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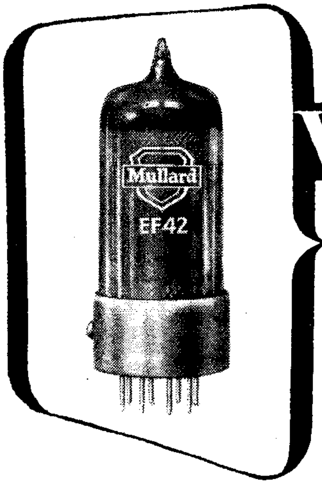

Valves and their applications

THE EF42 IN THE INPUT STAGE OF A WIDE-BAND OSCILLOGRAPH AMPLIFIER

The input stage of an oscillograph is generally less difficult to design than are the output stages as the operating conditions are rather less stringent. The inter-electrode capacitances appearing on the anode of the stage are rather lower in the former case so that a satisfactory frequency response is more easily obtained; in addition the fact that only relatively small voltages are required to drive the output stages means that the valve can be run under much lower current conditions.

For these reasons it is convenient to arrange for the input stage of the amplifier to provide as much gain as possible so that the overall sensitivity of the oscillograph shall be high.

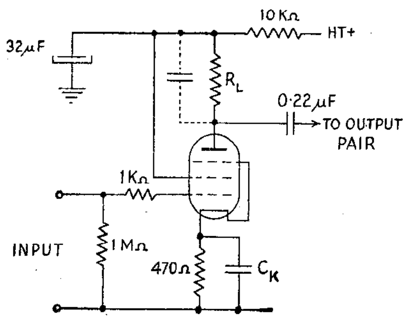

FIG. 1

A single valve circuit suitable for feeding the output stages*, is illustrated in Fig. 1. As can be seen, cathode compensation has again been used, and the condenser C_k can conveniently be 200-400pF. when the anode load R_L is 4.7 K Ω.

On the whole, this method of operation is rather wasteful since so much of the amplification is thrown away at low frequencies in order to boost the H.F. response, and a rather better solution can be obtained if the effects of the stray capacitances to earth at the anode of the stage can be reduced. In the case of a complete oscillograph amplifier this can be done by feeding a signal from the anode of the appropriate output valve of the push-pull pair via a very small capacitance (in this case about 2pF) to the anode of the first valve, when, by positive feedback, the effective capacitance to earth appearing across the anode circuit is reduced, but only up to the frequencies amplified by the output stage. When this is carried out, C_k can be increased to 500μF, thus giving full gain at low frequencies, and R_L can be as high as 10KΩ. The complete response curve of such a practical amplifier - C.R.T. combination is illustrated in Fig. 2; curves 1 and 2 are obtained respectively without and with the positive feedback network. The sensitivity is such that a 15mV signal (peak to peak) gives a trace of 1 cm. on the tube, while the transient response gives only a 5 per cent. "overshoot" to a square wave of 0.2 micro-secs rise time.

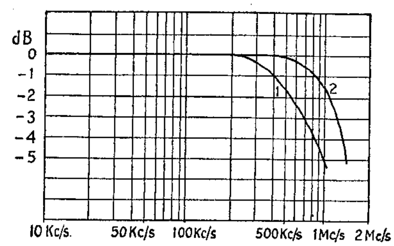

FIG. 2

In practice, some compensation is necessary for the phase delay introduced in the amplifier as this makes the positive feedback network operate at low efficiency at some frequencies but the simple correcting network illustrated in Fig. 3 is found to be quite effective.

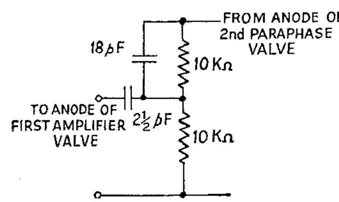

FIG. 3

* See "The EF42 in the Output Stage of Wide-Band Oscillograph Amplifier." — *Wireless World*, January, 1949.

Mullard

Reprints of this report from the Mullard Laboratories, together with circuit diagram of the input stage and feedback network, can be obtained free of charge from the address below.

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Wireless World

RADIO AND ELECTRONICS

APRIL 1949

Comments of the Month

PROGRAMME—COMPLETE WITH INTERFERENCE

WHEN so much attention is being paid to interference in television reception, we think that more notice should be taken of a form of interference which is apparently being radiated from Alexandra Palace itself along with the programme! Few viewers can have failed to notice a pattern of vertical or near-vertical bars which appear as a background to the picture. Sometimes the bars are steady, but more often they are continually varying in position and angle.

Were it not for one fact, we should hardly have the temerity to suggest that the B.B.C. could be to blame, but there seems to be conclusive evidence that this is so. The interference appears only when a particular camera is in use. When several cameras are employed to give different angles of view, as in the transmission of a play, it is most evident that the interference occurs only with one of them. The trouble disappears instantly whenever a change is made to one of the others.

The interference varies in intensity from time to time, but was extremely bad during the play "And so to Bed" on 6th March, and greatly detracted from the entertainment value of the production. It has been noticeable now for some eighteen months and while we do not doubt that the B.B.C. is aware of it and has attempted to cure it, we do feel that it is high time that some more active measures were taken.

The pattern appears to be produced by c.w. interference of a frequency in the neighbourhood of 1 Mc/s and this agrees with the suggestion which we have heard that it is actually due to pick-up of the Brookmans Park Home Service signal on the camera circuits. Certainly the appearance of the interference coincided, as far as we can remember, with the bringing into service of the new aerial system at Brookmans Park.

If this suggestion be correct, we think that the B.B.C. should take viewers into their confidence. Uncertainty and confusion as to the nature of this particular form of interference should be dispelled as quickly as possible. Until the trouble is overcome, use of the affected camera channel should cease. At present it must be doing considerable harm to television as in many areas it is far more noticeable than ignition interference.

WHAT IS A COMPONENT?

COMING so soon after the impressive and highly successful annual exhibition recently staged by the Radio Component Manufacturers' Federation, the raising of this question is perhaps rather ungracious. But the task of those whose duty it is to record happenings in the world of wireless is not being made any easier by the inclusion of more and more complex devices under the general classification of components.

To say that components should be defined as "devices represented by a single symbol on a circuit diagram" is obviously an over-simplification. According to that, a built-in loudspeaker could properly be described as a component but, by ordinary usage, an extension speaker certainly could not. Such things—and valves as well, for that matter—are commonly described as "accessories." That word, in its turn, we have heard defined rather fancifully as "devices capable of useful separate existence." As we understand this definition, a normal plug-in valve would be an accessory, while a wire-end miniature, of the kind used in hearing aids, would be a component.

All this is becoming very difficult and confusing. Clearly enough, there is so much room for differences of opinion that any classification—if indeed we need one—must come from some body endowed with dictatorial powers.

SINGLE-VALVE FREQUENCY-

New Principle Giving Wide Coverage

By K. C. JOHNSON, B.A.

IN order to vary the frequency of an oscillator it is generally necessary to change the resonant frequency of a tuned circuit, and there are many applications, such as "wobbulators," a.f.c. systems, or f.m. signal generators, where this has to be done electronically. Usually, for these devices, the well-known "reactance-valve" arrangement has been used, in which a resist-

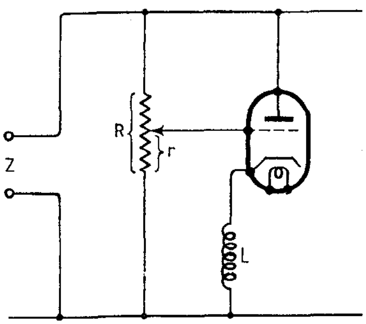


Fig. 1. Indicates how an ideal cathode-follower may be used to obtain a large effective inductance $Z = L\left(\frac{R}{r}\right)$.

ance-capacitance phase-shift network is connected between the anode and the grid of a variable-mu pentode. A phase-shift between the anode current and the anode voltage is thus introduced, so that the anode impedance is effectively reactive and, moreover, the value of the reactance depends on the slope and hence the bias of the valve. If this reactance is used as part of the tuned circuit of a conventional oscillator, it is possible to modulate the oscillation frequency by means of the bias voltage applied to the reactance valve.

This arrangement, however, cannot be made to give a very wide frequency coverage, for the phase-shift network must be designed to give a shift of as nearly as possible 90° throughout the range, so as to avoid variations in the oscillation amplitude as well as the frequency. This means that there must be heavy attenuation in the phase-shifting network, so that the coverage can only be small even at low frequencies, whilst at high frequencies the valve input capacitance becomes serious, making the network design difficult and the coverage extremely small. Lastly, there is the practical consideration that although a reactance valve must necessarily be separate from an oscillator, the arrangement to be described allows the two functions to be combined and a single valve to be used.

Modulation Principle.—The alternative method of "direct reactance modulation," which can give constant amplitude over a wide frequency range, does not use phase-shift networks at all, but depends on the principle* that the effective value of any impedance can be altered simply by arranging that although the current flows unchanged, the voltage actually applied to the impedance is only a definite fraction of the whole. Fig. 1 indicates how this principle can be used to obtain a large effective inductance, for if the valve is considered as an ideal cathode-follower, then the voltage swing actually applied to L is only $\frac{r}{R}$ of the swing across the terminals, but the whole of the current swing in L flows in at the terminals, so that they appear as an inductance taking less current, that is as a larger inductance, than L.

But valves are more suitable for dividing currents than voltages, since the suppressor grid of a pentode divides the cathode current between the anode and the screen in a ratio depending directly on the suppressor voltage and which can therefore be varied electronically; fortunately the principle holds just as well if it is the current which is divided instead of the voltage. That is to say that the effective value of any impedance can be altered by arranging that although the voltage is applied unchanged, the current actually passing through the impedance is only a definite fraction of the whole. It is not possible to give a simple circuit to illustrate this, but it can be used to obtain electronic modulation of impedances over wide ranges.

A particularly useful variation of this current division principle is possible with inductances, however, using the property of mutual inductance, for if L is the inductance of a coil carrying an alternating current $i_o \sin pt$, and a fraction $\frac{1}{x}$ of this same current flows in an ancilliary winding with a mutual inductance M between the two, then the voltage across the first coil is $(i_o p \, L \cos pt + i_o p \frac{M}{x} \cos pt)$ Thus the effective inductance of the first coil is $L + \frac{M}{x}$, and it is possible to arrange that M is negative by winding so that the current flows round in opposite directions in the two coils. If the second coil is wound with more turns than the first and the flux leakage kept small, it is even possible to have M greater than L so that the effective inductance

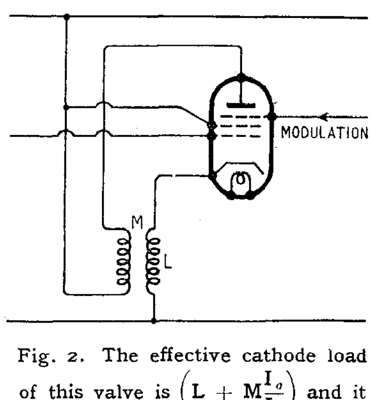


Fig. 2. The effective cathode load of this valve is $\left(L + M\frac{I_a}{I_k}\right)$ and it can be modulated by the suppressor grid voltage.

can be reduced from L right down to zero as the division fraction $\frac{1}{x}$ is increased.

Fig 2 shows how this principle

* Prov. Pat. applied for.

MODULATED OSCILLATORS

can be used to obtain a cathode load in a valve circuit whose effective value is always inductive but can be varied in magnitude electronically. The first coil, with self-inductance L, is placed in the cathode lead and carries the whole alternating cathode current I_k, while the second coil, with a

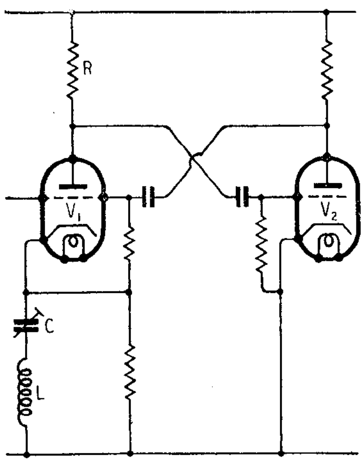


Fig. 3. An oscillator in which the tuned circuit elements are in series with a valve.

mutual inductance of M to the first, carries only the anode current I_a. But the action of the suppressor grid in a pentode is to divide the cathode current, between the anode and the screen in a ratio which depends on the suppressor voltage, but not on the cathode current itself, so that the effective cathode lead inductance is $\left(L + M\frac{I_a}{I_k}\right)$, where $\frac{I_a}{I_k}$ is the fraction of the total current which flows to the anode and so through the second coil.

Oscillator Circuits.—In order to use this principle to modulate the frequency of a practical oscillator, it is necessary to devise a circuit in which the actual oscillatory current flows through a valve in series with the tuned circuit elements. Fortunately this is easier than it might appear, since to make a "series tuned circuit" oscillate a voltage must be forced across it proportional to the current flowing (see E. W. Herold "Negative Resistance," *Proc. I.R.E.*, Oct., 1935) and this is most easily arranged by the circuit shown in Fig. 3. Here the resistance R develops a voltage proportional to the current flowing in L and C, which is phase-inverted by the second valve and applied to the tuned circuit by cathode-follower action in the first valve, so as to increase the current and excite oscillations.

But the second valve in this circuit is merely serving to invert the voltage, like the second valve in the familiar Franklin oscillator, and it can be quite satisfactorily replaced by a phase-inverting auto-transformer to give the circuit of Fig. 4 which is otherwise similar to Fig. 3. This transformer consists of a coil tuned to the central oscillation frequency and tapped so as to give a small gain, but heavily damped by a shunt resistance so that it cannot introduce undesirable phase-shifts, so tending to control the oscillation frequency, and reduce the range of frequency modulation obtainable.

The Completed Oscillator.—The completed frequency-modulated oscillator combines the mutual inductance modulation principle shown in Fig. 2 with either of the oscillator circuits of Figs. 3 and 4. The two valve circuit is slightly easier to make up, in practice, but the more economical single-valve circuit is shown in Fig. 5 and it will be seen that a mutually inductive coil in the anode of a pentode is used to modulate the effective value of the main tuning inductance without disturbing the oscillatory circuit seriously.

This means that the amplitude of oscillation can be very nearly constant over frequency ranges at least as great as ±15%, and at central frequencies up to at least 10 Mc/s, since all the effects of circuit capacities can be tuned out and the valve input capacitance is unimportant. It is hoped to

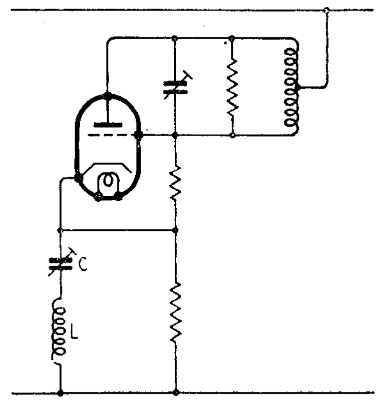
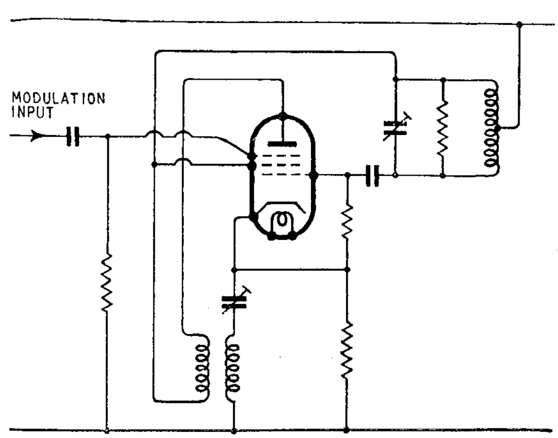


Fig. 4. The second valve in Fig. 3 can be replaced by a phase-inverting transformer.

deal with many of the more practical features of this circuit and in particular to give details of single-valve scanning oscillators for broadcast and television receiver alignment, in a second article to be published shortly; but it will already be clear that it has many advantages over the more usual reactance-valve arrangement, particularly as regards the frequency range covered and the higher central frequencies obtainable.

Fig. 5. Completed circuit of a single-valve frequency-modulated oscillator capable of ±15% deviation.



RANGE OF V.H.F.

Part 2.—Ground Communication

By **M. V. CALLENDAR,** M.A., (E. K. Cole, Ltd.)

THE actual range of communication between two stations on the ground is more difficult to estimate than the range between a ground station and an aircraft, owing to the greater number of obstacles usually intervening in the line of sight in the former case. However, even for ground-to-ground transmission much useful information can be gained from propagation theory, especially with regard to comparative ranges on different wavelengths, with different powers, or using aerials at different heights.

The minimum field required for intelligible reception at a fully efficient receiver is about 3 μV/m at 160 Mc/s and 2 μV/m at 80 Mc/s and 30 Mc/s, cosmic noise being the limiting factor at the latter frequency.

The distance at which the field falls to the minimum required has been calculated for a variety of conditions from the available formulæ (see Appendix) and the following tables give the range in miles for communication between two stations using vertical dipole aerials at the heights stated above ground. They are not intended to cover cases where a miniature battery portable, a super-regenerative set, or some other relatively inefficient receiver is used; reasonably small deficiencies in the receiver and losses in transmission lines, etc., can, however, be allowed for by choosing the appropriate column in the table.

TABLE I

RANGE IN MILES OVER LAND

Height of Aerials	30 Mc/s				80 Mc/s				160 Mc/s			
	A	B	C	D	A	B	C	D	A	B	C	D
6ft/6ft ...	2.0	3.5	6	10.	1.8	3	5	8	1.8	3	5	8
12ft/12ft ...	2.5	4.5	7.5	12	3.0	5.0	8.5	14	3.5	6	9	14
6ft/30ft ...	4.5	7.5	12	19	4	6.5	10	16	4	6.5	10	15
6ft/100ft ...	8	13	20	30	6	10	16	25	7	11	16	24
6ft/600ft ...	15	22	32	45	13	20	30	44	13	20	30	42
30ft/30ft ...	5.5	9	15	25	6.5	11	18	26	8	13	20	28
100ft/100ft or ... 30ft/330ft	15	22	32	45	16	26	38	52	19	28	38	49
100ft/1000ft ...	35	50	70	90	45	60	75	90	50	60	70	80

Explanation of Tables.

Use columns A, B, C, and D in Tables as follows:—

Loss is intended to cover the effects of:—

(a) Loss in signal due to obstructions, hills, houses, rigging on ships, etc.

(b) External interfering noise, other than cosmic noise.

(c) Any deficit in noise factor, or signal/noise ratio, of the actual receiver relative to a standard efficient receiver of noise factor = 10dB (or signal/noise ratio of 10dB for 30 per cent mod. at 1,000 c/s at 3μV from 70 ohms).

(d) Deficiencies in aerials and feeders relative to a standard dipole.

Loss of 10 *dB* corresponds to an average efficient equipment using a high slope r.f. valve, etc., in average country or open suburban areas, and represents the maximum likely loss over sea.

Loss of 20 *dB* should be allowed for in range estimates for cases

TABLE II

RANGE IN MILES OVER SEA

Frequency	30 Mc/s			80 Mc/s			160 Mc/s		
Worst Height H_w	180 ft			40 ft			14ft		
Aerial Heights	B	C	D	B	C	D	B	C	D
Aerials Low ($<.5\ H_w$)	40	55	75	16	25	37	7	12	20
6ft/30ft	40	55	75	15	23	35	7	12	20
6ft/100ft	40	55	75	17	27	39	15	23	32
30ft/30ft	40	55	75	14	22	33	8	14	22
30ft/100ft	40	55	75	16	25	37	16	25	34
100ft/100ft	37	50	70	19	30	44	28	38	49
100ft/1000ft	55	75	95	55	70	85	60	70	80

Worst Height H_w for transmission over sea : when the height of either aerial above the sea is within about $\pm$ 50% of H_w, range is actually less than for very low aerials; the maximum loss in range is between 20% and 30% and occurs when *both* aerials are at a height = H_w. Range figures are greater than for land when one or both aerial heights are less than H_w.

where low aerials are used in fully built-up areas, though larger losses may be encountered in blind spots close to houses or behind hills, especially on the highest frequencies.

Aerials

(a) Plain vertical dipoles are assumed for the tables above. If horizontal aerials are used, the range will become progressively less if the height of either aerial is reduced below 0.5λ over land or below H_w over sea.

(b) If aerials must not exceed 5ft total length, range is reduced 10 to 40 per cent (depending upon earth) on 30 Mc/s only.

(c) If optimum directors are used at both dipoles, range is increased to that for ten times higher power. Simpler arrangements, e.g., reflectors at one or both aerials, will give less increase and 3 element arrays slightly more.

TABLE III

Loss	Power Radiated				
	0.1w	1.0w	10w	100w	1Kw
0dB	B	C	D		
10dB	A	B	C	D	
20dB		A	B	C	D

(d) *Aerial Height* is that to centre of aerial: in the case of an aerial on a hill, in a valley, or on a tall building, it may be measured relative to the average height of the ground between the stations.

The Tables should give fairly reliable figures for average range obtained and for the variation of this average range with height of aerials and with transmitter power, etc. For example, we find that a given increase in power has a much greater effect than in the case of communication with aircraft; under most conditions we have here *an increase of ten times in transmitter power increasing range by about 70 per cent.*

However, when the range is great (much over 20 miles at 30 Mc/s or 10 miles at 160 Mc/s) the rate of increase in range with power becomes progressively less than that given by the above rule. Again, it is seen that doubling of the height of both aerials is equivalent to an increase of 16 times in power in most cases over land, but this rule does not hold for most practical heights over sea, nor for very low or very high aerials over land.

It is evident that horizontal aerials should not be used for transmission over sea, or for mobile operation with low aerials over land (except on 160 Mc/s), and that the lower frequencies should have preference when working over sea.

The two main factors which are not under control—viz., obstructions in the line of sight, and electrical interference—will often have a large effect in reducing the range obtained in any specific practical case. However, they should not greatly affect the *relative* ranges except in the following respects:—

(a) Electrical interference is mainly that due to car ignition systems, and this is most serious around 30 to 60 Mc/s. If such interference is serious, a "loss" at the receiver is, of course, no longer of importance within limits (e.g., 10 db loss at receiver is no longer equivalent to a reduction of ten times in transmitter power). This interference is less serious when horizontal aerials are used.

(b) Screening by houses, hills, etc., becomes progressively more serious as the frequency increases. This will tend to cancel, or even override, the effects of the reduced interference encountered at these frequencies.

The Tables may be taken to apply equally to amplitude or to frequency modulation systems, but the signal/noise ratio may be better with the latter type of modulation once the receiver is within the service area.

Range for the lightweight portable type set is normally less than that tabulated above for two reasons and apart from the low power available:—

(a) Noise factor is worse for for sets using battery valves.

(b) The aerial is restricted in length and suffers increased electrical losses if the set is carried or worn when in use.

The following table assumes a set using 1.4-volt valves, with a 2-watt d.c. input and 0.2-watt transmitter output. Figures for 4ft-aerial refer to the case where the set is worn when in use, while those for the λ/2 aerial assume the station to be temporarily on the ground. Theoretical range (0 db loss) is about 1.5 times that shown, and range under poor conditions is about half that shown. Ranges given for 160 Mc/s might not be attainable above about 140 Mc/s owing to difficulties with valves.

TABLE IV

Average Range for Portable		30 Mc/s		80 Mc/s		160 Mc/s	
Aerial Length	Aerial Height	Land	Sea	Land	Sea	Land	Sea
4ft	6ft (worn)	1.5	18	1.4	9	0.9	3
λ/2	6ft	3.0	30	1.7	10	1.0	3
λ/2	30ft	8	30	7	8	4	3

APPENDIX

As in Part 1 on air to ground communication, the figures here are based upon a paper on "Range of Low Power Radio Communication" by the present writer in *Jour I.E.E.* for November, 1948. This paper should be consulted if more complete formulæ and references are desired.

The horizon distance bears no simple relation to range when the aerials are at low heights. The following well-known simple formula is applicable to a good proportion of cases: $E = \frac{88\ h_1\ h_2}{\lambda d^2} \sqrt{P}$ where E is field in V/m. P is power radiated in watts and h_1 h_2 are aerial heights above ground; λ is wavelength and d is distance, all in metres. To cover the case of low aerials with vertical polarization, we must make the following simple correction:

Substitute 0.5λ (or $2.5\lambda^{3/2}$ if over sea) for h_1 or h_2 in all cases where h_1 or h_2 is less than the critical height of 0.5λ (or $2.5\lambda^{3/2}$ over sea).

For horizontal polarization the uncorrected formula holds down to the lowest practical heights.

However, at long distances

Range of V.H.F.—
additional attenuation occurs due to the earth's curvature, this extra attenuation reaching 3db at a distance of 13 $\lambda^{1/3}$ miles, and 8-10db at double this distance. This correction, and also smaller corrections required for very high aerials (over about 300ft) and for aerials near the critical height (or the "worst height" 1.8 $\lambda^{3/2}$ over sea) have been allowed for in the tables. Average constants (K = 10) are assumed for land.

The simple law given in the text for variation of range with power corresponds, of course, to the simple square law formula.

ELECTRONIC CIRCUITRY

Selections from a Designer's Notebook

By J. McG. SOWERBY (*Cinema Television Ltd.*)

Voltage Stabilizer for C.R. Tubes

As readers are well aware, the sensitivity of an electrostatic cathode-ray tube is inversely proportional to the final accelerating potential. Consequently, if a cathode-ray tube is to be more than a rather approximate device, and if any serious measurements are to be taken with it, this point must be allowed for. When recording photographically (in particular) some form of stabilized supply potential for the cathode ray tube should be provided. The type of circuit to be used will depend very much on the supply potential required, and at low voltage (up to 750 volts, say) the conventional series[1] or shunt[2] stabilizer is quite satisfactory. At higher potentials (750V to 5kV) the use of these conventional circuits is hampered by the lack of suitable valves among those currently available.

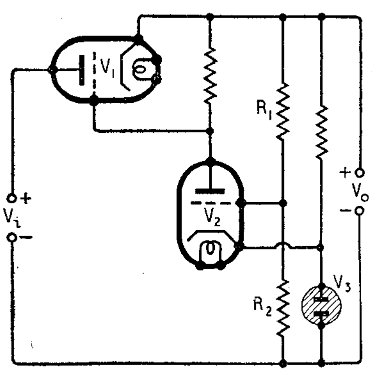


Fig. 1. Conventional series stabilizer.

The difficulty with conventional circuits is well brought out by consideration of one of them—as shown in Fig. 1. This represents a simplified series degenerative stabilizer. The reference potential is supplied by the drop across V_3 (100volts, say), and this is compared with the fraction of the output V_0 (2500 volts, say), obtained across the potential divider R_1, R_2. Any difference between these potentials is amplified by V_2 and applied to V_1 in such a way as to tend to keep V_0 constant. As the cathode-grid potential of V_1 will be small (10 volts, say), the anode-cathode potential of V_2 will approach V_0—taking the given figures it will be about 2400 volts. Now this is greatly in excess of the rated anode-cathode voltage of almost—if not quite—all small amplifier triodes and pentodes. Consequently, the circuit is rather unpractical and an alternative must be found.

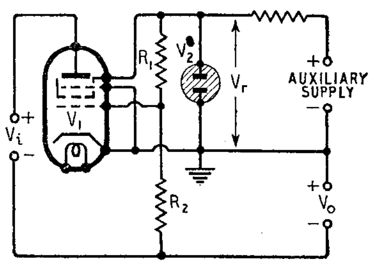


Fig. 2. Simple E.H.T. stabilizer.

A circuit which might be used to achieve the required result is shown in Fig. 2. Here V_1 is a so-called "time-base" pentode or tetrode rated at 10/30 watts dissipation with a top-cap anode rated to withstand several kilovolts peak. The EL38 is a typical example of this class of valve. The reference potential V_r is supplied by the drop across V_2 which is supplied through a ballast resistor from an auxiliary source—such as a time base or amplifier power pack. When V_r is large compared with the grid base of V_1, the stabilisation ratio, S_0, is given by:

$$S_0 = 1 + r_{a1}\frac{I_{a1}}{V_0} + \frac{\mu_1}{V_0/V_r + 1}$$

(approx.)

