a low-power audio-frequency amplifier is arranged to trigger a Class C power amplifier and also a heavily biased "positive modulator" valve. With r.f. drive only applied, the p.m. valve remains in the cut-off condition, but on applying an audio signal this valve releases additional r.f. power into the common tank circuit during positive half-cycles; see Fig. 3.

While the average input power of the British amateur is now probably about 80 watts, considerable interest has been maintained in "flea-power" transmission. For example, during the 1949 R.S.G.B. low-power contest, Mr. T. F. Herdson (G6ZN), of Horbury, Yorkshire, made 116 contacts in 24 hours using a simple 3.5-Mc/s Hartley oscillator and one 90 V h.t. battery giving an input between $\frac{1}{4}$ and $\frac{1}{2}$ watt. Similarly, the 200 or more stations taking part each year in the R.S.G.B. national field day are limited to a power input of 5 watts, yet long-distance contacts are regularly achieved. Such results, however, probably depend more upon operating skill than upon the use of any new techniques. Most pronounced feature of medium-power transmitters has been the popularity of beam tetrode valves, particularly the type 807 and its equivalents, which are widely used as frequency doubler, buffer amplifier and single-ended or push-pull power amplifier.

Another feature of post-war amateur technique has been the development of rotary beam aerials for long-distance transmission and for v.h.f. applications; although even to-day such structures—for the h.f. bands at least—are less common in this country than overseas, owing partly to the cost of suitable materials and partly to the restrictions imposed under local by-laws and the Town and Country Planning Act. Two- or three-element beams for 28 Mc/s, and more rarely for 14 Mc/s, give reasonably sharp horizontal lobes and low vertical angle radiation. These beams generally use Yagi-type arrays and can be swung so as to radiate signals in any desired direction, often being controlled from the normal operating position by a mechanical or selsyn-type device to indicate the direction in which the beam is pointing at any given moment. Rotating aerials of this type have few equivalents in commercial practice.

Similarly, the influence of the amateur as an operator/technician can be seen in the electronic keyer, also primarily an amateur development. Unlike the better-known "bug" key, the electronic keyer automatically controls the length of the dashes as well as the dots and, in some models, the interval between each symbol. The main drawback to these ingenious devices is the amount of practice required in order to become proficient in their use, but the "tape-like" character formation which is eventually possible has encouraged their adoption by amateurs seeking to raise the standard of manual telegraphy operation.

V.h.f. Developments.—Perhaps no aspect of post-war amateur activity has attracted so much attention in non-amateur circles as the results achieved on v.h.f. To the professional communications engineer, accustomed to regarding propagation at these frequencies as being limited to little more than "line of sight," the transatlantic contacts on 50 Mc/s during the sun-spot peak of 1947-48, the 1,200-mile contact in the United States and 520-mile contact between a West Country station (G2BMZ) and Germany from fixed locations on 144 Mc/s, and the 161-mile contacts on 420 Mc/s all represent interesting examples of "freak" conditions. But the amateur has also demonstrated that low-power 144-Mc/s transmissions can be received over distances greater than 100 miles with a regularity far exceeding that which would have been thought possible only a few years ago. To what extent have such results been attained by the use of unorthodox or new techniques?

It should be emphasized that, generally speaking, the amateur is restricted to the use of standard commercial types of valve in the lower-price range and the by-no-means-new e.h.f. types available as "surplus," a factor of increasing importance as frequencies are raised. Similarly, the workshop facilities required for the construction of e.h.f. "plumbing" are possessed by few experimenters. Yet it is interesting to note that whereas on the h.f. bands the British amateur tends to look to his fellow enthusiasts in the United States for many of his new developments, this is far less true of the v.h.f. and e.h.f. bands on which results in this country compare most favourably with those achieved elsewhere.

The amateur v.h.f. receiver, unlike most commercial equivalents, is required to tune over at least part of any particular band without losing the degree of stability normally associated at these frequencies only with crystal-controlled local oscillators. Much attention has accordingly been paid to the development of stable oscillator-tripler stages with the fundamental circuit on about 50 Mc/s; and also to tunable intermediate-frequency stages for use in conjunction with c.c. (crystal-controlled) oscillators

The well-equipped amateur radio station at the Uxbridge Festival of Britain Industrial Exhibition. A QSL card of appropriate design giving the station's call sign, G2FMF/A, is used to acknowledge the exchange of signals.

though it should be mentioned that the elimination of spurious responses has proved extremely difficult where a wide-coverage receiver is required. Another interesting development is the occasional use of panoramic reception, whereby the state of activity over all or part of a band is displayed on the screen of a cathode-ray tube by means of an f.m. oscillator.

The paramount importance of the first r.f. stage has encouraged the use of neutralized push-pull twin-triode valves such as the 6J6 or EC91 and also the currently popular Wallman cascode circuit (Fig. 4) which comprises a neutralized grounded-cathode triode followed by a grounded-grid triode, the usual combination for 144 Mc/s being a triode-connected 6AK5 and a half-section of a 6J6, EC91 or 12AT7. A few amateurs, by using noise-generator techniques, have been able to make systematic measurements of the sensitivity of their v.h.f. receivers, though the practical application of the noise generator on 144 Mc/s and above has not proved easy. On 420 Mc/s, crystal diode mixers, sometimes with crystal-controlled injection and "lighthouse" r.f. amplifying stages, have rapidly replaced the super-regenerative circuits favoured when the band was first released in 1948. The introduction of the 12AT7 and similar commercial valves is now permitting a less specialized approach to be made to this band.

For v.h.f. transmitting, commercial practice has been followed in the wide use of such valves as the 832, though at 420 Mc/s the output from this type is very limited and the "life" uncertain. Efficiency of power amplifiers in this band is being steadily improved as new valve types become available, and the South London U.H.F. Group have demonstrated an amplifier capable of an efficiency of about 60 per cent at 25 watts input. On both 144 and 420 Mc/s, multi-stage stabilized transmitters with a fundamental crystal frequency of about 8 Mc/s are now used by most amateurs working in these bands. Some interest is also being shown in the possible use of overtone crystal oscillator circuits with an ouput at about 72 Mc/s as a means of eliminating a number of frequency-doubling stages.

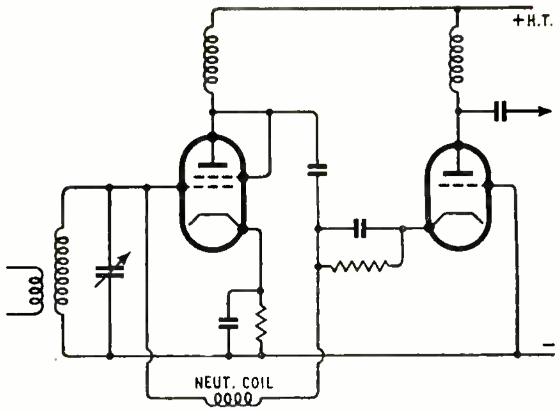


Fig. 4. The Wallman cascode r.f. amplifier, popular on the 144-Mc/s band.

Yagi and stacked-array aerials are equally popular, though the wider horizontal coverage of the stacked-array is proving increasingly useful in bands where the limited amount of activity makes searching for pencil-beam signals as much a trial of patience as of equipment.

