Wireless World

RADIO AND ELECTRONICS

NOV. 1949

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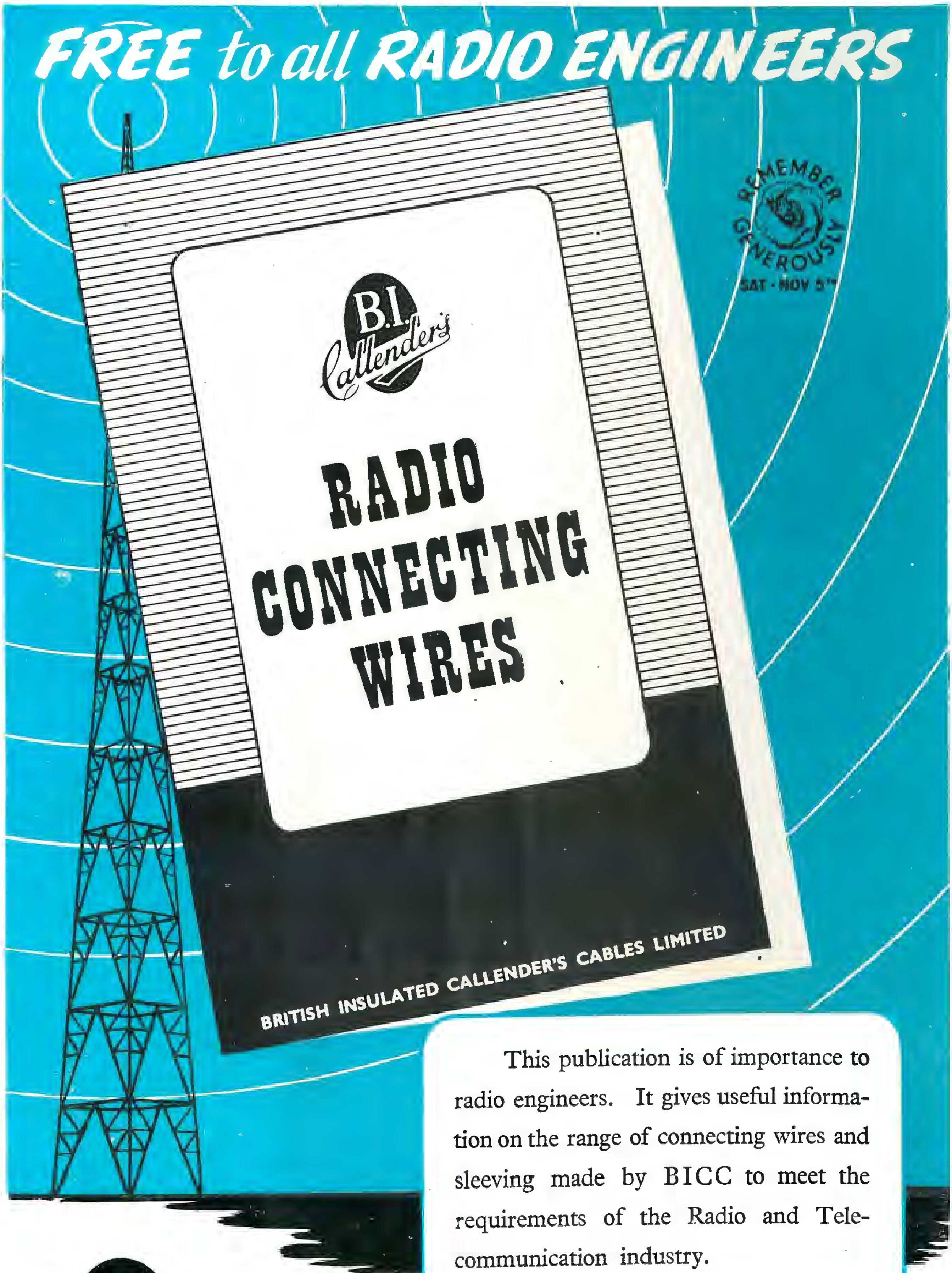

This publication is of importance to radio engineers. It gives useful information on the range of connecting wires and sleeving made by BICC to meet the requirements of the Radio and Telecommunication industry.

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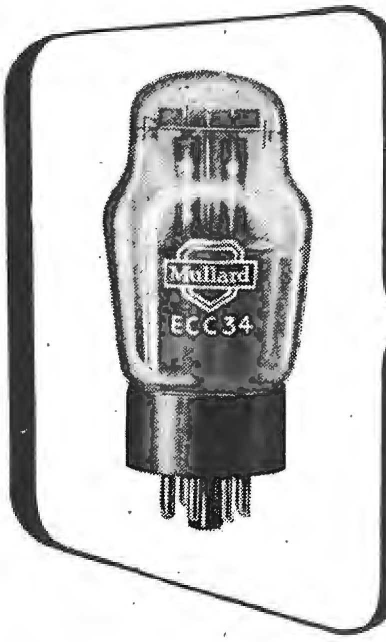
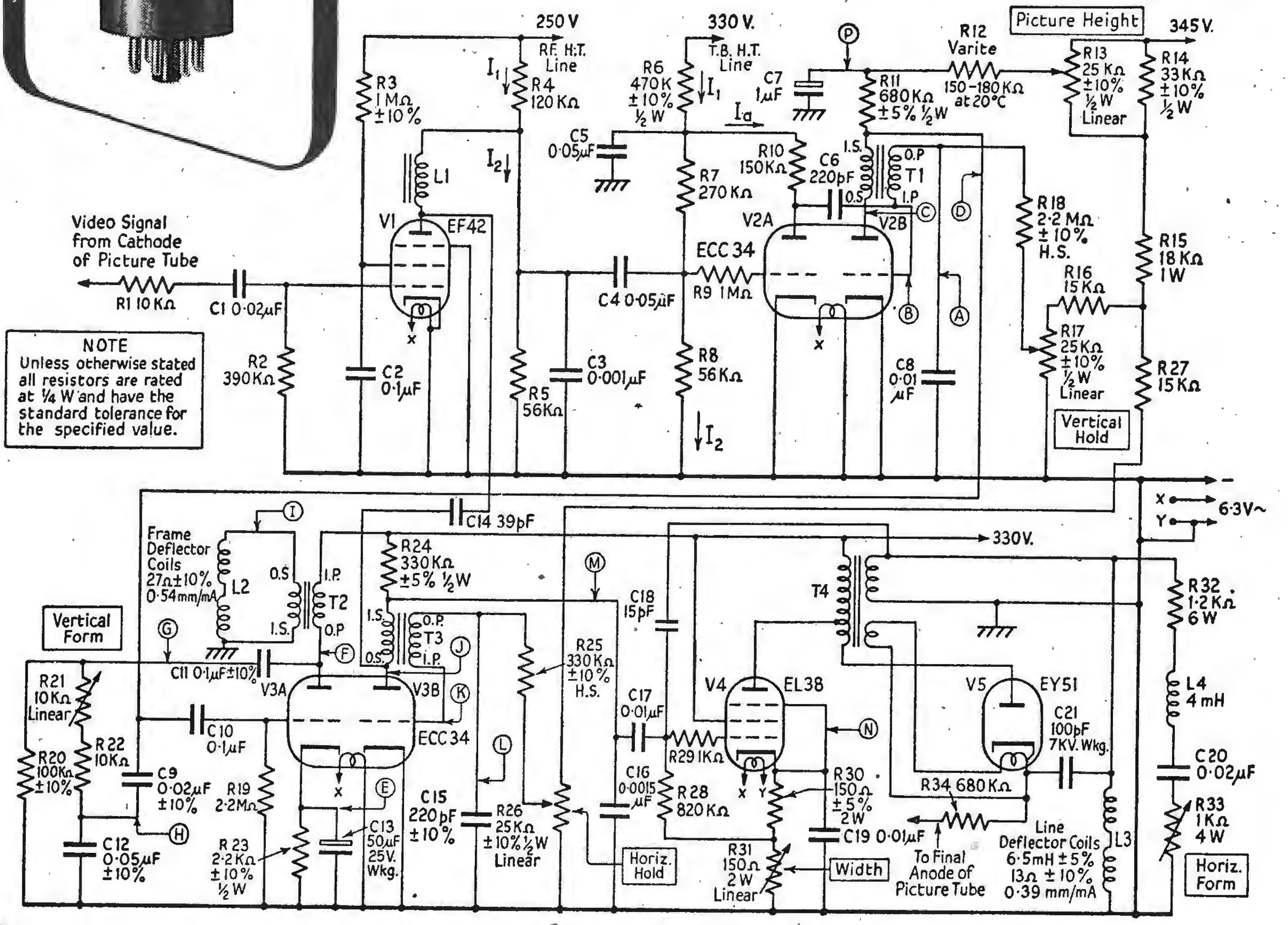
In This Issue

OUR COVER: Valve Manufacture (See Page 427).



Valves and their applications

CIRCUIT OF TELEVISION SYNCHRONIZING & TIME BASE STAGES USING EF42, ECC34 & EL38. No. 2



The circuit shown above gives steady synchronization (even under conditions of severe interference) and good linearity, is economical in components, and employs only four valves. In addition E.H.T. is available from the line time base with the use of only one rectifier valve. The six fundamental valve functions in the synchronizing and time base circuits are:—

(i) Separation of synchronizing pulses from the vision signal.
(ii) Separation of the frame synchronizing pulse from the line pulses.
(iii) Production of the synchronized frame saw-tooth waveform of potential.
(iv) Production of the frame scanning current in the deflector coils.
(v) Production of the synchronized line saw-tooth waveform of potential.
(vi) Production of the line scanning current in the deflector coils.

There are many ways in which these six functions can be performed with less than six valves. The method given in the circuit above, however, accomplishes this without any loss in performance.

Reprints of this circuit developed in the Mullard Laboratories together with a description of the circuit operation, may be obtained, free of charge, from the address below. Reprints of last month's article with complete constructional data for the components used are also available.

Mullard

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MVM 107

VOL. LV. NO. 11

Wireless World

RADIO AND ELECTRONICS

NOVEMBER, 1949

MONTHLY COMMENTARY:

Reflections on Radiolympia

IT will be generally agreed that the organizers of the 16th National Radio Exhibition, which closed on 8th October, are to be congratulated. In spite of an unpropitious start, brought about by circumstances entirely beyond their control, the show has succeeded in its primary object of demonstrating to a remarkably large cross-section of the population—and to many overseas visitors as well—that the radio industry is live and progressive. As will be seen from our review of the exhibition, printed elsewhere in this issue, real progress has, in fact, been made in nearly every branch. The large attendances at Olympia provide a gratifying indication of public interest.