Where r_{a1} = anode resistance of V_1, I_{a1} = anode current of V_1 and μ_1 = amplification factor of V_1.

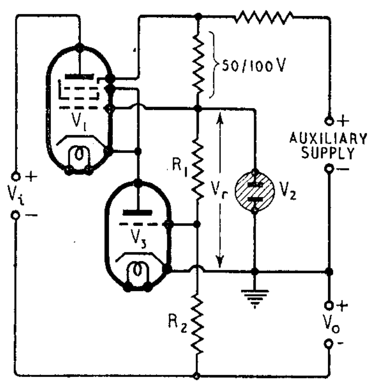


Fig. 3. Improved E.H.T. stabilizer.

If we now put in reasonable values for the parameters in this relation — assuming an EL38, (I_{a1} = 2 mA, r_{a1} = 100 kΩ, V_0 = 2,500 volts, V_r = 100 volts, and μ_1 = 100), we find S_0 = 5. This means that mains fluctuations will be reduced by a factor of 5 before reaching the cathode-ray tube. Although this is a step in the right direction, the advantages of the stabilizer are not very marked.

An improved circuit[3] used by the writer with some success is shown in Fig. 3, and it will be seen that another valve has been added in series with V_1 of Fig. 2.

When this circuit is analysed we find that the stabilization ratio is:

$$S_0 = 1 + \frac{\mu_1 r_{a3} I_{a3}}{V_0} + \frac{\mu_1\mu_3}{V_0/V_r + 1}$$

(approx.)

If we assume that μ_3 = 50 and r_{a3} = 30 kΩ, and take the other parameters as before (V_r = 100, V_0 = 2500 volts, etc.), we find S_0 = 2000 approximately. This, of course, is a very useful figure.

It will be noticed that V_3 may

[1] Scroggie, M. G. *Wireless World*, October, November, December, 1948.
[2] Sowerby, J. McG, *Wireless World*, June, 1948.

[3] Patent applied for.

be almost any sort of triode provided it has a reasonably high amplification factor, and is capable of passing the load current for the cathode-ray tube and bleeder network (about 2 or 3 mA altogether). The maximum anode-cathode potential of V_3 is roughly V_r plus the working grid bias of V_1, and need never exceed 150 volts at the maximum. Thus, the potential by which V_i exceeds V_0 appears almost entirely across V_1, and this may be a valve of the EL38 class capable of withstanding about 3 kV.

The resistance looking back into the stabilizer terminals is approximately $R_0 = \frac{1}{g_{m3}} \cdot \frac{V_0}{V_r}$, but this is not usually of much interest; if it is, in some particular application, then to maintain a low R_0, V_3 should be a valve having a large mutual conductance.

A further point should be noted; provided V_i is switched on only when V_1 and V_3 are "hot," V_1 need only withstand the fluctuations of the supply potential plus a margin for safety. Thus, with ordinary receiving valves stabilized output voltages up to about 10 kV may be obtained by the use of this circuit.

For the best results the heater of V_3 should be supplied via a "constant-voltage" transformer, and the network R_1, R_2—and any part of it which may be variable for adjusting V_0—should be screened.

A Pulse Stretcher

IT sometimes happens in electronic control applications that one is required to close a relay momentarily (e.g. for 1/10 to ½ sec.) each time a relatively short pulse occurs somewhere in the circuit. A typical example is the need to operate an electro-mechanical counter whenever a light beam falling on a photocell is interrupted. The natural choice of circuit for this sort of service would be a time-delay trigger circuit of one kind or another as previously discussed in these columns. It is not always remembered that an otherwise undesirable quality of a cathode follower can often be utilized for the purpose, and this sometimes leads to a considerable simplification with resultant economy.

The circuit of the cathode-follower pulse stretcher is shown in Fig 4. A simple analysis of the circuit shows that, provided the amplitude of the input pulse is considerably greater than the grid base of the valve, C_k charges (input increasing positively), with a time constant C_k/g_m approximately, where g_m is the mutual conductance of the valve. When the input pulse collapses from its peak to zero, V_1 is cut off and C_k discharges through R_k, until V_1 again conducts, with a time constant of C_kR_k—exactly as would be expected. Consequently, for an input waveform as shown in Fig 5(a), an output waveform as at (b) will be obtained provided $R_k \gg \frac{1}{g_m}$.

It is convenient to note that the ratio of the rising and falling time

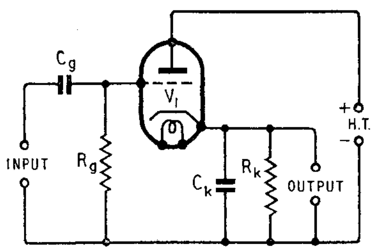


Fig. 4. Cathode-follower pulse stretcher.

constants is simply g_mR_k, so that for large inputs one may loosely say that the input pulse duration can be multiplied by the factor g_mR_k. It will sometimes happen that a relatively long time constant R_kC_k will be needed, and it is worth remembering that it is generally preferable to increase R_k rather than C_k, to obtain the desired result. The rate of rise of cathode potential is limited by C_k/g_m, and if the rate of rise of grid potential is in excess of that possible at the cathode, the valve will run into grid current in an attempt to charge up C_k rapidly. A valve with high mutual conductance will help to reduce this trouble, and will also operate correctly with a lower input amplitude than is the case with a low g_m valve.

If we use an EF50 for V_1, make R_k = 100 kΩ, and choose C_k with due regard for the input waveform, an input pulse duration may certainly be stretched 100 times, or more, and the output waveform used to operate a valve controlling a relay or any other device. If pulse stretching by a greater

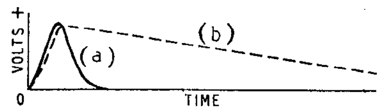


Fig. 5. Response (b) of the stretcher to a typical pulse input (a).

factor than this is needed it will usually be desirable to revert to the more complicated but more flexible time-delay trigger circuit.

MANUFACTURERS' LITERATURE

Leaflet describing the "Bafflette Bonnie" extension loudspeaker, from Richard Allen, Caledonia Road, Batley, Yorkshire.

The 1949 catalogue of components and accessories made by Belling and Lee, Cambridge Arterial Road, Enfield, Middlesex, has now been issued and is available to manufacturers, government and professional organizations. Copies will be sent automatically to those who already have previous editions.

Data sheet of valves and c.r. tubes, from Ferranti (Electronics Dept.), Moston, Manchester, 10.

Technical publication No. 21 ("Sorbsil" Silica Gel for water and organic vapour adsorption), from Joseph Crosfield and Sons (Chemical Dept.), Warrington, Lancashire.

Data sheets for the following transmitting valves: DET18, ACT19, BR124, BR125 and TT12, from Marconi's Wireless Telegraph Co., Ltd., Chelmsford.

Illustrated leaflet describing the new Type "A" potentiometer, from Morganite Resistors, Paulsway, Bede Trading Estate, Jarrow, Co. Durham.

Leaflet giving technical details of the Redifon Type G41 short-wave transmitter (5-7½ kW), from Rediffusion, Ltd., Broomhill Road, Wandsworth, London, S.W.18.

Information sheets showing the application of electronic control methods in industry, from Sargrove Electronics, Sir Richard's Bridge, Walton-on-Thames. Examples are given of the many uses to which the Sargrove rectifier-photocell and "Phasitron" circuits can be put for counting, inspection and machine protection.

Folder giving dimensions and electrical data of "Gecalloy" radio dust cores, from Salford Electrical Instruments, Silk Street, Salford, 3, Lancashire.

NOTES ON THE *Wireless World* TELEVISION RECEIVER

THE performance of the line time base is greatly affected by the core material of the line-scan transformer. Core losses are relied upon very largely for damping and the linearity control, although it does provide additional damping, does not give sufficient for some grades of iron.

During flyback, the equivalent circuit has the form shown in Fig. 1 (a), where L is the total effective inductance, C the shunt capacitance, R the resistance simulating the core losses and R_1 and C_1 the components of the linearity control. The circuit must have a natural frequency of about 34kc/s, so that one-half cycle is about equal to the fly-back time, and be so damped that the overshoot on the half cycle is only a few per cent.

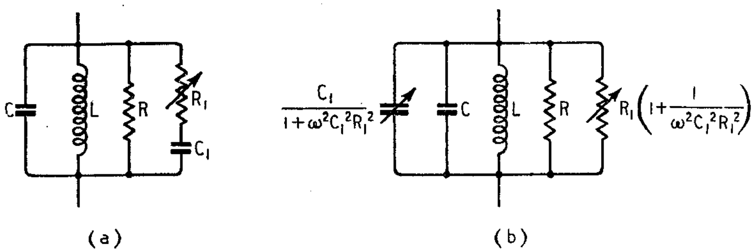


Fig. 1. **Equivalent circuit of output stage (a) and an alternative equivalent (b) which is approximately valid during the fly-back.**

At any single frequency R_1 and C_1 can be replaced by a capacitance and resistance as shown in Fig. 1 (b). A variation of R_1 thus varies simultaneously both the capacitance and resistance of the equivalent circuit. Under normal conditions the resistance variation predominates. However, if the transformer core losses are abnormal, the range of control given by the circuit is inadequate, for it is then necessary to change C_1 as well as R_1. This does not form a satisfactory arrangement, however, for the optimum value of C_1 is quite critical under some damping conditions.

It has been found better to modify the circuit to the form shown in Fig. 2, so that the damping resistance is directly in shunt with the transformer secondary. The capacitance effect of C_s of the original diagram is now provided by a shunt capacitance on the secondary. This is represented by C_A and C_B in parallel.

A variable capacitor of 0.0015μF maximum should meet all requirements and C_B would then be unnecessary. Such a capacitance is readily obtained from a 3-gang capacitor with its sections in parallel, but while this is convenient experimentally, it is rather clumsy as a permanent feature of the set. It is practically convenient, therefore, to make C_A of 500pF only and to add an appropriate fixed capacitance C_B in shunt. This must be found by trial, but will usually be 500pF. The capacitor should be rated for 750V peak. An ordinary bakelite-dielectric reaction capacitor has been used successfully for C_A and is both cheap and compact. While the voltage is considerably above that normally used on such a component, one has been working satisfactorily for some time. No damage to other components is likely to result from a breakdown. The capacitor must be mounted with its shaft earthy.

As an alternative to C_A and C_B, a 100-pF variable capacitor can be connected across the transformer primary. As this component must withstand up to 3-kV peak, it is usually easier to use the larger capacitance on the secondary.

The adjustment of C_A is critical. Adjust the width for about a 6-in picture and examine it carefully. If the left-hand side is expanded and there is a whitish vertical line or band on the right of this expanded portion, reduce the resistance by R_{19}—R_{23}. If the left-hand side is linear but folded over, increase the resistance. Adjust the resistance until there is a small amount of expansion on the left.

Next increase picture width. The expansion will be reduced and may disappear and be replaced by a foldover. If so, increase the resistance. A vertical white line an inch or so from the left may now appear. Adjust C_A to minimize it. Continue the process until the proper width is obtained. Check the fly-back time on the test pattern. If it is too great, C_A must be reduced and this will necessitate reducing the width slightly and readjusting the resistance.

It is normally possible slightly to overscan the tube so that there should be no difficulty in obtaining the full width. When the values are approximately correct, the resistance adjustment is not very critical, but C_A needs precise setting.

The circuit has been used successfully with transformers having cores of Silcor II, 0.018-in, laminations, and Silcor III, 0.02-in. With core materials of greater loss, the original circuit is preferred.

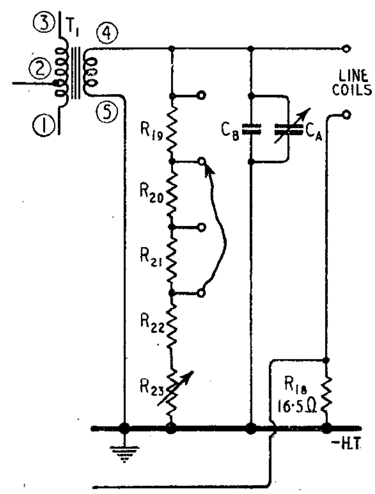


Fig. 2. **Modified damping circuit recommended for transformer cores having low losses. The references are as on the original diagram except for the new parts C_A, C_B.**

ELECTROMEDICAL STIMULATORS

Application of Radar Circuit Techniques for Diagnosis and Treatment

By O. B. SNEATH, B.Sc., and E. G. MAYER, D.Sc.
(Multitone Electric Company)

IN physiotherapeutic and orthopaedic practice it is desirable to have available certain electric currents for the purpose of stimulating muscle and nerve tissue. The reactions enable assessment to be made of faults in these tissues, and the stimulation can also be used to treat muscle and nerve fibres.

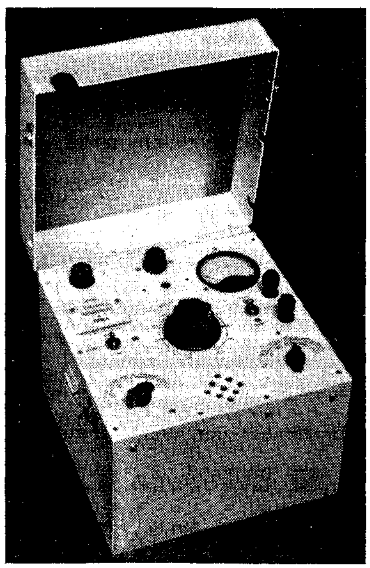
By passing a d.c. current through muscle tissue, a contraction is obtained and in the past this was supplied by a source of d.c. passed through a mechanical interrupter to the electrode in contact with the body surface. The interrupter usually took the form of a "Metronome" having a curved crossbar at the top of the inverted pendulum, one end dipping into a bottle containing mercury at each stroke and thus gave the necessary interruptions. The speed of the "Metronome" controlled the length of shock and repetition rate, the shock length varying approximately from 0.3 to 1.0 second.

Nerve tissue responds to comparatively short shocks which have no effect on muscle fibre, and for nerve stimulation damped waves were used. These were produced by means of a "Faradic Coil" which consisted of a vibrator interrupting a direct current through the primary of a double-wound transformer, the current in the secondary being applied to the tissue where stimulation was required.

For diagnosis, muscle reactions to d.c. shocks were noted and also the effect of damped waves applied to motor nerves controlling the muscle. Large variations were encountered due to varying "Metronome" and vibrator speeds, neither of which was generally very accurately measured; at best the results of tests were described by different people in varying ways.

The current generators described above were more satisfactory in the treatment of muscles and nerves by stimulating exercise, but were extremely uncomfortable to the patient and the constant increase and decay of current to contract and relax a muscle at a natural speed in many cases caused such pain that sufficient output could not be tolerated.

Experiments were carried out by Professor A. E. Ritchie, now at St. Andrews University, who found that long pulses of approximately 0.1 millisecond duration produced with electronic square-wave generators, stimulated muscle tissue, whilst shorter pulses affected motor nerves only, the reaction falling away rapidly at 0.01 milliseconds. Professor Ritchie collaborating with O. B. Sneath, then perfected a muscle stimulator producing pulses of 100, 10, 1, 0.1 and 0.01 milliseconds which could be applied to muscle tissue in such a manner that the voltage necessary at each pulse length to produce a given stimulation could be accurately read. A graph could then be drawn showing voltage against pulse length. This makes accurate diagnosis possible by showing the point when response falls, and the degree of nerve and muscle degeneration.



Ritchie-Sneath stimulator unit for diagnostic work.

It was found that the square voltage pulse output of the electronic apparatus was comfortable compared with older forms of mechanical generators and interrupters, and so this technique was applied to treatment units. These units first took the form of multi-current generators producing long, medium and short duration pulses, sinusoidal and uninterrupted direct currents, all of which could be applied in various modified forms with fast and slow repetition rates, and surged from zero to a pre-set maximum strength. A further instrument has been produced to replace the old "Faradic Coil." The output is 0.3 millisecond pulses repeated 50 times per second, and this output can be surged at five different rates with adequate spacing between surges for muscle relaxation.

Pulse generators have been extensively developed in connection with radar and telecommunication, and whilst electromedical apparatus is not generally required to give as great a stability of pulse length and interval as radar, it is necessary to be able to obtain, by switching, pulses of widely varying lengths and repetition rates. The pulse lengths commonly employed are 1 second, 100, 10, 1, 0.1 and 0.01 milliseconds, though the longest and shortest of these are often dispensed with. The repetition rate required may be 50 per second to produce continuous nerve excitation and also one or several per second as does the "Faradic Coil."

Electromedical Stimulators

In apparatus for treatment, as distinct from diagnosis, the rapidly repeated pulses require to be surged or varied from zero to maximum at a rate from 6 to 100 times per minute depending on the treatment. Spacing between surges should be sufficient to allow muscle tissue to relax and though this may be achieved manually by moving the strength control, it is far more convenient and accurate for this to be done automatically.

It will be realized that the long pulse lengths and slow repetition rates involved raise problems of coupling and decoupling somewhat different from those usually met with in radio practice.

In addition to square pulses, sinusoidal and continuous currents may be required, and provision must be made for surging these; a further requirement is to apply alternate surges, either with reversed polarity or to different pairs of electrodes in order to stimulate opposing muscles in turn.

One of the chief problems in the design of the apparatus is to produce this wide variety of currents without undue complexity in the switching, and to avoid the use of an excessive number of valves. In general, the maximum output voltage required is approximately 100 volts at 100 mA, although for short pulses of 1 millisecond or less nearly double these values may be necessary.

The only standard valves suitable for such relatively high current-to-voltage ratios, are output valves designed for use in a.c./d.c. instruments as for example 35L6's or Mullard CL33's in parallel. By connecting the screens to h.t. + through suitable resistors the drop across the anode load, when the grid is not biased, may be made only a fraction less than the h.t. supply voltage. Applying pulses to the grids, which are normally biased to cut-off, causes the valves in the output stage to resemble a high-speed relay in their action.

The best-known circuit for producing square-topped pulses is probably the multivibrator employing two triodes. The output may be obtained from a potentiometer in the anode of one of these triodes, but variations in output load, and most methods of surging the power would, in normal circuits, vary the pulse length.

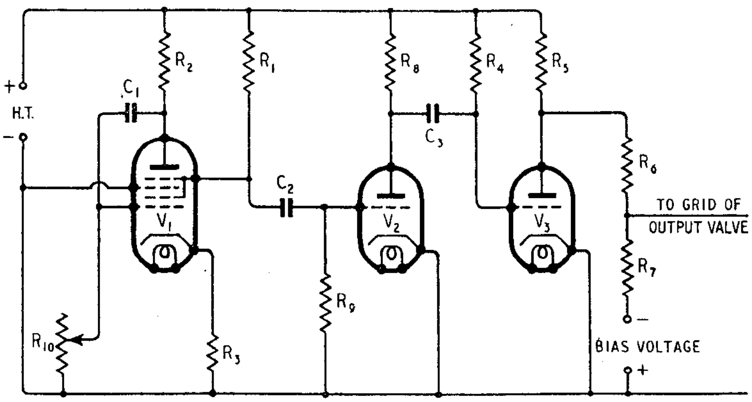


Fig. 2. "Miller integrator" type of circuit using a hexode as oscillator.

To overcome this difficulty the anode of one of the valves in the multivibrator may be coupled to the grid of the output valves which serve merely as an "on-off" switch for the current.

A factor of importance in this application of the multivibrator is the limitation of the maximum ratio obtainable between the periods of the two phases. This depends on the fact that the valve which is "blocked" for the long period has to have its grid condenser recharged during the short period, and is of the order of the ratio of the maximum value of grid leak employed to the anode load impedance. It is not generally satisfactory to use a grid leak of more than 10 megohms; thus if the anode impedance is 10,000 ohms the interval-to-pulse ratio will be limited to approximately 1,000/1 although by using a power valve biased to cut-off on the shorter pulses, a higher ratio can be obtained. There is no need for the valves to be similar, and a high-impedance valve with a higher resistor in the anode circuit could be used in conjunction with the power valve.

A modified form of "multivibrator" circuit devised by O. B. Sneath enabling 10 or 100 microseconds, or 10 or 100 millisecond pulses to be repeated one a second, employs a triode and hexode as shown in Fig. 1. It will be seen that the triode V_1 is coupled to both the inner and outer control grids of the hexode V_2, the condensers C_2 to C_6, coupling it to the inner grid, vary the pulse lengths. When the time factor of

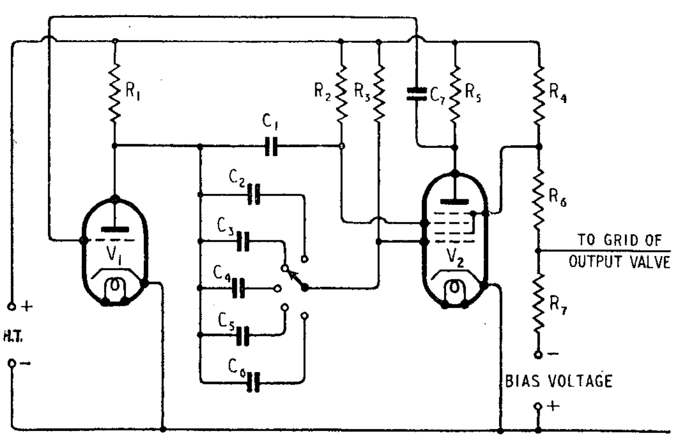
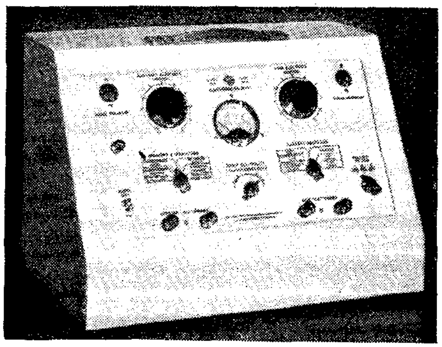


Fig. 1. Modified multivibrator circuit giving variable pulse length and spacing.

the coupling to the inner grid is greater than that of the outer, the circuit behaves as a normal multivibrator, the outer grid only being



Multi-treatment unit providing all types of current required in physiotherapy.

biased when V_2 is not passing current owing to the outer grid being biased to cut-off; this condition applies for pulses of one millisecond or longer, using condensers say C_2 to C_4.

For short pulses the anode of V_2 remains positive for a period depending on the coupling to the outer control grid, which is adequate to charge the condenser C_2, but the screen from which the output is taken remains positive for a shorter time depending on the coupling condensers C_5 or C_6. Under this condition the output from the screen is not a true multivibrator output, as the unbiasing of the inner screen is gradual, but allowing for steepening effect due to the gain of the output valve it can be made satisfactory.

Another method of producing square waves is to apply the output from a multivibrator, both constants of which are longer than the required pulse length, through a capacitor and resistor giving the required period to the grid of an amplifier which serves as or contains a limiter.

Instead of the usual multivibrator circuit, a form of circuit which has been previously described in *Wireless World* under the titles " Miller " or " Blumlein " oscillators may be employed, and is the start of the circuit for producing square pulses shown in Fig. 2. It was, however, found advantageous to employ a hexode rather than a pentode valve, as this enables the anode to be biased off by the outer grid with a lower value of cathode resistor; the outer grid takes the place of the suppressor, and the two coupled screens that of the single screen of the pentode. The behaviour of the circuit is as follows.

Assume the inner grid of V_1 to be biased, the bias will gradually decrease as C_1 discharges through R_{10} and both screen and anode voltage will fall. The valve V_1 causes the time constant of C_1 and R_{10} to be multiplied by a factor equal to one plus the effective amplification factor of the valve in conjunction with its anode resistor R_2, and hence the circuit is very convenient where long time intervals are required. As the current increases, a point will be reached where this increase continues but the anode current falls and anode potential starts to rise, due to the cathode resistor R_3 increasing bias on the outer grid; the rise in anode potential is communicated through condenser C_1 to the inner grid, and the screen current suddenly rises until the anode current is cut off by the bias on the outer grid, and the inner grid is driven positive. This causes grid current to flow as in the normal multivibrator until the anode and inner grid drops back and stability is reached, with the inner grid not completely biased to cut-off.

The resistor R_{10} has one end taken to h.t. − rather than to h.t. +, as this reduces the values of C_1 and R_{10} for a given pulse repeat rate, it also reduces frequency instability with varying h.t. supply. The output of V_1 is taken from the screen and not the anode, as this circuit has a lower impedance. It is coupled to V_2 through a resistance-capacitance coupling of long time constant compared with the pulse length, and this triode V_2 has its anode coupled to the grid of V_3. The coupling condenser C_3 and resistor R_4 between the grid of V_3 and h.t. + controls the length of the pulse.

The pulse is produced once in each complete cycle of V_1, when the screens of V_1 suddenly become positive, causing the anode potential of V_2 to drop, and V_3 to be biased to cut-off. The steepness of the termination of the pulses is increased by raising the gain of V_3, so that a smaller change in grid voltage is required to carry it out of the cut-off condition to the low anode potential position.

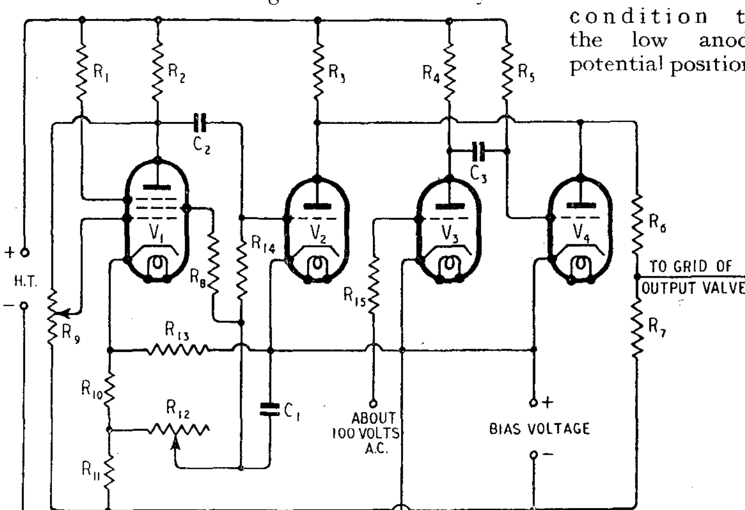


Fig. 3. Circuit for periodic amplitude control or surging of pulses at mains frequency.

The most obvious way to surge a series of rapidly repeated pulses at a slow rate would appear to be to vary the h.t. supply to the output valves. This, however,

Electromedical Stimulators

involves a duplication of the power valves and also an increase in the initial h.t. voltage and power dissipation, as there is bound to be a voltage drop in the surging valve even when the surge is at maximum. An alternative method is to couple the grid of the output valve to the anode of two valves connected together, one of these valves shown as V_4 in Fig. 3 ceasing to pass current during each pulse, and the other, V_2, being arranged to pass minimum current at the peak of the surge. The output valve only passes current when V_4 is "blocked" out, the amount of such current depending on the state of bias on V_2. Fig. 3 shows a circuit for producing surged pulses at a repetition rate of mains frequency. The circuit of the surge-producing valve V_1 is capable of producing surges with both a gradual rise and a gradual decay, but the rise and decay may be different, and the ratio is controlled by the value of the resistors R_{10}, R_{11} and to a lesser extent by the potentiometer R_9.

The cycle of operation is as follows. Assuming the suppressor grid of the pentode V_1 is at zero potential or has only a small negative bias, the anode will then pass current, and if R_2 is sufficiently high, will be at fairly low potential. Owing to the coupling through the potentiometer R_9, the inner grid will, however, be somewhat biased, and the total cathode current fairly low. This will cause the cathode potential to be low, and the negative bias on the suppressor will gradually increase, due to the current flowing through R_{12} charging C_1. Finally a point is reached where this bias causes the anode voltage to rise, which causes a rise of the inner grid voltage, and, provided that the screen resistor R_1 is low, a sudden rise in total current through V_1 and also of cathode voltage. The suppressor grid will now gradually lose bias until the anode becomes relatively negative again and the cycle is completed. Suitable values of resistors to obtain this result are: $-R_2$, 220kΩ; R_1, 22kΩ; R_{13}, 15kΩ and R_9, a 1MΩ potentiometer. A source of negative bias is required of about the same voltage as the high tension. The voltage across R_1 is fairly steady at a low value for a part of the cycle and at a higher voltage for the remainder, but at the junction of R_{12} and C_1 there is a fairly steady rise followed by a fairly steady fall of negative bias. The total length of the cycle is controlled by R_{12}. The junction of R_{12} and C_1 is coupled through a high resistance to V_2 which surges the pulses, these can be produced by applying a.c. at about 100 volts, 50 c/s to the grid of V_3 through a resistance. Approximately square pulses are produced on the anode of V_3, which is coupled through a condenser C_3 to the grid of V_4. This condenser and a resistor R_5 to h.t. + determine the pulse length.