SOURCES OF INTERFERENCE

INEFFICIENT aerial-earth systems are, according to figures published in the Post Office *Telecommunications Journal*, by far the biggest individual cause of interference with sound broadcasting; but in the case of television the main individual cause is electric sewing machines. In both sound and television, however, faulty receivers hold second place.

In an endeavour, therefore, to reduce the ever-growing number of calls made on the Post Office Interference Investigation Service, a new pamphlet has been issued giving simple tests which can be made by listeners and viewers to ascertain whether or not the trouble is in the installation. "Good Wireless and Television Reception," as it is called, includes a form for enlisting the services of Investigation Officers if the cause of interference appears to be outside the control of the set owner.

In the appended table the most frequent sources of interference are given as percentages of the cases investigated.

	SOUND		TELEVISION	
	Complaints	%	Complaints	%
Unknown; interference not observed by P.O. staff	18,018	23.8	7,068	29.2
Inefficient aerial/earth systems	15,246	20.1	947	3.9
Faulty receivers	9,507	12.5	1,972	8.2
Faulty wiring of buildings	5,029	6.6	234	0.9
Refrigerators	2,255	3.0	331	1.4
Fluorescent tubes	1,787	2.4	—	—
Radiation from receiver time-base circuits	1,725	2.3	—	—
Radio transmitters	1,469	2.0	1,007	4.2
Bedwarmers	1,423	1.9	—	—
Motors, misc.	1,334	1.8	315	1.3
Sewing machines	1,162	1.5	2,374	9.8
Overhead power lines	900	1.2	632	2.6
Drills	791	1.0	221	0.8

	SOUND		TELEVISION	
	Complaints	%	Complaints	%
Radiation from radio receivers i.fs.	622	0.8	156	0.6
Misoperation of receivers	539	0.7	204	0.8
Thermostats, misc.	539	0.7	184	0.7
Smoothing irons	528	0.7	—	—
Vacuum cleaners	527	0.7	257	0.9
Neon sign tubes	503	0.7	192	0.8
Underground mains	492	0.6	—	—
External cross modulation	414	0.5	—	—
Fans	391	0.5	521	2.1
Calculating machines	353	0.5	150	0.6
Hairdryers	292	0.4	697	2.9
Motor car ignition	—	—	1,096	4.5
Medical apparatus (valve-operated)	—	—	306	1.2
Filament-type lamps	—	—	305	1.2

Dimensions

A Useful Check on Formulæ and Calculations

By "CATHODE RAY"

IF you indulge occasionally in bouts of algebra, do you find, as I do, how distressingly easy it is to miss out a "squared" sign somewhere, or accidentally turn a " × " into a " +," or misplace a bracket? If one eventually spots the mistake, it may not be soon enough to avoid wasting a lot of time and effort; and if one doesn't . . . !

It may not be known to everyone who works about with formulæ how helpful it is to keep an eye on their "dimensions." You derive a formula for the impedance of a particular kind of circuit, shall we say, with the idea of finding out how it varies with frequency. If you have made a slip anywhere in the algebra the odds are considerably in favour of it affecting the dimensions of the equation; and (when you know how) it takes only a few moments to check that. Not every error can be detected by this test, but a worth-while proportion can. Quite apart from fault-finding, attention to dimensions is a more intelligent attitude to formulæ than mere blind substitution of figures.

The basic principle is that one can't add or subtract or equate things that are of different kinds or "dimensions," such as hours and miles, or square yards and gallons. But the quantities of them can be multiplied or divided, giving a quantity with different dimensions from either. A mile is a measure or unit of distance or length, and an hour a unit of time. Adding 100 miles to 4 hours is nonsense, but the number of miles can be divided by the number of hours, giving a quantity 25 of a unit of speed—the mile-per-hour. The dimensions of speed are length divided by time. Mere numbers, like the 25 in this case, can be ignored, because they have no dimensions in themselves and are there merely to fit in with the particular units chosen. The 25 would become some other number if one worked in cms/sec instead of miles/hour.

So if the upshot of some mathematical manipulation were a formula such as

$$v = \sqrt{25d + \frac{1}{t^2}}$$

where v was the speed (or velocity) of something or other and d and t were a distance and a time respectively, you would know straight off that it was wrong. Velocity is neither the square root of distance nor the reciprocal of time.

So far as dimensions are concerned, width, breadth, distance, height, circumference, diameter, perimeter, etc., are all the same—length. If any two lengths are multiplied together the product is a quantity whose dimensions are length-squared, or area. And the product of three lengths is length-cubed or volume. So if you were to read that the volume of a sphere was $4/3\ \pi r^2$ (r being the symbol for radius, which is a length) you would know for certain that it was wrong, and would probably suspect (quite rightly) that the ^{2} was a misprint for ^{3}. (π, being the ratio of two lengths, is a mere dimensionless number.)

I have brought length in rather prominently at the start, because it is one of the recognized fundamental dimensions. It would be difficult to think of any more fundamental quantity in which to express length. One could, of course, say that it is velocity multiplied by time, but that would hardly be helpful seeing that velocity is itself derived from length and time. In fact almost all the multitudinous physical quantities, except electrical and magnetic, can be expressed in terms of three fundamental dimensions: length, time, and mass. That is why systems of units are named by three letters, such as c.g.s. (meaning the centimetre-gramme-second system) and m.k.s. (metre-kilogramme-second). We have already noted the simple example of velocity or speed, which is length/time.

To avoid confusion with other meanings of symbols, the dimensions of quantities are written in square brackets: $[L]$* for length; [T] for time; [M] for mass. The "dimensional equation" for velocity would therefore be

$$[v] = \frac{[L]}{[\mathrm{T}]}$$

but it is usually written

$$[v] = [L\mathrm{T}^{-1}]$$

using the conventional alternative method of indicating division, by a negative "index." All mechanical quantities can be expressed by "powers" of length, time, and mass. L is of course L^1, or the first power of L. And any quantity to the power 0 is 1, which is unit quantity with no dimension—a mere numeral. And if we remember the rules about powers or indices—to multiply, add them; to divide, subtract—then dimensional equations are simple. There should be no difficulty about this one:

$$[\mathrm{A}] = [L^2]$$

where A stands for area. For volume we shall use another italic letter to distinguish from voltage:

$$[V] = [L^3]$$

If we come across a volume divided by an area we could therefore write

$$\frac{[L^3]}{[L^2]} \text{ or } [L^3\, L^{-2}] = [L]$$

Acceleration is change of velocity per unit time, so its dimensions are $[v]/[\mathrm{T}]$ or $[L\mathrm{T}^{-2}]$; force is equal to the acceleration imparted to unit mass, so dimensionally is $[L\mathrm{T}^{-2}\mathrm{M}]$; and so on. The dimensions of any mechanical quantity can be expressed by three numbers—the powers of L, T and M; in this case, 1, − 2, 1.

But it is about time we got on to electrical quantities, before this subject begins to look more difficult than it really is. In most cases it is remarkably easy, because there is no need to analyse right down to

* I have taken the liberty of using an italic letter for length, to distinguish it from inductance (L) which we shall be using later.

basic dimensions. A large proportion of the equations likely to be seen in *Wireless World* concern impedances. All impedances can be reckoned in ohms and therefore have the same dimensions. (That is, if one is concerned only with magnitude and not with the more subtle distinction of phase. It is possible, if necessary, to maintain the distinction between resistance and reactance by writing the dimensions of inductive reactance as $[jR]$ and capacitive reactance as $[-jR]$; but the examples to follow will take account of magnitudes only.)