FEARS have been expressed that the emphasis laid on television would have an effect on the public mind that might prove prejudicial to the industry. If we are to be guided by the experience of America, it must be admitted there is a real danger here. A correspondent in U.S.A., telling us of the bad state of radio business in that country, writes " The trouble has come about because, although we have only 70 television stations, the operators of these stations have tried to do a general job of selling the public out of audio broadcasting in order to promote television. They have made extravagant claims and promises which have no basis in fact whatever. Actually, the 44 cities where the television stations are located represent only a small coverage of the total areas in the United States. Still, people in sections where there is no likelihood of their ever having television have stopped buying audio sets because they have been led to believe that very soon they will have television."

There may be some risk of that kind of thing happening here. But, though so much prominence was given to television at Olympia, the new art was presented in a sane and balanced manner, with little or no tendency to " ballyhoo " it at the expense of sound broadcasting, which certainly has not been neglected. If the public conceives the mistaken idea that broadcasting without vision is now out of date, or that the two methods of diffusing information are already competitive (instead of complementary) it will be no fault of the average exhibitor. Almost every manufacturer has produced new broadcast receivers in a variety catering for all tastes, requirements and purposes. Perhaps the most noticeable feature was the departure from " austerity " but we were particularly interested in a tendency to cater for those who fancy the simplest possible kind of switch-over tuning for the selection of a very limited number of programmes. This represents a trend we have long expected to see. The combination of portable receiver and hearing aid, as well as the provision of a headphone output for the deaf on at least one receiver, represent the new tendency to cater for abnormal requirements.

IN the field of television, the somewhat irrational public objection to the smallness of the directly viewed tube picture has been met by a surprisingly large number of projection models, though we imagine that these relatively expensive sets will have a limited appeal. Complications brought about by the imminent extension of the service to the Midlands (and soon, we hope, farther afield) have prevented anything approaching standardization of receiver design.

Electronic equipment—radio-like apparatus and techniques applied to non-communication purposes—has now become quite an important part of the exhibition. Here the difficulty is to show the layman (from our point of view) how much we can do to help him, and it is to be hoped that means will be found at subsequent exhibitions to tell this story convincingly.

ELECTRONIC DIVERSITY

Advantages Over Combined Diversity Systems

By H. V. GRIFFITHS and R. W. BAYLIFF

(Engineering Division, B.B.C.)

THE electronic switch for diversity reception, first described by the authors in the *B.B.C. Quarterly* [1] was actually developed in 1948. Progress has since been made with a modified discriminator circuit, and much operational experience has been gained which favours switched diversity in comparison with the conventional forms of combined diversity circuits. The original details published excited an unexpected volume of interest, and for this reason it may be desirable first to restate the case for switched diversity. Before doing so, however, it must be emphasized that the chief reason for modifying the dual-diversity switch design of 1948 was the withdrawal of the EF8 valve from current manufacture. The exceptionally low ratio of screen to anode current in this valve was particularly favourable to the original circuit, and the absence of any other type of valve with closely similar characteristics made further development imperative. The modified circuit, based upon preferred valve types, enabled the prototype triple-diversity switch to be simplified and improved but the original design of the dual-diversity switch is not inferior to the modified circuit, provided that the specified EF8 valves can be obtained and used.

Switched v Combined Diversity

Methods of improving short-wave reception by the combination of signals from separate receivers energized from "spaced" aerials have been the subject of many descriptive articles in pre-war years, published in *Wireless World*[2] and other technical publications. Usually, the audio-frequency outputs of the separate receivers were combined in a passive network, although some designers used biased diodes or other valve circuits to effect combination The a.g.c. circuits of the individual receivers also were combined, either by simple parallel connection or in more complex ways necessitating additional d.c. valves. The principal criticisms that can be levelled at the accepted methods of combined diversity are (a) that the undesired, weaker output signal may appear at the combined output in proportionate amplitude, together with the desired signal, (b) that distortion associated with the onset of a selective fade can also be present in the combined output, and (c) that the combining circuits may interfere with the normal, individual operation of the receivers' a.g.c.

The possibilities of an alternative method, suggested by F. E. Terman[3] and others, in which only the output from the receiver carrying the strongest signal at a given moment would be accepted by the diversity circuit, were first explored by the authors in 1936 and have resulted in the present design of electronic switch. In this and in the earlier design, the individual a.g.c. circuits of the receiver are entirely unaffected by the connection to the discriminator circuit of the switch, and the outputs from the receivers, although momentarily "combined" in process of switching from one to another, are not paralleled. Interaction between receiver outputs cannot occur, impedance conditions remain constant and the momentary presence of a combined signal at the switch output is a device introduced deliberately to overcome the undesirable effect of instantaneous switching between signals which may not be exactly in phase. The operation of the discriminator of the switch, in selecting the stronger or strongest signal, would otherwise be very rapid, the change-over being effected in approximately one microsecond.

When the design of a switching device was first considered, it was recognized that there would be some advantage in switching at intermediate frequency. By altering the component values in the gate-valve circuits, the present electronic switch circuit could easily be used for i.f. switching, but the receivers employed in conjunction with it would have to be modified to provide an i.f. output, and the switch would need to be followed by an external second detector and a.f. amplifier unit, common to all receivers. It is believed that a system based upon *audio* frequency switching has enhanced value because it does not demand any significant modification of a normal, communications - type radio receiver. For this reason, the greater difficulty of suppressing internally-generated transients in the audio-frequency switch was accepted and has been overcome.

Basic Design for Dual Diversity

In the radio receiver, there exist d.c. potentials at the a.g.c. line and at the signal detectors that are proportional to the strength of the received signal at any moment. Either of these potentials, negative with respect to earth, provides a suitable method whereby the switching process may be controlled to select the stronger signal. The potential from the signal diode was chosen, in preference to the a.g.c. voltage, because selective fading is usually accompanied by a rapid reduction of received carrier level, followed by an equally rapid return to normal. The rate of change of

SWITCHING

carrier level may be too great for the average a.g.c. circuit—with a time-constant between 100 and 500 milliseconds—to follow faithfully. The smaller time-constant of the signal detector is considerably more effective in this respect.

Basically, the diversity switch may be divided into two parts, each having separate functions:

1. *The Discriminator*, in which the d.c. potentials from the receivers are continuously monitored, and a differential switching voltage is thereby developed.

2. *The Gate*, in which the audio-frequency output from the receiver carrying the weaker signal is blocked and the output from the stronger signal receiver is passed on.

A simple modification of the output circuit of the radio receivers (Fig. 1) makes connection from the signal diode load resistance, through a 1.8-MΩ resistor bypassed to earth by 0.01 μF, to the junction of two 39 kΩ resistors which are connected in series across the receiver's a.f. output jack. By this means, the operating potentials for the discriminator circuit are obtained by making a cord connection from the receiver output jacks to the diversity-switch input jacks, the d.c. potentials being "phantomed" across the audio-frequency circuits, thereby avoiding the need for a third conductor. The function of the 1.8 MΩ and the 0.01 μF capacitor is to provide some filtering of the a.f. component, which would otherwise cause unstable operation of the discriminator.

Fig. 2 shows the complete schematic of the dual-diversity switch.

Discriminator

The discriminator is a modified form of Eccles-Jordan circuit,[4] in which two valves have interconnected anodes and screen grids. In the earlier design of the diversity switch, the valves were Mullard EF8 hexodes, but, as stated, the withdrawal of these valves from production has necessitated the substitution of EF55 pentodes, with some circuit changes.

The two EF55's, V_3 and V_4, have—as before—interconnected anodes and screen grids. The control potentials, E_1 and E_2 are obtained from the junctions of the resistors R_{18}-R_{19} and R_{28}-R_{29} and applied to the two control grids. This arrangement has two stable states in which one valve is heavily conductive and the other is nearly cut off. The regenerative nature of the valve couplings ensures a very rapid change from one state to the other. The state existing at any given instant of time is determined by the relationship of the two control potentials. If, for example, the potential E_1 is more negative than E_2, then V_3 is nearly cut off and V_4 is heavily conductive. When, because of diverse fading, conditions change so that E_2 becomes more negative than E_1, the circuit snaps into the other state, that is, V_3 becomes heavily conductive and V_4 approaches cut-off.

A high impedance is provided in the cathode circuit of V_3 and V_4 so that the current passed by the heavily conductive valve is approximately constant despite the large changes which may occur in its grid potential. To avoid the inconvenience of an excessively large potential drop such as would occur if a resistor were used, the impedance takes the form of a pentode valve, V_2. The screen potential of this valve is adjustable by means of a preset control so that the initial bias of V_3 and V_4 may be set to a suitable value. The miniature neon lamps N_1 and N_2 are associated with the anode circuits of V_3 and V_4, thus giving continuous indication of which signal is effective and which is blocked. This facility enables the initial gain adjustments, always required of receivers operated in diversity, to be carried out quickly and accurately. Conventional diversity systems achieve comparable ease of adjustment only by the employment of complex and expensive metering arrangements.

The cathode-follower valves V_{1a} and V_{1b}, through which the control potentials are applied to V_3 and V_4, are necessary to reduce the apparent resistance in the grid circuits of these valves. Without this provision the resistance of the grid circuits would be at least 1.8 MΩ (the value employed in the filter circuit shown in Fig. 1) and difficulty would be experienced, due to gas current in V_3 and V_4. It is not practicable to reduce substantially the value of the filter resistor without incurring undesirable disturbance of the operation of the receiver signal detector.

The preset ("Balance") potentiometer R_8, enables any dissimilarities in the characteristics of V_3 and V_4 to be compensated so that the action of the discriminator is symmetrical and does not favour one input more than the other.

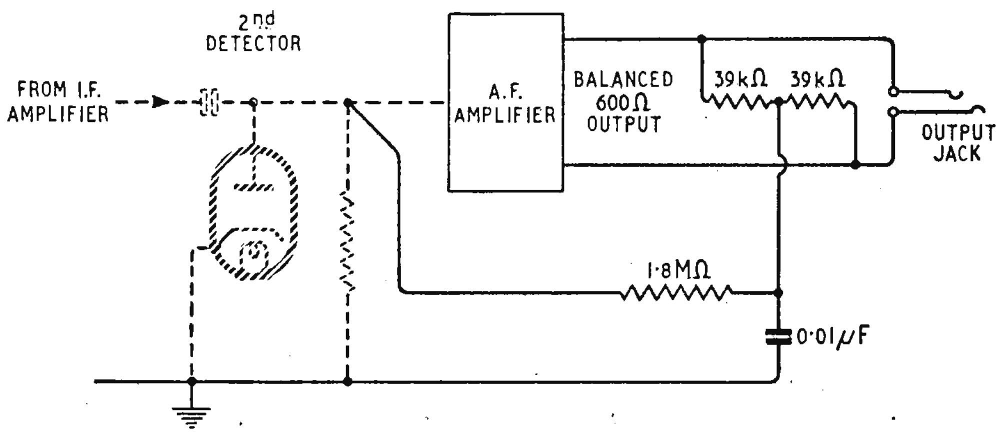


Fig. 1. Modifications required in the receiver circuits are simple.