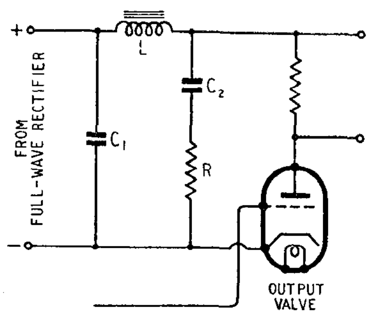


Fig. 4. Stabilizing circuit for h.t. supply when using long pulses.

The form of surge usually desired is a gradual rise followed by a rapid decay. The surge should be effective for about a quarter of the time, which in general means that it should be over half value for about a quarter of the time. It is of little consequence how much of the remaining time the pulses are absent or at a low level. It is probably almost as effective to have a gradual rise followed by an instantaneous decay, and a number of well-known circuits similar to those used for television scanning can be adapted for this purpose. Many of these circuits can only be varied over the required range, while retaining their wave form, by employing ganged controls.

It is desirable to provide a source of constant amplitude sinusoidal voltage and also to surge this voltage at varying repeat rates. Whilst "continuous sinusoidal" is, of course, obtainable from the secondary of the mains transformer, it is very involved to surge this without entirely changing the waveform. Probably the simplest method is to produce surged square pulses of approximately 10 milliseconds in length at a repeat rate of 50 per second and to connect in parallel with the output a 50-c/s resonant circuit.

A special problem arises in connection with the longer pulses, and is due to the gradual fall in voltage after the start of the pulse owing to the discharging of the reservoir condensers in the power pack. This could be solved by the use of a stabilizing device normally drawing current comparable with that of the pulse, but this would greatly increase the power dissipation of the apparatus, and is therefore undesirable. The arrangement shown in Fig. 4 has been employed,* and the general effect is that when the valve starts to draw current, this is obtained from the condenser C_2 charged to open circuit power pack voltage, but the voltage is dropped by the resistor R. As the current continues, the voltage of C_2 falls, but the effect is compensated by the rise of current through the choke L. Owing to the non-linear nature of the rectifier resistance and the complication due to the first reservoir condenser, no simple formula can be given for the value of R and perfect squaring is not achieved, but reasonably good results were obtained with R, 600 ohms, L, 12 henrys, C_1, 16μF and C_2 32μF.

* Patent has been applied for in connection with this arrangement.

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Ritchie, A. E. "Thermionic Valve Stimulators, *British Journal of Physical Medicine* 1948, Vol. 11, p. 101.

PORTABLE RECORD PLAYER

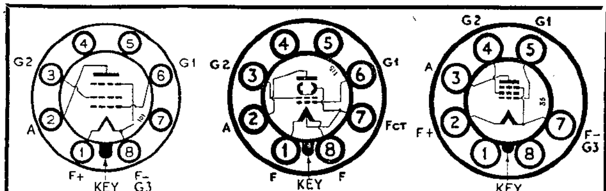
DESIGNED for operation from a.c. mains, the "Karrigam" record player made by the V.S.E. Construction Co., 5-7, Denman Street, London, W.1, employs the new all-class B8A miniature valves and the heaters are fed in series through a capacitor. Negative feedback is employed, and the output is 2½ watts to a flat-type 6½in moving-coil loudspeaker mounted in the lid of the rexine-covered carrying case. A lightweight Garrard turntable unit is used and bass-boost at 3.8db per octave is provided in the 3-valve circuit which works in conjunction with a high-quality magnetic pick-up. The weight of the player is 16¾ lb and the price is £26 19s 8d.

Two rare valves—the answer lies in using types to *BRIMARIZE!

TYPE 1LA4 and 1LB4 are small output valves used in portable battery equipment. Two substitute valves are available: type 3D6 which requires slightly more filament current, or type 1A5GT which necessitates a change of socket.

To keep battery consumption to a minimum, only one half of the 3D6 Filament is employed, Pins 7 and 8 of the socket being joined together for this purpose.

For AC/DC Battery operation type 1A5GT is the only suitable substitute as the filament ratings of all the valves must be identical in such receivers.



TYPES ILA4, ILB4 — TYPE 3D6 — TYPE IA5GT

CHARACTERISTICS

	TYPES ILA4, IA5GT	TYPE ILB4	TYPE 3D6 (One Filament)	
Filament Voltage	1.4	1.4	1.4	volts
Filament Current	0.05	0.05	1.1	amp.
Anode and Screen Voltages	90	90	90	volts
Anode Current	4.0	5.0	4.2	mA
Screen Current	0.8	1.0	0.65	mA
Control Grid Voltage	—4.5	—9.0	—4.5	volts
Mutual Conductance	0.85	0.93	1.2	mA/V
Optimum Load	25,000	12,000	20,000	ohms
Power Output	0.12	0.2	0.185	watts

CHANGE VALVE		CHANGE SOCKET		CHANGE CONNECTIONS		OTHER WORK NECESSARY	PERFORMANCE CHANGE
FROM	TO	FROM	TO	FROM OLD SOCKET	TO NEW SOCKET		
ILA4	3D6	Loctal NO CHANGE		Disconnect any wires to Pin 7. Join Pins 7 and 8 of socket together		—	INCREASED OUTPUT
	IA5GT	Loctal	Octal	Pin No. 1 ,, ,, 2 ,, ,, 3 ,, ,, 6 ,, ,, 8	Pin No. 2 ,, ,, 3 ,, ,, 4 ,, ,, 5 ,, ,, 7	—	NO CHANGE
ILB4	3D6	Loctal NO CHANGE		As for ILA4		Decrease Bias Resistor to give 4.5 volts bias only	NO CHANGE
	IA5GT	Loctal	Octal	As for ILA4		As above.	REDUCED OUTPUT

BRIMAR says.. watch our next advertisement for a special announcement

BRIMAR
RADIO VALVES

STANDARD TELEPHONES AND CABLES LIMITED, FOOTSCRAY, SIDCUP, KENT.

← PUNCH HOLES HERE →

ILA4
ILB4

INSTRUCTIONS: Punch holes where indicated, cut away this portion and file sheets in order of appearance. This column will then form a quick reference index.

25

Vortexion

"STEREOPHONIC" AMPLIFIER

This new amplifier with triode cathode-coupled output stages has the effect of making the reproduction more like the original than ever before. A small proportion of this improvement results from the reduction of the Doppler effect, which is achieved without lowering the damping factor on the speakers, with the consequent distortion and transient loss which would follow.

When listening to an orchestra the low frequencies are usually heard towards the right, and the high frequencies towards the left. When reproduced through the Vortexion " Stereophonic " amplifier with low and high frequency speakers suitably spaced according to required listening angle, the high and low frequencies are heard in their relative positions simulating the effect and appreciation of the original.

This speaker placing is necessary because our ears are on a horizontal plane. The effect would be lost if our ears were positioned one above the other, as can be proved by inclining the head sideways.

Our efforts to achieve " Stereophonic " results by the use of various choke and condenser cross-over networks between the amplifier and speakers were unsuccessful, due to the large variation of speaker impedance at various frequencies, unevenly loading the resonant circuits.

After many months of research we finally achieved our aim with what is basically two special low-distortion, high-damping factor amplifiers in one, each covering a portion of the audio spectrum with a sharp cut per octave at change-over frequency. The acoustical efficiency of the bass and treble speakers may vary, so a balancing control is fitted to the amplifier. This simplifies the choice of speakers, since each speaker has only a narrow frequency coverage.

The " Stereophonic " amplifier is now in production, and we invite you to hear a demonstration of what we believe to be something new and which will add to your enjoyment of music.

Chassis complete with valves

Price 36½ gns

VORTEXION LIMITED, 257-261 THE BROADWAY, WIMBLEDON, LONDON, S.W.19

Telephones: LIB 2814 and 6242-3 Telegrams: "Vortexion, Wimble, London"

DEVELOPMENTS IN COMPONENTS

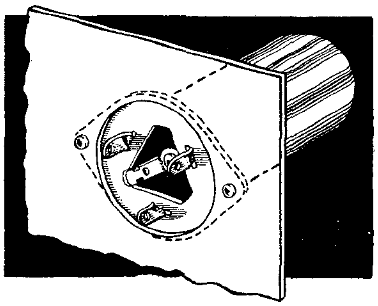
R.C.M.F. Exhibition, 1949

THIS year's annual private exhibition of radio components and accessories, organized by the Radio Component Manufacturers' Federation, was held in London from March 1st-3rd. The following survey of exhibits is classified under headings of the main products, with lists of makers. A general list of exhibitors, with their addresses, is given at the end.

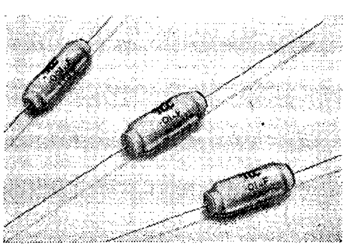
CAPACITORS

With few exceptions the general tendency in the design of capacitors, both variable and fixed, is to reduce size as far as practicable.

A notable development along these lines is a new range of fabricated plate (FP) electrolytic capacitors in aluminium cases made by the British Electrolytic Condenser Company, one of the Plessey group of companies. By using a gauze-like material on which pure aluminium is deposited, the effective area presented to the electrolytic is increased by as much as twelve times compared with plain foil. A 16-μF, 350-V FP type, for example, measures ¾in diameter and 1⅞in high only. Capacitors of from 2 to 50 μF are available at up to 450 V d.c. working in this pattern; multiple types were also shown.



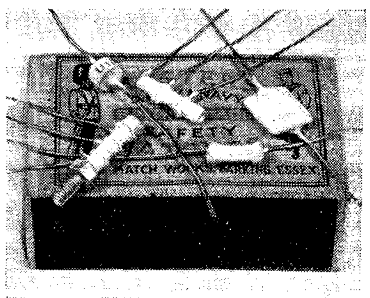
New method of fixing used on British Electrolytic Condenser FP capacitors



T.C.C. miniature Metalmite capacitors

Coupled with this development is the introduction of a new method of fixing. Short lugs are formed on the base of the cylindrical case, and these are inserted in slots arranged round a centre clearance hole in the chassis. The lugs are then twisted to anchor the component.

Plessey adopts this method of fixing and so also does Dubilier for their latest range of small-sized electrolytic capacitors in aluminium cases. They are called "Ear-mounting" Drilitics. As an interim measure small base plates with the necessary fixing slots and centre hole are available for eyeletting or bolting to the chassis. Hunts also employ this method of fixing.

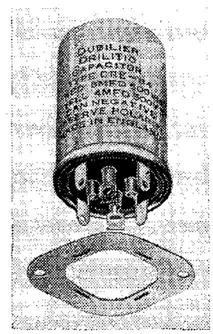


Group of United Insulators miniature silvered ceramic capacitors. The match box gives a good indication of their size.

Plastic film is now being used by T.C.C. for the dielectric in some of their latest types. These capacitors are known as "Plastapacks" and the advantages claimed are very high insulation resistance, of the order of 250,000 megohms/μF and a power factor equal to the best mica. They also have a negative temperature co-efficient. In small tubular types this range is from 50 to 5,000 pF. T.C.C. have also made some additions to their Metalmite range, the latest models being very small in size and covering capacitances of from 200 pF to 0.01 μF.

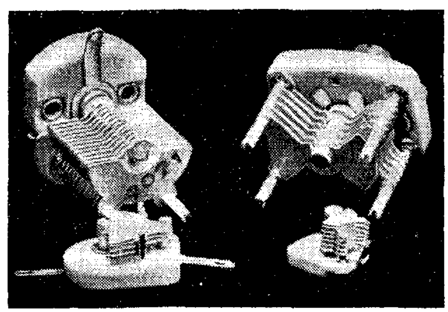
A range of sub-miniature silvered ceramic capacitors made of a new ceramic, Unilator K3000, was shown by United Insulators in various forms. There was a tiny wafer type measuring ½in × ⅜in with wire ends in 680, 1,000 and 1,500 pF, a small pearl-shaped model of from 0.47 pF to 470 pF, a tiny tubular in sizes of 680 pF to 0.01 μF and some double and triple types up to 2,200 pF.

Erie had a new post-type Ceramicon smaller than made hitherto. It, also, is a silvered ceramic and is available as single, dual or triple units and up to 1,800 pF.



Dubilier Drilitic capacitor with new "Ear-mounting" feature

So far as variable capacitors are concerned the main feature noticed was even better finish than hitherto. Small subsidiary band-spread units embodied in the main assemblage is used by Wingrove and Rogers (Polar) and Plessey. The former were showing an extended range of miniature types of silvered brass construction for v.h.f. use and these included a sub-miniature air trimmer on a ½in × ⅜in ceramic base and in sizes of 1-5 and 1-10 pF.



Group of Polar miniature air-dielectric trimmers

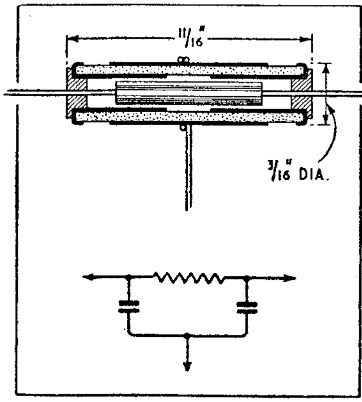
Makers*: Bird (T, V), British Electrolytic Condenser (E), B.I. Callenders (E, P), British N.S.F. (P, M), Bulgin (T), Daly (E), Dubilier (C, E, M, P, T), Erie (C, T), Ferranti (E, P), Hunt (C, E, M, P, T), Jackson (T, V), London Electrical Manufacturing (C, M), Mullard (T), Plessey (T, V), Stability Radio (M), Standard Telephones (M, P), Static Condenser (P), Telegraph Condenser Co. (C, E, M, P, T), Telephone Manufacturing Co. (M, P), United Insulators (C, M), Walter Instruments (T), Wego (C, M, P), Welwyn (T), Wingrove & Rogers (T, V).

**Abbreviations:* C, ceramic; E, electrolytic; M, mica; P, paper; T, trimmers and pre-set; V, air dielectric variables.

Developments in Components—

RESISTORS

Negative temperature resistors are a comparatively new development and they are beginning to find applications in a.c./d.c. receivers to safeguard valves and dial lamps when first switching on. When cold the resistance is extremely high and it falls rapidly with a rise in temperature, or with increase in current through the element. For example, the latest Standard Telephones "Brimistors" can provide a change in resistance from 5,000 ohms when cold to 50 ohms or so at 250°C. In terms of current the type CZ1 with 0.1-A valves limits the initial surge to 0.12 A, its resistance change being 3,000 ohms when cold to 200 ohms with 0.1 A. There are other types for 0.15-A and 0.3-A circuits as well as for many other purposes.



One of the new Erie combined units: a diode filter with circuit shown below

Serving the same function is the new Mullard Varite. This employs a ceramic type of material and is made in a variety of types to suit the function it is required to perform. In addition to surge limiting in a.c./d.c. sets it is being employed as an automatic picture height control in television receivers as well as for many other purposes.

High-stability resistors where constancy is of vital importance, such as in attenuators and measuring equipment, were more in evidence this year. Welwyn Laboratories have developed a new type especially for use in v.h.f. circuits and said to be entirely reliable at 100 Mc/s and possibly far beyond. Discs and rods for embodying in co-axial lines were shown. Mullard were showing the high-stability type in four sizes, ¼- to 2-watts rating, while Dubilier and Erie each had a comprehensive range, fully insulated models being available in either make.

Little change has been made in the ubiquitous rod-type resistor except that Morganite now have a new range with axial wire ends. In ½-watt size the range is 47 ohms to 4.7 megohms and the 1 watt extend from 22 ohms to 10 megohms.

Makers*: Advance (A), Belling & Lee (S), British Electrical Resistance (P, R, V, W), British N.S.F. (P, W), Bulgin (P, W), Colvern (P, W), Dubilier (C, HS, P, S, V, W), Erg (HS, V, W), Erie (C, P, S), Igranic (W), Morganite (C, P), Mullard (HS, NC), Oliver Pell (R, W), Painton (A, P, V, W), Plessey (P), Standard Telephones (NC), Welwyn C, HS, V, W).

**Abbreviations:* A, attenuators; C, composition; HS, high stability; NC, negative coefficient type; P, potentiometers; R, rheostats; S, suppressors; V, vitreous; W, wire-wound, fixed and pre-set.

RESISTOR-CAPACITOR SUB-ASSEMBLIES

The combined resistance-capacity unit, once very popular for a.f. couplings, has now reappeared in a new dress. Some of the assemblies are r.f. and i.f. diode filters, while others are a.f. couplings and decouplings. They were shown by Dubilier and Erie.

A twin capacitor which needs only the addition of a resistor to form a diode filter unit was shown by Stability Radio. This provides 100 + 100pF and is of silvered mica construction.

COILS AND TRANSFORMERS

Radio Frequency.—The design of signal and intermediate-frequency coils for broadcast equipment has become, if not standardized, at least stabilized and the well-tried practice of the past is still followed. Perhaps the only change which is noticeable in the greater number of miniature types.

Examples of air-core coils were shown by Automatic Coil Winder, and Wearite had their well-known P range. The latter firm also had a tuning unit on view. This has three bands for aerial and oscillator tuning and has dust-iron core coils adjustable for trimming. The type 705 covers long, medium and one short-wave band whereas the 706 covers 3-23 Mc/s in two bands as well as medium waves.

Miniature i.f. transformers usually have adjustable dust-iron cores for trimming and are commonly ¾in to 1in square and about 1¾in high. Models were shown by Plessey, Wright and Weaire and Igranic.

Makers: Advance Components, Automatic Coil Winder, Igranic, Plessey, Teledictor, Wright & Weaire.

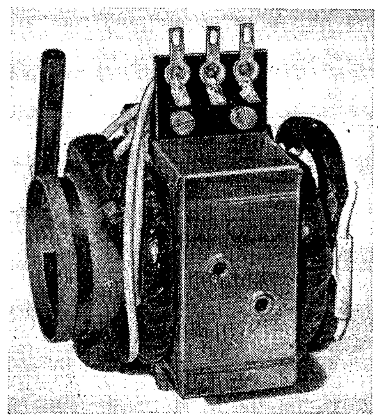
Mains and A.F.—The advantages of the so-called high-frequency power supplies for aircraft apparatus were well brought out by a range of miniature transformers shown by Ferranti. Hermetically sealed and designed to withstand a shock test of 60*g* a transformer for 70 VA weighs only 1.17lb and measures 1$\frac{23}{32}$in by 1¾in by 3$\frac{1}{32}$in. The operating frequency is 1,100 c/s but models for frequencies of 800 c/s to 2,800 c/s can be supplied.

The 50-c/s types of transformer show little change. Impregnation is now quite general and most firms can supply hermetically-sealed types for arduous conditions. Some of these are fitted with pressure-equalizing bellows.

The range of a.f. transformers shown by Varley includes intervalve types. Output transformers are made by most transformer and loudspeaker manufacturers.

Makers: Acoustic Products, Advance Components, Associated Electronic Engineers, Automatic Coil Winder, Bulgin, British Electric Resistance, British Rola, Celestion, Electro-Acoustic Industries, Ferranti, Goodmans Industries, Igranic, Oliver Pell Control (Varley), Parmeko, Partridge Transformers, Plessey, Reproducers & Amplifiers, Taylor Electrical Instruments, Teledictor, Truvox, Vitavox, Woden, Wright & Weaire.

Television Coils.—Both Igranic and Plessey showed television deflector coils of the "bent-up end" type together with line- and frame-scan transformers and blocking-oscillator transformers. Plessey also had a frame yoke on view designed for use with a self-oscillating drive stage. It is of the U-shaped type with the windings on the bottom member, the deflecting field being produced across the sides of the U.



Igranic television deflector-coil assembly.

Makers: Igranic, Plessey.

CHASSIS FITTINGS

One or two new switch designs have made their first appearance. Bulgin were showing a new toggle switch (S.258) with improved terminals designed to take large conductor cables, and an all-moulded toggle switch (S.377) rated at 250 V, 6 A with insulation greater than 40 MΩ at 250 V. This latter type is suitable for non-earthed apparatus and meets the requirements of many Continental countries. A.B. Metal Products were showing a light-action lid-operated switch (Type DS1) for use in personal portable receivers and also the prototype of a coupled switch unit for radio-gramophone-television sets.

Makers*: A. B. Metal Products (S), Antiference (PS), Associated Electronic Engineers (TB), Belling & Lee (C, CRH, PS, S, T, VH, VT), British Electrical Resistance (K), B. I. Callender's (C), British Mechanical Productions (C, CRH, F, MS, P, PS, ST, T, VH, VP), British N.S.F. (S), Bulgin (C, F, G, J, K, L, MS, PS, S, T, VH, VT), Carr Fastener (C, CRH, E, F, L, MS, PS, ST, TB, VA, VP, VT), Clarke (P), Colvern (TB), Edison Swan Electric (CRH), Electrothermal (S, VR), Erie (S), Hallam, Sleigh & Cheston (I), Igranic (PS), Imhof (CH, P, R), Jackson (D), Long & Hambly (PS, RM, TM, VR), McMurdo (K, VH), Oliver Pell (S), Painton (K, PS, S, T), Plessey (C, D, PS, S, VH), Reliance Electrical Wire (C, PS), Reslosound (PS), Ripaults (C, T), Salford Electrical Instruments (D), Erwin Scharf (K), Shipton (J, S), Standard Telephones & Cables (C, PS, S), Taylor Electrical (K, S, T), Telegraph Construction & Maintenance (C, PS, T), Telephone Manufacturing Co. (J), Tucker Eyelet (E, T, VT), J. & H. Walter (CH, P, R), Walter Instruments (S), Wingrove & Rogers (D), Wright & Weaire (S).

**Abbreviations:* C, connectors; CRH, cathode-ray tube holders; CH, chassis; D, drives; E, eyelets; F, fuses and fuseholders; G, group boards; I, instrument mountings; J, jacks; K, knobs; L, lampholders; MS, mounting strips; P, panels; PS, plugs and sockets; R, racks; RM, rubber mountings; S, switches; ST, soldering tags; T, terminals; TB, terminal blocks; TM, television masks; VH, valve holders; VP, valve pins; VR, valve retainers; VT, valve top connectors.

VIBRATORS

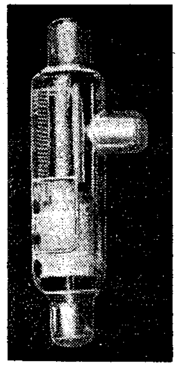
Little change has occurred in vibrators for h.t. supplies and both synchronous and non-synchronous types were in evidence. Input voltages range from 2 V to 24 V, but 6 V and 12 V are the most usual, while the power ratings are 10-120 W. Complete vibrator power units were also shown.

Makers: Bulgin, Plessey, Wimbledon, Wright & Weaire.

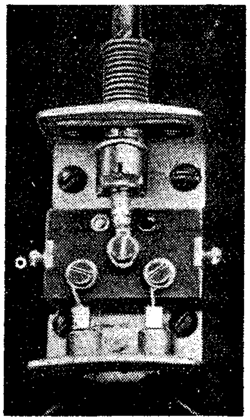
AERIALS

Those firms concerned with the production of aerial equipment have given quite a lot of thought to the design of television aerials and accessories. These call for good engineering practice since in the main they are self-supporting structures. For example, Antiference have introduced a 3-element array for "fringe areas" consisting of a director one-eighth wavelength in front of the aerial element and a reflector a quarter wave behind.

Belling-Lee outdoor television aerials are now constructed of a high-tensile light-weight alloy, thereby considerably easing erection and lessening the strains and stresses on the fixing harness or wall brackets. A new type of pole cap is employed, which, in conjunction with a limited number of standard parts, enables aerials to be assembled on the site for every likely form of mounting. Belling and Lee also have a range of indoor television aerials, the newest being the "Doorod" model. The upper half of this aerial is a copper rod but the lower half is a length of 300-ohm twin polythene insulated flexible which can be run at right angles to the vertical element, straight down, below the carpet or even coiled.



Ferranti KD60 stabilizer



Television aerial outlet box feeding two receiver points, shown by Antiference (Left)

Makers*: Antiference (AI, B, T), Belling & Lee (AI, B, F, T), B.I. Callenders (AI, F), London Electric Wire Co. & Smiths (W), Reliance Electrical Wire (W), Ripaults (W), Telegraph Construction & Maintenance (F).

**Abbreviations:* AI, anti-interference; B, broadcast; F, feeders; T, television; W, aerial wire.

VALVES

Miniature valves with the B7G, B8A and B9A bases are far from being new, but what is new is the appearance of complete ranges for all purposes from broadcast receivers to e.h.f. input stages. An example of the last is the Brimar 12AT7, a double triode with a 12.6-V heater centre-tapped for use on 6.3 V. Each section has a mutual conductance of 6.6 mA/V and the valve will oscillate up to 700 Mc/s. It is suitable for use as a grounded-grid input stage.

Mazda valves include a range with 0.1-A heaters for series operation. Among them is a high-*g* r.f. pentode, the 10F3, with a mutual conductance of 9 mA/V, while a triode-heptode frequency-changer, a variable-mu pentode and a duo-diode-triode are included in addition to an output tetrode.

The Osram television pentode has the B7G base. It is the Z77 and has a 0.3-A heater.

Mullard exhibited valves ranging from the well-known E50 series to sub-miniature types for hearing-aids. A series of valves designed for series-heater operation in a.c./d.c. television sets was shown; the PL38, a line-time base output valve is similar to the EL38 but has a 30-V, 0.3-A heater.

Among the range of Ferranti valves, the KD60 neon voltage-stabilizer is of interest. With a normal drop of 63 V it will give regulation of ±0.4 V for a current of 0.125-2.5 mA. The tube has end caps and can be used as a visual indicator.

Makers: Ediswan, Ferranti, G.E.C., Mullard, Standard Telephones & Cables.

CONTACT RECTIFIERS

Copper-oxide and selenium rectifiers now find wide application in telecommunications. Their use in power supplies is well known and there is hardly any limit to the range of voltages and currents with which they will deal. Compact types for up to 2.5kV at 0.5mA were shown by Westinghouse, who also had e.h.t. supply units on view. These provide some 4kV from a 350-0-350V input.

In addition, signal-frequency types are made and find great application at the lower radio and audio frequencies, especially in telephone equipment. Bridge rectifiers for meters are also popular and the Salford types have a bakelite case for the rectifier elements, the whole being sealed under pressure in a polythene outer case. The 1-mA type has a frequency response extending to 100 kc/s.

Makers: Salford, Standard Telephones & Cables, Westinghouse.

CATHODE-RAY TUBES

The television tubes shown were universally for magnetic deflection and were chiefly 9in and 12in types, although Mullard had a 2½in projection tube. This is the MW6-2. It is intended for use with a Schmidt optical system to give a picture 15in by 12in with a 25 kV h.t. supply. The well-known 9in and 12in types were also shown.

The Ferranti T12/46 is a 12in tube with a triode gun rated for operation at 7 kV with a peak beam current of 150 μA, and needing 24 V

Developments in Components—

signal input. Brimar showed a flat-faced 12in tube—the C12B—with an aluminized screen which draws 200 μA at 12 kV. This firm also had a 9in type of more normal design. Aluminizing is not only claimed to give a brighter picture but also to give freedom from ion burn.

Flat-face 9in tubes were displayed on the G.E.C. stand. There are several models, the differences being mainly in the presence or absence of external graphite coatings and in the type of heater used.

Ediswan showed 9in and 12in types with triode guns.

Makers: Ediswan, Ferranti, G.E.C., Mullard, Standard Telephones & Cables.

INTERFERENCE SUPPRESSORS

The radio interference suppressors shown at this exhibition can be broadly divided into two classes: those that are incorporated in, or in some way connected to, offending electric appliances and those that are interposed between the radio receiver and the mains supply point. The function of the former is to prevent intermittent voltage or current surges being radiated or being injected into the supply mains while that of the latter is to prevent any such surges on the mains reaching the radio receiver.