There are some very commonly used formulæ for finding the parallel reactance and resistance equivalent to a given series combination, and *vice versa*. In this example

$$R_s = \frac{R_p X_p}{R_p^2 + X_p^2}$$

where the symbols are too obvious to need a key, I either have or have not introduced a deliberate mistake. Perhaps you would like to say which, without looking it up in a book. By using the dimensions idea one can tell at a glance. Writing it out in full dimensional equations:

$$[R] = \frac{[R^2]}{[R^2]} = [R^0]$$

which is absurd. One might guess that a ^{2} has dropped out of the numerator; actually it should be $R_p X_p^2$.

Notice that in this simple example it was unnecessary to break down any of the quantities into more fundamental dimensions, because they were all the same at the beginning, so one had only to compare the indices on each side of the equation.

In calculating complicated circuits the algebra spreads over the paper in an alarming way, and it is very easy to make a slip when multiplying out the factors and adding similar terms. Suppose you had been dealing with Fig. 1 in this way and had arrived at the following:

$$Z = \frac{R_1 R_2 (R_1 + R_2) + R_1 X_2 + R_2 X_1}{(R_1 + R_2)^2 + (X_1 + X_2)^2} + j\frac{R_1^2 X_2 + R_2^2 X_1 + X_1 X_2 (X_1 + X_2)}{(R_1 + R_2)^2 + (X_1 + X_2)^2}$$

A slip in such an effort would be excusable, so to go and use the formula straight away without looking it over would be inexcusable. Since all the denominator terms are resistance (or reactance) squared, the numerator terms must all be cubed. Most of them are, but two culprits immediately stand out—$R_1 X_2$ and $R_2 X_1$. Again, a ^{2} must have dropped out from each. Assuming that in other respects the equation is correct, we can make a shrewd guess at whether it is the R or X that ought to be squared. For the circuit is quite symmetrical, and so are the resistance and reactance halves of the formula; the numerator terms in the resistance half are the same as those in the reactance (j) half except that R and X are interchanged. So as it is the R's that are squared on the reactance side we would expect the X's to be squared on the resistance side. And that, in fact, is correct; the resistance numerator should be $R_1 R_2 (R_1 + R_2) + R_1 X_2^2 + R_2 X_1^2$.

A very familiar equation is the one relating the resonant frequency (f_r) of a tuned circuit with the inductance (L) and capacitance (C):

$$f_r = \frac{1}{2\pi\sqrt{LC}}$$

Here there is no difficulty about frequency; it is a

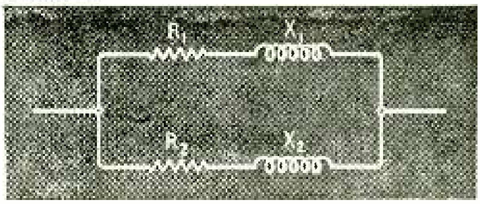


Fig. 1. Although this circuit looks fairly simple, the formula for its impedance is quite impressive and deserves to be checked by "dimensions."

number (of cycles) divided by a time (usually one second), so it is the reciprocal of time, and its dimensional equation is therefore

$$[f] = [T^{-1}]$$

But we have at the moment no clue to the dimensions of L and C, except that we know that when multiplied by frequency they are related to one another by their common relationship to reactance. But that fact doesn't get us any farther, because it is the one from which our equation was derived (by the act of making the inductive and capacitive reactances equal and defining f_r as the frequency that makes them so).

We might try another approach by looking up the formulæ for capacitance and inductance. Here is a well-known one for the capacitance between parallel plates:

$$C = \frac{0.0885AN}{t} \quad \text{in pF}$$

where A is the area of each plate in sq. cms., N the number of spaces between plates, and t the thickness of each spacing in cms. N being just a number it can be ignored dimensionally, and so presumably can 0.0885; [A] is $[L^2]$ and $[t]$ is $[L]$, so

$$[C] = [L]$$

Or so it seems. And here is one of the many inductance formulæ:

$$L = \frac{0.00987\, d^2 N^2 K}{l} \quad \text{in } \mu H$$

where d is the diameter of the coil in cms, N the number of turns, l the length of the coil, and K is "Nagaoka's constant." Inquiry shows that K is just a number, so all we are left with is d^2/l, which is a length, so we have

$$[L] = [L]$$

If you happen to know that at one time it was quite usual for both capacitance and inductance to be reckoned in centimetres, you may be satisfied with the above two results. But if you are so relentless as to go back to the frequency formula and incorporate these new findings, the outcome will not be quite so happy:

$$[f] = [T^{-1}] = [L^{-\frac{1}{2}}][C^{-\frac{1}{2}}] = [L^{-\frac{1}{2}}][L^{-\frac{1}{2}}] = [L^{-1}]$$

Therefore $[T] = [L]$

or time equals length. If that were true it would make things very much simpler—or would it? Anyway if it is, I'm a brass monkey and you are—anything you don't like—and it doesn't matter, because all science is nonsense. So on the whole it may perhaps be better to look over our capacitance and inductance formulæ and see if we've forgotten anything. If we had looked up the more painstaking kind of reference book we might have found them complicated by the factor μ for inductance and κ for capacitance—permeability and permittivity respectively. The only excuse for omitting them is that it was supposed to be understood that the formulæ concerned air-cored coils and air-dielectric condensers, and that with the particular units employed the values of μ and κ are then both 1 so can be left out. But they must not be forgotten altogether—when considering dimensions, anyway. Presumably the absurdity about length being time would be put right if the dimensions of μ and κ were included. What are their dimensions ?

If I could give you the right answer to that I would at once become a sensation, because scientists have long wanted to know. The best that can be done is to work back from the frequency formula, putting $[C] = [L\kappa]$ and $[L] = [L\mu]$:

$$[f] = [T^{-1}] = [L\kappa]^{-\frac{1}{2}}\,[L\mu]^{-\frac{1}{2}}$$

$$\text{So } [T] = [L]\,[\kappa\mu]^{\frac{1}{2}}$$

$$[\kappa\mu]^{\frac{1}{2}} = [TL^{-1}]$$

Time divided by distance is a quantity that could perhaps be named " slowness of movement," but its reciprocal is more commonly used—speed or velocity. So turning both sides of the equation upside down we get