Electronic Diversity Switching—

The discriminator sensitivity varies somewhat with the input voltage, but, over its normal operating range, one control potential must exceed the other by 3 to 5 per cent to initiate the change-over from one state to the other. Thus, when used with sensitive communications receivers, signal differences of the order of 2 or 3 db will operate the discriminator.

Gate Circuits

V_5 and V_6 are triode-hexode valves (6K8's) and form the actual gate circuit. The injector grids (g_1) are coupled directly to the respective anodes of the discriminator valves, V_3 and V_4. Proper operating conditions for V_5 and V_6 are obtained by running these valves, together with the output valve V_7, from a separate h.t. supply unit, the negative pole of which is adjusted, by the preset potentiometer R_{12}, to be at about the mean potential of the anodes of V_3 and V_4. Since one of the discriminator valves, say V_3, is conductive, its anode potential is much lower than the mean: consequently V_5 is cut off in both triode and hexode positions, and the signal voltage applied to the hexode signal grid (g_3) ,through the transformer T_1, is blocked. The other discriminator valve, V_4, is passing little or no anode current; its anode potential is much higher than the mean, and so both sections of V_6 are conductive. The signal applied through T_2 to the hexode signal grid is then amplified and passed on to the output circuits. The resistor R_{33}, in conjunction with the g_1-cathode path of V_6, limits the g_1 potential and prevents it from being driven appreciably positive with respect to its cathode. In the case considered No. 2 input had the stronger (negative) control potential.

During the initial consideration of the switch design it was thought that switching transients could best be eliminated by arranging that the change-over time should be very short—say 1 microsecond. The energy contained in any pulse generated during the change-over would then fall mainly outside the audible spectrum. The condition, implied in the introduction, paragraph two (a), that the two signals should not be mixed, would also be fulfilled completely. However, the first experimental model proved that, although a practically instantaneous change-over could result in complete freedom from internally generated clicks, the characteristic of a fading short-wave signal had not been fully appreciated. The a.f. signals from receivers arranged for diversity reception have random and continually changing phase relationships and only rarely are they in phase. An abrupt change-over will almost invariably result in a change in the output waveform which becomes audible as a click.

The difficulty was overcome by arranging that the change-over should be accompanied by a momentary mixing of signals. The duration of this combining period had to be short enough to enable the switch to complete the change-over during the beginning of a selective fade, before the carrier level has fallen sufficiently for appreciable "over-modulation" to result. After considerable experiment a mix duration of 50 milliseconds was adopted. This completely eliminated clicks due to signal-phase inequalities without appreciable reduction in the ability of the switch to remove the worst effects of a selective carrier fade. The realization of this increased operating time was achieved by the use of amplified time constants of the type devised by the late A. D. Blumlein.[5] The triode sections of V_5 and V_6 are arranged as amplifiers with capacitors C_6 and C_7 connected between anode and grid. The time constant effective at the triode and hexode injector grids is, in the case of V_5, approximately $R_{27}C_6(1 + A)$, where A is the voltage magnification of the triode. The amplification of the time constant is

Value of Components Used in Circuit of Fig. 2

Component	Value	Rating	Component	Value	Rating
R_1	240 kΩ	½ watt	R_{34}	1 MΩ	½ watt
R_2	150 Ω	,,	R_{35}	15 kΩ	,,
R_3	240 kΩ	,,	R_{36}	1.5 kΩ	,,
R_4	240 kΩ	,,	R_{37}	6.8 kΩ	,,
R_5	15 kΩ	2 watt	R_{38}	3.3. kΩ	,,
R_6	47 kΩ	½ watt	R_{39}	1 MΩ	,,
R_7	47 kΩ	,,	R_{40}	1.5 kΩ	,,
R_8	10 kΩ	2 watt potr (linear)	R_{41}	220 Ω	¼ watt
R_9	15 kΩ	2 watt	R_{42}	220 Ω	,,
R_{10}	240 kΩ	½ watt	R_{43}	470 Ω	,,
R_{11}	47 kΩ	,,	C_1	8 μF	550V (electrolytic)
R_{12}	20 kΩ	2 watt potr (linear)	C_2	8 μF	,,
R_{13}	47 kΩ	½ watt	C_3	8 μF	,,
R_{14}	20 kΩ	2 watt potr (linear)	C_4	500 pF	350V (mica)
R_{15}	47 kΩ	½ watt	C_5	50 μF	25V (electrolytic)
R_{16}	47 kΩ	,,	C_6	5000 pF	350V (mica)
R_{17}	10 kΩ	1 watt	C_7	5000 pF	,,
R_{18}	39 kΩ	¼ watt	C_8	0.02 μF	350V (paper)
R_{19}	39 kΩ	,,	C_9	0.1 μF	,,
R_{20}	10 kΩ	½ watt	C_{10}	3000 pF	,,
R_{21}	20 kΩ	2 watt	T_1	1 : 11.5	Line—grid
R_{22}	5 kΩ	,,	T_2	1 : 11.5	,, ,,
R_{23}	100 kΩ	½ watt	T_3	4.44 : 1	Anode—line
R_{24}	100 kΩ	¼ watt	V_1	6SL7	
R_{25}	600 kΩ	½ watt	V_2	EF55	
R_{26}	220 kΩ	,,	V_3	EF55	
R_{27}	1.8 MΩ	,,	V_4	EF55	
R_{28}	39 kΩ	¼ watt	V_5	6K8	
R_{29}	39 kΩ	,,	V_6	6K8	
R_{30}	100 kΩ	,,	V_7	6SN7	
R_{31}	1 MΩ	½ watt	N_1	Osglim "G"	
R_{32}	220 kΩ	,,	N_2	Osglim "G"	
R_{33}	1.8 MΩ	,,			

only indirectly useful in this application; the important feature is the sensibly linear rise and fall of hexode anode currents during the switching operation, which minimizes clicks caused by spurious changes of potential across the common anode load, R_{23}.

Switching clicks and surges are finally reduced to insignificant proportions by the application of a large degree of negative feedback. V_{7a} and V_{7b} are two low-gain R-C coupled amplifier stages and the whole of the signal voltage appearing at the anode of V_{7b} is applied to the hexode grid circuits. The voltage amplification between hexode grid and V_{7b} anode is, without feedback, about 300 times. The reduction of switching transients by negative feedback will, therefore, also be by a factor of 300 (i.e. 50 db). Stability at very low and very high frequencies is maintained by the CR networks C_{10}—R_{38} and C_4—R_{20}, which suitably modify the gain/phase-shift characteristics of the amplifier at extreme frequencies. The attenuator pad R_{41}, R_{42} and R_{43} is included so that the overall gain of the switch unit, when operated with 600 ohms input and output impedances, is unity. Since the feedback factor is large, the voltage gain between hexode grid

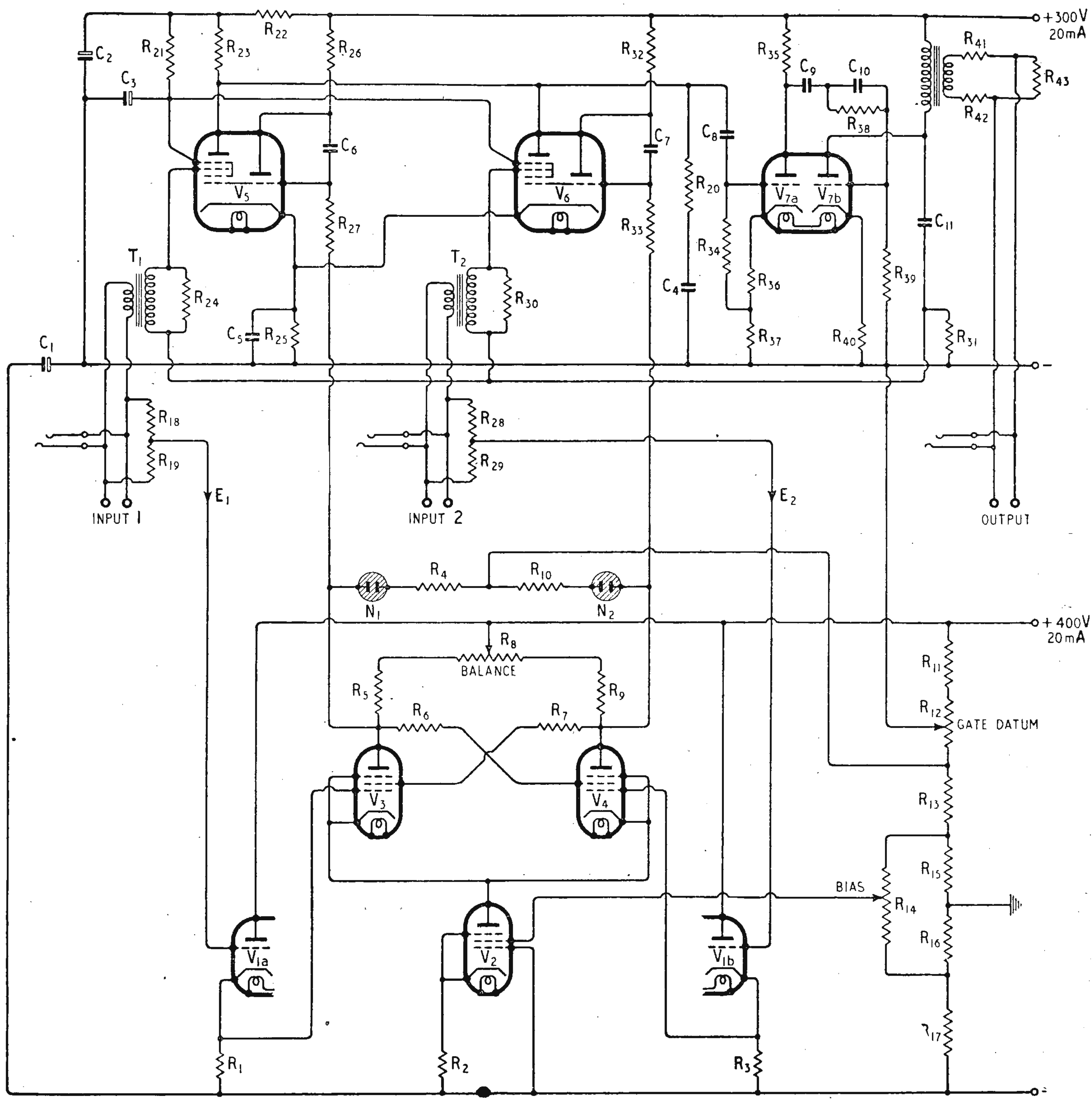


Fig. 2. Schematic circuit diagram of dual-diversity electronic switch (Mk.II, 1949).