Makers*: Belling & Lee (Ap, M, R), Dubilier (Ap, M), Erie (M), Hunt (Ap), Morganite (M), Static Condenser (Ap), Telephone Manufacturing Co. (Ap, R), Telegraph Condenser Co. (Ap, R).

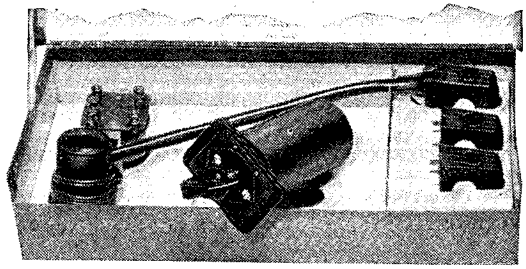
**Abbreviations:* Ap, appliance; M, motor car; R, receiver type.

SOUND REPRODUCTIONS

Pickups.—A new B.T.H. lightweight pickup has been introduced by Edison Swan Electric. It is of the moving-iron type and makes use of a special needle designed for ease of replacement. The weight at the needle point is 0.6 oz, and the output is of the order of 3.5 mV with an impedance of 20 ohms.

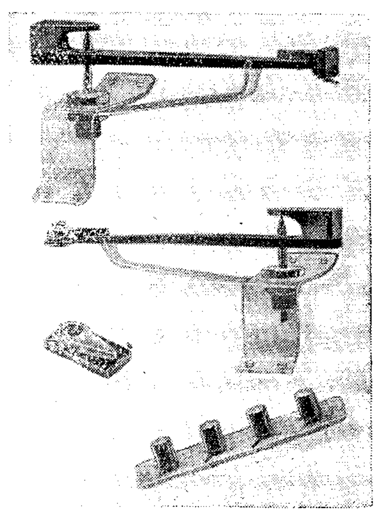
There seems to be a trend towards the use of high-impedance windings in high-fidelity pickups in order to obtain an output of the order of 0.3 to 0.5 V without the use of a step-up transformer. Both Collaro and Gerrard fit pickups of this type in their record changers.

Plug-in pickup heads are also the order of the day, and Garrard can supply three alternative heads—"Standard" for ordinary needles, output 0.5 V, impedance 9,000 Ω, needle pressure 2 oz; "Miniature" for miniature steel needles, output 0.3 V, impedance 4,000 Ω, needle pressure 1 oz; and "High Fidelity" with natural sapphire point, output 0.35 V, impedance 6,500 Ω, stylus pressure 1 oz. Plessey can also supply alternatively a crystal, "Decca" moving-iron, or a dynamically balanced moving-coil pickup head in their single record-player unit.



Goldring "Headmaster" pickup with three interchangeable heads having styli of different radii. A tone compensation unit provides correction for the principal British and American recording characteristics.

Erwin Scharf ("Goldring") have produced a pickup outfit of particular interest to quality enthusiasts. It has been named "Headmaster" and includes as standard three interchangeable lightweight moving-iron heads with sapphire styli having tip radii of 2, 2½ and 3 mils, the first for deeply cut records, the second standard and the third for worn or noisy grooves. A head can thus be chosen to suit any type or condition of record, and a microgroove head can be added later if required. The outfit includes a variable-ratio output transformer, and a three-position tone equalizer adjusted to suit H.M.V., Decca and the American N.A.B. recording characteristics.



Cosmocord "Microcell" crystal pickups. (Top to bottom) single-pivot tone arm with type GP17 head; tone arm for Type GP15 head; additional needle pressure weight for 78 r.p.m. recordings; and a group of Type GP15 cartridges.

The new Cosmocord type GP15 "Microcell" crystal pickup is approximately ½in diameter and ¾in deep and has an interchangeable stylus arm. Sapphire points of 0.0025in radius for standard 78-r.p.m. records and 0.001in for microgroove records are available and a single-pivot tone arm has been designed. When using the microgroove point, the pressure required is only 7 gm and an extra weight is provided to bring the pressure up to the still low figure of 14 gm for standard records. The output is 0.75 V on standard records and 0.5 V on microgroove.

In an alternative arrangement (Type GP17), in course of development, a bakelite capsule will be used for microgroove and a separate metal capsule for standard 78 r.p.m. records, thus automatically ensuring the correct relationship between weight and tip radius.

Makers: Collaro, Cosmocord, Edison Swan Electric, Garrard, Plessey, Erwin Scharf.

Record Changers.—The Garrard RC70, which will play up to ten 10-in or ten 12-in records with a change cycle time of 4 seconds, is normally supplied with an a.c. motor, but for use in countries where mains supplies may not be available a permanent magnet d.c. motor, with a large-diameter horizontal governor mechanism has been designed, for supply voltages as low as 6 V. Ample power is developed for an expenditure of only 12 watts.

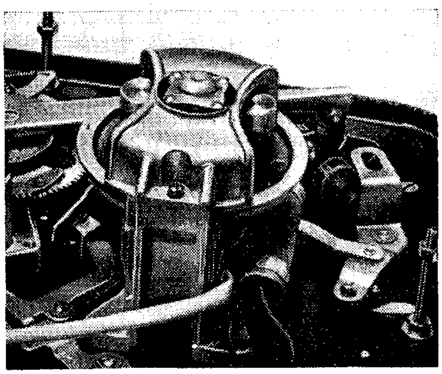
In the Collaro RC49 a rim-drive mechanism has been fitted in which the idler wheel is automatically retracted when the motor is switched off, thus preventing the formation of "flats" on the circumference, due to the overrun of the turntable. Another interesting feature of this record changer is the safety device which prevents the tone arm from being lowered unless there is a record on the turntable; it is impossible to "play the cloth" or damage the pickup movement.

Makers*: Birmingham Sound Reproducers (DR, GM, GU), Collaro (DR, GM, GU, RC), Garrard (DR, GM, GU, RC), Plessey (GU, RC).

**Abbreviations:* DR, disc recorders; GM, gramophone motors; GU, gramophone units; RC, record changers.

Loudspeakers. — An interesting corner-cabinet reproducer based on the design of P. W. Klipsch was shown by Vitavox. It makes use of the new K15/40 15-inch unit working into a re-entrant horn for the lower register (30-500-c/s), and a Type S2 pressure unit and H.F. horn for the range 500-15,000 c/s. The cabinet is of excellent design and workmanship and the instrument as a whole should appeal to the connoisseur; the price is £135. Incidentally the K15/40 unit is obtainable separately with alternative diaphragms for horn or baffle loading.

The Goodmans 12in range of loudspeakers is now available with dust-proof construction comprising a bakelized linen back centring diapragm and hemispherical gauze front cover inside the diaphragm. A high-flux version (Type R22) of the single-diaphragm T2 is now available with a density of 17,500 gauss in the 1¾in diameter gap.



Permanent-magnet low-voltage driving motor with large-diameter governor, used in the Garrard RC70 record changer.

Loudspeakers for the set manufacturers were mostly of the low-leakage centre-pole magnet type, notable examples being shown by Acoustic Products (Lectrona), British Rola, Celestion, Electro Acoustic Industries, Plessey and Teledictor.

The new "700" series shown by Reproducers and Amplifiers was notable for the high-quality standard finish and included a 12-in size. Truvox have introduced an elliptical loudspeaker (Type BX4) measuring 4in × 6in approximately, which should solve many of the problems met with by designers of compact portables.

Makers: Acoustic Products, British Rola, Celestion, Edison Swan Electric, Electro Acoustic Industries, Goodmans Industries, Plessey, Reproducers & Amplifiers, Reslosound, Teledictor, Truvox, Vitavox.

Microphones.—The new "Sintercell" crystal microphone made by Cosmocord incorporates a front diaphragm of porous sintered bronze, which acts as an acoustic filter and gives a smoother response than normal diaphragm crystal types.

Reslosound were showing a ribbon microphone (Type RV) of very compact design with a ribbon area of only 0.15 sq in and 2½ microns thickness.

For ultrasonic measurements Cosmocord have produced a "pressure standard" (Model SI1) consisting of a probe microphone and pre-amplifier head. The pickup head is a hermetically-sealed crystal unit of small diameter, to minimize diffraction errors, and the useful frequency range is 100 c/s-20 kc/s in air and 100 c/s-100 kc/s in water.

Makers: Birmingham Sound Reproducers, Cosmocord, Reslosound, Vitavox.

Magnetic Recorders.—A console type magnetic tape recorder (BCS-3254) shown by Salford Electrical Instruments is now in production and has a playing time of 1 hour 50 minutes. A total length of 1,000 yds of iron-oxide coated tape is accommodated in the 11½-in diameter reels.

In the "Tape Deck" magnetic recorder, produced by Wright and Weaire as a unit for incorporation in any type of equipment, the method of loading the tape has been considerably simplified and no threading is necessary. The reels hold 1,250ft of tape, giving a playing time of 70 minutes at 3¾ in/sec, or 35 minutes at 7 in/sec. A footage indicator is included. If desired, two tracks can be recorded in the width of the tape and played either consecutively or simultaneously. The controls are simple and operation is virtually foolproof.

Makers: Salford Electrical Instruments, Wright and Weaire.

MATERIALS

Magnetic Alloys.—In addition to the standard range of high-permeability alloys such as Mumetal, Rhometal and Crystalloy, the Telegraph Construction and Maintenance Co. were showing H.C.R. alloy which has been developed specially for use in transducers for magnetic amplifiers.

The Permanent Magnet Association were showing for the first time two new permanent magnet alloys containing the comparatively rare element niobium. From the following table it will be seen that higher coercivities have been obtained without sacrifice of energy (BH max). Alcomax II which has been in use for some time is included for reference.

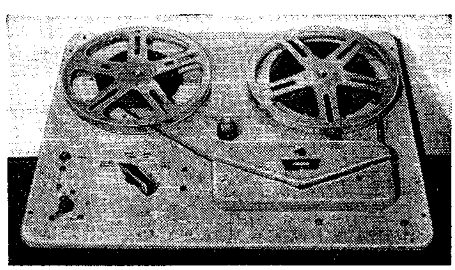
	Remanence	BHmax	Coercivity
Alcomax II ...	12,400	4.3×10^6	570
Alcomax III	12,200	4.75×10^6	650
Alcomax IV	11,200	4.3×10^6	750

Examples of short centre-pole magnets for loudspeakers and special pickup magnets using the new alloys were shown.

Wires and Cables.—Instrument wires with safe working temperatures of 110° C and dielectric strength of 600 volts per mil. were exhibited under the name of "Lewmex" by London Electric Wire Co. and Smiths. The enamel is a synthetic compound of polyvinyl acetal modified with phenol formaldehyde and shows improved mechanical and solvent-resisting qualities over conventional oil-based enamels.

A range of special microphone and loudspeaker cables has been developed by British Insulated Callender's Cables for the public address industry. Type T3108 contains twin screened-core microphone cables and two additional conductors for relay or signalling circuits in a p.v.c. outer sheath only 0.13in in diameter. The cables for loudspeaker surface wiring (R9001 and R9002) are twin flat cables with 0.036in and 0.050in conductors insulated with polythene and sheathed with p.v.c. The range of connecting wires made by this firm includes silicone rubber and p.c.p. (polychloroprene).

Insulants.—The outstanding development since last year has been the introduction of polytetrafluorethylene, a substance similar in appearance to polythene but with improved electrical properties and greater thermal stability. Examples of the application of this material in the construction of valveholders, connectors, etc., were shown by British Mechanical Productions ("Clix").



"Tape Deck" magnetic recorder, by Wright and Weaire.

Solders.—A new shape of core with a fluted cross-section has been

Developments in Components—

developed by H. J. Enthoven and Sons, who state that the reduction in the thickness of the solder wall gives better dispersion of the flux on fusion. A similar development is announced by the Du Bois Company.

Multicore solders have introduced a new two-core solder with "Arax," a non-resin, extra-active, acid-free flux for difficult soldering problems. It is not intended to replace "Ersin" three-core solder, which is more suitable for radio and electrical work.

Makers*: Antiference (C,W), Associated Technical Manufacturers (CO, IM, IS, PVC, W), Bray (CE), B. I. Callender's (C, CO, PVC, S, W), British Rola (L), Bullers' (CE), Clarke (IM, MI), De La Rue (IM, IS, W), Du Bois (S), Duratube & Wire (B, IM, IS, PVC, W), Enthoven (S), Hellermann (IM, IS), London Electric Wire Co. & Smiths (IS, W), Long & Hambly (IM), Magnetic & Electrical Alloys (DC, L, M), Mullard Electronic Products (C, M), Multicore (S), Murex (M, MO, T), Permanent Magnet Association (M), Plessey (DC), Reliance Electrical Wire (B, C, CO, PVC, W), Ripaults (B, C, CO, IS, PVC, W), Salford Electrical Instruments (DC), G. L. Scott (L), Spicers (IM, IS), Standard Telephones & Cables (C, CO, M, PVC, W), Steatite & Porcelain (CE), Suflex (B, CO, IS, PVC, W), Symons (IM, IS, PVC, V), Taylor, Tunnicliffe (CE), Telegraph Construction & Maintenance (C, CO, IM, IS, L, M, PVC, W), Telephone Manufacturing (DC), United Insulator (CE).

**Abbreviations:* B, Braiding; C, cables; CE, ceramics; CO, cords; DC, dust cores; IM, insulating materials; IS, insulating sleeving; L, laminations; M, magnetic alloys; MO, molybdenum; MI, mica products; PVC, polyvinyl chloride tapes, wires, etc.; S, solder; T, tungsten; V, varnished materials; W, covered wires.

LIST OF EXHIBITORS

A.B. Metal Products, Ltd., Hatton Works, Feltham, Mddx.
Acoustic Products, Ltd., 50-58, Britannia Walk, City Road, London, N.1.
Advance Components, Ltd., Back Road, Shernhall Street, London, E.17.
Antiference, Ltd., 67, Bryanston Street, London, W.1.
Associated Electronic Engineers, Ltd., Dalston Gardens, Stanmore, Mddx.
Associated Technical Manufacturers, Ltd., Vincent Works, New Islington, Manchester 4, Lancs.
Automatic Coil Winder & Electrical Equipment Co., Ltd., Winder House, Douglas Street, London, S.W.1.

Belling & Lee, Ltd., Cambridge Arterial Road, Enfield, Mddx.
Bird, Sydney S., & Sons, Ltd., Cambridge Arterial Road, Enfield, Mddx.
Birmingham Sound Reproducers, Ltd., Claremont Works, Old Hill, Staffs.
Bray, Geo., & Co., Ltd., Leicester Place, Blackmans Lane, Leeds 2, Yorks.
British Electric Resistance Co., Ltd., Queensway, Ponders End, Mddx.
British Electrolytic Condenser Co., Ltd., 52, Vicarage Lane, Ilford, Essex.
British Insulated Callender's Cables, Ltd., Surrey House, Embankment, London, W.C.2.
British Mechanical Productions, Ltd., 21, Bruton Street, London, W.1.
British Moulded Plastics, Ltd., Avenue Works, Walthamstow Avenue, London, E.4.
British N.S.F. Co., Ltd., Ingrow Bridge Works, Keighley, Yorks.
British Rola, Ltd., Ferry Works, Summer Road, Thames Ditton, Surrey.
Bulgin, A. F., & Co., Ltd., Bye-Pass Road, Barking, Essex.
Bullers, Ltd., 6, Laurence Pountney Hill, Cannon Street, London, E.C.4.

Carr Fastener Co., Ltd., Brantwood Works, Tariff Road, London, N.17.
Celestion, Ltd., Ferry Works, Summer Road, Thames Ditton, Surrey.
Clarke, H., & Co. (Manchester), Ltd., Atlas Works, Patricroft, Manchester, Lancs.
Collaro, Ltd., Ripple Works, Bye-Pass Road, Barking, Essex.
Colvern, Ltd., Mawneys Road, Romford, Essex.
Cosmocord, Ltd., 700, Great Cambridge Road, Enfield, Mddx.

Daly (Condensers), Ltd., West Lodge Works, The Green, Ealing, London, W.5.
Dawe Instruments, Ltd., 130, Uxbridge Road, Hanwell, London, W.7.
De La Rue Insulation, Ltd., Imperial House, 84, Regent Street, London, W.1.
Dubilier Condenser Co. (1925), Ltd., Ducon Works, Victoria Road North, Acton, London, W.3.
Du Bois Co., Ltd., 15, Britannia Street, King's Cross, London, W.C.1.
Duratube & Wire, Ltd., Faggs Road, Feltham, Mddx.

Edison Swan Electric Co., Ltd., 155, Charing Cross Road, London, W.C.2.
Electro Acoustic Industries, Ltd., Stamford Works, Broad Lane, Tottenham, London, N.15.
Electrothermal Engineering, Ltd., 270, Neville Road, London, E.7.
Enthoven, H. J., & Sons, Ltd., Croydon Works, 230, Thornton Road, West Croydon, Surrey.
Erg Industrial Corp., Ltd., 10, Portman Square, London, W.1.
Erie Resistor, Ltd., Carlisle Road, The Hyde, Hendon, London, N.W.9.

Ferranti, Ltd., Hollinwood, Lancs.

Garrard Engineering & Mfg. Co., Ltd., Newcastle Street, Swindon, Wilts.
General Electric Co., Ltd., Magnet House, Kingsway, London, W.C.2.
Goodman's Industries, Ltd., Lancelot Road, Wembley, Mddx.

Hallam, Sleigh & Cheston, Ltd., Widney Works, Bagot Street, Birmingham, 4, Warwick.

Hellermann Electric, Ltd., Tinsley Lane, Crawley, Sussex.
Hunt, A. H., Ltd., Bendon Valley, Garratt Lane, London, S.W.18.

Igranic Electric Co., Ltd., Elstow Road, Bedford.
Imhof, Alfred, Ltd., 112-116, New Oxford Street, London, W.C.1.

Jackson Bros. (London), Ltd., Kingsway, Waddon, Surrey.

London Electric Wire Co., & Smiths, Ltd., 24, Queen Anne's Gate, London, S.W.1.
London Electrical Mfg. Co., Ltd., 459, Fulham Road, London, S.W.6.
Long & Hambly, Ltd., Empire Works, Slater Street, High Wycombe, Bucks.

Magnetic & Electrical Alloys, Ltd., 101-103, Baker Street, London, W.1.
McMurdo Instrument Co., Ltd., Ashtead, Surrey.
Measuring Instruments (Pullin), Ltd., Electrin Works, Winchester Street, Acton, London, W.3.
Metro Pex, Ltd., 71, Queen's Road, Peckham, London, S.E.15.
Morganite Resistors, Ltd., Bede Trading Estate, Jarrow, Co. Durham.
Mullard Electronic Products, Ltd., Century House, Shaftesbury Avenue, London, W.C.2.
Multicore Solders, Ltd., Mellier House, Albemarle Street, London, W.1.
Murex, Ltd., Rainham, Essex.

Oliver Pell Control, Ltd., Cambridge Row, London, S.E.18.
Painton & Co., Ltd., Kingsthorpe, Northampton.
Parmeko, Ltd., Percy Road, Aylestone Park, Leicester.
Partridge Transformers, Ltd., Roebuck Road, Tolworth, Surrey.
Permanent Magnet Association, 301, Glossop Road, Sheffield, 10, Yorks.
Plessey Co., Ltd., Vicarage Lane, Ilford, Essex.
Plessey International, Ltd., Vicarage Lane, Ilford, Essex.

Reliance Electrical Wire Co., Ltd., Staffa Road, Leyton, London, E.10.
Reproducers & Amplifiers, Ltd., Frederick Street, Wolverhampton, Staffs.
Reslosound, Ltd., 359, City Road, London, E.C.1.
Ripaults, Ltd., Southbury Road, Enfield, Mddx.

Salford Electrical Instruments, Ltd., Peel Works, Silk Street, Salford, Lancs.
Scharf, Erwin, 49-51, De Beauvoir Road, London, N.1.
Scott, Geo. L., & Co., Ltd., Cromwell Road, Ellesmere Port, Cheshire.
Shipton, E., & Co., Ltd., Ferndown, Northwood Hills, Mddx.
Spicers, Ltd., 19, New Bridge Street, London, E.C.4.
Stability Radio Components, Ltd., 14, Norman's Buildings, Central Street, London, E.C.1.
Standard Telephones & Cables, Ltd., Connaught House, Aldwych, London, W.C.2.
Static Condenser Co., Ltd., Toutley Works, Wokingham, Berks.
Steatite & Porcelain Products, Ltd., Stourport-on-Severn, Worcs.
Suflex, Ltd., Aintree Road, Perivale, Greenford, Mddx.
Symons, H. D., & Co., Ltd., Park Works, Kingston Hill, Surrey.

Taylor Electrical Instruments, Ltd., 419-424, Montrose Avenue, Slough, Bucks.
Taylor Tunnicliff (Refractors), Ltd., Albion Works, Longton, Stoke-on-Trent, Staffs.
Teledictor, Ltd., 214, Birmingham Road, Dudley, Warwicks.
Telegraph Condenser Co., Ltd., Wales Farm Road, North Acton, London, W.3.
Telegraph Construction & Maintenance Co., Ltd., 22, Old Broad Street, London, E.C.2.
Telephone Mfg. Co., Ltd., Hollingsworth Works, Martell Road, West Dulwich, London, S.E.21.
Truvox Engineering Co., Ltd., Truvox House, Exhibition Grounds, Wembley, Mddx.
Tucker, G., Eyelet Co., Ltd., Walsall Road, Birmingham, 22, Warwick.

United Insulator Co., Ltd., Oakcroft Road, Tolworth, Surbiton, Surrey.

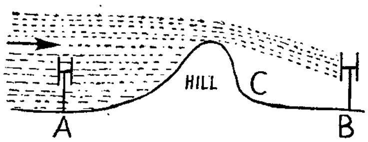
Vitavox, Ltd., Westmoreland Road, London, N.W.9.

Walter Instruments, Ltd., Garth Road, Lower Morden, Surrey.
Walter, J. & H., Ltd., Farm Lane, Fulham, London, S.W.6.
Wego Condenser Co., Ltd., Bideford Avenue, Perivale, Mddx.
Welwyn Electrical Laboratories, Ltd., Links Road, Blyth, Northumberland.
Westinghouse Brake & Signal Co., Ltd., 82, York Way, King's Cross, London, N.1.
Wimbledon Engineering Co., Ltd., Garth Road, Lower Morden, Surrey.
Wingrove & Rogers, Ltd., Polar Works, Old Swan, Liverpool, Lancs.
Woden Transformer Co., Ltd., Moxley Road, Bilston, Staffs.
Wright & Weaire, Ltd., 138, Sloane Street, London, S.W.1.

THE "BELLING-LEE" PAGE

Providing technical information, service and advice in relation to our products and the suppression of electrical interference

Distant Television Reception



There are many cases on record of viewers getting a consistently poor television picture, while others, miles further away from the television transmitter obtain results beyond expectation. The reason generally given for this inconsistency may be illustrated as above. The dipole "A" may be considered to be fifty miles from the transmitter. The waves close to the ground at this point have been attenuated considerably, but those higher up are still strong, they pass over the hill and the (un-attenuated) waves bend down and meet the dipole "B" which may enable the viewer to enjoy a much stronger signal. Close in under the shadow of the hill, at "C" there would probably be a "dead" spot where little or no signal would be received.

*1. "Doorod" Television Aerial.

We have been somewhat alarmed at the results reported from this new fully dimensioned indoor dipole. Reports come in that they are being used, with considerable satisfaction, in places as far from Alexandra Palace, as Southend and St. Albans, i.e. 30 and 18 miles respectively. Whereas, we first claimed five or six miles and later eight to ten miles.

We have made calculations based on known field strengths and find that the results are less surprising than was first thought

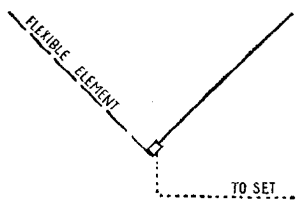
The only condition against which one must guard is the presence of concealed pipes, girders or other conductors in the walls (outside drain pipes), etc, which happen to be a functional distance from any proposed indoor dipole.

A Need for Caution.

It should not be overlooked that a new Television receiver is in its first flash of high gain, the valves are giving full emission, everything is just right. Such a receiver may give satisfactory results with an indoor aerial at exceptional distances, but, it is quite possible that after a few months use, the gain of the receiver drops, you can no longer hold synchronisation, and disappointment sets in. Everything is normal, and an outside aerial is necessary.

Use of "Doorod"*1. as a "Veerod"*2.

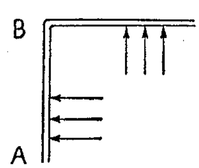
The "Doorod"* may be used as a "Veerod" either inverted or "V" style thus endowing it with directional properties at the expense of slight loss in pick-up. The "Doorod" may be so arranged on the wall of the hall of a house as indicated in the diagram. On the ground floor, upstairs landing, or for maximum results in the loft. In certain positions an extension length of coaxial cable will be necessary.



In locating a "V" shaped dipole to take advantage of its directional properties, start with one element pointing in the direction of the transmitter. It may be useful to bear in mind that the "Veerod" has a very marked minima at right angles. This feature may be used to reduce interference.

The Why and Wherefore of the "Veerod."

It is all a question of polarisation. In a house it is difficult to be certain what you are dealing with—vertical or horizontal. The signal leaves the



transmitter vertically polarised. Refer now to sketch.

It is picked up on a gaspipe A-B which has currents induced in it. The pipe goes round the corner and conforms to B-C. with the same currents as A-B. But now they are horizontally polarised.

Which has most influence on any indoor aerial? At a guess there is about a fifty-fifty chance and it does not really matter if the "Veerod" is upright or inverted.

> **New addition of "Belling-Lee" main catalogue.**
>
> This 84-page publication is now off the press, it is however not for general distribution but has been prepared for the use of designers of electronic equipment, electrical engineers etc.

Undoubtedly the most efficient position in which to use it as an indoor aerial is in the loft, as high up as possible, with its apex tucked right up out of the way of water-pipes etc., which, in the loft, mostly run in a horizontal plane. But if a "Doorod" is being used as a "Veerod" it is generally more logical to use it as a "V" as illustrated, as this will allow a shorter run to the receiver, but a ladder will have to be used so as to fix the free end of the flexible element. A real practical advantage in using the "Doorod" with the apex uppermost i.e. as an inverted "V," is the fact that the rigid element can be fixed with the apex out of reach while you are comfortable with both feet on the floor. The flexible element can then be held in position and fixed with tacks or drawing pins. In this case the lead must drop from the apex.

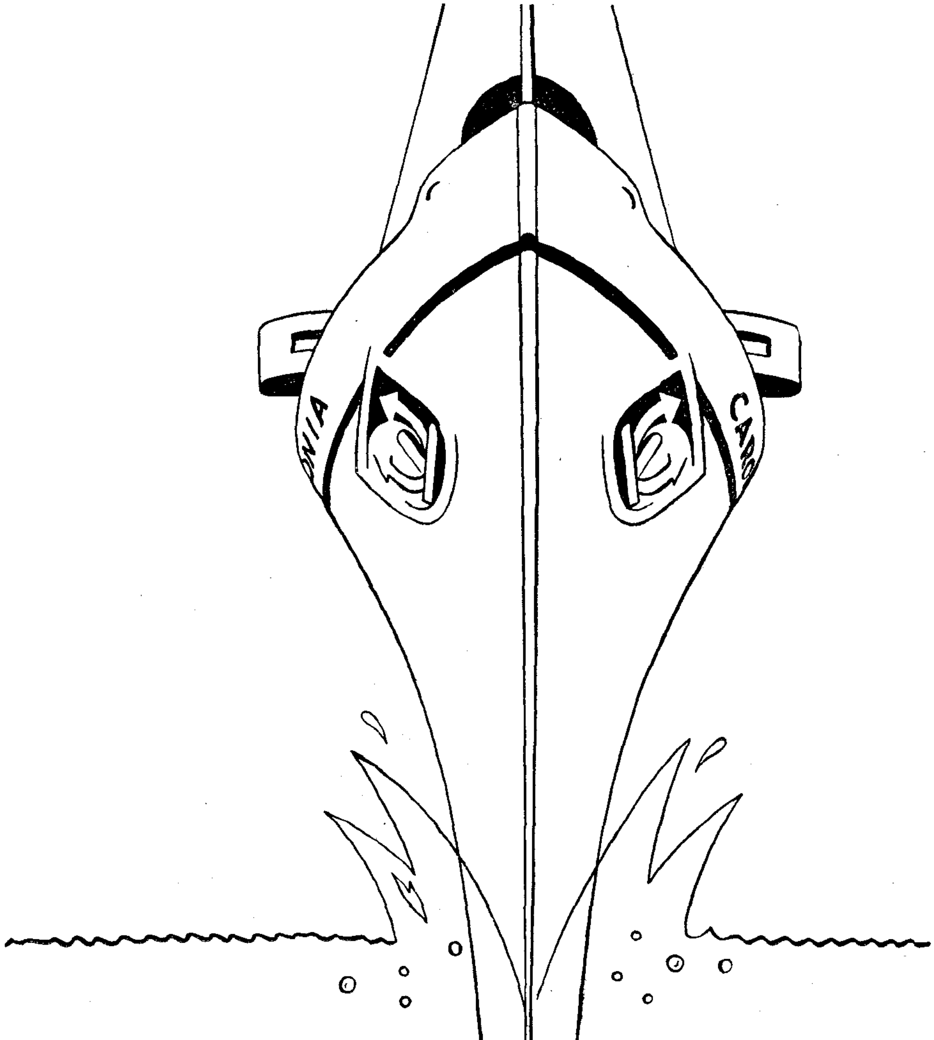
Combined Broadcast and T.V. Aerials.