$$[\kappa\mu]^{-\frac{1}{2}} = [LT^{-1}] = [v]$$

Any healthily inquisitive person would now ask " What velocity ? " and this time the answer *is* available, and a very interesting one it is too—the velocity of electromagnetic waves through a medium having permittivity κ and permeability μ. But, you may say, there must be something wrong about this ; κ and μ for air are both 1, and the speed of light through air is rather more than 1 cm. per sec ! But this is forgetting the little matter of units. Our capacitance and inductance formulæ were for pF and μH, not F and H ; and there were numerical constants beside. If you insist on κ and μ being 1 without any constants being brought in, then you will have to accept 186,282 miles as the unit of length ! Since you will probably find that more than a trifle inconvenient (imagine reckoning the flux density in a loudspeaker gap in lines per 34,701,000,000 square miles !) you will probably be glad to accept the numerical constants in the formulæ already quoted, because when the convenient sub-units (pF and μH) are used these constants are not absurdly large or small. If, however, you are prepared to suffer some numerical inconvenience—within reason, of course—for the sake of principle, then you might go for the alternative, the m.k.s. system, in which the units are the metre, the farad and the henry ; and to make everything right the values of κ and μ for empty space (which are denoted by κ_0 and μ_0) must be very nearly $1/(36\pi \times 10^9)$ and $4\pi/10^7$ respectively. They could be given other values within this framework, so long as $1/\sqrt{\kappa_0 \mu_0}$ was equal to 299,790,000 metres per sec. or whatever the true velocity of light may be. You see, nobody knows the actual separate values of κ_0 and μ_0, or their dimensions ; all we know is the value and dimensions of their product, $\kappa_0 \mu_0$. It is as if we knew the voltage across a given resistor but had no means of finding either its resistance or the current through it. We would know IR without knowing either I or R.

All this about κ_0 and μ_0 may seem rather academic and in the air (or perhaps, more appropriately, in space !), but it is an issue that cannot be dodged if one is to tackle electrical and magnetic dimensions, because every one of them involves κ_0. or μ_0. One of the dangers, in fact, of " practical " formulæ is that by making these factors equal to 1 they can be left out and are liable to be forgotten.

Since we don't know their dimensions separately we are stuck. The only way out is to conceal our ignorance by introducing a fourth fundamental dimension to supplement *L*, T and M. This fourth dimension is still a matter of controversy. Officially it is μ. But for some purposes it is more convenient to use electrical charge Q ; unit, the coulomb. Another alternative quartet that has been proposed is : *L*, T, I, V, leaving mass out. Each different selection of the fundamental four means a different list of dimensions for all the electric and magnetic quantities. If only we knew the dimensions of either κ_0 or μ_0, all this uncertainty would be avoided. If, as might well be, κ_0 and μ_0 are expressible in terms of *L*, T and M, there would be no need at all for a fourth fundamental dimension.

But since in order to go any further it is necessary to make some sort of a choice, I will follow a number of authorities in taking Q (quantity of electric charge, not tuned circuit " goodness " factor), and on this basis here are the dimensions of the main electromagnetic quantities.

Quantity	Symbol	*L*	T	M	Q
Capacitance ..	C	− 2	2	− 1	2
Current	I	0	− 1	0	1
Electric Charge ..	Q	0	0	0	1
Electric field strength ..	ϵ	1	− 2	1	− 1
Frequency ..	f	0	− 1	0	0
Inductance ..	L	2	0	1	− 2
Magnetic field strength ..	H	− 1	− 1	0	1
Magnetic flux ..	Φ	2	− 1	1	− 1
Magnetic Flux density ..	B	0	− 1	1	− 1
Magnetomotive force	F	0	− 1	0	1
Permeability ..	μ	1	0	1	− 2
Permittivity ..	κ	− 3	2	− 1	2
Power	P	2	− 3	1	0
Reluctance ..	S	− 2	0	− 1	2
Resistance (also reactance and impedance) ..	R	2	− 1	1	− 2
Voltage or e.m.f.	V, E	2	− 2	1	− 1

Although this table is not exhaustive, it includes the quantities most commonly used in practice—enough to provide plenty of practice for a start. Here is a very simple example—the time constant of a resistance-capacitance combination, which as you probably know is RC. To get the dimensions of this product, you *add* the index numbers for R and C. Under *L*, C is − 2 and R is + 2, so that goes out. T is + 2 and − 1, so that goes in, to the first power. M and Q both go out, so the result is [RC] = [T], which is obviously correct for a time constant. Now suppose you know that an inductive circuit, consisting of L and R, also has a time constant, but you don't know the formula. You could arrive at it by using the table. Try it.

Next consider another simple and well-known formula :

$$\lambda = \frac{3 \times 10^8}{f}$$

λ being wavelength and f frequency. $[\lambda]$ is, of course, $= [L]$, and $[f] = [T^{-1}]$. So it looks as if we are back at our old absurdity $[L] = [T]$. But having been caught once in this sort of trap we are too wise to buy it again, especially as 3×10^8 is easily recognizable as the approximate velocity of light in space. Putting in its dimensions makes everything right. By now it ought to be clear that one must be on guard against concealed dimensions—hidden under some numerical " constant " which is really a dimensioned quantity with a particular value written in. And in this connection, the speed of light or radio waves in space is such an important constant scientifically that it is sometimes forgotten that in air it is slightly less and in paraffin wax or polythene or other solid or liquid dielectric it is a good deal less, because it depends on the value of κ. So the wavelength for a given frequency depends on where the waves are travelling.

Here is another example :

$$Z_0 = \sqrt{\frac{L}{C}} \sqrt{1 - \frac{\omega^2 LC}{4}}$$

If this is to be correct, then ω^2 LC must be dimensionless, because it is to be added to 1. And as the whole second factor under the root sign would then be dimensionless, $\sqrt{(L/C)}$ must have the same dimensions as Z_0, which presumably is an impedance. (Actually it is the characteristic impedance of a simple low-pass T filter section.) As to the first point, ωL is a reactance, and so is $1/\omega C$, so ω^2 LC is a reactance divided by a reactance and is, therefore, dimensionless. The second point could be checked in a similar way, but let us use the table. We first subtract the C index numbers from the L numbers (because L is divided by C) and then halve the result (to give effect to the square-root sign).

	L	T	M	Q
L	2	0	1	−2
C	−2	2	−1	2
L/C	4	−2	2	−4
√(L/C)	2	−1	1	−2

As you see, the last line is the same as for resistance, impedance, etc. If you would like another example or two to check, here is the formula for the frequency at which a Wien-bridge type of oscillator oscillates:

$$f_0 = \frac{1}{2\pi\sqrt{R_1 R_2 C_1 C_2}}.$$

And if you want something to get your teeth into, here is one from p. 410 of the November, 1950, issue (No ! Not guilty this time !) :

$$\frac{\dfrac{2\,\omega\,C\,R}{\omega^2 C^2 R^2 - 1} + \dfrac{2\,\omega\,C_1 R_1}{\omega^2 C_1{}^2 R_1{}^2 - 1}}{1 - \left(\dfrac{2\omega\,C\,R}{\omega^2 C^2 R^2 - 1} \cdot \dfrac{2\,\omega\,C_1 R_1}{\omega^2 C_1{}^2 R_1{}^2 - 1}\right)} = 0$$

Actually it is nothing like so hard as it looks, and anybody who has had some practice with the kind I have just worked out should be able to O.K. it almost at a glance.

The next one will send you back to the table, and to make it a little more interesting I have introduced a deliberate mistake—a superfluous ^{2}. Can you work out which one it is ?

$$C = \frac{L^2 I^2}{V^2{}_{HT}} \left(\frac{V_{HT}/V_M}{1 + V_{HT}/V_M}\right)^2$$

The correct version is on p. 314 of the September, 1950, issue, but to save you the trouble of looking it up I will give the answer at the end.