Electronic Diversity Switching—
and V_{7b} anode is unity; the ratios of the input and output transformers are determined by matching considerations and are 1 : 11.5 and 4.44 : 1 respectively. Thus the attenuator loss factor should be $11.5/4.44 = 2.6$. The unit normally operates with a power input level of 1 mW.

(*To be concluded.*)

REFERENCES:

[1] H. V. Griffiths and R. W. Bayliff, "An Electronic Switch for Diversity Reception," *B.B.C. Quarterly*, April 1949.

[2] H. V. Griffiths, "Diversity Reception" *Wireless World*, Jan., 1938.

[3] F. E. Terman, "Radio Engineering" 2nd Edn, p. 590 footnote 3.

[4] W. H. Eccles and F. W. Jordan, *Radio Review* 1919 Vol. 1, p. 143.

[5] F. C. Williams "Introduction to Circuit Techniques for Radiolocation" *Journal I.E.E.* 1946, Vol. 93, IIIA, p. 303.

SMOOTHING CIRCUITS:
(2) Inductance-Capacitance

How to Calculate the Hum Voltages

By "CATHODE RAY"

LAST month we began the study of smoothers by considering the very simple combination shown in Fig. 1(a). Alternatively (as they say in law) if we didn't (or did, and have forgotten it all), it should be quite easy to pick it up, because this month's circuit (Fig. 1(b)) is to be tackled along exactly the same lines, making only the changes necessitated by the fact that L takes the place of R.

To be more strictly correct it is the inductive reactance (X_L, equal to ωL, or $2\pi fL$) that takes the place of R, because a reactance, like a resistance, is a particular kind of impedance, and it is the impedances in the filter that determine its effectiveness as a smoother. A convenient standard by which to reckon such effectiveness is the attenuation, which we have been denoting by the symbol α and defining as input-voltage/output-voltage, V_i/V_0 (at the particular frequency being considered).

We found that if we could make two assumptions the whole thing became extraordinarily easy. The attenuation, in fact, became practically equal to what we denoted by p—the ratio of resistance to capacitive reactance, R/X_c. And X_c, of course, is $1/\omega C$, so a longer but more directly useful form of p is ωCR (or $2\pi fCR$). This shows that the attenuation is directly proportional to frequency and to C and R. Or, rather, that it would be approximately if our assumptions were justified. These assumptions are:

(a) The "shunting" assumption, that the load impedance is so high compared with X_c that it makes no appreciable difference to α. If we can assume this it is a tremendous relief, not only because it vastly simplifies the calculations but because we might not even know at first exactly what the load impedance was going to be.

(b) The "vector" assumption, that R is at least several times greater than X_c at all the frequencies concerned. This allows us to say that the whole impedance of the smoother (from the input side) is approximately equal to R, instead of having to use the correct value, $\sqrt{R^2 + X_c^2}$.

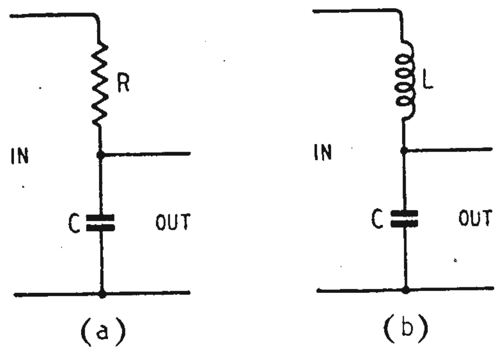


Fig. 1. Comparison between RC smoother discussed last month (a), and the LC smoother (b).

We found that fortunately these assumed conditions do actually apply, unless the smoother is a very poor one with an α of, say, 3 or less. Using several Fig. 1 sections in cascade complicates the shunting assumption, admittedly, because each section shunts the one in front of it; but after we had worked out the best number of sections to give any required attenuation we found that the worst error due to this shunting was not likely to be enormous and in any case was on the right side—the actual smoothing was better than that calculated by the simplified theory.

Coming now to Fig. 1(b), we are as grateful as ever to avail ourselves of the shunting assumption. There is not quite so much point in using the vector assumption, however, because X_L and X_c directly subtract instead of having to be combined under a square root sign. And we shall see that because of this the error due to using it is considerably greater.

One other assumption we shall make, most of the time, is that the resistance of the inductor is negligible.

Treating Fig. 1(b) (as we did (a), by virtue of the shunting assumption) as a potential divider, the attenuation is equal to the whole impedance divided by the impedance of C alone:

$$\alpha = \frac{X_L - X_c}{X_c}$$

$$= \frac{\omega L - 1/\omega C}{1/\omega C}$$

and multiplying above and below by ωC

$$= \omega^2 LC - 1$$

$$= (2\pi f)^2 LC - 1 \qquad \ldots \qquad (1)$$

Making the vector assumption just knocks off the 1, which, at the higher frequencies at least, is generally small compared with $\omega^2 LC$. This $\omega^2 LC$, by the way, is the ratio of X_L to X_c, taking the place of R to X_c in Fig. 1(a). We found it convenient to denote R/X_c by p, and with the seam idea we shall denote the corresponding quantity in the inductive smoother, X_L/X_c, by q. So, making the shunting (but not the vector) assumption,

$$a = q - 1 \quad .. \quad .. \quad (2)$$

Before going on to find the best number of sections into which to divide the LC smoother, it may be a good thing to note some points of contrast between it and the RC type.

The first is that using L to provide the high series impedance for reducing the unwanted a.c. avoids having to have the same impedance in series with the wanted d.c. Even if, to reduce the d.c. voltage, we actually need resistance, the amount of it that is right for that purpose is unlikely to be the best choice for smoothing purposes. And often the less resistance the better. Of course even with an inductor it isn't possible *economically* to obtain unlimited series impedance with negligible resistance. But at least there is much more scope than with resistance only.

Next, the inductive smoother is double-acting; not only does the impedance of C decrease as the frequency rises, but the impedance of L increases. So instead of being proportional to frequency, a is proportional to frequency-squared. This steepens the cut-off slope, as shown in Fig. 2 (top right-hand corner and beyond). In figures, LC gives 12 db per octave, compared with 6 for RC. As it happens, the sensitiveness of the ear to weak sounds in the 50–500 c/s region also increases at about 12 db per octave, so for sound-making apparatus this is another reason for preferring an inductive smoother to a single-section resistive type.

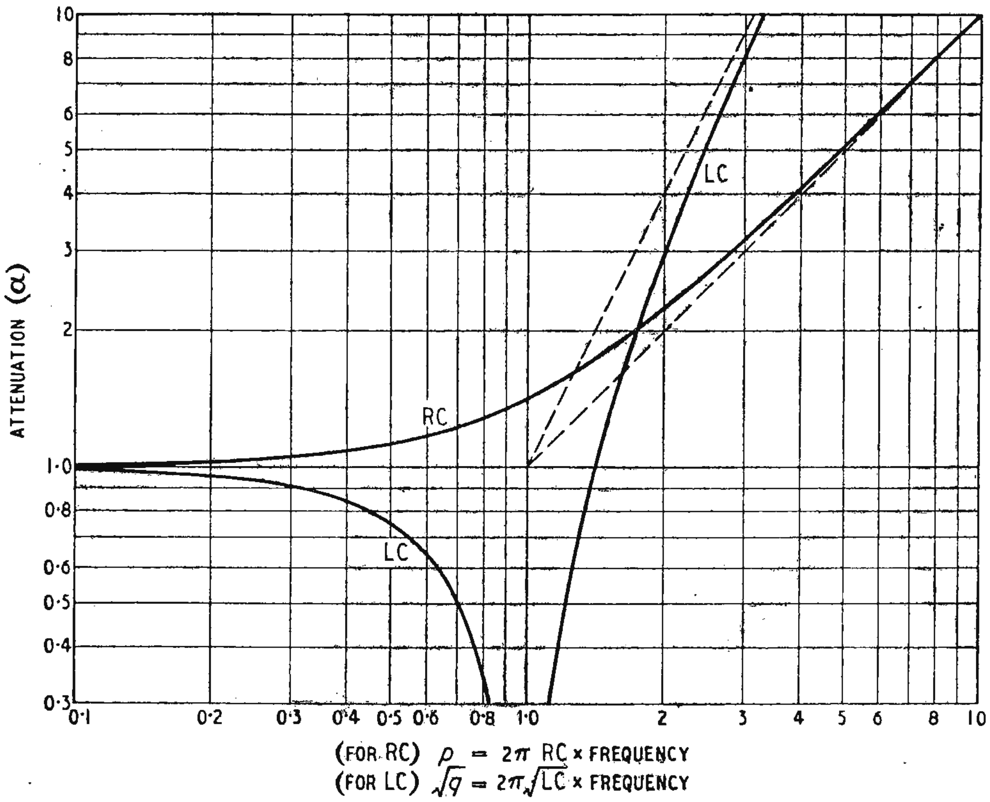


Fig. 2. The performance of single RC and LC smoother sections is compared here. The dotted lines show the results of making the "vector" assumption—the discrepancy becomes very large near $\sqrt{q}=1$, because L and C resonate. But the full-line curve itself is highly theoretical here, as it neglects the resistance of the choke and the effect of the load resistance. The useful part of the characteristic lies mainly off the diagram, beyond the top right corner.

While the frequency curve of a single-section LC smoother is practically the same as that of a 2-section RC smoother in the useful or "assumption" region, where a is substantial, it is decidedly different at the foot of the bend. Whereas the RC curve slides smoothly down to $a = 1$ (i.e., output voltage as big as input) at zero frequency, the LC curve dips well below that level, meaning that the output ripple-voltage is actually greater than the input. Where $X_L = X_c$ (which happens when $q = 1$) series resonance occurs, and according to equation (1) a would be 0 and the output ripple infinitely large! In practice, of course, there are several reasons why it doesn't get quite as bad as that; but at least it is a situation to be avoided. The way to avoid it is to see that ω^2LC is well above 1 at the lowest frequency to be suppressed.