We have had a number of letters from readers asking if it is a fact that anti-interference systems can be applied to television. The answer is yes and no. We have never claimed to offer an interference free television aerial but "Belling Lee" were the first to take advantage of the fact that the mast of a television aerial could be used as a collector of broadcast programmes, and could be used to feed an anti-interference system. It is easy to see how the misunderstanding occurred.

*1. "Doorod" (Reg. app. for) indoor T.V. aerial **30/-**.

*2. "Veerod" (Reg. app. for) Attic Model **52/6**. Chimney model **90/-**.

BELLING & LEE LTD
CAMBRIDGE ARTERIAL ROAD, ENFIELD, MIDDX
ENGLAND



"Caronia" passengers telephone by 'Standard Radio'

R.M.S. "CARONIA" IS FITTED WITH THE FOLLOWING 'STANDARD' EQUIPMENT.... The D.S.9 Single-sideband Telephony Transmitter, having an output of 300 watts on 4-22 Mc/s.

The R.X.9 Independent-sideband Receiver. Capable of receiving either or both channels of a double-channel circuit. Whilst one channel is busy with 'subscriber' calls, the other can be used as an 'order wire'. Suitable for reception of high-fidelity double-sideband telephony. Automatic frequency control.

The E.S.4-B dual purpose transmitter providing telegraphy at 1 kW or double-sideband telephony at 300 watts on 24 pre-set channels grouped in the marine h.f. bands.

Direct inter-continental telephone conversations, either from public booths or private staterooms, are enjoyed by passengers in the new Cunard White Star liner "Caronia".

The first passenger vessel to be fitted for transmission and reception of single-sideband telephony sets a new standard in ship-to-shore communication.

Equipment by 'Standard' of course.

Standard Telephones and Cables Limited

REGISTERED OFFICES: CONNAUGHT HOUSE, ALDWYCH, LONDON, W.C.2

CARONIA

RADIO DIVISION

OAKLEIGH ROAD, NEW SOUTHGATE, LONDON, N.11, ENGLAND

WORLD OF WIRELESS

New Servicing Certificate ✦ Extending Television ✦ Exhibition Plans

Television Servicing

A SCHEME has been drawn up jointly by the City and Guilds of London Institute and the Radio Trades' Examination Board to provide a recognized qualification in the servicing of television receivers similar to the Radio Servicing Certificate.

Candidates must have passed one of six approved examinations in radio servicing in order to enter for the examination, the first of which will be held next year. It is proposed that from 1955 candidates must possess the City and Guilds and R.T.E.B. Radio Servicing Certificate in order to be eligible for entry.

Application forms for the Television Receiver Certificate Examination, which will comprise two written papers each of three hours' duration and a three-hour practical test, are obtainable from the R.T.E.B., 9, Bedford Square, London, W.C.1. The examination fee is three guineas.

The syllabus covers light and vision; production of the picture signal, including principles of scanning; reproduction of the picture from a signal, including principles of c.r.t.; t.r.f. and superhet. receivers; sync separation; aerial and feeder systems; and the cause and correction of picture defects.

E.H.F. Cost

EXPENDITURE by the B.B.C. during the past twelve months on e.h.f. transmitting equipment was stated by the P.M.G. to be £85,000. This equipment is for the new Wrotham, Kent, station, which will initially transmit both frequency modulation and amplitude modulation on e.h.f.

Television Topics

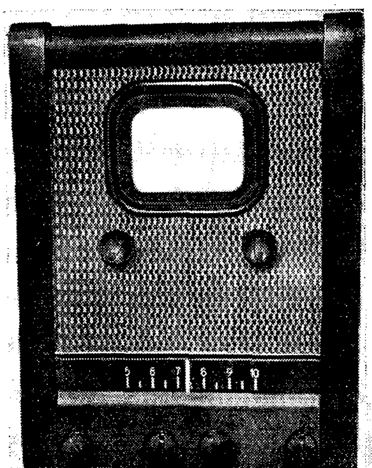
AS work proceeds apace on the erection of the Sutton Coldfield station speculation continues on the date it is likely to start transmitting, which officially remains as "in the autumn." In order to enable servicemen in the area to benefit by the knowledge and experience gained in the London television area, B.R.E.M.A. has organized a conference covering such subjects as servicing and interference suppression for dealers in the Midland service area.

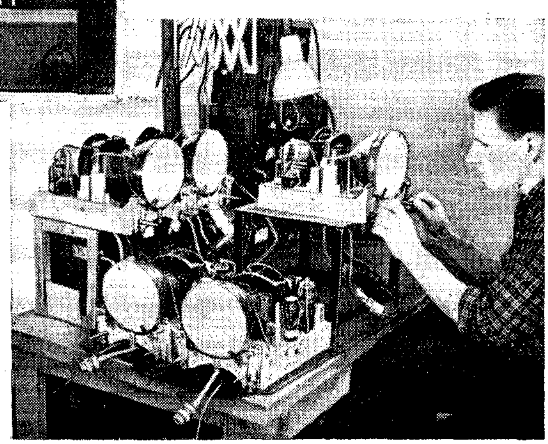
In reply to a question in the House, the P.M.G. has stated that the estimated capital cost, at present-day prices, of the proposed five stations—Birmingham, S. Lancs, Scotland, S.W. England and N.E. England—is about £1.75 million. This figure does not include the cost of providing the necessary links.

The World's Journals

A FEATURE of our sister journal, *Wireless Engineer*, is its 20-page Abstracts and References Section in which is included abstracts from and references to articles in the world's technical journals. An index to the year's abstracts is published separately and that for 1948 will be available shortly, price 2s 8d including postage.

In addition to the usual subject and author indexes it includes a list of most of the 200 or more journals regularly scanned for abstracting. This list includes the addresses of the publishers or editorial offices and the abbreviated titles used in references in both *W.W.* and *W.E.*





RUSSIAN TELEVISION.

Internal and external views of the "Moskvitch" television receiver which is being mass produced in Moscow. The set, which incorporates a comparatively small tube, gives a picture of 135 × 100 mm. 5.4 × 4in.

Radiolympia

AS is to be expected, television will be a feature of the 16th National Radio Exhibition which, as already announced, will be held at Olympia from September 28th to October 8th. A new television aerial is to be erected on the roof of Olympia and improved arrangements are being made for visitors to view television.

For the first time since the war, exhibits by the Navy, the Army and the R.A.F. will be included. The D.S.I.R., G.P.O. and Ministry of Supply will also be exhibiting.

The section of the show devoted to communications equipment, radio navigational aids and industrial electronics will be considerably enlarged.

PERSONALITIES

A.V-M. E. B. Addison has been appointed Director-General of Signals, Air Ministry. During the war he was engaged on the development of radio counter-measures.

D. A. Bell, M.A., B.Sc., who contributes to both *Wireless World* and our sister journal *Wireless Engineer*, has been appointed a lecturer in electrical engineering at Birmingham University. Since 1946 he has been with British Telecommunications Research, Ltd., prior to which he was with A. C. Cossor, Ltd.

C. H. Davis, of the Reliance Electrical Wire Company, has been invited by the President of the Board of Trade to become a member of the Exhibitions Advisory Committee which advises the B.o.T. on exhibitions at home and overseas.

M. M. Macqueen (G.E.C.) has been elected chairman of B.R.E.M.A. for 1949 in succession to H. Slater (Philips). The new vice-chairman is **P. H. Spagnoletti** (Kolster-Brandes).

T. R. Porter, M.B.E., has been appointed superintendent of the Control and Radio Department of Metropolitan Vickers. He joined the company in 1920, was appointed senior production engineer in 1934, took charge of radar production in 1938 and since 1944 has

World of Wireless—
been assistant superintendent of the Transmitter Department.

C. I. Orr-Ewing, B.A., who until recently was in charge of B.B.C. television outside broadcasts, has been appointed technical commercial advisor to A. C. Cossor Ltd., and a director of Cossor Radar. Prior to joining the B.B.C. in 1938 he was with H.M.V. During the war he held a number of radar administrative positions in the R.A.F.

W. G. Richards (Marconi's W/T Co.) is representing the Radio Industry Council on the B.I.F. Council of Exhibitors.

IN BRIEF

A Record Increase of 19,050 television receiving licences has been announced by the Post Office for January, making the total 111,850. The increase in "sound" licences was 84,050. The total receiving licences in force in Great Britain and Northern Ireland at the end of January was 11,559,900.

Radio Relays.—In reply to a question in the House of Commons, the P.M.G. stated that, as radio relays were closely linked with the general question of broadcasting in this country, they would be considered by the Committee of Enquiry on the B.B.C.'s Charter. The licences granted to operators of relay exchanges have been extended to the end of 1951.

R.G.D. is providing the 150 portable radio-telephone transmitter-receivers required by the harbour authorities at Liverpool to be used in conjunction with the recently installed Sperry harbour-supervision radar. The sets will be used by the pilots to enable them to communicate with the radar supervisor whilst bringing vessels into port in poor visibility. They will presumably operate on 156.8 Mc/s, the frequency allocated at Atlantic City for harbour control communications.

"Television Receiver Construction."—A further quantity of reprints of the series of ten articles describing the construction of a television receiver, which appeared in *Wireless World* in 1947, is now available. The straight set described is designed for reception of the London transmissions and is not, therefore, suitable for receiving the asymmetric sideband transmissions from Birmingham. Copies of the forty-eight page booklet can be obtained by post from our Publisher, price 2s 9d or from booksellers and newsagents price 2s 6d.

Telecommunications.—A new quarterly journal is being issued by the Post Office. The primary object of the *Post Office Telecommunications Journal*, as it is called, is to give wider publicity to the papers on telecommunications delivered to local groups of Post Office workers and to provide a forum for the discussion of problems associated with the P.O. services. In the first issue Sir Archibald Gill, Engineer-in-Chief, contributes an article on engineering developments.

Marconi radio, radar and d.f. equipment has been installed in the new 11,500 ton Port Line motor-vessel *Port Brisbane*.

Aerial Classification.—The Panel of the R.C.M.F. which prepared the classification of broadcast receiving aerials to which reference was made last month (page 113) is now considering the classification of television aerials.

Five-metre Band.—The P.M.G. announces that amateurs will not be permitted to use the frequency band 58.5 to 60 Mc/s after March 31st. It will be recalled that this band, which was not allocated to amateurs in the Atlantic City Agreement, has been used temporarily by British amateurs since January 1st.

G.C.A.—Ground Controlled Approach equipment has been installed and is now in operation at Belfast (Nutts Corner) aerodrome. This is the sixth aerodrome in the United Kingdom to be equipped with G.C.A. The other five are London, Prestwick, Liverpool, Northolt and Hurn.

Revised "Q" Code.—Applicants for the Civil Aircraft Radio Operators' exam. for certificates of competency are reminded by the Ministry of Civil Aviation that the "Q" Code as amended at Atlantic City will be used. The amended code is given in the Ministry's publication DOC.6100, COM/504, which will soon be obtainable from H.M.S.O., price 2s.

I.S.W.C.—To mark the twentieth anniversary of the formation of the International Short-wave Club a DX contest is being organized. Particulars of the contest, which covers reception of both s.w. broadcasting and amateur stations, are obtainable from the I.S.W.C., 100, Adams Gardens Estate, London, S.E.16.

S.T.C.—A wall chart showing the Atlantic City frequency allocations has been issued by Standard Telephones and Cables. To facilitate identification, the various services are arranged in separate columns; these are subdivided into the three Regions which are coloured to correspond with a regional map of the world included on the chart. Frequencies allocated to each service are over-printed in black on the colours. The chart, size 40×25in, is obtainable from Standard Telephones and Cables, Connaught House, Aldwych, London, W.C.2, price 3s 9d, including postage.

E.M.I. Reprints.—Our note on the E.M.I. reprints of papers on quality recording and reproduction last month was a little ambiguous. Each paper is reprinted separately and costs 2s 6d. The next one to be issued will be on magnetic tape recording.

Cintel.—In the description of the Cintel metal detector on page 86 of the March issue, it should have been stated that the equipment was designed and made *by* and not *for* Cinema Television, Ltd. We regret the use of the wrong preposition.

Waste Paper.—The Waste Paper Recovery Association states that the fact that more paper is generally available and, too, that some manufacturers have announced that their cartons and packing need no longer be returned, must not be taken as an indication that there is now no need to salvage waste paper.

FROM ABROAD

U.S.S.R. Television.—According to the *Bulletin* of the International Broadcasting Organization regular transmissions have been radiated from the Soviet television station in Leningrad since last August. The 6.5-kW vision transmitter operates on 32.5 Mc/s. Scanning rate is 441 lines with 25 frames interlaced. The sound transmitter is frequency modulated. Another transmitter, is in operation in Moscow and two new stations are being erected at Kiev and Sverdlovsk.

Canadian Television.—In view of the fact that some 1,200,000 Canadians are within the service area of American television stations, the Radio Manufacturers' Association of Canada has decided to start producing television receivers. The estimated output for this year is given as 12,700.

Citizen's Radio.—Approval has been given by the F.C.C. for the production of miniature transmitter-receivers for civilian use in the 465-Mc/s band allocated in the U.S. for citizen's radio. The sets measure only 6in×2⅜in×1¼in and weigh 11 ounces including the folding aerial which extends from one end of the case. The total weight, including earpiece and battery, is 2½ lb.

Pakistan.—The first short-wave broadcasting station in Pakistan has been opened at Dacca, East Bengal. The 7.5-kW transmitter operates on 11.89 Mc/s. A new, high-speed radio-telegraphic service was recently opened between east and west Pakistan.

Belgian Amateurs are now permitted to operate on the following frequencies:—3.51-3.625, 7.02-7.28, 14.05-14.35, 28-30, 144-146, 420-460, 1,215-1,300, 2,300-2,400, 5,650-5,850 and 10,000-10,500.

Facsimile equipment has been installed at the United States Federal Weather Bureau and Chicago Airport for the transmission and reception of weather reports.

EXPORT

"Tropic Proofing" is the title of a pamphlet issued by H.M. Stationery Office, which gives some of the results of the research being undertaken at the Ministry of Supply Establishment in Nigeria to combat the ravages of weather, insects and fungi on, among other things, radio equipment.

Exports.—The export target for the radio industry in general for 1949 has now been set by the Government. The monthly target at the end of last year was £1.2 million which has been increased to £1.32 million for 1949.

Exporting Television.—The Belgo-Dutch television delegation which recently came to this country at the invitation of the Government, visited the Marconi Works at Chelmsford to see a demonstration of the company's 625-line television equipment. It will be recalled that this was the standard agreed upon by three of the main British manufacturers of transmitting equipment and the Dutch firm of Philips. The High Commissioner for Australia also visited the works recently and inspected 625-line equipment in which the Australian Government is known to be interested for its projected television service.

Decca Navigator Co. is to erect a chain of three stations in the Bahrein area of the Persian Gulf for the American Bahrein Petroleum Company to enable its surveyors to fix their position when undertaking surveys for oil beneath the sea bed.

Pye e.h.f. mobile radio-telephone equipment to the value of £10,000 has been supplied to the Netherlands Government.

G.E.C. two-channel frequency-modulated e.h.f. gear, costing £25,000, is to be supplied to the Hong Kong police to provide a communication system between mobile units and headquarters.

South Africa.—Tenders for the supply of a variety of test equipment, including signal generators, field-strength measuring sets and precision condensers, is called for by the South African Railways' Stores Department, Johannesburg. The specification, No. 8622, can be obtained from the B.o.T. Commercial Relations and Exports Department, Room 1076, Thames House, North, Millbank, London, S.W.1., quoting reference C.R.E.(IB)556/49. Closing date is May 5th.

Portugal.—The Lisbon firm of Viuva de Eduardo A. Fernandes and Cia. are anxious to secure the agencies for British radio components in Portugal. Quotations and literature should be sent direct to the company at Rua da Alandega 118, 2° D., Lisbon.

INDUSTRIAL NEWS

Festival of Britain.—In preparation for the 1951 "Festival of Britain" the Council of Industrial Design is compiling a "Stock List" which is a photographic card index of products for submission to the panel of selectors. Manufacturers are asked to send photographs of representative equipment for inclusion in the list. The exhibitions will largely consist of "end products" to illustrate scientific development in various fields. In selecting the products design will be considered from the æsthetic, engineering and functional aspects.

R.C.E.E.A. Council.—The names of Pye and Standard Telephones Cables should have been included among the firms listed last month as members of the R.C.E.E.A. Council for 1949.

Marconi's have established a Main Air Service Depot at Croydon Airport where aircraft fitted with the company's gear can have it tested and repaired. In addition to the repair and maintenance section there is a demonstration room where instruction can be received in operating the latest aircraft radio equipment.

Preventing Corrosion.—Although only remotely connected with radio, manufacturers may be interested to learn of a recent book, "Prevention of Iron and Steel Corrosion; Processes and Published Specifications," issued by the Louis Cassier Co., Dorset House, Stamford Street, London, S.E.1, priced 5s.

Telcon.—The telephone number of the Telcon Works of the Telegraph Construction and Maintenance Company is now Greenwich 3291.

Industrial Finishes.—The first exhibition in this country of industrial finishes will be held at Earls Court, London, from August 31st to September 13th. Sir Edward Appleton is serving on the honorary advisory council.

I.M.R.C.—The administrative, technical and stores departments of the International Marine Radio Company have been transferred from Leicester Street, Southport, Lancs, to the company's new offices and factory at 21, Progress Way, Purley Way, Croydon, Surrey.

A.B. Metal Products, Ltd., have opened a London office at Ludgate House, 107, Fleet Street, E.C.4 (Tel.: Central 5667/8).

Raymond Electric, Ltd., are now at Brent Crescent, North Circular Road, London, N.W.10 (Tel.: Elgar 6687/8).

Electro-Acoustic Developments have moved to 18, Broad Road, Lower Willingdon, Nr. Eastbourne, Sussex.

Clix.—British Mechanical Productions, Ltd., are now centring their production at their No. 2 factory at Barton Hill Works, Bristol, 5 (Tel.; 57823/4), to which all correspondence should be sent.

MEETINGS

Institution of Electrical Engineers

The fortieth Kelvin Lecture on "Semi-Conductors and Rectifiers," by Prof. N. F. Mott, M.A., F.R.S., at 5.30 on April 21st.

Discussion on "The Scheme for the Interchange of Information on Electrical Engineering Laboratory Practice," opened by E. Bradshaw M.Sc. Tech., Ph.D., and on "Transient Display Apparatus," opened by A. C. Normington, B.Sc. (Eng.) at 6.0 on April 11th.

Radio Section.—"Hot-Cathode Thyratrons: Practical Studies of Characteristics," by H. de B. Knight, M.Sc., at 5.30 on April 6th.

Informal lecture on "Radio-Frequency Heating" by R. H. Barfield, D.Sc., at 5.30 on April 12th.

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

Cambridge Radio Group.—Informal lecture on "Printed Circuits, including Miniature Components and Sub-miniature Valves," by J. E. Rhys-Jones, M.B.E., and G. W. A. Dummer, M.B.E., at 6.0 on March 29th, at the Cambridge Technical College.

"Meteors," by A. C. B. Lovell, O.B.E., Ph.D., at 8.15 on April 26th at the Cavendish Laboratory.

North-Eastern Centre.—Faraday lecture on "Television" at 7.0 on March 29th at the City Hall, Newcastle-on-Tyne.

Sheffield Sub-Centre.—"Speech Communication under Conditions of Deafness or Loud Noise," by W. G. Radley, C.B.E., Ph.D. (Eng.), at 7.0 on March 30th at the Scunthorpe Technical School.

North-Western Radio Group.—Discussion on "Audio Reproduction," opened by G. J. Scoles, B.Sc. (Eng.), A. G. F. Smith and G. I. Thomas, B.Sc., at 6.30 on April 27th at the Engineers' Club, Albert Square, Manchester.

Scottish Centre.—Faraday lecture on "Television" at 7.0 on April 5th at the Central Hall, Tollcross, Edinburgh.

South Midland Radio Group.—Informal lecture on "Television Developments," by K. R. Sturley, Ph.D., at 6.0 on March 28th at the James Watt Memorial Institute, Great Charles Street, Birmingham.

North Staffordshire Sub-Centre.—"Scientific Work of the Post Office," by L. E. Ryall, Ph.D., at 7.0 on April 6th at Duncan Hall, Stone. (Joint meeting with the Institute of Post Office Electrical Engineers.)

British Institution of Radio Engineers

London Section. — Discussion on "Frequency Modulation and Amplitude Modulation," at 6.0 on April 21st at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1.

South Midlands Section.—"Electronic Voltmeters," by R. A. Lampitt, at 7.0 on April 28th at the Technical College, The Butts, Coventry.

West Midlands Section.—"Broadcast Reception for Rediffusion Systems," by M. Exwood, at 7.0 on April 27th, at the Wolverhampton and Staffordshire Technical College, Wulfruna Street, Wolverhampton.

Merseyside Section.—"Modern Technique in Radio Telecommunication Systems," by M. M. Levy at 7.0 on April 6th at the Incorporated Accountants' Hall, Derby Square, Liverpool, 2.

N.W. Section.—"The Measurement of F.M. Transmitter Performance," by D. R. Willis at 6.45 on April 8th at the College of Technology, Sackville Street, Manchester, 1.

Scottish Section.—"Pulse Testing," by Prof. M. G. Say, Ph.D., M.Sc., at 6.30 on April 12th at the Herriot-Watt College, Edinburgh, 1.

N. Eastern Section.—"R.F. Coil Design and Tracking Methods in Superheterodyne Receivers,' by A. E. Coghlan, at 6.0 on April 13th at the Neville Hall, Westgate Road, Newcastle-on-Tyne.

British Sound Recording Association

"Developments in Magnetic Sound-on-Film," by Dr. O. K. Kolb, at 7.15 on April 6th at the G.B. Theatre, Film House, Wardour Street, London, W.1. (Joint meeting with the British Kinematograph Society.)

Television Society

Midlands Centre.—"Electronic Testing Instruments," by A. E. Crawford, at 7.0 on April 8th at the Chamber of Commerce, New Street, Birmingham.

Radio Society of Great Britain

"Some Aspects of High-Quality Sound Recording and Reproduction," by R. W. Lowden, at 6.30 on April 29th at the I.E.E., Savoy Place, London, W.C.2.

Institute of Navigation

"The Influence of Echo Sounding," by A. J. Hughes, O.B.E., at 5.0 on April 15th at the Royal United Services Institution, Whitehall, London, S.W.1.

Junior Institution of Engineers

Informal meeting, including two films, "Kelvin—Master of Measurement" and "Kelvin-Hughes Marine Radar," introduced by R. Bagot and E. F. Alldritt, at 6.30 on April 1st at 39, Victoria Street, London, S.W.1.

TELEVISION INTERFERENCE

Its Nature and How to Reduce It

By A. H. COOPER, B.Sc.
(E.M.I. Engineering Development)

IT is exceptional for the short waves used for television broadcasting to be reflected from the ionosphere to any point within the service area of the transmitter, so that normal fading is almost unknown in television. An effect which is exactly similar does, however, occur when an aircraft takes the place of an element of the ionosphere; waves reflected from the aircraft interfere with the direct waves from the transmitter and produce changes in the received signal like natural fading.

In the television case there is one essential difference which arises from the importance in television reception of the "fine structure" of the received signal. The indirect wave reflected from the ionosphere or from an aircraft will have travelled by a longer path than the direct wave, and will arrive correspondingly later at the receiver. In sound broadcasting there is no means available to the ordinary listener of knowing that the reflected wave is arriving some milliseconds later than the direct wave; one merges with the other and cannot be aurally disentangled. But in a television picture, each element of the received signal has a separate significance and does not merge with other elements in anything like the same manner.

Fig. 1 shows what happens to a television signal, idealized for simplicity, when a weaker and delayed signal combines with it. A simplified signal (simply a white bar down the middle of a grey picture) is shown in the top line, and below it is a similar signal, attenuated four to one. This second signal, which typifies the indirect wave, is shown in units of two picture-lines, each pair of lines being progressively delayed by an eighth of a line. These attenuated and delayed signals are then combined with the "direct" signal shown immediately above them; the first picture-line is assumed to be arriving so that the two carriers are in phase, so that they add; the second picture-line in each pair is assumed to represent the state of affairs when the aircraft has moved so that the difference between the direct and indirect path-lengths has changed by half a wavelength; the carriers are now in anti-phase and combine subtractively. The eight combined waveforms in the bottom row therefore represent eight "snapshots" of the signal as received while the aircraft moves and changes the difference between the lengths of the direct and indirect paths.

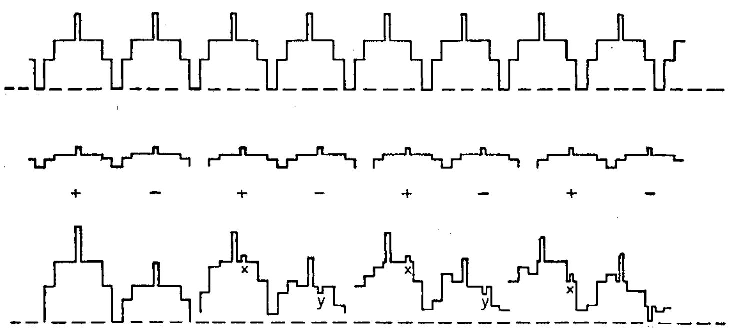


Fig. 1. This diagram illustrates how fading and ghost images occur. The directly-received signal is shown at the top, with various forms of reflected, and so delayed, signal below. Their combination is given in the bottom row.

In each case it will be seen that the first of each pair of waveforms is larger than the second; this is the equivalent of the straightforward amplitude fade in sound reception. But, in addition, the fine structure of the indirect signal is apparent in the combined signal, even in the presence of the much greater direct signal; in the "in-phase" cases there is a weak echo of the main white-line signal in the middle of the picture, which moves progressively across the frame as the path-difference increases, as is shown at x in the bottom row. This implies that the white line will be accompanied by a weaker white ghost, spaced away from it. But between each in-phase state and the next there will be an anti-phase state, and here the signals subtract; the ghost of the white line is black, as seen at y in the bottom row.

We can now add the second ingredient to our fading phenomenon; the picture is accompanied by a ghost which moves across the frame, but which alternates between positive and negative according as the picture has at the moment faded up or down. If the reflected wave is not very intense and if the picture is not one which will show strong echoes, the effect may not be noticed except for one part of the picture-line which is always present and always likely to produce a good echo, namely, the sync pulse. The converse is also true; elements of the picture may be echoed into the sync pulse interval so that this pulse will lose either its sharp edges or its depth, or both; when this happens the fading of the picture is accompanied by a break in synchronizing, usually happening once every fading cycle.