Lastly, here is a formula for the effective height (in metres) at f kc/s of a rectangular frame aerial having N turns H metres high and W metres wide. The question is, does the 300,000 conceal any dimensions, and if so what ?

$$2NH \sin\left(\frac{\pi f W}{300{,}000}\right)$$

In case the " sin " bothers you, I may explain that it must be the sine of an angle, and an angle is equal to the ratio of two lengths.

Apart from its value for checking, study of dimensions gives one a more intelligent interest in the formulæ one encounters, and often enables one, by grouping the symbols according to the dimensions, to extract a useful meaning from a new algebraical result.

And with that little summary of the matter, it only remains for me to say that the 300,000 in the last example must have the dimensions of a velocity, as you might have guessed from the number—though you might possibly have been put off by the absence of the other 000, which cancels out because f is in *kilo*cycles per second. And the intrusive ^{2} in the previous example is the one attached to L.

New Unit of Sensitivity ?

THE great pioneers of electricity are immortalized in the names of the standard electrical units. Why should the equally great pioneers of radio be denied a similar honour? There are plenty of radio units now awkwardly expressed in electrical terms that deserve decent names of their own.

The thought is brought to mind by a recent leading article in our French contemporary *Toute la Radio.* It points out that the present expression for receiver sensitivity—so many microvolts to give standard output—is unfortunate and misleading because the greater the sensitivity the lower is the figure for expressing it. A way to improve matters, it says, would be to turn the figure into millivolts and give its reciprocal; thus a sensitivity of 20μV would become 50 and a sensitivity of 50μV (which is lower) would become 20. For the name of the proposed unit, the article suggests the French pioneer General Gustave Ferrié. He was head of the French military wireless service, which he started in 1900, but is remembered chiefly as the designer of the famous Eiffel Tower station. He did a good deal of original research and was associated with Marconi in some of the early cross-Channel experiments. Britain honoured him with a doctorate of science of Oxford University and he was a vice-president of the old Wireless Society of London, now the R.S.G.B.

General Gustave Ferrié
1868—1932

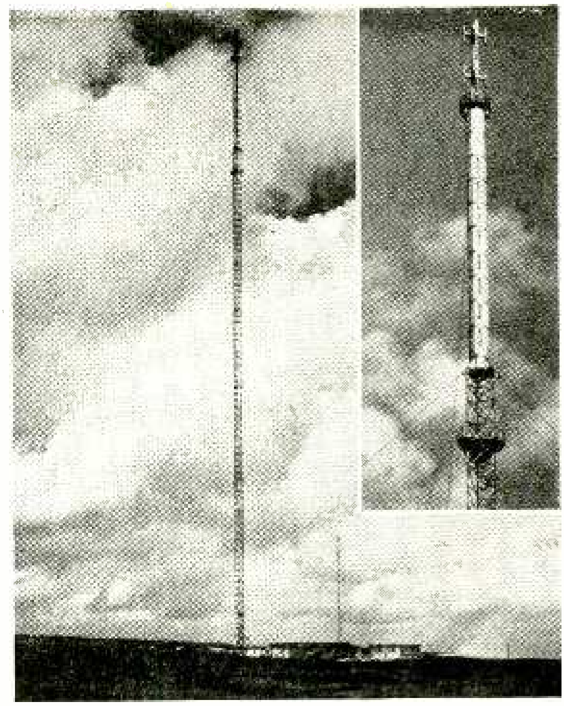
So which do you prefer, a sensitivity of 25 microvolts or 40 ferriés?

CORRECTION

The Haynes e.h.t. unit illustrated on page 393 in the October issue is not oil-immersed as stated, but it is housed in a metal container.

Holme Moss Television Station

B.B.C's Third Transmitter Opens



THE new transmitter is situated some eight miles south of Huddersfield on the moor 1,750ft above sea level. The aerial, which is supported by a 750-ft mast, comprises two tiers of four folded dipoles to give all-round coverage. The radiation pattern is restricted in the vertical plane and by this restriction a horizontal gain of 4db is obtained.

The vision transmitter has a power output of 45kW corresponding to peak white and is claimed to be the most powerful television transmitter in the world. The figure of 45kW does not include the aerial gain; if this were added in accordance with American practice, the station would be classed as one of 110kW. The frequency is 51.75Mc/s and the radiated sidebands lie below the carrier frequency.

The accompanying sound transmitter has a carrier power of 12kW and operates on 48.25Mc/s. The outputs of the two are combined in the transmitter building and fed to the aerials via a 5-in diameter coaxial cable having an impedance of 51.5Ω. This is fitted with expansion joints every 150ft and is blown to prevent condensation.

The combining unit is made of coaxial resonant sections arranged in the form of a balanced bridge so that substantially the whole of the output of each transmitter is fed to the aerial and very little indeed into the other transmitter. The loss in the resistance load on the bridge is only 300W.

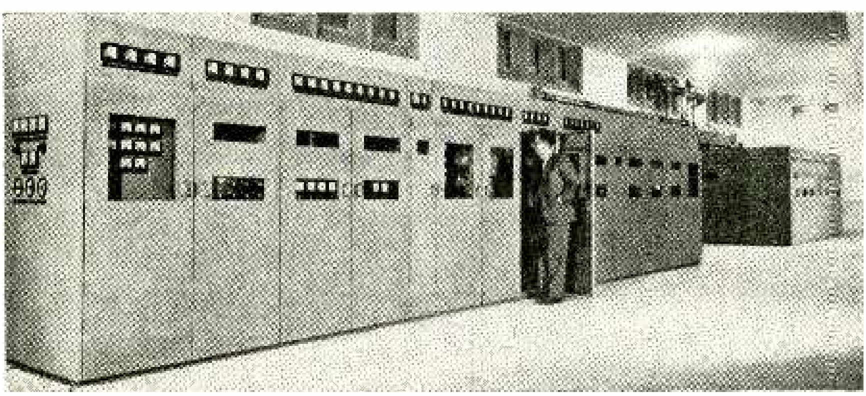
The vision transmitter starts off with a crystal-controlled drive unit operating at one-sixth carrier frequency. Following stages multiply the frequency and amplify it. The power stages comprise a push-pull class C air-cooled triode stage which drives a push-pull cathode-follower stage. In its turn this drives the output stage, which is grid-modulated, and uses water-cooled triodes in push-pull.

On the video side the incoming signal is amplified and the picture-sync pulse ratio is adjusted to 7/3. In the sub-modulator and modulator stages shunt-regulated amplifiers are used. The one in the modulator stage has an initial shunt-regulated amplifier with two ACM3 valves followed by a shunt-regulated cathode follower. This modulator has an output impedance of only 5Ω and is capable of dealing with the varying grid current of the r.f. stage. This varies from zero to 3A and has a shunt capacitance of 400pF!

The shunt-regulated amplifier is one in which the valve concerned has another valve as its load, this load valve being driven also by a signal derived from the first. In the cathode-follower version, the second valve forms the cathode load of the first and its grid is driven from the voltage developed across a resistance in the anode of the first one. The principles involved have already been described[1], and result in an extremely-low output impedance being obtained and a correspondingly great bandwidth.