Inductive Coupling

Whereas most of the features of the inductive smoother are in its favour, it must be admitted that an inductor is generally larger, heavier, and much more expensive than the corresponding resistor, and is liable to generate hum inductively in nearby audio windings, to say nothing of humming itself if the stampings are not tight.

In calculating the number of sections that gives the greatest attenuation for a given total LC, I have assumed that there is no inductive coupling between sections. Although the vector assumption gave results that were near enough with the RC smoother the errors with LC would be too much, so I have used equation (1). This makes the calculation of the table slightly more complicated, but the general idea is this: q is our abbreviation for ω^2 times the total LC in the smoother. If it is all used to make one section, the attenuation of that section (a_1) is equal to $q - 1$. But if it is divided equally into two sections, both L and C have to be halved, so the q per section is $q/4$ and the attenuation per section is $q/4 - 1$, and a_2 (the attenuation of the two sections) is $(q/4 - 1)^2$. In the

n	q_n	a_n	LC per section when f = 100 c/s
1	23.5	22.5	60 henry-microfarads
2	67	248	42.5 ,, ,,
3	136	2,800	38 ,, ,,
4	234	34,500	37 ,, ,,
5	362	450,000	37 ,, ,,

Smoothing Circuits—

same way the attenuation of the smoother when divided into n sections is

$$a_n = \left(\frac{q}{n^2} - 1\right)^n$$

To find the critical value of q, which we call q_n, such that the same attenuation is obtained when the same total L and C are divided among $n + 1$ sections, we put $a_n = a_{n+1}$. Doing this for $n = 1$, 2, etc., up to 5, we get the figures given in the table on the preceding page.

Compared with the corresponding RC figures, these show a

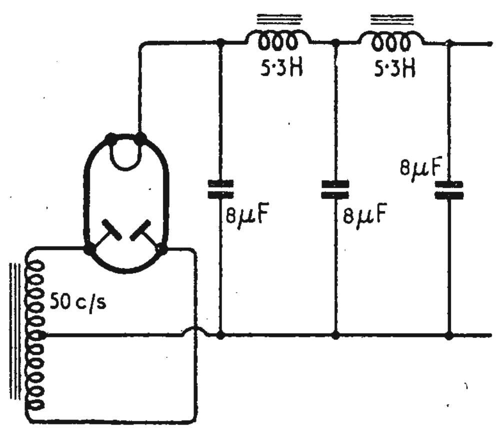


Fig. 3. Example of suitable values for typical requirements.

tendency for fewer sections to be needed. So I haven't gone as far as $n = 6$, because 5 gives more than all the a anybody is likely to want. Nor have I included the column to show the lowest possible q per section, because it is obviously more than in the RC table, and even that was sufficient to justify the shunting assumption.

The reason for the higher q_n figures is the fact that the a per section is 1 less than q, so q has to be larger to make sectionalizing worth while.

To take an example, suppose a total attenuation of 2800 at 100 c/s is about right. This being a_n for $n = 3$, the best number of sections is 3. (Four would give approximately the same attenuation for the same total L and C, but would presumably cost more). The table also shows that q_n is 136, so putting $(2\pi f)^2$ LC = 136 we get LC = $136/(200\pi)^2$=345 henry-microfarads. If we happen to have available a good line of 6H chokes, one for each section, the total C to go with them should be $345/18 = 19\mu$F or roughly 6μF per section. Doubling C, of course, would allow us to halve L.

The last column by-passes most of this calculation by showing directly the LC *per section*, corresponding to total attenuation and number of sections (a_n and n respectively), for a ripple frequency of 100 c/s, which is the lowest from a properly balanced full-wave 50 c/s rectifier. An interesting point is that with, say, 8μF capacitors in each section, the best value of choke lies within the narrow limits of 4.6 to 7.5 H. Present practice, it seems, tends to use too few chokes of too high inductance.

Naturally everybody is out to reduce costs as much as possible, so the results of the foregoing investigation are more than welcome in so far as they indicate that smoothing chokes need not have such a large inductance as is usually supposed. The same conclusion helps in minimizing choke resistance, too. But the idea of using a whole string of chokes—even small ones—is not quite so attractive. Designers may be reluctant to go beyond two.

So it is worth seeing what two can do. Fig. 3 shows a 2-section smoother based on the table, using the customary 8μF for each section and also for the reservoir. The inductance of each choke is only 5.3H, and the total attenuation at 100 c/s is 248 by the table. (That doesn't count the smoothing due to the reservoir, of which more anon). And it increases as the 4th power of the frequency, so the attenuation of the 400 c/s harmonic (for example) will be 256 times as much as at 100 c/s, or 65,300. That ought to be good enough there, but if the loudspeaker reproduces 100 c/s strongly (though the makers usually try to keep the cone resonance off it) the relatively strong ripple at that frequency may be

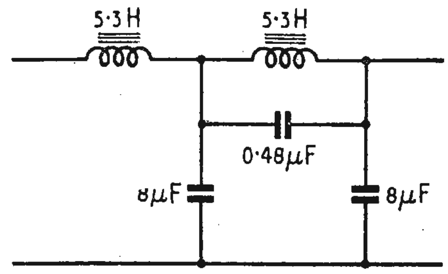


Fig. 4. A device for tuning out the main hum frequency.

troublesome. What is the answer? Use three sections? ("No!" says the designer firmly).

In cases like this, where the smoothing at all frequencies except one seems adequate, it may pay to use the trick shown in Fig. 4. It is one that will reappear, under the curious name of an "m-derived" section, when we consider filters. At the moment it looks like just what it is—a rejector circuit tuned to the offending frequency. At the higher frequencies this section will be markedly inefficient, because it will tend to act as a capacitance

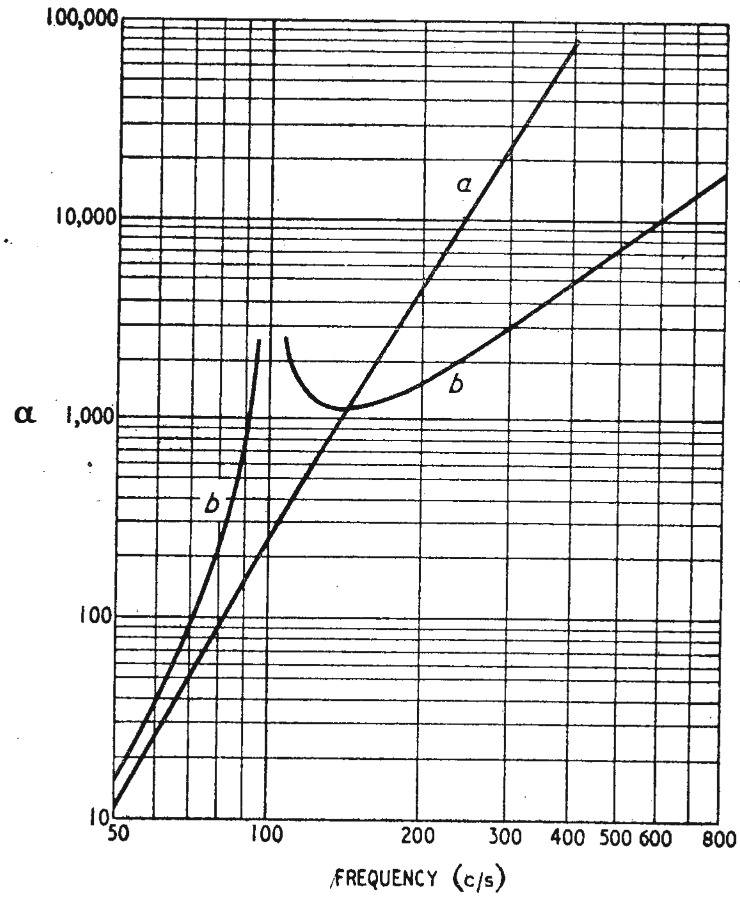


Fig. 5. Curve b shows how the Fig. 4 circuit affects the low- and high-frequency hum, as compared with Fig. 3 (curve c).

potential divider having an attenuation of only about 18. One therefore relies heavily on the first section to deal with them.

In Fig. 5 the performance of the modified system (curve *b*) can be compared with the original one (curve *a*). (If you intend to study filters you ought to take particular note of the shapes of these two curves). The resonance peak at 100 c/s is not completely drawn in because its height depends on the resistance of the choke, which we don't know.

With reasonably good judgment (or luck), the large reserve of high-frequency α in the normal type of section will be enough and the 100 c/s (or other troublesome low frequency) attenuation will be brought up to the required standard without having to resort to wasteful brute force.

Tuning Difficulties

The fact that this device is not more used may suggest to the cautious reader that there are some snags. One is that a rather odd value of capacitance may be needed for tuning the choke. Another is the wide tolerance in the inductance of commercial chokes. A third is that the inductance depends largely on the d.c. carried, so that even if it is right for one loading it is not for another. Owing to the flatness of the tuning, however, these snags don't amount to as much as might appear. Even if the d.c. milliamps are liable to vary over a wide range, it is usually satisfactory to make the tuning correct at or near the maximum current, where the effectiveness of the first section is least.

Choke-tuning is a dodge worth remembering if you have an ordinary 2 (or more) section smoother that is not quite good enough, and you don't want any drastic alterations.

As with last month's treatise. I thought that undiluted theory might be considered somewhat bald and unconvincing, so hastened to take a few readings on an actual smoother. Fig. 6 shows the test circuit. The two chokes were marked 9H 0.1A, and (unlike most of their kind) their rated inductance at the rated current turned out to be reasonably correct. With 8μF total capacitance this gave a total q at 100 c/s of 57.5, which according to the table would give of its best in two sections. In one section, (a), the hum voltage viewed on the oscilloscope seemed to be mainly 100 c/s, but with appreciable 50 c/s. The latter was unimportant at this stage, but later became more obvious and was balanced out by inserting some resistance in series with one of the rectifier anodes. When this was done, the hum was nearly pure 100 c/s, and amounted to 0.33V r.m.s.

With the same L and C connected as two sections (b) the voltage was reduced to 0.14V.

Next, capacitance was connected across the second choke to tune it to 100 c/s, (c). It was then, with the predominant 100 c/s removed, that the 50 c/s became obvious. It amounted to 0.12V; but after balancing the rectifier the residue of hum was only about 0.03V. The value of capacitance required to tune the choke confirmed the inductance rating.

Lastly, the first choke was tuned instead of the second, (d). The results were much as before, but there seemed to be rather more high-frequency ripple. Possibly there was some intermodulation due to the relatively large amplitude in the first choke.