The frequency of the fading cycle will depend on the position and velocity of the aircraft with respect to the transmitter and receiver. Three sets of cases have been computed, which by symmetry cover eight courses separated by 45°; these are reproduced in Fig. 2. On each course it is assumed that the aircraft flies uniformly on a straight course, passing at a stated distance from the receiver at its nearest point; this distance is the direct separa-

MS received by the Editor October, 1948.

BY AIRCRAFT

tion and may be horizontal, vertical or oblique, and various values have been taken varying from 200 feet (a near approach) to 5,000 feet. The aircraft is assumed to be flying at 250 feet per second, a reasonable average speed, and the signal frequency is taken as 45 Mc/s.

These curves show a frequency range from about 25 c/s down to zero, the changes in frequency taking place most rapidly around the time of nearest approach. The more complex case of curved courses will give rise to frequencies of the same order, but the actual values and the rate of change will be more complicated. An aid to visualizing the complex cases is the family of ellipses in Fig. 3, which represents a plan of the neighbourhood of the receiver, each line representing a crest in the fading pattern. (The lines have been drawn much farther apart than they would be on any reasonable scale, simply for clarity.) If the aircraft flies along one of these ellipses, it produces no variation in the signal, which is either permanently increased or decreased, with any echoes retaining their position; in fact, such accuracy of flight is almost impossible, a sideways movement of only a few feet taking the aircraft from the crest to an adjacent trough. Any other course will, in general, give a flutter of varying frequency which can be estimated by laying off the course on the plan and noting the intersections of the course and the ellipses.

The amplitude of the fade will depend on many factors (such as the shape and attitude of the aircraft and its position relative to the transmitter and receiver) which are not amenable to calculation. The writer has the mixed fortune to live very close to two airfields, namely London Airport (Heathrow) and Langley, which provide opportunities for observing the effect every few minutes, so that it is possible to substitute a mass of individual results, in a wide variety of circumstances, for the alternative difficult (and possibly over-simplified) calculations. Taking the sum total of all observations, it is clear that there is no significant difference between the various directions in which the aircraft may be; taking the observations singly, it is clear that there is usually a distinct position or positions of the aircraft for maximum reflected signal at the receiver in each case, but that the direction of this maximum varies from case to case. A complete picture of the whole range of observations would be virtually impossible to reproduce and if there is any preferred direction which gives the maximum reflected signal, it varies from one occasion to another.

The fading trouble will be worst (indeed it may be said only to be seriously apparent) in locations which are near or beyond the horizon of the transmitter. In such

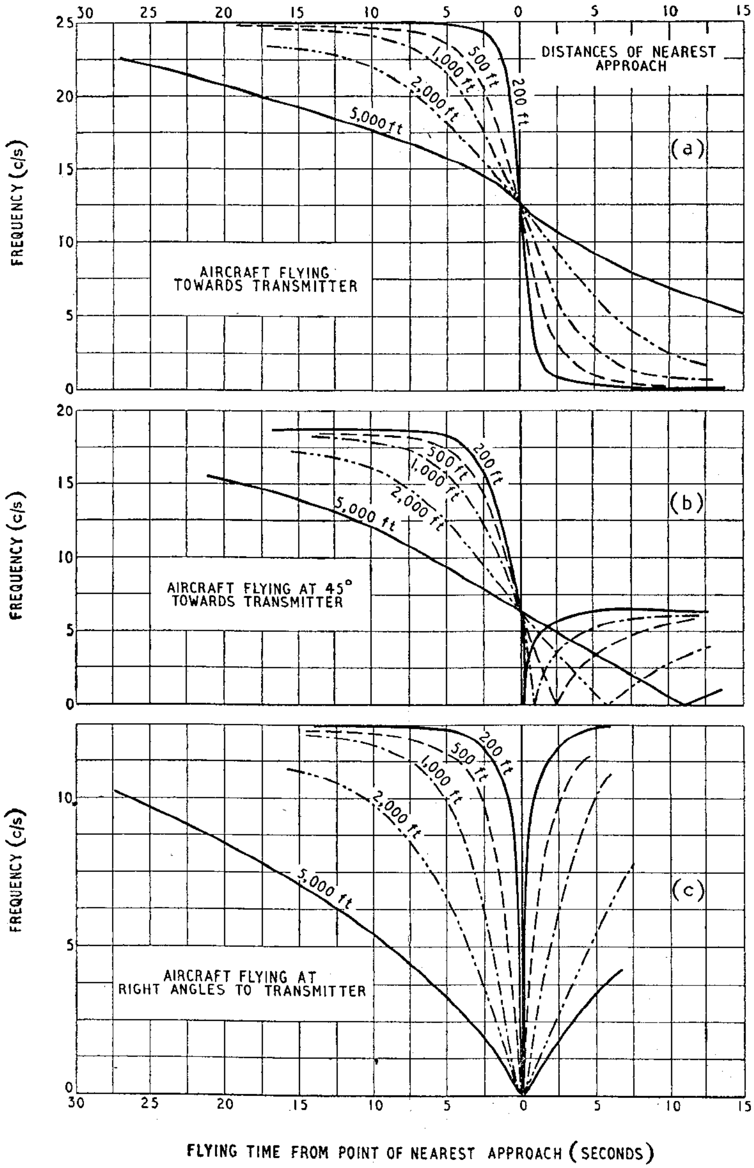


Fig. 2. Calculated curves showing the frequency of the fading cycle against flying time from the point of nearest approach for an aircraft speed of 250 ft per second. Curves (a) are for an aircraft flying towards the transmitter, (b) for one on a course at 45° to the foregoing and (c) for a course at 90°.

Television Interference by Aircraft— locations, from which the transmitter can hardly be "seen," if at all, the direct wave is attenuated, but the reflected wave from the aircraft (which being higher can "see" the transmitter without obstruction) is relatively much more powerful.

Reciprocity would suggest that a similar effect should be experienced with a receiver near the horizon when an aircraft flies near the transmitter; but no evidence can be offered of actual observations. It would, however, be expected that exact symmetry would not occur in the two cases between (1) when the aircraft is near the receiver and (2) when it is near the transmitter, since the geometry of the two aerial locations, and their polar diagrams, will, in general, be different.

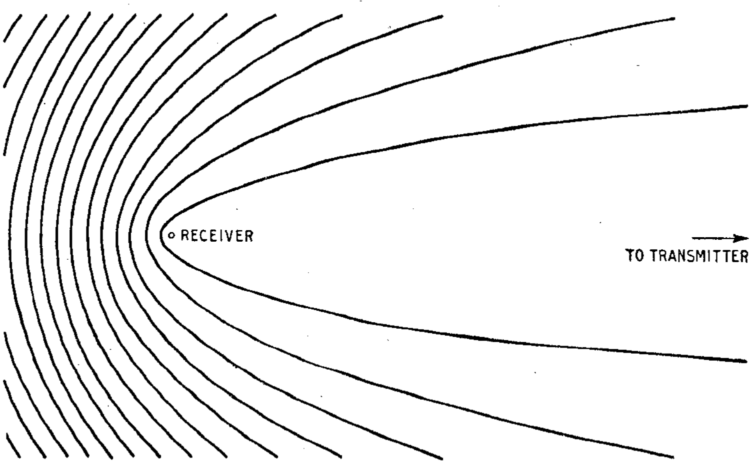


Fig. 3. Family of ellipses representing aircraft courses along which the direct and indirect rays combine to give a constant signal at the receiver.

The first method that comes to mind as a cure for fading is automatic gain control, but this is not nearly as useful as in sound reception. There is the practical difficulty of obtaining the a.g.c. voltage, particularly with positive modulation as used in this country; although, even with negative modulation, there are difficulties as is shown by the fact that a.g.c. is being omitted from this year's American receivers. But more important is the fact that a.g.c. only evens out the variations in picture brightness; it does not affect the extent of the ghost images and, indeed, by increasing the gain during the downward fades it increases the severity of the negative ghosts. Nor does a.g.c. have any effect upon the intrusion of ghosts into the sync pulses; with a.g.c. the picture loses hold as easily as before.

Directional aerials are another popular remedy, but they do not contribute much. The dipole-plus-reflector, which is most people's idea of a directional aerial, does no more than reduce to some extent the reception from the direction away from the transmitter; this is not a particularly serious source of reflected interference and this kind of directivity would probably produce no noticeable effect. Directivity of a far higher order, such as can be had from a three- or four-element array, or a long-wire aerial, can be a real help by reducing the interference to the time when the aircraft is between the receiver and the transmitter; at this time the interference will be as bad as ever but, in cases where the trouble is often present, it is a relief to be able to reduce the time of its incidence even if it cannot be eliminated or reduced in amplitude.

Reference must be made to two articles,* from which it would appear that the worst trouble is to be expected when the aircraft is "behind" the receiver, so that directional aerials of almost any sort would be worth while. The difference between the results attained in these articles and in practice, lies in the simplifying assumptions on which the articles depend; assumptions which reduce the mathematics from being impossible to being merely extremely difficult. Their results are true for substantially vertical reflecting surfaces (e.g., an aircraft); they are not true when the reflecting surface is horizontal, nor when it lies between the transmitter and receiver, in which case it sometimes acts as though it were an element of the ionosphere.

One powerful cure is to reduce the relative intensity of the reflected signal by raising that of the direct signal; this can, in most cases, be done by raising the height of the receiving aerial. An additional effect results from the distortion of the plane of polarization in the neighbourhood of roofs of houses, so that a low vertical aerial may not be optimum for the direct signal but will, on occasion, be in the right direction for the rotated polarization of the reflected signal; raising the aerial into a region where the polarization of the wanted signal is more truly vertical has therefore a double effect in reducing the relative intensity of the reflected wave. It is the writer's experience that this is the most powerful single cure for this trouble and the amount of civil engineering required to raise the aerial is usually less than that required to make even the simplest form of directional aerial.

It has been noticed that certain receivers are less disturbed by aircraft; in these receivers, the designers† have deliberately degraded the d.c. component of the signal to less than 100 per cent in order to avoid the ill effects of too great contrast or gamma variations which may occur, for example, in News Reel transmissions. Conversely, there are many receivers in which all the ill effects of aircraft reflections are exceptionally bad because the d.c. component is over 100 per cent.

This leads to a modification of the receiver with an effect comparable with that of a.g.c. but

* D. I. Lawson, "Multipath Interference in Television Transmission," *J. Instn Elect. Engrs,* 1945, Vol. 92, Part II, p. 125; D. A. Bell, "Approximate Method of Calculating Reflections in Television Transmission," *J. Instn Elect. Engrs,* 1946, Vol. 93, Part III, p. 352.

† C. L. Faudell and N. Atkinson, British Patent 505,899.

which is far easier to apply; i.e., the removal of the d.c. component from the signal. Figs. 3, 4 and 5 show that the fading frequency cannot rise so high as 50 c/s and it therefore appears to be an advantage also to attenuate the lower frequencies. The position is, in fact, not so simple as this; the fading trouble is not merely the addition of a low-frequency component to the received signal; it is a modulation of the received signal at the fading frequency.

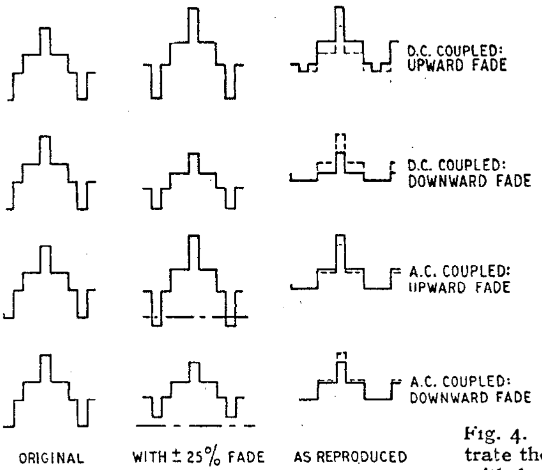


Fig. 4. These diagrams illustrate the effects of interference with d.c. and a.c. coupling to the cathode-ray tube.

As a result, the signal amplitude swells and shrinks about the zero axis, giving an exaggeration of the depth of fading; by removing the d.c. component we cause the signal amplitude to swell and shrink about its mean brightness level, so that the mean picture brightness does not fluctuate.

This improvement is demonstrated in Fig. 4, which takes a signal similar to the one previously used to demonstrate the "echo" effects, and subjects it to a fade of ±25%. In the left-hand column, the signal is in its original form; in the second, it is combined, either in or out of phase, with a "reflected" signal of a quarter of its amplitude to simulate the fade (although in practice the matter would be complicated by the presence of echoes, here omitted). The first two examples (reading downwards) are for plain d.c. coupling; the third and fourth are for d.c. suppression, which results in variations of the absolute level of the signal, as is shown by the departure of the bottom of the sync pulses from the previous level, here shown chain-dotted. The last column shows the signal as reproduced on the cathode ray tube; i.e., with all parts of the wave-forms lying below the pre-set black level suppressed. The dotted lines indicate the signal as it would be in the absence of fading and make it clear that a considerable advantage is gained by making the brightness swell and shrink around its mean level rather than with respect to the "blacker-than-black" level of the bottom of the sync pulses.

Removal of the d.c. component is attended by the well-known disadvantages; the mean picture brightness is made constant so that "high-key" and "low-key" pictures, which the producer may seek to exploit in order to attain a dramatic effect, will all be reproduced as though they were normally illuminated and the automatic suppression of the scanning return-lines, which is a feature of constant-black-level working, does not take place. Some other method must therefore be provided to prevent these undesirable effects.

The most satisfactory solution to this aspect of the problem is inherent in the observed fact that the disturbance becomes much less objectionable if the frequency of the disturbance can be reduced below one cycle in 1 or 2 seconds. It remains, therefore, to design a filter* which will attenuate frequencies between 1 and 25 c/s. In practice, this filter is incorporated in the network comprising the previously mentioned a.c. coupling. The addition of a suitably delayed d.c. component helps to provide freedom from aeroplane disturbance.

The actual circuit modification is normally associated with the video amplifier which usually has circuit elements which can be readily adapted to a filter network. By way of example, the modified circuit of a commercial receiver is shown in Fig. 5, where the a.c. coupling comprises the capacitance C_2 and the resistance R_3 and where the d.c. path through the resistances R_4 and R_3 is delayed by the time constant C_3 R_5 whose value may be controlled by the choice of a suitable value for C_3. This arrangement gives an attenuation of the order of 20 db at 3 c/s. Suitable values of components are indicated on the diagram.

This discussion has so far been confined to the effect on the received picture; sound reception suffers similarly though, generally, to a much less extent. The eye is very worried by a flutter producing a 10% change in brightness, but the corresponding 1-db change in sound level would pass unnoticed except perhaps on a constant tone. It could, of course, be made negligible by a.g.c., but, if conditions are such as to warrant a.g.c. on sound, the picture would be quite intolerable.

*C. D. Faudell, British Patent App. 20726/47.

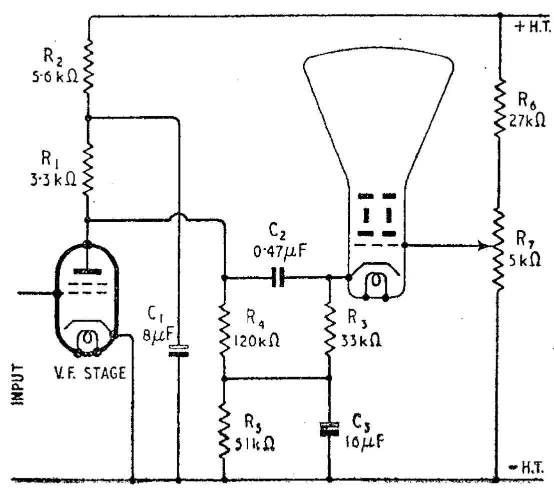


Fig. 5. Circuit of the v.f. stage of a commercial receiver modified to reduce the effects of aircraft interference.

AMERICAN MICROGROOVE RECORDS

Some Details of New Commercial Developments

By DONALD W. ALDOUS

IT has long been the aim of the gramophone record industry to produce a practicable long-playing high-quality disc of the customary 10in or 12in diameter. Many attempts have been made to introduce records with increased playing-time into the commercial record field, e.g., by making use of the constant linear speed method, but they were not a technical success.

It is also of interest to recall the Pathé discs, 11 and 20in in diameter, of the early 1900s, which can be regarded as attempts to tackle the running-time problem. Outside the domestic record field one can instance the first 16in slow-speed "talkie" discs and, of course, to-day lacquer discs up to $17\frac{1}{4}$in diameter are regularly employed by the B.B.C. and other organizations for specific applications requiring extended playing time.

The impact on the record industry of "wrapped up" magnetic wire and tape systems, providing playing time limited only by the length of the carrier or medium used, has stimulated developments, and the "record conscious" American public has recently been offered long-playing "microgroove" records, presumably as the answer to the belief of some enthusiasts, chiefly record collectors, that the disc system is obsolescent.

What is a "microgroove" record? It is a name given to the 7-, 10- or 12-in pressings in high-grade vinylite, with a rotational speed of $33\frac{1}{3}$ r.p.m., providing about $5\frac{1}{4}$-$5\frac{1}{2}$, 15 and $22\frac{1}{2}$ minutes per side respectively. These long playing times are made possible largely by the combination of reduced rotational speed and increased grooves per inch from the conventional 96-100 to 224 up to 300.

As it was found necessary to reduce the groove width to about one-third the size of normal record grooves, the name "Microgroove" was coined originally by Columbia Records, Inc., for their $33\frac{1}{3}$ r.p.m. records, but it would now appear to be used in America as a generic term for all such fine-pitch records.

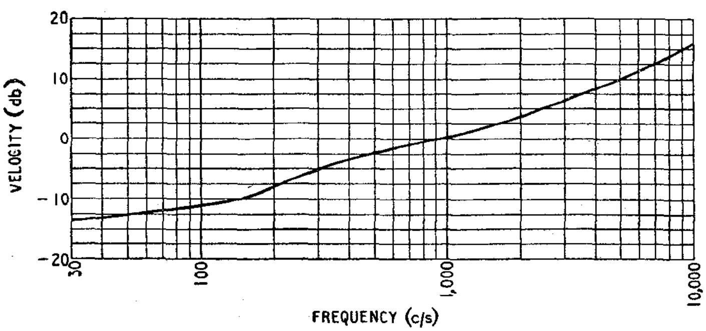


Fig. 1. Columbia LP "Microgroove" recording characteristic.

Before discussing the recording characteristic adopted for these records and the exacting technical requirements in processing and reproducing equipment that have to be met to ensure optimum quality, a few notes on the early research will not be amiss.

Dr. Peter Goldmark, Director of Engineering Research and Development of the Columbia Broadcasting System, which owns Columbia Records, Inc., initiated the experiments in 1945, and this research project was later transferred to the laboratories of Columbia Records, to adapt it to commercial recording and manufacturing conditions. The final "Microgroove" record marketed was the result of the combined efforts of Dr. Goldmark, William S. Bachman, Director of Engineering Research and Development for Columbia Records, and their associates.

It is appropriate to mention that, in 1939, when Columbia Records, Inc., were taken over by C.B.S., the possibility of long-playing records was envisaged and, consequently, in all sessions from that year onwards Columbia masters were cut on 16in lacquer discs at $33\frac{1}{3}$ r.p.m., as well as on the standard 78 r.p.m. masters. The frequency response claimed for these masters was from 50 to above 10,000 c/s. Thus a considerable repertoire of recorded material was available to launch these new "Microgroove" records.

We come now to an outline of the technical problems that had to be solved before a satisfactory "microgroove" record could be produced. The two significant contributions were the development of a first-class lightweight pickup that would trace a waveform accurately with very low forces at the needle tip, and the manufacture of a satisfactory inexpensive slow-speed rim-driven turntable motor to provide constant speed free from rumble.

For Columbia "Microgroove" discs a 0.001in tip radius needle, operating with a total force of $\frac{1}{5}$oz, has been achieved in the Philco "phono-combination," using a crystal cartridge, the first record-player for these records to be put on sale (at 29.95 dollars) in the U.S.A.

The "Microgroove" bottom radius is less than 0.0002in and the groove shape has an included angle of $87° \pm 3°$. The change in rotational speed from 78 to $33\frac{1}{3}$ r.p.m. decreases the linear speed and the recorded wavelength by a factor of about 2.35, but as the playback tip radius has been reduced by a factor of 2.5 to 3, the high-frequency loss with changing diameters is less than with ordinary records. In fact, an improvement in useful frequency response of 1.28 times, with reduced intermodulation distortion at small diameters near the centre of the record, is claimed.

The actual recording characteristic employed for Columbia "Microgroove" recording is very similar to the N.A.B. (National Association of Broadcasters) standard for lateral transcriptions, except at the low-frequency end, below 100 c/s, where the characteristic is approximately 3 db. higher. With this characteristic the treble response is pre-emphasized, reaching some 16 db. at 10,000 c/s, relative to the 900 c/s level. (See Figs. 1 and 2.) The absolute level recorded is only about 4 to 6 db lower than that on normal records. The recording characteristic has gradually changing slopes, so that precise equalization can be obtained with simple RC networks.

The salient technical features of Columbia "Microgroove" records are shown in the table.*

As examples of the recorded material available Columbia offers the entire Dvorak "New World" Symphony on one 12in disc, price 4.85 dollars, and the Mozart Symphony in G Minor, K.550 on a double-sided 10in record, price 3.85 dollars. Items of less than one side in length are recorded in sections, so that any one can be selected as desired. Six or more popular dance tunes can be recorded on one "Microgroove" disc. The 7in Columbia "Microgroove" disc is called LP Junior, and gives a playing-time comparable with an ordinary 12in 78 r.p.m. record, at less cost.

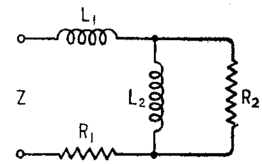
The conception of fine-pitch records is not new, but to summarize the technical considerations of "Microgroove" recording that have made commercial applications practicable, one may add to the lightweight pick-up, miniature stylus, rumble-free and wow-free motor, the recent refinements of processing technique and the use of suitable plastics providing a lower noise level, consequently an adequate dynamic range.

COLUMBIA "MICROGROOVE" DIMENSIONAL SPECIFICATIONS.

	10in records	12in records
Diameter...	$9\frac{7}{8}$in ± $\frac{1}{32}$in	$11\frac{7}{8}$in ± $\frac{1}{32}$in
Centre hole diameter ...	0.286in + 0.001in −0.002in	0.286in + 0.001in −0.002in
Thickness (to be measured at 1in from the edge at four points 90° apart).	0.075in + 0.010in	0.075in ± 0.010in
Lead-in spiral	To start at outer edge of the music grooves and to consist of at least one complete turn before reaching recording pitch.	
Concentricity	The indicated run-out of the music grooves relative to centre hole shall not exceed 0.010in.	
Diameter of first groove at recording pitch.	$9\frac{1}{2}$in ± 0.02in	$11\frac{1}{2}$in ± 0.02in
Minimum inside diameter of recording.	$4\frac{3}{4}$in	$4\frac{3}{4}$in
Groove shape :—		
Included angle	87° ± 3°	87° ± 3°
Bottom radius	Under 0.0002in	Under 0.0002in
Width of groove ...	0.0027 to 0.003in	0.0027 to 0.003in
Rotational speed ...	$33\frac{1}{3}$ r.p.m.	$33\frac{1}{3}$ r.p.m.
Eccentric run-out groove diameter.	$4\frac{7}{16}$in	$4\frac{7}{16}$in
Run-out relative to centre hole.	0.250 ± 0.015in	0.250 ± 0.015in
Groove shape	Contour approximately same as music grooves: min. depth 0.003in.	

The importance of extreme care and skill in manufacture to avoid even the slightest blemish arising in any process, cannot be overstated, and it is reported that each individual pressing is checked. The purchaser, too, must handle and store the records carefully to prevent any surface scratches.

What are the reactions so far of



$$R_2 = 4R_1$$

$$\frac{L_1}{(R_1+R_2)} = 100\mu\text{SEC.}$$

$$\frac{(L_1+L_2)}{R_1} = 1{,}590\mu\text{SEC.}$$

Fig. 2. The curve, shown in Fig. 1, is identical in shape to the impedance/frequency characteristic of the network shown here.

the American public and record dealers to this innovation? Enthusiasts claim that "'Microgroove' records are the greatest single step forward in the history of phonograph records," but the record shops in New York do not share their enthusiasm.

The situation at the moment is, to say the least, confusing. The RCA-Victor organization has just introduced a new 7in fine-pitch record known as "Victorgroove," rotating at a new speed of 45 r.p.m. These records have a 2in centre hole, surrounded by a thick ring from which the disc proper extends as a thinner fin. The purpose of this ring is to prevent the record surfaces from coming into contact in storage or when stacked on the new RCA-Victor auto-change player, which has a 2-second cycle when handling eight "Victorgroove" 7in records, providing a total playing-time of about 42 minutes.

Radiogramophone and record-player manufacturers in America have got to decide whether to make units that will play $33\frac{1}{3}$, 45 and 78 r.p.m. records, or, say, any two of these speeds, and the scramble to get apparatus on the market has started. For instance, Webster-Chicago has a new Model 133 "Microgroove" changer available; the Crosley and Admiral firms are producing two-speed auto-changers. Special needles have been developed, with either sapphire or osmium-alloy tips.

* The author acknowledges with thanks information received from Mr. C. J. Lebel, Vice-President, Audio Devices, Inc., U.S.A.

American Microgroove Records

The manufacturers of recording equipment, too, are very active, and such well-known companies as Presto and Fairchild are already producing special disc recorders able to meet the rigid requirements of the new "microgroove" technique.

The battle of the r.p.m. has begun. It need hardly be added that British record manufacturers are following the conflict very closely.

SHORT-WAVE CONDITIONS

February in Retrospect : Forecast for April

By T. W. BENNINGTON and L. J. PRECHNER (Engineering Division, B.B.C.)

DURING February, the average maximum usable frequencies for these latitudes increased very considerably, both by day and night. The daytime increase—mentioned in this column for February—was due to the normal seasonal trend after the "Midwinter Effect," while the night-time increase was also in accordance with the usual trend towards the midsummer maximum. The much increased sunspot activity in February probably accentuated these increases.

As the month was much less disturbed than January, long-distance communication on higher shortwave frequencies was good to most parts of the world. The rise in m.u.fs after the "Midwinter Effect" was very noticeable, particularly in the middle of the month. Frequencies as high as 50 Mc/s were practically never usable, although reception of transmissions from the United States on 47 Mc/s has been reported. Transmissions on 28 Mc/s from New Zealand, travelling via the long path, have been received in the evening very much earlier than is usually the case for this time of the year. Reception conditions were, on the whole, quite good, and some of the short-lived storms, which were usually associated with large sunspots, affected frequencies of the order of 14 Mc/s much more than the higher frequencies. During the night, frequencies as low as 7 Mc/s continued to be workable, although the corresponding January value was 3.5 Mc/s.

Again an abnormally high rate of incidence of Sporadic E for this time of the year was recorded, the value being much higher than in January, and more than three times the corresponding value for February, 1948.

Sunspot activity in February was much greater than in January. No fewer than eight fairly large groups were observed, which crossed the central meridian of the sun on 2nd, 5th (two groups), 16th, 19th, 20th, 27th and 28th. The first three groups could be clearly seen with the naked eye in many localities, owing to the sun's glare being dimmed by fog.

February was a much less disturbed month than January. Ionosphere storms were observed on 7th, 22nd and 27th, those occurring on the first two days being fairly violent.

"Dellinger" fadeouts were recorded in February on a number of occasions, those occurring on 1st and 11th being very severe.

Long-range tropospheric propagation was observed on a few occasions at irregular intervals.

Forecast.—During April, the daytime m.u.fs in the Northern Hemisphere should begin to decrease towards the midsummer minimum, while the night-time m.u.fs should continue their increase towards the midsummer maximum. The effects of these variations will be modified on most transmission paths by longer duration of daylight, and moderately high frequencies will remain in use for considerably longer periods. Consequently while, during April, working frequencies for most transmission paths will be somewhat lower than in March during the full daylight period, they will be somewhat higher during the morning and evening periods, and considerably higher during the full darkness period.