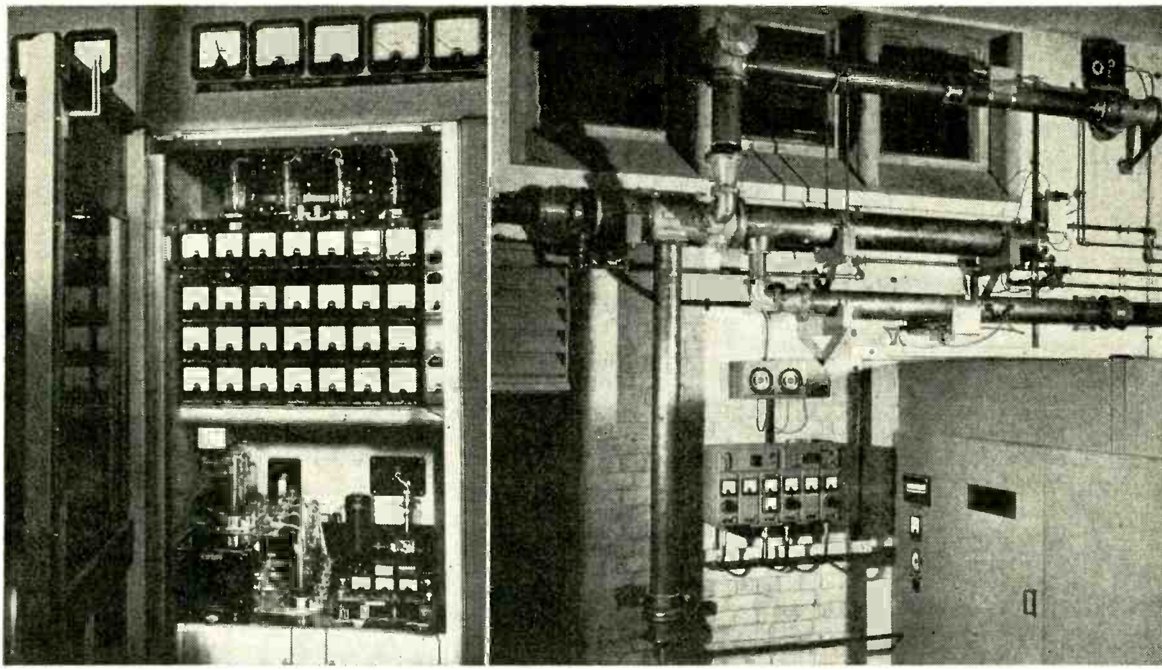
The vision signal is taken to Holme Moss from London via Birmingham by standard coaxial cable of

[1] "Shunt-Regulated Amplifiers," by V. J. Cooper, *Wireless Engineer*, May, 1951, p. 132.



Above: A view of the 750-ft mast of the Holme Moss transmitter showing the station buildings and the stand-by mast. The detail of the television folded-dipole aerials and the v.h.f. slot aerial appears inset

Left: The 45-kW vision transmitter (left) and the 12-kW sound transmitter (right)



(Left). The final stage of the vision modulator showing also the meter panel. (Right). The sound and vision signal combining unit. Here the signals from the two transmitters are mixed before being passed to the aerial

the type being laid throughout Europe for communication circuits. The cable actually contains six $\frac{3}{8}$-in coaxial tubes, 16 paper-insulated quads for control circuits and 172 quads for local telephone traffic. Two only of the coaxial tubes are available for television, the remainder being used for multi-channel telephone circuits. The signal is shifted in frequency and occupies the band 0.5–4.5Mc/s; special repeaters are used and, since harmonics of the carrier frequency lie within the pass-band, the repeaters are designed to keep second-harmonic production at least 75db below the fundamental.

At the station the signal is frequency-changed in two steps back to the video form, the change in two steps being necessary to avoid the production of interfering freqnencies.

For the future station at Kirk O'Shotts, the signal is to be conveyed by a radio link from Manchester, so that the present Manchester–Holme Moss cable will then form a spur off the main channel.

The cable, repeaters and terminal equipment have been installed and are operated and maintained by the Post Office. The transmitters, both sound and vision, have been supplied by Marconi's W.T. Company and are operated by the B.B.C.

On account of the exposed nature of the site, the building is of the cavity-wall type with double windows and is well heated. Since winter may at times isolate it, stocks of food and bedding are held in case the staff are unable to leave the station.

In addition to the main transmitters and aerial, a complete low-power transmitter (5kW vision, 2kW sound), and a second aerial system on a 150-ft mast, have been installed for emergency use. The main transmitters can be used on the emergency aerial, but with power restricted to 20kW.

NEWS FROM THE CLUBS

Birmingham.—The annual general meeting of the Slade Radio Society will be held on November 23rd. At the meeting on December 7th G. P Thwaites, of Standard Telephones & Cables, will talk on the manufacture of cathode-ray tubes. Meetings are held on alternate Fridays at 7.45 in the Parochial Hall, Broomfield Road, Erdington. Sec.: C. N. Smart, 110, Woolmore Road, Birmingham, 23.

Cleckheaton.—"The History of the R.S.G.B." is the subject of the talk by C. Sharp, G6KU, at the November 7th meeting of the Spen Valley Radio & Television Society. Films provided by the Yorkshire Electricity Board will be shown at the meeting on November 21st. Meetings are held on alternate Wednesdays at 7.30 at the Temperance Hall, Cleckheaton. Sec.: N Pride, 100, Raikes Lane, Birstall, nr. Leeds.

Kingston.—An exhibition has been organized by the Kingston & District Amateur Radio Society in aid of the United Appeal for the Blind. It will be held from 2 to 10 p.m. on November 10th at the club's headquarters, Penrhyn House, Penrhyn Road, Kingston-on-Thames, and exhibits will include the radio-controlled model boat "Miss Eedee," which recently crossed the Channel. A transmitter will be in operation and home-constructed gear will be exhibited. Sec.: R. S. Babbs, 28, Grove Lane, Kingston-on-Thames, Surrey.

Leicester.—"Electrons" is the title of one of the films to be shown to members of the Leicester Radio Society on November 6th at the Club Room, Holly Bush Hotel, Belgrave Gate, Leicester. Sec.: L. Milnthorpe (G2FMO), 3, Winster Drive, Thurmaston, nr. Leicester.

Manchester.—Another club was added a few months ago to those already active in and around the city. The Waterloo Radio Society, as it is called, meets each week at St. Albans School, Barrow Hill Road, Waterloo Road, Cheetham. Sec: J. C. Henderson, 47, Maple Street, Cheetham, Manchester, 8, Lancs.

Manufacturers' Products

New Equipment and Accessories for Radio and Electronics

Tape Recorder Unit

AN endless loop of tape is used in the magnetic recorder mechanism recently put on the market by Phidelity Magnetic Products, Ltd., of 65-66, Chancery Lane, London, W.C.2. This is 600ft long and gives 30 minutes of reproduction at a speed of $3\frac{3}{4}$in per second. A higher running speed is also provided for, and this, with the aid of the footage counter. permits rapid selection of various parts of the loop. By means of contactor strips joined into the tape an automatic stop relay can be operated, so that if the loop is used for a number of short recordings it can be stopped at the end of each. For normal use a single contactor strip serves to identify the start and finish of the loop.