Resistance Balance

One conclusion to draw is that although tuning is very effective in reducing the main ripple, it is by no means safe to assume what the books tell us, that 50 c/s is absent from the output of a full-wave rectifier. Most of the centre-tapped power transformers I have come across are very lopsided as regards resistance, however well balanced they may be for voltage.

Another thing to notice is that the 2-section arrangement is rather less than $2\frac{1}{2}$ times as good as the single section, whereas $(57.5/4-1)^2$ is over 3 times more than $57.5-1$. This discrepancy is opposite to what we had with resistive smoothers. But whereas one resistive section shunted across the capacitance of the previous one tends to reduce the impedance and thereby improve the smoothing, an inductive section shunted across capacitance tends to increase its impedance (by going some way towards forming a rejector circuit), with the opposite result. So while the RC table tends to underestimate the value of sectionalizing, the LC table tends to overestimate it. And taking into account the

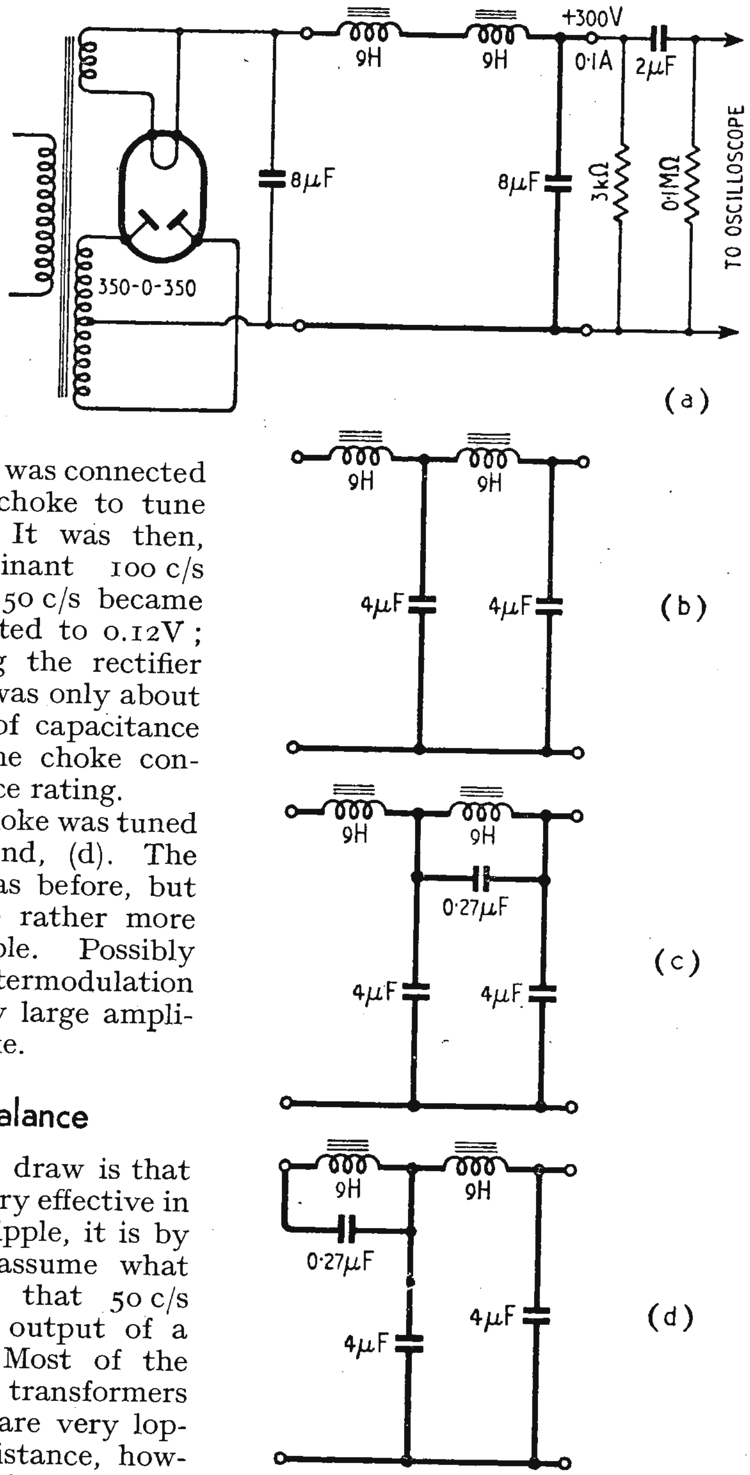


Fig. 6. Test circuit used for comparing various smoothing arrangements.

C

Smoothing Circuits—

greater cost of divided chokes and capacitors, the conventional values may not be so unsuitable after all.

The final thing to be done is to see how to calculate the actual hum voltage. With the capacitor-input or reservoir type of circuit, which is the only kind we are considering, it is easier than might appear. That is because it is a fair assumption that the current flows through the rectifier into the reservoir in the form of pulses. Fig. 7 is a reminder of how this comes about. The alternating voltage is denoted by v_a. Current (i_i) can flow through the rectifier only when v_a exceeds v_i, and diagram (b) shows how this happens only at the peaks of v_a. Now although this current is far from steady it is d.c. of a kind (in the sense that it is unidirectional), and exactly the same amount of current, on the average, must come out somewhere, namely, into the load, after having been ironed out by the smoother. So if we know the load current (i_0 at (c)) we know the average value of i_i—it is the same. Diagrammatically, the shaded area in (b) is the same size as that in (c).

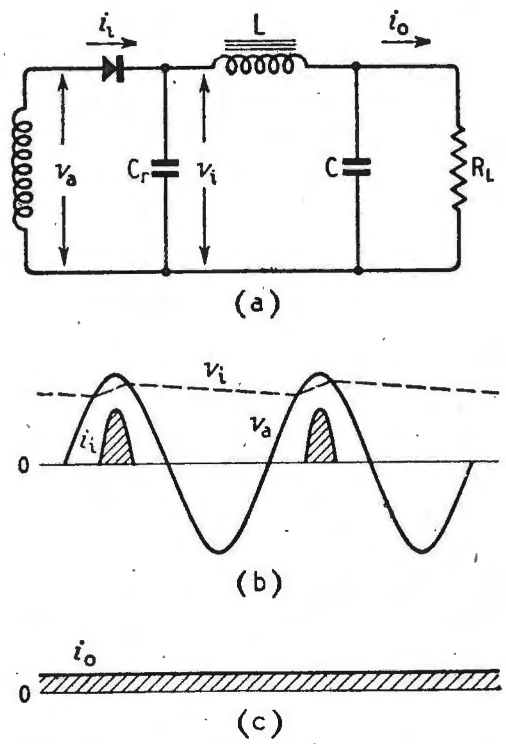


Fig. 7. Showing how the formula is obtained for calculating the hum voltage.

Provided that the reservoir capacitance is large enough for its job, it is not far wrong to assume that the whole of i_i flows while v_a is at its peak. That being so, investigation of pulse waveforms shows that the peak fundamental alternating component of i_i is very nearly $2i_0$. (If i_i really did all occur exactly at the peak of v_a, so that the pulse was infinitely narrow, all the harmonics would also be equal to $2i_0$; but owing to the finite width of the current pulse the harmonic amplitudes fall off at the higher frequencies). So if we take the *r.m.s.* value of the ripple current of any one frequency from the rectifier into the reservoir (denoted by I_i) as $\sqrt{2}$ times the load current, we shall be nearly correct for the lowest frequency, and shall be progressively overestimating the higher frequencies—so shall be always on the safe side.

To get the r.m.s. ripple voltage at the input to the smoother (V_i) we make the shunting assumption again and multiply I_i by the reactance of the reservoir capacitor C_r. Putting all this together:

$$V_i = I_i X_{cr} = \frac{I_i}{\omega C_r} = \frac{\sqrt{2}i_0}{\omega C_r} \qquad \text{.. .. (3)}$$

What we want is V_0, the corresponding output ripple voltage. But since V_i/V_0 is what we have been calling a, we have

$$V_0 = \frac{V_i}{a}$$

$$\text{(substituting (3))} \quad = \frac{\sqrt{2}i_0}{a\omega C_r} \qquad (4)$$

Taking the circuit of Fig. 7(a) and making the usual assumptions,

$$a = \omega^2 LC - 1$$

So (substituting in (4))

$$V_0 = \frac{\sqrt{2}i_0}{(\omega^2 LC - 1)\ \omega\ C_r} \qquad \text{.. (5)}$$

The same principle can easily be applied to any system for which the assumptions apply. If $\omega^2 LC$ is large enough for 1 to be neglected, the rule simplifies to:

Divide $\sqrt{2}$ times the output d.c. (in amps) by all the ωL's, ωC's, and R's used for smoothing, including the reservoir.

Applying this to Fig. 6(a) we have

$$V_0 = \frac{\sqrt{2} \times 0.1}{(2\pi \times 100)^3 \times 18 \times 8 \times 8 \times 10^{-12}} = 0.495\text{V}$$

This should, as we saw, be an overestimate (especially when rather a lot of current is being drawn in relation to the reservoir capacitance), and in fact the measured value was roughly 0.34V.

To get some practice in the use of all this groundwork you might care to design a smoother to give two or more outputs; say, 70 mA output roughly smoothed and a 10 mA output at a lower voltage, thoroughly smoothed.

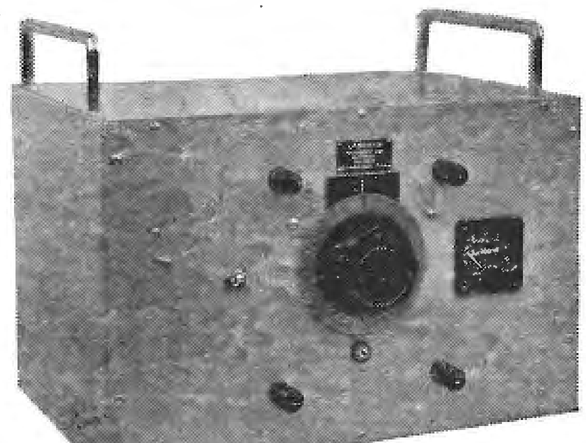
L.T. UNIT

Variable D.C. Voltage from A.C. Mains

A SUPPLY unit that provides a well-smoothed d.c. output continuously variable from 0 to 15 volts has been introduced by Labgear, Willow Place, Fair Street, Cambridge. It is known as the Eliminac, and is intended to replace accumulators for laboratory and other applications when a d.c. supply of up to 5A is required. The hum level is said to be only 0.01 per cent and the output is continuously monitored by a built-in voltmeter. The rectifiers employed are of the selenium type.