Daytime communication on high frequencies (like the 28-Mc/s band) should be still frequently possible, but is likely to be somewhat less than of late. Over many circuits, frequencies as high as 15 Mc/s—and even higher in some cases—should remain usable till well after midnight. Frequencies lower than 9 Mc/s will be seldom required at any time during the night.

For transmission distances between about 600 and 1,000 miles the E layer will often control transmissions during the daytime, so that higher working frequencies may be called for at such times than would otherwise have been the case.

Sporadic E may begin to increase, although the real increase usually occurs in May. As, during this year so far, the incidence of sporadic E has been abnormally high, it may be that it will be more prevalent in April than is usually the case.

Below are given, in terms of the broadcast bands, the working frequencies which should be regularly usable during April for four long-distance circuits. (All times G.M.T.) In addition, a figure in brackets indicates the highest frequency likely to be usable for about 25 per cent of the time during the month for communication by way of the regular layers:—

Montreal :	0000	11Mc/s	(16Mc/s)
	0200	9 ,,	(14 ,,)
	0800	11 ,,	(16 ,,)
	1000	15 ,,	(20 ,,)
	1200	17 ,,	(23 ,,)
	2200	15 ,,	(19 ,,)
	2300	11 ,,	(16 ,,)
Buenos Aires :	0000	15Mc/s	(19Mc/s)
	0200	11 ,,	(17 ,,)
	0700	15 ,,	(21 ,,)
	0800	17 ,,	(24 ,,)
	0900	21 ,,	(28 ,,)
	1100	26 ,,	(34 ,,)
	1800	21 ,,	(26 ,,)
	2100	17 ,,	(22 ,,)
	2200	15 ,,	(20 ,,)
Cape Town :	0000	15Mc/s	(19Mc/s)
	0300	11 ,,	(16 ,,)
	0500	15 ,,	(22 ,,)
	0600	17 ,,	(27 ,,)
	0700	21 ,,	(29 ,,)
	0800	26 ,,	(34 ,,)
	1800	21 ,,	(27 ,,)
	2000	17 ,,	(22 ,,)
Chungking :	0000	9Mc/s	(12Mc/s)
	0300	11 ,,	(16 ,,)
	0500	15 ,,	(20 ,,)
	0600	17 ,,	(23 ,,)
	0800	21 ,,	(28 ,,)
	1400	17 ,,	(23 ,,)
	1600	15 ,,	(19 ,,)
	1900	11 ,,	(14 ,,)

April is usually a moderately disturbed month. At the time of writing it would appear that ionosphere storms are more likely to occur during the periods 1st/2nd, 10th/11th, 13th/14th, 16th/18th, 29th/30th, than on the other days of the month.

AIR *v.* WATER COOLING FOR VALVES

AT a discussion meeting of the Radio Section of the I.E.E. on February 15th, 1949, it was pointed out that air cooling, which was at present suitable for powers up to about 5 kW, might be expected to show still further improvement, but had to contend with strong competition, so far as higher powers were concerned, from modern closed-circuit water-cooling systems in which comparatively small volumes of water with a supernatant atmosphere of nitrogen were used with induced-draught coolers.

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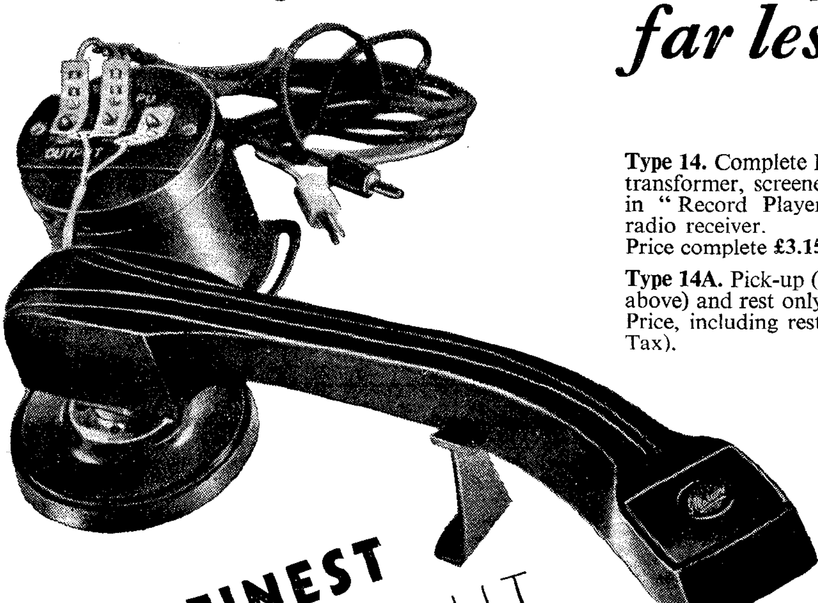

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• **Pick-up-output** for average record, 6 mV. Output at secondary of matching transformer is 1.5V.

• **Needles.** Needle changing is simple (no needle screw to operate) and up to 100 playings with steel needles and 2,000 playings with all-sapphire needles are possible. Ordinary needles must not be used with these instruments. Recommended types are the Columbia 99, Columbia Permanent sapphire or Columbia Miniature Thorn.

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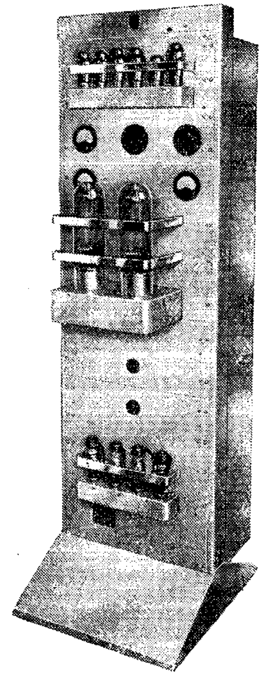

* What expression should be used to refer *generally* to amplifiers, and related apparatus? "Public Address?" This hardly applies to gear that may well be used in private for purposes other than addressing. "Sound Equipment?" This can also mean tom-toms, or brewery apparatus in sound condition! We have adopted the Navy's term "S.R.E." or "Sound Reproducing Equipment", as in our submission there is no other so accurate or so generally applicable.

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RADIO INTERFERENCE

How It Is Caused by Switching D.C. or Low-frequency Circuits

By "CATHODE RAY"

THE subject of radio interference is of such public importance nowadays that even Members of Parliament are expected to know something about it. What some of them did or didn't know came to light during the debate on the Wireless Telegraphy Bill.

There may be a few things about it that even *Wireless World* readers do not know. For instance could they all give a satisfactory answer to the question, "Why does switching things on and off cause radio interference?" To the technically ignorant outsider the whole of radio is so mysterious that there is nothing about this interference business that is likely to strike him as more than usually difficult to explain. But every *Wireless World* reader knows that a receiver is tuned to one particular radio frequency (or, more accurately, a narrow band of frequencies), and that it generally succeeds quite well in rejecting all other frequencies. The frequency at which an electric light or other appliance is switched may be only once in several hours or days, so in comparison with radio frequencies is almost infinitely low. How then, does varying an electric current at a very low frequency indeed produce something that can force its way in past the selectivity of the set?

Admittedly, the interference resulting from switching consists only of isolated clicks, so is not very annoying. It is a different matter with certain types of motor-driven appliances, which cause an apparently continuous rattling or buzzing. The chief offender is the "universal" motor with its commutator, which is just a name for a special type of self-operated switch making and breaking connections several times per revolution of the motor. But even in the fastest motor this frequency of switching is still too low to be classed as a radio frequency; so the perplexity remains. By contrast, current coming from the 50 c/s supply causes no radio interference, yet by its very nature it stops and starts 100 times a second—much more frequently than any hand-operated switching.

The older readers, with memories of spark transmitters, will be quick to point out that the silent alternations of a.c. occur sparklessly, whereas switches (or any of the other appliances that cause noises to come out of the loudspeaker) are unintentional spark transmitters The reason why spark transmitters were abolished—one of the reasons, anyway—was that they interfered badly by coming in over a wide band of receiver tuning. If we retort that spark transmitters did at least have recognizable frequencies or wavelengths at which they could be tuned in, whereas the unintentional sparkers come in almost everywhere, the old hands may explain that a spark transmitter sparked into properly designed tuned circuits, whereas the circuits affected by the noise-making appliances are likely to be anything but sharply tuned.

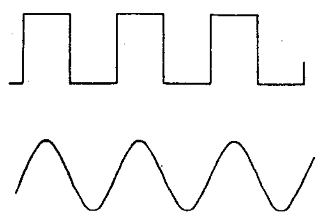


Fig. 1. Electrical power having a low-frequency sine waveform (b) is confined to one frequency, but if it has a steep-sided waveform (a) it is distributed over a wide range of frequencies.

Well, that explanation is all right so far as it goes, but it doesn't go very far towards making it clear to the readers who are too young to take spark transmitting for granted just *why* interrupting a direct or low-frequency current "sparkily" generates *radio* frequencies. And it completely fails to explain the fact that certain low-frequency generators cause radio interference without any sparks at all. For instance, about ten years ago* *Wireless World* published a description of a 400 c/s oscillator that could be heard over all the wavebands in a receiver, even up to 20 Mc/s. There was no deception—its signal was picked up as a genuine radio frequency by the r.f. tuning circuits, not by low-frequency induction or any such backstairs method.

And there we have the key to the mystery, if it is a mystery. Since your copy of this key (if you ever had it) may have been lost in the blitz or sacrificed to the paper-saving campaign, I will explain that the oscillator in question generated a square wave with very steep—almost instantaneous—sides, as in Fig. 1(a). (An actual multivibrator waveform is slightly more complicated, but the steep sides are the essential features.) If the 400-c/s oscillator had a smooth sine wave as in Fig. 1(b) it certainly wouldn't cause radio interference. But, as is well known, distortion of this fundamental waveform inevitably generates higher frequencies—harmonics—which are multiples of the fundamental frequency. With the small amount of distortion that is considered tolerable in reproduction of programmes, the 2nd and 3rd harmonics are the only ones that are likely to amount to more than one per cent of the fundamental (though in fact much of the audible unpleasantness may be due to minute traces of harmonics as high as the 9th or 11th). But with the aforementioned waveform, harmonics can be detected up to at least the 50,000th! The frequency of the 50,000th

* "Monarch Multivibrator," April 13th, 1939, p. 349.

Radio Interference—

harmonic is 50,000 × 400 c/s = 20 Mc/s, so there is no further question about where the radio frequencies come from.

Mathematicians can calculate the relative amplitudes of all the harmonics necessary to build up any given periodic waveform. ("Periodic" means a waveform that exactly repeats again and again, so has a definite fundamental frequency.) They show that a perfect square wave wouldn't have a 50,000th harmonic—or any even harmonic—but it would have a 50,001th, which is $\frac{1}{50{,}001}$ times the amplitude of the fundamental. And similarly for the other harmonics, up to infinity.

A good way of showing the ingredients of a waveform is by means of a spectrum. Fig. 2 is part of the spectrum of a 400-c/s square wave. Each harmonic is represented by a vertical line at the appropriate point on the frequency scale, and the heights of the lines indicate the relative amplitudes of the harmonics.

If you find it as difficult as I did to believe that combining a sufficient number of sine waves will form a perfect square wave, you may be interested in Fig. 3, reproduced from p. 359 of the December, 1945, issue of this journal. Here, in the left-hand half-cycle, are drawn all the odd harmonics up to the 15th, in proportionately decreasing amplitude, and all starting off in phase. The heavy line is the result of adding them all together. It is not by any means a perfect square wave, but it is so obviously tending that way that it is not too difficult to believe that if the odd harmonics up to (say) 50,001 were added it would approximate very closely indeed. The fact that so many (25,001) sine waves were made to start in step would mean that the combination of them all would have a slope 25,001 times as steep as that of one of them, so would be practically vertical. And because they are all odd harmonics they next come into step (in the opposite direction) at the end of half a fundamental cycle, forming an equally precipitous descent. In between, their ups and downs tend to cancel out, forming the "flats."

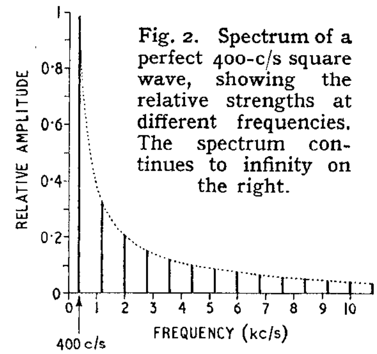


Fig. 2. Spectrum of a perfect 400-c/s square wave, showing the relative strengths at different frequencies. The spectrum continues to infinity on the right.

The mathematical analysis of a 400-c/s square wave is borne out in practice by the fact that a radio receiver picks up a continuous succession of oscillations that become gradually weaker as the frequency arises. One might expect them to come in at 800 c/s intervals, but since a multivibrator does not generate a perfect square wave the even harmonics are not quite zero, and signals are generally detectable every 400 c/s.

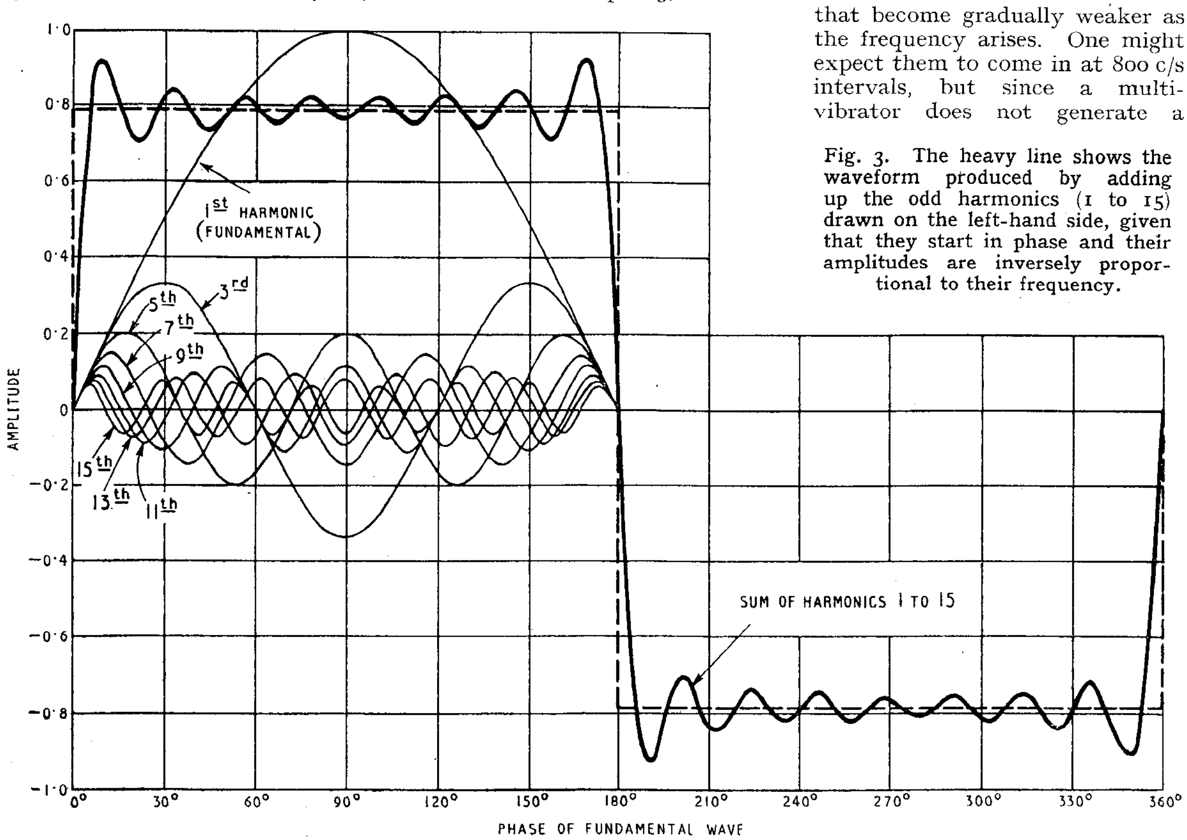


Fig. 3. The heavy line shows the waveform produced by adding up the odd harmonics (1 to 15) drawn on the left-hand side, given that they start in phase and their amplitudes are inversely proportional to their frequency.

In any case, the lower the frequency of the fundamental, the closer the harmonics are spaced. A 1-c/s square wave could be generated by switching d.c. on and off once each way every second, the switching operations being spaced at exact half-second intervals. Harmonics would occur at 2-c/s intervals from 1 c/s upwards and would extend theoretically to infinity. But unless the amount of current interrupted was 400 times greater than in the 400-c/s multivibrator, the interference at any given frequency would be less. Just over 1 Mc/s, for example, we would have the 2,501th harmonic of the multivibrator, but the 1,000,001th harmonic of the switch.

Reducing the frequency of the switching still more, finally to one isolated operation, the spectrum resolves itself into lines so close together as to be a continuous mass, so that they cover all frequencies; but they would be very weak. It is a fact of experience that a good clean make or break of current causes very little audible interference, probably none at all when the sensitivity of the receiver is reduced by a local station's carrier wave and unless the aerial is closely coupled to the circuit being switched. Most switches, however, cause a rapid series of current variations when they are operated, and these set up much stronger interference, as one would expect from theory.

There is one other sort of wave that can be analysed fairly easily, and to which some sorts of interference approximate. It is the sharp narrow pulse, Fig. 4(a). As before, the spectrum consists of separate harmonic frequencies, but instead of their amplitudes falling off in proportion to the number of the harmonic, they are almost equal to the fundamental until the frequency is not much less than that of the pulses if they were close enough together to have equal positive and negative half-cycles. That sounds terribly involved, but should be quite clear if we take an example. Suppose pulses occur at 400 c/s, and each pulse lasts for 0.1 microsecond (one ten-millionth of a second). Then if these pulses were square waves, Fig. 4(b), each cycle would last 0.2 μsec, and their frequency would be 5 Mc/s. All harmonics up to about 5 Mc/s would be nearly as strong as the fundamental. The actual relationship is shown in Fig 4(c). Amplitudes above the first zero (10 Mc/s in this case) are relatively small.

So one would expect brief pulses of current like this to be more serious interferers. And so they may be unless carefully screened, as aircraft radio engineers know well enough. The pulses of engine ignition current, and radar pulses if any, could cause much trouble if unshielded.

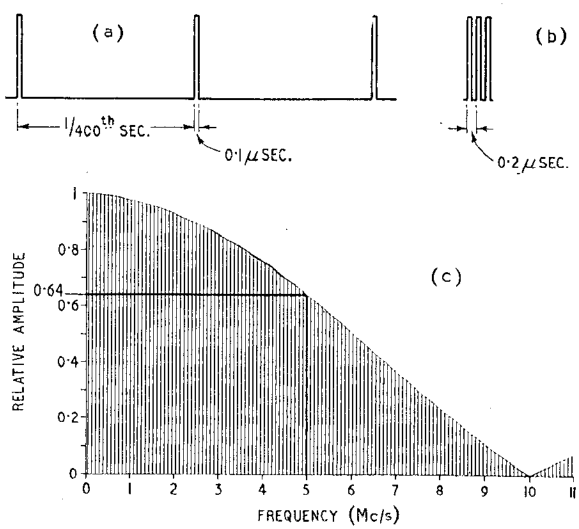


Fig. 4. Example of pulse waveform (a), the fundamental frequency being 400 c/s. The spacing of the lines in the spectrum is determined by this frequency, as in Fig. 2, but the falling off in amplitude is slower the narrower the pulses, as at (c), (where the lines are too close together for all of them to be shown). If the pulses were pushed together to make positive and negative half-cycles equal, their frequency (5 Mc/s) would mark the place in the spectrum at which amplitude had fallen 36 per cent.

Radio Interference—

We can sum up the findings so far by saying that sharp corners or spikes in a waveform must have high-frequency ingredients, just as a mosaic with fine detail must include small pieces and couldn't be made exclusively of unhewn mountain boulders. Therefore the act of causing d.c. to stop or start suddenly, as in Fig 5(a), brings into temporary existence a wide range of frequency, theoretically infinite. The same applies to 50 c/s a.c. Even if you happen to catch it at the moment when it is zero, the sharp corner at the start causes some disturbance, (Fig. 5(b).

According to theory, then, d.c. and a.c. transients such as these might be expected to create interference over a wide band of frequency, but falling in strength with rising frequency. It is a fact that most interference is worst on long waves, less on medium waves, and often inaudible on short waves. But not always. One has only to think of ignition interference with television.

That is because the waveform theory is only part of the story. In real life, current can never spring instantly from one value to another, because there is always some inductance in any

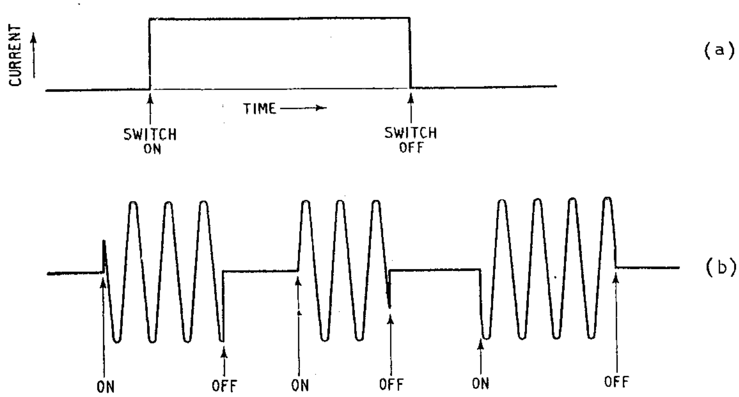


Fig. 5. **"Waveforms" of switching d.c. (a) and a.c. (b) on and off. With a.c., the steepness of wavefront depends somewhat on the phase at which switching takes place.**

circuit, and if the current in it were to change at an infinitely rapid rate it would develop an infinitely large back e.m.f. Voltage can't change infinitely fast either, because there is always some capacitance in a circuit, and an infinitely large current would be necessary to change it in zero time. One effect of the inevitable L and C, then, is to round off the sharp corners and ease the precipitous gradients, cutting down

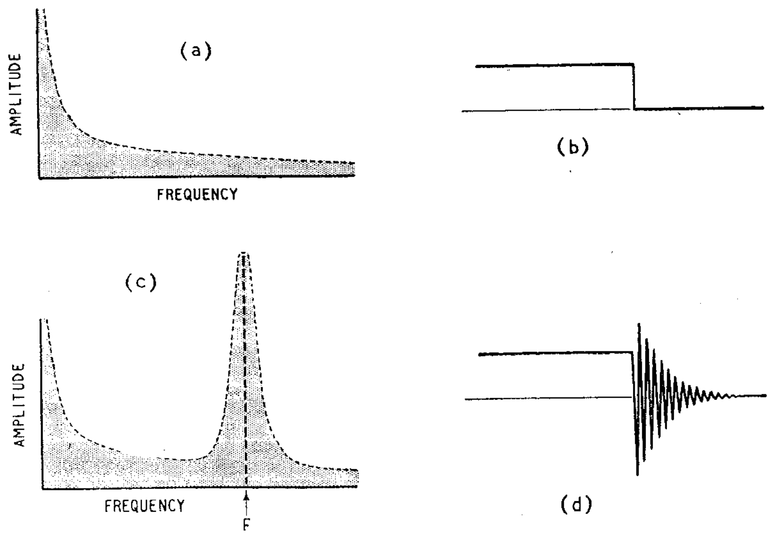


Fig. 6. **When the current in a resistive circuit is switched off the waveform is a "step" (b) and the spectrum like (a) (i.e. similar to Fig. 2 but no separate lines). But if the inductance and capacitance are sufficient, the interference at some frequencies will be accentuated by oscillation, spectrum (c) and waveform (d).**

the spectrum at the high-frequency end.

Another feature of L and C is that they store energy. If there were such a thing as a purely resistive circuit, when the current in it was switched off it would just cease. But no real circuit can carry current without setting up a magnetic field (that is another way of saying it has inductance), and a magnetic field contains energy. When the current is cut off, the energy expresses itself as an e.m.f. that tends to keep the current flowing, and sparks angrily if it is thwarted. Similarly the voltage across a capacitance cannot be brought to zero without the stored electrical energy manifesting itself as a discharge current. A sudden release of energy in either case spreads over a wide band of frequencies.

More important still, often, inductance and capacitance in combination considerably modify the distribution of frequency. In Fig. 6, (a) shows the spectrum of the perfect switch-on or -off, waveform (b). The amplitude is inversely proportional to frequency. But if L and C resonate together at any frequency in this range, say F in Fig. 6 (c), then interference in that region of frequency may be enormously increased. The waveform, instead of being a plain "step," will be obviously oscillatory (d).

A good example is the interference caused by the ignition systems of cars. The dimensions of the sparking-plug circuits cause them to resonate at the very-high frequencies, so that instead of the pulses of current in these circuits setting up interference almost equally at all frequencies, it is much the most troublesome on television and other v.h. frequencies. Putting resistances of the order of 15,000Ω in series with the ignition leads into these circuits damps down the resonances, to the great benefit of the viewing public.

One might ask why, if capacitance may make matters worse, it is the chief ingredient in many of the "interference suppressors" on the market. One answer is that their capacitance is generally made so large that any resonance due to it is below radio frequency. Another is that its purpose is to short-circuit radio-frequency currents, preventing them from wandering through lengths of circuit which radiate them or couple them to receptive aerials.

As a tailpiece I offer a hint on how to become a radio expert in a single one-minute lesson. When people complain about their sets it is generally because of interference or weak reception or both. You ask "Are you using an outdoor aerial?" If they say "Yes" you are stuck. But nine times out of ten their reply will be "No." Thereupon, assuming an appearance of infinite wisdom, you advise them to install a good outdoor aerial. The number of times this prescription brings about a sensational improvement will quite overwhelm the awkward experiences when the trouble happens to be due to a dud output valve or grit in the loudspeaker, and your local prestige will be immense.

NEWS FROM THE CLUBS

Birmingham.—Commencing on April 11th the general meetings of the Birmingham and District Short-Wave Society will be held on the second Monday of each month at the Colmore Hotel, Church Street, Birmingham, 1. The club room at 220, Moseley Road, Birmingham, 12, will be open on the third and fourth Mondays. Sec.: N. Shirley, 14, Manor Road, Stechford, Birmingham, 9, Warwicks.

Chester.—Fortnightly meetings of the Chester and District Amateur Radio Society are held at the United Services Club, Watergate Street, Chester. Next meeting, April 5th at 7.30. Sec.: H. Morris, G3ATZ, 24, Kingsley Road, Boughton Heath, Chester.

Dorking.—Meetings of the Dorking and District Radio Society are held each Tuesday at 7.30 at the club's headquarters, 5, London Road, Dorking. The society's transmitter, G3CZU, is operating on 80 and 160 metres on both 'phone and c.w. Sec.: J. Greenwell, G3AEZ, 7, Sondes Place Drive, Dorking, Surrey.

Edinburgh.—At the next meeting of the Lothian's Radio Society at 7.30 on March 31st in the Chamber of Commerce Rooms, 25, Charolette Square, Edinburgh, D. T. N. Williamson—designer of the Williamson Amplifier—will give a lecture on sound reproduction. The society meets on the last Thursday of each month. Sec.: I. Mackenzie, 41, Easter Drylaw Drive, Edinburgh, 4.

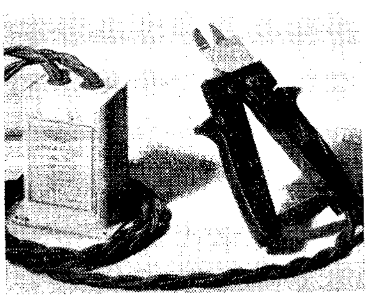
Leicester.—The Leicester Ham Radio Society's permanent headquarters is now at the Holly Bush Hotel, Belgrave Road, Leicester, where meetings are held at 7.30 on the first Friday of each month. Sec.: L. Milnthorpe, 3, Minster Drive, Thurmaston, Leicester.

Portsmouth.—The South Hants Radio Transmitting Society continues to meet on the last Thursday of each month at 7.30 at the Civic Centre, Cosham, Hants, but is endeavouring to secure permanent headquarters where a transmitter can be installed. Sec.: H. G. Martin, G3ACM, 184, Kirby Road, North End, Portsmouth, Hants.