Suitable for building into a complete tape recorder, the unit is light in weight and has the unusually small dimensions of 10in × 6in. It can be supplied with record and erase heads of either low impedance or high impedance.

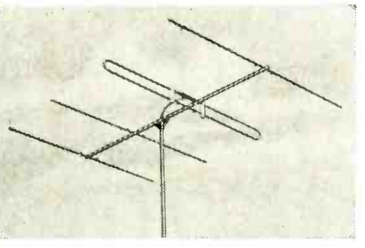
Miniature Earphone

ANYONE who has experienced the discomfort of having his ears flattened against his head for several hours at a stretch will appreciate the advantages of the miniature hearing-aid type of earphone. The ME3 model produced by Bonochord, of 48, Welbeck Street, London, W.1, is an example of what can be done in small size and light weight—it measures $1\frac{3}{16}$in (diam) by $\frac{3}{8}$in (depth) and weighs $\frac{1}{3}$oz. Inside is a radial Alcomax magnet with a Radiometal pole-piece and a polystryrene bobbin wound with nylon-covered wire. For general use (not as a hearing-aid) the diaphragm is made of annealed steel and has an armature of silicon steel in the centre—by varying these the frequency response can be altered within limits. The impedance is 80Ω at 800 c/s and the d.c. resistance of the coil is 42Ω. Maximum power admissible is 25 milliwatts.

Electrical connection is made through spring contacts which retain the plug with a definite click-action.

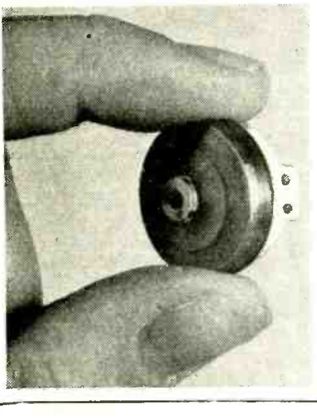
Amateur Beam Aerial

DESIGNED for use on the 2-metre amateur band, the Eddystone beam aerial in the illustration has a bandwidth of 144-146 Mc/s when properly adjusted to the mid-band point. The radiator is a folded dipole formed of two brass tubular U-sections which fit into a centre section permanently fixed to the main boom; the other elements slide into support tubes welded on to the boom at the correct spacings. All elements can be adjusted in length and then locked. Overall gain is 9db and the back-to-front ratio is 20db.



Eddystone amateur beam aerial.

The aerial is constructed of brass and copper and weatherproofed with durable black enamel. Measuring 43in × 42in (maximum) and weighing $2\frac{3}{4}$lb, the array has a low wind resistance and can be mounted on unstayed masts of up to 25ft in height. It is available from the makers, Stratton & Co., Ltd., Alvechurch Road, West Heath, Birmingham 31, at £4 16s 3d.



Bonochord miniature earphone type ME3.

Phidelity tape recorder unit.

RANDOM RADIATIONS

By "DIALLIST"

Simple, My Dear Watson!

A CORRESPONDENT, who tells me that, although he has long been a land-line telegraph operator, he knows nothing of wireless, is puzzled by the performances of a single-valve short-wave receiver which he has rigged up. He is not so much surprised by the fact that he can pick up morse transmissions from most parts of the world as by his ability to change from station to station without tuning. One night he ranged, without touching a thing, from Sweden to Panama, from Italy to Dutch Guiana, from Poland to Brazil, the United States, Holland, Honduras and many other countries. How, he asks, could this be possible? Simple, my dear Watson! Anyone who remembers using a home-made single-valve set in the early days of short-wave transmission and reception could give the answer at once. Just a case of hand capacitance, or body capacitance, to use the alternative name for the same thing. It occurs to me that many of the younger readers of *W.W.* may never have had experience of, or been exasperated by, this interesting effect. If you do your short-wave listening with a modern superhet, it isn't likely to be noticeable; but with a simple single-valve set it is usually very much in evidence.

Hand Capacitance

The tuning of such a set is a very critical business, particularly on faint signals. If large unscreened coils are used (as they were in those days by most of us, and as I gather they are now by my correspondent), capacitance between the body of the operator and the coils—and, for that matter, other parts of the receiver—can have quite remarkable effects on the tuning. A common experience in the old days was to work up some faint signal to reasonable strength by long and patient hairbreadth tuning—and then to lose it (often for good and all!) by a small movement of hand or head. There were not so very many short-wave stations then, so that losing one did not often mean an automatic change to another, as it well might with that kind of set on to-day's crowded wavebands. Those who used early short-wave single-valve receivers will recall the metal screens behind the front panels and the enormously long extension tuning spindles that we fitted in the hope of eliminating the effects of this capacitance. There was an apocryphal tale of an expert who, on being asked by the twentieth beginner in one day "How can I avoid hand-capacity?" (we called it capacity then), replied wearily "Try tuning with your toes, young man."

Television in the States

ON THE DAY on which these notes were written I had a visit from a young friend who had just arrived back by air from a visit to Washington and New York; it was, in fact, less than 36 hours since he had left America. As he is a television enthusiast, we naturally soon found ourselves discussing the comparative merits and demerits of 50-c/s, 405-line, and 60-c/s, 525-line television. He had been greatly impressed by the size of c.r.t. screens in the U.S.A., by the number of programmes available at almost any reasonable hour and by the fact that it seemed to be the normal thing for hotels to be prepared to install a television set in any visitor's room in a matter of minutes, should he desire one and be willing to pay the charge made for the use of it. And, moreover, anyone can have the benefit of television, whether or not he owns a receiver or hires one in his hotel room; for television sets are part of the ordinary equipment of countless shops, bars, restaurants and so on. Television, in a word, is now firmly established as part of the everyday life in the big cities in the U.S.A.

The Technical Aspect

My young friend formed the opinion that the general standard of television there is, from the technical point of view, nowhere near that set by the B.B.C. Note that I write "the general standard". the big transmitting stations, run by important manufacturing concerns, have high technical standards, which are rigidly maintained. But these stations are vastly outnumbered by others, often of very low power to our way of thinking, whose main purpose is to use television as the jam which mitigates the underlying dose of publicity. The quality of the transmissions from these stations was generally speaking not too good; and often it was very poor. Defective linearity was the most frequent shortcoming, but other forms of distortion also occurred in many of the transmissions. His general impressions may be summed up like this: it was pleasant to have such a number of alternative programmes on tap for such a large part of the day, but not so good to find so few genuinely watt-worthy. America is a little ahead of us in the matter of large-picture receivers and naturally a good deal ahead in long-distance relaying; but, taking it all round, our quality standards are higher and better maintained in both transmission and reception. Our 405-line system gives at least as good a "direct" picture as their 525-line, and a much better picture from the majority of O.Bs and relays.