In addition to the d.c. output, the unit also gives a variable a.c. supply of up to 20V at a maximum load of 10A.

The unit is housed in a metal case measuring 14½ × 12 × 11in, and weighs 50 lb. The price is £18 18s.



Labgear Eliminac l.t. supply unit giving continuously variable d.c. and a.c. outputs up to 15V and 20V respectively.

AT LAST—

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Type Number	Application	Heater Volts	Heater Amps.	Anode Voltage Normal	Screen Voltage Normal	Grid Voltage Normal	Anode Current mA	Screen Current mA	Impedance Ohms	Mutual Conductance mA/V	Optimum Load Ohms	Power Output Watts
1T4	Batt. Pent. Vari-Mu	1.4	0.05	90	67.5	0/–16	3.5	1.4	500,000	0.9	—	—
1R5	Heptode F.C.	1.4	0.05	90	67.5	0/–14	1.6	3.2	600,000	300*	—	—
1S4	Batt. Beam Tetrode	1.4	0.1	90	67.5	–7	7.4	1.4	100,000	1.58	8000	0.27
1S5	Batt. Diode Pentode	1.4	0.05	90	67.5	0	1.6	0.4	600,000	0.63	—	—
3S4	Batt. Beam Tetrode	1.4 2.8	0.1 0.05	90	67.5	–7	7.4	1.4	100,000	1.58	8000	0.27
3V4	Batt. Beam Tetrode	1.4 2.8	0.1 0.05	90	90	–4.5	9.5	2.1	100,000	2.15	10000	0.27

* Conversion Conductance in Micromhos.

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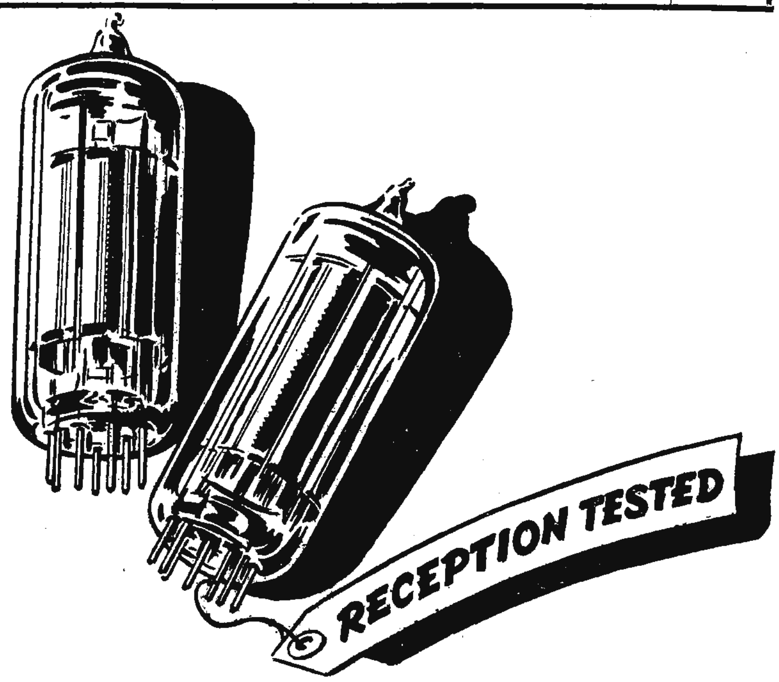

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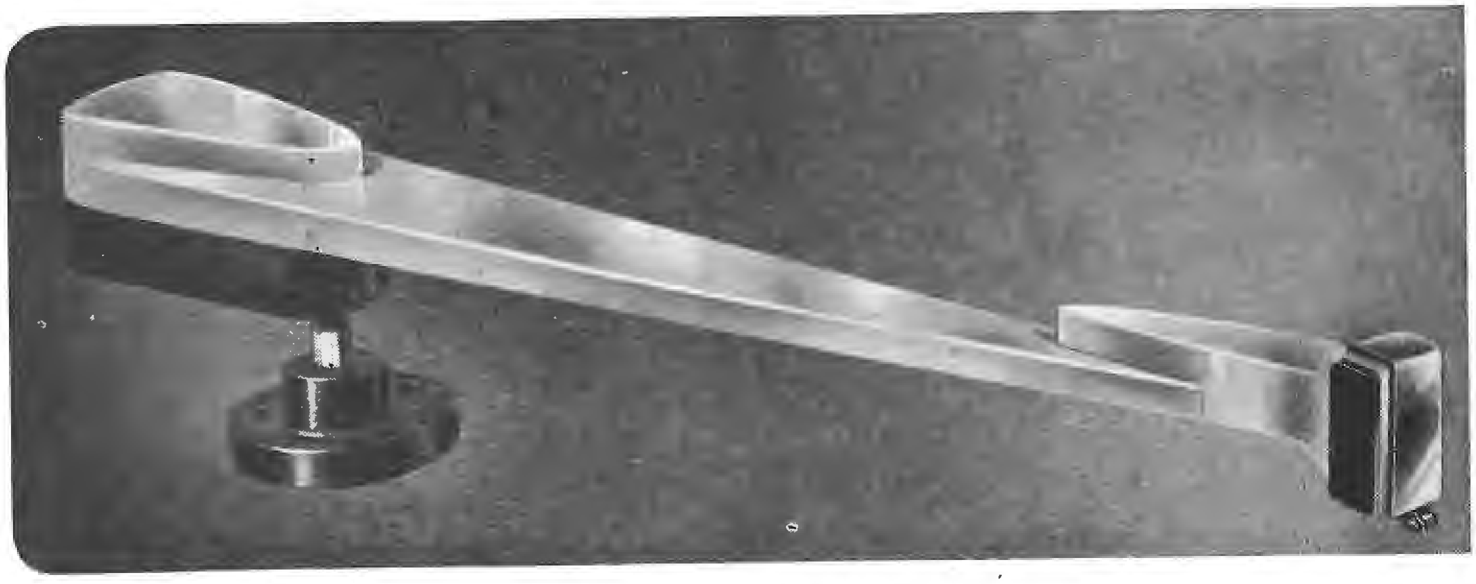

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HIGH-QUALITY AMPLIFIER: New Version

(*Continued from page 369 of October issue*)

Alternative Pre-amplifiers for Gramophone Reproduction

By D. T. N. WILLIAMSON (*Ferranti Research Laboratories*)

ALTHOUGH all the refinements outlined in the previous issue are desirable, individual requirements will vary considerably and will determine how much complication should be attempted. Two gramophone pre-amplifier circuits will therefore be described, which should cover most requirements.

Fig. 13 shows a simple circuit which gives good compensation for the Decca recording characteristic. The circuit constants have been adjusted to give as high a degree of attenuation below 20 c/s as is consistent with simplicity. This involves a slight sacrifice of the response at 20 c/s.

The method of operation is as follows: Negative feedback is applied to the valve by the potential divider formed by R_{34} and the impedance of C_{14}, C_{15} and R_{33}. At medium frequencies the reactance of C_{14} is small, and that of C_{15} large compared with the resistance of R_{33} and R_{34}, and the gain of the stage is determined by the values of these resistors. As the frequency is lowered the impedance of the top limb increases, giving a progressive reduction of feedback. This produces a gain/frequency characteristic which rises to a maximum, determined by the circuit constants, and then decreases due to the coupling components C_{16}, R_{35} and R_{36}. With increasing frequency the impedance of C_{15} decreases, increasing the negative feedback and producing a falling gain/frequency characteristic.

The capacitance between the input transformer secondary winding and earth may, if large, affect the response at the extreme upper end of the audible spectrum. This effect is negligible with a well-designed component, but long leads should be avoided. The

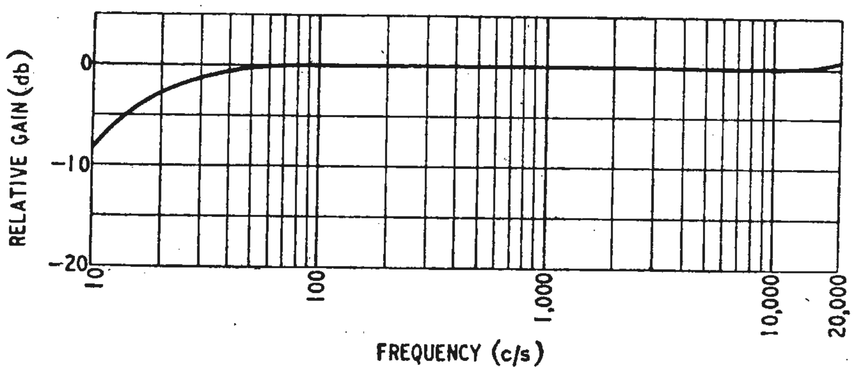


Fig. 14. Response curve of circuit of Fig. 13 with ideal "velocity" pickup.

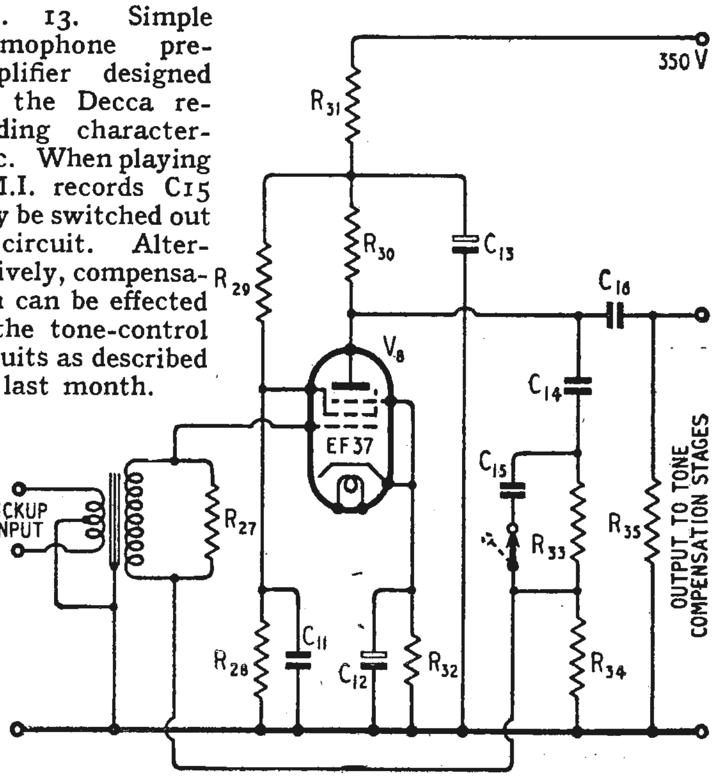
List of Components for Fig. 13.