Southall.—The annual general meeting of the West Middlesex Amateur Radio Club, attendance at which is restricted to members, will be held at 7.30 on April 13th at the Labour Hall, Uxbridge Road, Southall, where the club meets on the second and fourth Wednesday of each month. Sec.: C. Alabaster, 34, Lothian Avenue, Hayes, Middlesex.

Southend.—A committee has been set up by the Southend and District Radio Society to organize a Field Week at the Boy Scouts' International Jamboree to be held at Rochford in August. The vice-chairman of the society, J. E. Nickless, G2KT, will lecture at the next meeting on April 1st at 7.15 in the Municipal College, Southend. Sec.: J. H. Barrance, M.B.E. (G3BUJ), 49, Swanage Road, Southend-on-Sea, Essex.

P.V.C. WIRE STRIPPER



This electrically heated tool ("Stanelco: Standard Telephones and Cables) is for stripping P.V.C. insulation from connecting wires; it is designed to prevent nicking or breaking of solid or stranded conductors.

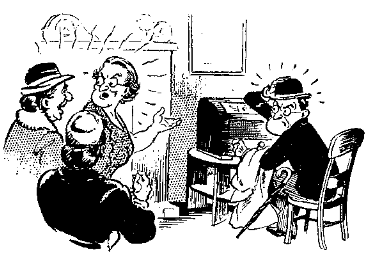
Unbiased

By FREE GRID

Peccavi ?

THOSE of you who resisted the undoubted attraction of playing noughts and crosses in school when you ought to have been studying European history may recollect that Catherine the Great, of Russia, although a lady of remarkable achievements who certainly left her mark on the map of Europe, once expressed her great sorrow that she had no appreciation of music whatsoever. To her it was just nothing but noise. There are, of course, many like her in this modern world. I, personally, know of one eminent figure in the realm of radio who has said unashamedly that he is so far lacking in musical appreciation that he only recognizes the difference between the National Anthem and the sound of a pneumatic drill by the fact that men remove their hats and women stop talking when they hear the former.

As for myself, I am, I suppose, in a sort of halfway house in the matter of musical appreciation, for I do recognize that, in the words of the popular song, "some sort of music makes me sick and you sick, while some sort is noble and grand." But the music which really does annoy me is the sort that is interpolated in the midst of a programme of dialogue, or more usually comic polylogue, in order to give a breathing space to actors and some necessary relaxation of attention to listeners.



Competitive Polylogue.

My objection is that after carefully adjusting the set to give adequate volume for the dialogue so that none of a comedian's gags be lost, the musical interlude suddenly crashes out with a volume that rattles all the ornaments on the old Victorian chiffonier and sends one flying to the volume control, which must, of course, be turned up again as soon as the dialogue is resumed.

Now I don't want to get myself bogged down in the quagmire of scale distortion and suchlike things, and I do realize that, no matter with what Agagian delicacy I walk along this thorny path, I am laying myself open to a devastating flank attack by both the musical and technical sections of my readers. What I ask is that the B.B.C. boost up the volume of the dialogue or, alternatively, that set designers provide us with a special kind of audio a.v.c. which will distinguish between speech and music and so do the job at the listener's end.

Let me make it quite clear that I am complaining of programmes which contain a mixture of music and dialogue; I fully realize that I must expect to readjust my volume control when the programme changes from the peaceful quietude of a "twilight hour" programme to a nerve-shattering brass band performance

Sheer Ignorance

ONE not infrequently finds abysmal ignorance flourishing like a weed in places where one would expect to find only the fair flower of learning. A classic example is provided by the late Lord Curzon, whom a contemporary so aptly described as "a very superior purzon." He once astonished the Upper Chamber by pronouncing the cockney word "beano" as if it were of Italian origin, as indeed he thought it was. It did not altogether inspire me, therefore, one Sunday afternoon a little while back, when the erudite members of the two teams in the B.B.C. Round Britain Quiz programme floundered hopelessly concerning the question of the international distress signal used by ships and aircraft.

They were asked what was the radio-telegraphic equivalent of the radio-telephonic distress call "Mayday." It was obviously meant as a trap for those who take the B.B.C. or the popular press as their sole source of learning and information, and accord to their pronouncements an aura of *ex-cathedra* infallibility. In saying this I am not in any way seeking to belittle the efforts of these two very worthy public institutions. They are, like the pianist, doing their best; and it is their misfortune rather than their fault that they have not been brought up to observe the same strict standards of accuracy as *Wireless World* and myself. I correctly anticipated that the quiz savants would wrongly reply SOS, but I certainly didn't expect the question master to pass the answer as correct. I was a little surprised, also, that these scions of, figuratively speaking, the Cam and Isis

". . . sole source of learning . . ."

should be so hesitant over the "*M'aidez*" origin of "Mayday."

The SOS heresy became established in the public mind as the international radio distress call at the time of the loss of the ill-fated *Titanic* in April, 1912. Some enterprising journalist, who badly needed a course at a theological college to enable him to distinguish between body and soul, even told us that SOS meant "Save Our Souls." The same enterprising gentleman, disregarding grammar, further informed us that the CQD call, also sent out by the *Titanic* (*vide* official report of enquiry) meant "Come Quick, Danger."

The so-called SOS signal had, at the time of the disaster, only recently come into force to replace the CQD call, which was merely the still-current CQ call followed by D—the prefix to an urgent message. But the international distress call, which took the place of CQD, was not SOS at all but simply · · · — — — · · ·. It is no more SOS than it is VMS or a host of other literal combinations (not necessarily three-letter ones) which an imaginative mind could construct if spacing were as meaningless as punctuation is to most women. The B.B.C. is, of course, largely to blame for perpetuating this error by using the expression "SOS messages" for urgent appeals which, since they are telephonically transmitted, could very aptly and alliteratively be called Mayday messages.

But possibly the B.B.C. has never heard of Mayday, and thinks that the Mayday Hospital at Croydon was founded by the Labour Party.

LETTERS TO THE EDITOR

Land-water Signal Paths ✦ Television Aspect Ratio: Test Card for Interlacing ✦ "Piped" Television ✦ "S" Meter Functions ✦ Relay Circuit

"*Propagation Over Coastlines*"

BY way of a footnote to the abstract in your March issue (p. 117) of my letter to *Nature*, it should perhaps be stressed that the extent of the phenomenon depends upon the wavelength used and upon the earth constants of the land. The figure of 12 db. was given for the specific conditions of the experiment and is not, as your abstract implies, a constant associated with the general phenomenon. It was difficult within the space of a short letter to make this clear, though I suggested in my introductory remarks that it varied with conditions. The phenomenon is essentially a ground-wave one, and would be difficult to detect and of little practical significance with horizontal polarization.

G. MILLINGTON.

Baddow Research Laboratories, Marconi's W.T. Company.

"*Television Goodness Factor*"

MAY I deal briefly with one or two points concerning my article in last month's *Wireless World* which have been raised by readers? Some readers (and the writers of some books) do not agree with my assumption that the aspect ratio of a television image is that of the long (horizontal) to the short (vertical) sides of the visible portion of the transmitted pattern. They maintain that it is, in fact, the ratio of these sides of the entire theoretical image transmitted: that is, that it includes initial and final blacks as well as "blacker than black" sync pulses. I have it on the best authority that for the B.B.C. service the aspect ratio is—and that for all services it should be—that of the visible part of the whole image. It is, in fact, the area covered by the active portions of the active scanning lines. For B.B.C. transmissions the aspect ratio of the whole transmitted pattern is $5 \times 99/83.5 : 4 \times 405/377$ = approx. 5.9 : 4.3.

The equation $f_{min} = \dfrac{L^2 an}{2}$ appearing in some books must be a relic from the old scanning disc days which has somehow escaped revision.

In the article in question I was careful to stress the fact that f_{min} is the minimum modulation bandwidth for anything like equality in horizontal and vertical definition. The optimum bandwith is probably about $1.5 \times f_{min}$. It follows that the most desirable definition ratio is not unity. It is attained when

$$\frac{f_{mod}}{f_{min}} = 1.5$$

Hence $D_{opt} = 1.5$.

Defective interlacing is a not uncommon fault in television receivers. Would it not be a great help to designers, manufacturers and servicemen if a test card containing 188½ black and 188½ white lines were used from time to time? The card would, of course, have to be drawn with extreme accuracy and to be positioned exactly in the field of the transmitting Emitron camera. Very careful monitoring at the transmitting end would also be necessary.

R. W. HALLOWS.

"*Television Distribution*"

I READ with interest this article in your January issue.

I think it is pertinent to point out that a television distribution system was developed and installed in a number of blocks of flats prior to the war by the company to which I was chief engineer. I am not clear in what essentials the system described by your contributor differs from that to which I refer. Can it be that some of the installations mentioned by Mr. Adorian were in fact made by my colleagues?

In view of this I find it surprising that no acknowledgment has been made to those, whom so far as I am aware, were the only engineers concerned with the original scheme.

W. B. J. HACKNEY.

London, S.E.5.

Value of an "S" Meter

G2MC's letter in your January issue has raised several points which need clarifying when discussing S meters.

A clear understanding of the true function of an S meter, its advantages and its disadvantages, sum up to it being a necessary addition to an amateur receiver, providing always, readings are interpreted in conjunction with several other known factors, including aerial characteristics, etc.

First and foremost an S meter is

Letters to the Editor—

usually an indication of a.v.c. and a.g.c. characteristic, and as such will give an indication only of the r.f. conditions as applied across the input of the receiver. And as the a.v.c. characteristic of the average amateur receiver is not linear with frequency, the same input at different frequencies will not give the same S meter readings unless the receiver has been developed to have a constant gain over the frequency range in which it is used. I am pleased to hear that one manufacturer claims to have arranged the radio frequency section of his receiver to have a flat response over the amateur bands and that a similar S meter reading is indicated over the whole band for a constant level input.

Two other points that are very necessary in S meter circuits are:

(a) The determination of what input level shall represent S1, in terms of microvolts per meter input, and this again will be governed to some extent by the signal-to-noise ratio of the receiver or its "goodness factor." (b) What ratio of input increase will represent an increase of one S point?

The popular school of thought in the industry seems to be that a change of 6 db input will raise the S meter reading by 1 point, so that using a scale of 0 to 9 an S9 signal signifies an input of carrier to the receiver of 54 db above the receiver threshold level. G2MC's suggestion that a report of "loud and clear" would be more useful than an S meter report does not hold water in view of the various ideas that most amateurs have of what constitutes a full 100 per cent modulation level.

"Loud and clear" reports would be based on aural judgments made on loudspeaker or headphone outputs and so give no indication of carrier level, but only an indication of modulation fullness.

Hence Station A, with a low-level carrier modulated in the neighbourhood of 120 per cent could be given a "loud and clear" report, whereas Station B, with a higher carrier level modulated to an average depth of 30 per cent would, by the same standard, be given a lower assessment of output.

In conclusion, I would say that an S meter reading from a reporting receiving station is definitely useful if given together with: a statement of aerial conditions, i.e., height above ground, type of array, and feeder system used; the receiver performance in terms of signal-to-noise ratio for a detector current reference; a statement of modulation depth as indicated on an oscilloscope or its equivalent; and a statement of distortion factor or content including 50- or 100-c/s hum level.

In the case of a c.w. report, one should remember to correct S meter readings for the displacement due to the local b.f.o., which does affect the a.v.c. characteristic of most receivers, however well designed they may be.

Instead of a modulation report, a c.w. operator might welcome a few words on his keying characteristic by a nearby reporting station.

In testing with a receiving station if the first S meter reading is taken as an arbitrary level, then immediate subsequent readings are of a definite value to a transmitter making test adjustments and assessing their effect on the radiated signal. H. HARDY, G4GB.

Ruislip, Middx.

OUR COVER

Towers, 130 feet high, have now been erected by the G.E.C. on the sites of the four relay stations—at Harrow, Dunstable, Byfield and Rowley Regis—for the G.P.O. London-Birmingham television link. These masts, erected for the field tests, will be used for the initial working of the system until the specially constructed towers have been built. This month's cover illustration shows the mast at Harrow. The smaller paraboloid has been fitted so that a signal can be transmitted direct from the G.E.C. Laboratories at Wembley during tests, thus avoiding routeing transmissions via the terminal station in London.

Long-delay Relay Circuit

THIS circuit, described in your February issue, works well in practice, and I have used it for a year or more. The best results are obtained by using a high-slope triode having a short grid base, and I have recently found that an EC91 (miniature triode) used with C=2 mfd. and R=3.3 megohms will easily enable a 5-minute time delay to be attained.

A similar result can be obtained by connecting R_c in the anode instead of the cathode circuit of the valve, and C from anode to grid, instead of grid to h.t. negative.

Whichever circuit arrangement be used, the time constant CR becomes effectively multiplied by the amplification factor. If any of your readers are seeking more information they might be interested in an article by the writer published in *The Engineer* of 29th October, 1948, in which these circuits are described and analyzed. J. H. LUCAS.

Mullard Electronic Research Laboratory.

"Simple Tone Control Circuit"

I SHOULD like to draw your attention to the fact that a tone-control circuit exactly similar to that described by E. J. James in your February issue, except for the slight differences in values of elements, was designed by our engineer

Michael Volkoff as early as July, 1939, when the first amplifier embodying this circuit was built. We have used this circuit ever since then, and there are now over one thousand amplifiers in Belgium with this tone control built in.

WILLY L'HOEST,
Rocke International, Ltd.
Brussels.

SENSITIVE ELECTRONIC RELAY

R.F. Oscillator Controlled by External Capacitance

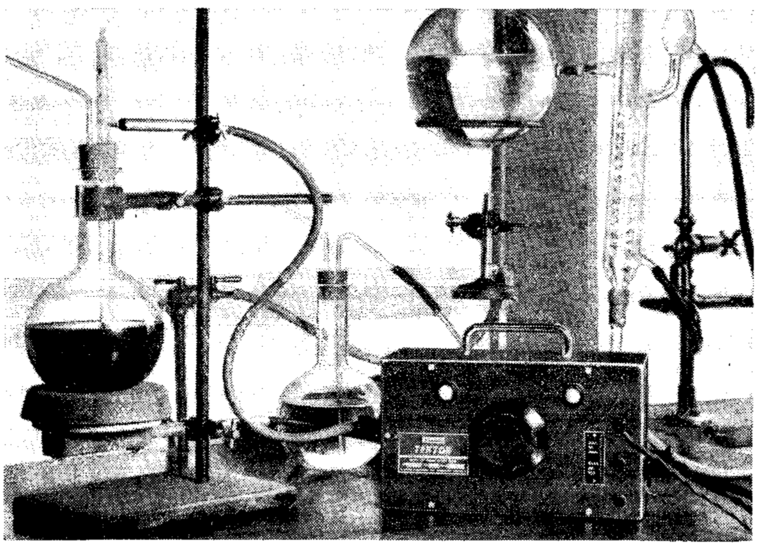
A RANGE of electronic units designed for industrial use and functioning on the principle that the proximity of a substance, whether solid, liquid or a gas, trips a relay has been introduced by Fielden (Electronics) Ltd., Holt Town Works, Manchester, 10.

The tripping of the relay can be utilized to perform a variety of functions, for example, counting the number of items passing a given point, giving warning when the level of a liquid has reached or fallen below a certain level, or, alternatively, to operate mechanism to stop or start the flow of liquid. Many other applications will suggest themselves.

In the case of objects, it is not necessary that they be conductors, and the devices will be actuated by any body of a reasonable size, be it jam-jars, biscuits, bricks, motor cars or people.

The apparatus is known as the "Tektor" and consists of a valve oscillator with a capacitance bridge in the feedback circuit and arranged so that a change of capacitance at the end of a cable joined to the bridge reverses the phase of the oscillator feedback voltage. Thus if the circuit is set up to be in an oscillating state, the proximity of a body, liquid or gas to the remote electrode will stop oscillation. Conversely, it can be made to start oscillation.

The behaviour of the oscillator is easily utilized for any number of functions, mechanical or electrical, by rectifying the radio frequency or even using the change in anode current between the oscillating and non-oscillating state.



Fielden Tektor proximity switch attached to a thermometer and arranged to give remote warning when a liquid reaches a pre-determined temperature.

At present the Tektor is available in four different forms, a proximity switch, a proximity counter, a double Tektor for recording movement in two directions such as high and low levels of liquid in a container, and a meter relay which is actuated by current or voltage readings on an indicating meter. This unit has an additional pointer on the meter which can be moved to any part of the scale and when the normal indicating pointer comes opposite the fixed pointer the electronic relay is actuated and can be made to sound an alarm.

The apparatus operates from the a.c. supply mains and consumes between 20 and 25 watts according to the functions required.

RANDOM RADIATIONS

By "DIALLIST"

A Clever Gadget

IT IS OFTEN a whole lot easier to explain the principle underlying an electrical or electronic process if you can think out a mechanical analogy, or, better still, make a working model to demonstrate the analogy. As neat a working model of this kind as I have seen for a long time was in use on the Westinghouse stand at the R.C.M.F. Exhibition to explain the operation of the Cockcroft and Walton type of "ladder" voltage multiplier, which is used in the "Westeht" e.h.t. unit. It's not easy to describe without the aid of drawings, but I'll do my best. Take in imagination a four-foot length of metal trough of semicircular section, half an inch in diameter. Bend it into a series of V-shaped zig-zags, each zig and each zag being six inches long. Done that? Very well; you now have four zigs from, say, left to right and four zags from right to left. Next, solder or spot-weld the whole zig-zag track to a metal rod about three feet long. At either end of a base-board, some three feet long by one foot wide, fix a bearing for the rod, arranging matters so that the bearing at the end of the rod nearest you is roughly two inches higher than that at the far end. Make a motor-driven device that will, at intervals of about ten seconds, turn the rod (and the zig-zaggery mounted upon it) thirty degrees to the right and then thirty degrees to the left. Starting from the end of the semicircular channel nearest you, fix up a simple one-way gate an inch from the apex of each V. A gate consists of a small metal arm, lightly spring-loaded, hinged to one wall of the semicircular trough and provided with a stop which makes it possible for it to open only in the direction away from the end of the channel nearest you. Now introduce a polished steel ball half an inch in diameter into the near end of the channel and set the motor to work.

How It Works

At the first swing the ball travels up the first zig, passes the gate and (owing to the downward inclination of the rod carrying the channels) reaches a point a little beyond the apex of the first V. Whatever happens, it cannot run back because of the one-way gate behind it. The next swing takes the ball along the first zag and through the second gate. Each apex reached represents one stage of voltage magnification. Eventually the ball reaches the far end (point of highest voltage) of the ladder. At the next swing of the rod it drops through a hole and is returned to its starting point for the whole cycle to begin anew. Actually, the number of balls in use is equal to that of the zigs. At any moment each zig or each zag contains a ball on its way up to a higher level. The analogy is by no means perfect—few analogies ever are; but it does provide a graphic illustration of the way in which voltage multiplication is carried out by ladder methods. The one-way gates represent the rectifiers, whilst the "storing" of the balls now in the apices on the left and now in those on the right simulates the charging of the capacitors and their subsequent discharges.

Television Bandwidth

ONE OF THE greatest needs at the present day is a method of transmitting television images of high definition by means of a band of modulation frequencies a good deal smaller than that required by any system now known. Unless and until something of the kind is discovered it is difficult to see how any such thing as 1,000-line television can ever become a vehicle of ordinary home entertainment. Increase the number of scanning lines and the width of the modulation band of frequencies goes up at an alarming rate. Alarming? Yes, because it is impossible by any means now in our power to keep pace with it in the kind of televisor that the ordinary man or woman can afford to buy. At present it's about as much as we can do to turn out at popular prices television receivers responding adequately to the 2.7-Mc/s bandwidth of the B.B.C.'s 405-line service. If the carrier and both sidebands are dealt with in the s.f. and i.f. stages, this means a total bandwidth of 5.4 Mc/s. Even with single-sideband working there must be a good response to approximately $2.7 + 1 = 3.7$ Mc/s. Receivers able to deal with the bandwidths three or four times as great required by television of much higher definition can no doubt be produced; but their cost must, so far as one can see, be so high that they can find a place only in the homes of the wealthy, or, used in conjunction with big-screen projection systems, in the cine theatre. At the recent Paris Television Conference one inventor read a paper on an attempt to reduce by the use of a "Knight's-move" system of scanning. I have not yet been able to get hold of a copy of this paper; but I can't see how, according to our present lights, any juggling with the movements of the scanning spot can get over the fact that each and every change from white to black, or *vice-versa,* needs one half-cycle of the modulating voltage. And it's those half-cycles that add up to the almost astronomical requirements of high-definition television.

Ups and Downs

WRITING FROM CHICAGO, an American friend gives me two interesting bits of news about television in his country. The first is that the link-up with New York is now completed and that a vast improvement in programmes has occurred in consequence. No mean achievement, that linking, by the way. It is over 700 miles as the crow flies (if you can imagine even an American crow flying 700 miles) and a good deal more as the link system is laid out. The second pieces of news is that at the moment considerable over-production of television receivers appears to have taken place in America, particularly in those high-priced console models which cover "sound" broadcasting as well as television. My friend tells me that he sees sets of this kind offered in the shops at not much over half price. He does not believe that there is anything more than a temporary slump, or that it will affect any but the more expensive sets. Some of these sets are too large and—dare one say it?—too ugly to be welcome in the modern American home. Again, people in several parts of the States may grow tired of local programmes of mediocre quality and little in-

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iere.

. nopes that neither
.rican manufacturers nor our own will jump to the hasty conclusion that the prices of televisors must be cut at all costs; and that the real money-maker is the cheap instrument, giving an indifferent picture accompanied by poorly reproduced sound. I've always held that a big mistake was made here in educating the public down instead of up in the matter of broadcast reception. A similar process could take place in television. Both eye and ear are accommodating and fairly readily accept poorish reproduction, if nothing better is available. It would therefore be possible, by cutting out all refinements and sacrificing accuracy in both vision and sound reproduction, to go on producing cheaper and cheaper televisors. Even that wouldn't enormously matter so long as the public was told plainly: "The performance of these sets isn't too bad; it's the best that can be had for the money; but if you go for a better set, costing a bit more, you will get far superior results." The fatal thing is to lead people to believe by sheer weight of publicity that the cheap radio or television receiver puts up the finest possible performance and that it's foolish to pay more for home entertainment equipment. There's plenty of room for both high-grade and cheap televisors, as is the case with motor cars, cameras, musical instruments and many other things. The worst thing that could happen would be for the mediocre receiver to become the standard type and the good set the rare exception.

Believe It or Not

HONESTLY, see that wet, see that dry, I did overhear this conversational gem between two charming elderly ladies.

First Lady: "You know, I think there's something funny about this National electricity we're getting now. My wireless sounds quite different."

Second Lady: "Yes, I know, and have you noticed how an electric fire dries your throat up nowadays?"

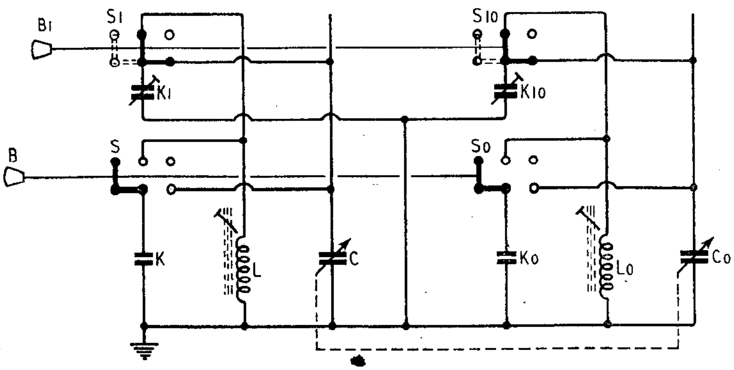
RECENT INVENTIO

A Selection of the More Interesting Ra

Bandspread Tuning

RELATES to the tuning control of a superhet receiver, particularly of the bandspread type, covering at least two alternative wavebands. The object of the invention is to reduce the cost of the circuit components, and to apply a single-point method of trimming or lining them up.

Two inductances L, Lo, of the semi-fixed type, in parallel with variable condensers C, Co, are used to tune the r.f. and local oscillator circuits respectively. When the short-wave button B1 is depressed, to bring the L-shaped contacts of the switches S1, S10 into the full-line positions shown, trimming condensers K1 and K10 are inserted in parallel with the variable tuning condensers. Alternatively, the long-wave button B operates switches S and So to replace the condensers K1, K10 by condensers K, Ko of the fixed type.



Bandspread switching circuit.

For lining-up, the button B is first depressed, and the inductance L is adjusted for a selected spot frequency, and then locked in position. The button B1 is next operated to allow the condenser K1 to be trimmed. The local oscillator circuits are similarly set, but so as to produce the required beat frequency.

A. C. Cossor, Ltd., and A. H. A. Wynn. Application date, December 20th, 1945. No. 605377.

Suppressing Interference

DISTURBANCES due to meter ignition systems and other sources of impulsive interference, are eliminated by taking advantage of the fact that their slope, or rate of rise of potential, is steeper than that of an ordinary amplitude-modulated signal.

The rectified signal is fed to a diode valve, the anode of which is coupled to a direct-current source through a resistance shunted by a capacity, the last two having a time constant of predetermined value. This is designed to cope with voltage variations corresponding to the maximum frequency and amplitude of the signal to be received, but not with the more rapid voltage rises created by short, impulsive disturbances, which are therefore prevented from passing through the diode. Preferably two diodes are used, one to suppress positive-going and the other negative-going disturbances.

D. Weighton and Pye, Ltd. Application date, October 24th, 1945. No. 605206.

Onlaid Circuits

THE component parts of a radio set are connected together by conductors which have been etched out from a metallic coating laid over a panel of thermoplastic material forming the chassis.

A sheet of tin-plated copper foil is hot-pressed on to a sheet of bakelite which has first been coated with a liquid adhesive. A stencil is used to mark out the circuit pattern in acid-resisting paint, and apertures for contact tags, valveholders and the like are made by drilling or punching. The unprotected parts of the metal foil are then dissolved in a solution of ferric chloride, and the acid-resisting paint is removed from the circuit that is left, together with the adhesive originally used to secure it. If necessary, the conductors so formed can be strengthened by electro-deposition.

Alternatively, the metal foil is coated with a photo-sensitive solution and exposed to light through a "positive" stencil, so as to leave an insoluble circuit pattern under subsequent development.

Sir E. T. Fisk and W. Seby. Application dates, August 23rd, 1945, and March 30th, 1946. No. 602492.

Eliminating Interference

THE ordinary type of signal is radiated as a carrier wave with sidebands. These are formed as sum and difference frequencies in the process of modulation, in symmetrical pairs on each side of the centre or mean frequency. Impulsive interference, on the other hand, pe quency band, withou symmetrical characteristic. Adv is taken of this essential difference to design a receiver in which impulsive types of interference are automatically balanced out.

Preceding the second detector in a superhet, three separate signal channels are provided, the first and second of which are identical and include the usual r.f. and i.f. stages. The third includes a local oscillator, carefully tuned to the carrier frequency, and also a modulator and phase inverter. All the three channels are in parallel. The output from the third channel includes the signal sidebands, and also sidebands produced as the result of modulating the impulsive disturbances. These are all in phase-opposition with the incoming signals and disturbances, and so can be used to neutralize the contents of the second channel, leaving a residual set of "interference" sidebands to eliminate those in the first or primary signal channel, which alone feeds the loudspeaker.

I. M. Jones. Application date, July 31st, 1945. No. 602488.

F.M.-A.M. Reception

THE invention is based on the fact that the mutual conductance of a four-electrode valve depends upon the transit time of the electrons passing between the auxiliary grid and the anode. Accordingly, if amplitude-modulated signals are applied to the control grid, anode detection will occur automatically, the best results being obtained when the spacing between the auxiliary grid and the anode, and the applied biasing potentials, are such as to make the electron transit time equal to the periodic time of the carrier wave to be detected, or a whole multiple of it.

The mutual conductance of the valve is also found to vary with frequency, so that the same circuit can be used to convert a frequency-modulated carrier, applied to the control grid, into an amplitude-modulated carrier in the anode circuit, from which the signal can be rectified in any known way. In this case, the best results are secured when the spacing of the electrons, and their operating potentials, are such as to make the electron transit time equal to two-thirds of the periodic time of the unmodulated carrier.

Philips Lamps, Ltd. Convention date (Netherlands), January 15th, 1941. No. 605808.

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