Preferred Values

ONE DAY during a wartime radar course I was being put through a practical test by the chief instructor. "What's the value of that resistor?" he asked, pointing to one of the dozens that could be seen from the back of a stripped receiver. "Somewhere about 50,000 ohms," I replied. "Come, come, I want a less vague answer than that. These radar sets are precision instruments." Being a student of rather senior rank I ventured to say: "Yes, I know; but the value of that particular resistor isn't all that critical. The book says 47,000 ohms, but I'm open to bet that if we take this one out and measure it, it will be some way off that figure." Well, we did take it out and it measured up at 49,250 ohms. It might equally well have shown any value between 42,300 and 51,700 ohms, for it was one of the ± 10 per cent tolerance range. I don't know what happened in the other Services, but in the Army there was a tendency at one time to accept those preferred-value 47s as fundamental truths—and it's quite possible that people were occasionally ploughed for giving "wrong" answers that were actually right. One sometimes finds the same sort of tendency in civil life. After all, 47 . . . *looks* like an exact figure and is therefore apt to be misleading. The purpose underlying the adoption of these preferred values was to enable manufacturers to market colour-coded resistors of *about* 500, 5,000, 50,000 and 500,000 ohms. With a ± 10 per cent or ± 5 per cent tolerance 47 . . . is a convenient middle figure—for manufacturing purposes. It isn't so convenient for other purposes and I would like to see a return in circuit diagrams and so on to the fives and fifties. What do you think?

The Bowl Fire

The problem I offered in the September issue was, briefly, this: with various domestic electrical appliances at work in the room, a wireless receiver produced loud interference noises from its loudspeaker. No electrical measuring instruments were available. How (a) could you most quickly determine which, if any, of the appliances at work was guilty? And (b) given that a bowl fire was responsible, what do you think was happening? I warned readers that it was something that I'd never come across before. The quickest way of tracking down the culprit is to switch off the appliances, one at a time. Cutting out the bowl fire brought instant peace. It was switched on again and the noises restarted almost at once. This bowl fire had a screw-in heater element and a small intermittent arc was seen to be occurring at a point near the outer end of the socket between the male and female threads. I had the chance next day of examining the thing before it went off to be repaired. It was connected by a properly wired 3-pin plug to a wall socket. The phase-lead connection was to the central "button" of the heater but the male thread of the heater and the female thread of the socket were coated with the dirt and oxidization of years of happy-go-lucky neglect. Moral: if you've a bowl fire, take out the heater element every so often and give both its thread and that of the socket a clean up with an old piece of fine emery cloth.

Manufacturers' Literature

Message Repeater, a tape equipment for recording and repeating messages over a telephone network, described in a booklet from the Westinghouse Brake & Signal Company, 82, York Way, King's Cross, London, N.1.

Automatic Announcer tape equipment suitable for railway stations, described in another booklet from Westinghouse.

Osram Valve Manual Part 1, including receiving valves, c.r. tubes and electronic devices, available from The General Electric Co., Magnet House, Kingsway, London, W.C.2, at 5s.

"High Definition" television receiver with a 15-in tube, described in a leaflet from Sound Sales, Ltd., West Street, Farnham, Surrey.

Hearing Aid, a new Melotone model claimed to be economical to maintain, described in a leaflet from Cunningham Beattie, Ltd., 49, Wigmore Street, London, W.1.

UNBIASED

By FREE GRID

Comfort While You Look

JUST lately Mrs. Free Grid has been away from home, having gone on a mountaineering expedition by helicopter with some other members of a "Women's Uplift Society" to which she belongs. This has rather left me to my own devices and I have been compelled, among other things, to patronize one of those establishments fitted with a dozen or more washing machines—laundrettes I believe they are called—which enable people to rend their own garments instead of leaving the job to somebody else.

I was washing out my smalls the other day and marvelling at the ingenuity of the slick business man who had first thought of the money-making possibilities of fitting up a large empty shop with rows of washing machines, when the idea came to me of trying to make an honest penny myself by fitting up a similar shop with lines of television sets where people might come and enjoy the television programmes in comfort.

Now some of the less well-informed among you may ask why I should expect people to patronize my proposed public television parlour when they can enjoy the programmes in greater privacy in the comfort of their own homes. But anybody who is in touch with housing conditions to-day knows that privacy is at a premium and our budding Benedicts are forced into the Rank atmosphere of the local amatorium where they are compelled to sit herded together in the darkness with a complete absence of home comforts.

There will be none of that sort of thing in my proposed establishment, which will have curtained cubicles and comfortably cushioned armchairs to reproduce, as far as possible, the conditions of home as it should be.

Washing my Smalls.

But anybody who expects to find what our American friends would probably call a "petting parlour," or maybe a "necking niche," will have Mrs. Free Grid and her Watch Committee to reckon with, as the guiding principle will be comfort and not cuddles while you look.

Which Came First?

ONE of the most interesting articles in the September issue of *W.W.* was that on radio telearchics. I must confess, however, that I feel very troubled about the misleading effect which the opening sentence may have on some of you. To save you the messy business of unwrapping your fish and chips, I will quote the exact words of the learned scribe: "Probably one of the earliest radio telearchic systems was that demonstrated at the Paris Exhibition of 1906, when Professor Branly, using his famous coherer, showed how apparatus could be switched on and off at a distance."

Now I don't quarrel with the facts as stated, but I feel much less easy in my mind about the interpretation expressed in the opening words. I cannot help thinking that if I let this go unchallenged, some of you, who are too young to know anything of the early days of wireless, may think that radio telearchics was invented subsequently to wireless telegraphy, and I have more than a suspicion that the writer of the article, through a mental oversight, may even think that himself.

Actually, the reverse is true and radio telearchics was first in the field; indeed, it *had* to be as you will realize if you will give the matter a moment's thought. We will go no farther back than Marconi and his contemporaries of the 'nineties, all of whom sought a practical means of sending messages without the aid of wires over distances outside the range of optics and acoustics. Now in those days Mr. and Mrs. Piddington had not made telepathy the popular pastime it is to-day and so Marconi and other pioneers could not hope that their ether-borne messages would act directly on the brain cells of the intended recipients. It was obviously necessary, therefore, to devise means whereby the incoming wireless waves would switch on some sort of machinery which would automatically switch itself off when they ceased to arrive. The coherer and the morse inker (and later the headphone diaphragm) provided the answer to the problem, the decoherer and the back-spring of the inker-armature restoring the *status quo* when wave-trains ceased to arrive. Whichever way you look at it, therefore, telearchics had of necessity to *precede* telegraphy; it had, in fact, to be invented as a necessary preliminary to communication.

Earls Court, 1913.

Talking of telearchics, I should like to say how good I thought the demonstration was at Earls Court, but I don't think it was better than a telearchic display I saw, also at Earls Court, as long ago as 1913. In view of the limited technical resources available then, it certainly was marvellous but not quite so wonderful as *W.W.'s* over-enthusiastic Venerable Bede of those days would have us believe when he wrote in the September, 1913, issue that the model airships taking part in the demonstrations were "propelled by wireless."

Modulation

THE divided opinions in technical circles about the respective merits and demerits of a.m., f.m. and p.m. are strongly reminiscent of the state of affairs which existed forty years or so ago when the burning question of the hour was c.w. or spark, or, in terms of personalities, Poulsen or Marconi. C.W. seemed, in broad theory, as though it ought to be the answer to the wireless maiden's prayer, but, in practice, it certainly was not. Long years afterwards, of course, c.w., with improved and, indeed, totally different methods of generation, turned the tables and pushed spark clean off the map, if I may mix my metaphors.

Casting our minds forty years on, it is highly probable that improved technique will have enabled one particular method of modulation to put all others out of court. I wonder which it will be?