	Value	Type	Rating	Tolerance
R_{27}	Value to suit transformer	High-stability carbon		
R_{28}	0.1 MΩ	do.	½W	
R_{29}	0.68 MΩ	do.	½W	
R_{30}	0.22 MΩ	do.	½W	
R_{31}	47 kΩ	do.	½W	
R_{32}	4.7 kΩ	do.		
R_{33}	0.22 MΩ	Composition		10%
R_{34}	22 kΩ	do.		10%
R_{35}	2.2 MΩ	do.		

All resistors may be ¼W rating tolerance 20% unless otherwise specified.

	Value	Type	Rating (V d.c. working)	Tolerance
C_{11}	0.5 μF	Paper	250	
C_{12}	50 μF	Electrolytic	12	
C_{13}	16 μF	Electrolytic	450	
C_{14}	4000 pF	Silvered mica	350	10%
C_{15}	100 pF	Silvered mica	250	10%
C_{16}	0.05 μF	Paper	500	

Fig. 13. Simple gramophone pre-amplifier designed for the Decca recording characteristic. When playing E.M.I. records C15 may be switched out of circuit. Alternatively, compensation can be effected in the tone-control circuits as described last month.



High-Quality Amplifier—
transformer should be mounted on the pre-amplifier chassis, which in turn may conveniently be fixed beneath the motor board.

The overall characteristic with an input from perfect "velocity" pickup on a Decca disc is shown in Fig. 14.

A more complex circuit, which gives nearly perfect compensation and a very rapid attenuation (30 db/octave) below 20 c/s, is shown in Fig. 15. This pre-amplifier has a higher gain than the previous one, and is particularly suitable for use in equipment where the pickup is located at some distance from the rest of the amplifier as the circuit terminates in a cathode follower.

The construction of this circuit is not recommended for those without access to facilities for checking the response of the finished unit, as the performance may be seriously affected by an error in component values.

The frequency characteristic of this amplifier is produced by the combination of two curves shown at A and B in Fig. 16. These, when added, give the curve C. Curve A is produced by the circuit associated with V_{13}, which is similar in principle to that of Fig. 13. The attenuation at low frequencies is due to the combined effect of the intervalve couplings. Curve B is produced by feedback over V_{14} through a parallel-T network tuned to 20 c/s.

The overall frequency response curve, taken under the same conditions as that of Fig. 14, is shown in Fig. 17.

Fading Control.—The circuits of Figs. 13 and 15 have no provision for electrical fading. Fig. 18 shows a network which, when connected to the cathode of V_8 in

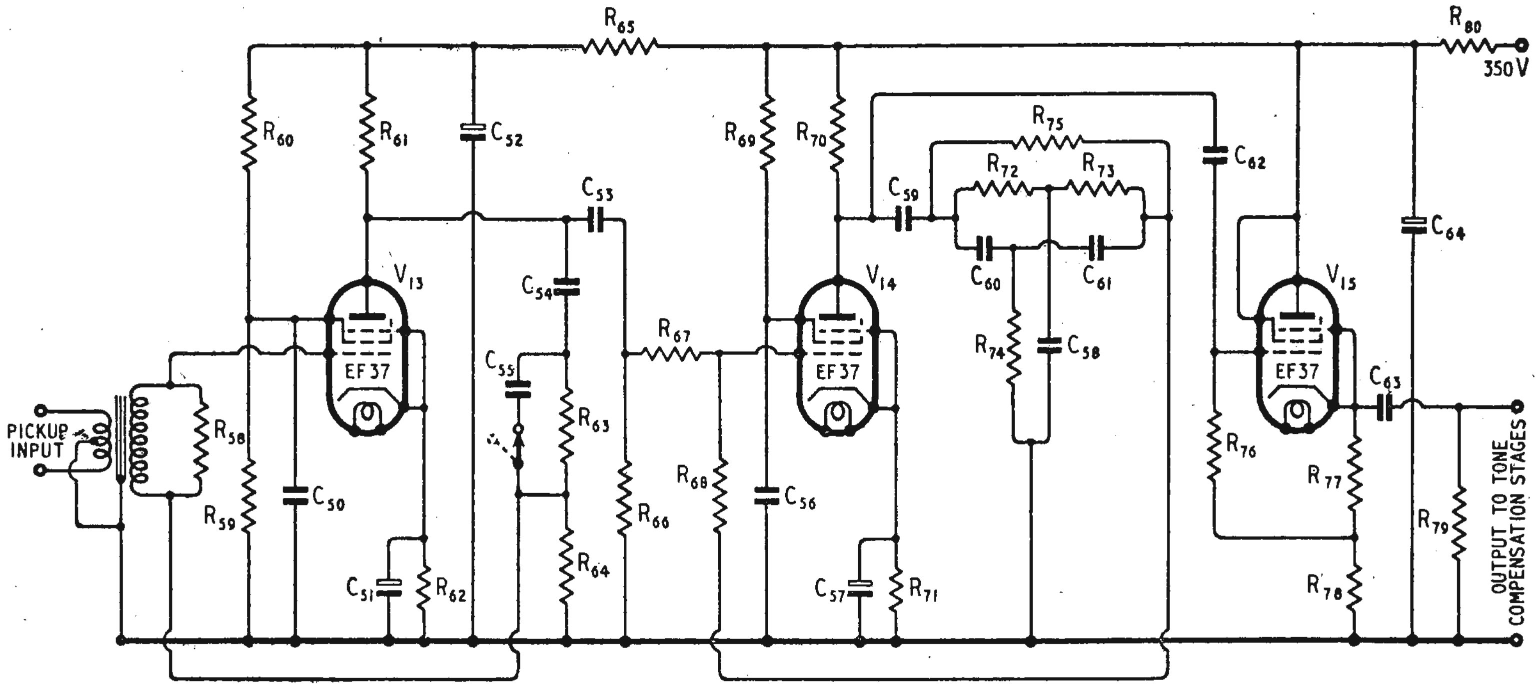


Fig. 15. Pre-amplifier with high-pass filter.

Component Values for Circuit of Fig. 15.

	Value	Type	Rating	Tolerance
R_{58}	Value to suit transformer	High-stability carbon		
R_{59}	0.1 MΩ	do.	½W	20%
R_{60}	0.68 MΩ	do.	½W	20%
R_{61}	0.22 MΩ	do.	½W	20%
R_{62}	4.7 kΩ	do.		20%
R_{63}	0.22 MΩ	Composition		10%
R_{64}	20 kΩ*	do.		
R_{65}	22 kΩ	High-stability carbon	½W	20%
R_{66}	0.22 MΩ	Composition		10%
R_{67}	0.20 MΩ*	do.		
R_{68}	4.7 MΩ	do.		5%
R_{69}	0.47 MΩ	do.	½W	20%
R_{70}	0.22 MΩ	do.	½W	20%
R_{71}	2.2 kΩ	do.		20%
R_{72}	2.0 MΩ	do.		1% or matched
R_{73}	2.0 MΩ	do.		1% or matched
R_{74}	1.0 MΩ	do.		1% or matched
R_{75}	10 MΩ	do.		5%
R_{76}	47 kΩ	do.		10%
R_{77}	1 kΩ	do.		20%
R_{78}	47 kΩ	Composition	1W	20%
R_{79}	0.22 MΩ	do.		20%
R_{80}	10 kΩ	do.	1W	20%

* May require adjustment.

All resistors may be ¼W rating, except where otherwise stated.

	Value	Type	Rating (V d.c. working)	Tolerance
C_{50}	0.5 μF	Paper	250	20%
C_{51}	50 μF	Electrolytic	12	
C_{52}	16 μF	Electrolytic	450	
C_{53}	0.02 μF	Paper	350	10%
C_{54}	4000 pF	Silvered mica	350	10%
C_{55}	100 pF	Silvered mica	350	10%
C_{56}	50 μF	Electrolytic	12	
C_{58}	0.01 μF	Silvered mica	350	1% or matched
C_{59}	0.25 μF	Paper	500	20%
C_{60}	5000 pF	Silvered mica	350	1% or matched
C_{61}	5000 pF	Silvered mica	350	1% or matched
C_{62}	7000 pF	Silvered mica	350	10%
C_{63}	0.5 μF	Paper	500	20%

Fig. 13 or V_{13} in Fig. 15, enables the gain to be reduced to zero in about a second when the switch S_5 is closed. On opening S_5 the

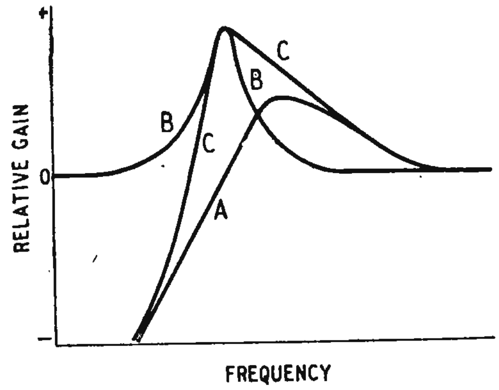


Fig. 16. Derivation of high-pass characteristic.

gain is restored to its normal value in a similar period.

Complete Variable Compensation Unit.—It is now necessary to connect together the circuits just described to form a flexible tone compensation unit. This must be done in such a manner that each works well within its signal-handling capacity and does not influence the others adversely. Fig. 19 on the following pages shows the final arrangement.

Power Supplies.—The High Quality Amplifier has a frequency response which is useful down to 2 c/s. This necessitates a few precautions when auxiliaries are connected to the input. At these very low frequencies, the balance of the push-pull stages may not be good, and there may be considerable signal in the supply line. A very carefully designed and necessarily expensive decoupling system is required if a high-gain pre-amplifier is to operate satisfactorily from the amplifier power supply. The cost of such decoupling is higher than that of a separate power supply unit producing, say, 350 V at 20 mA, and therefore the use of a unit of this type is strongly recommended.

Performance.—*Frequency Response.*—Reference to Figs. 6, 11, 14 and 17 will enable the frequency response of any combination of units and control settings to be determined. The effect of intermediate control settings may be arrived at by interpolation.

Gain.—The figures underlined in Fig. 19 are the peak signal voltages necessary to give maximum output at 1,000 c/s when the pre-amplifier is used in conjunction with the High Quality Amplifier.

The simple pickup pre-amplifier (Fig. 13) has a gain of 11 at 1,000 c/s. Thus, when this unit is used, full output may be obtained with a pickup which produces 18 mV peak. Should it be required to use the system with an insensitive microphone, disconnection of C_{14} in Fig. 13 will raise the gain of the stage to about 150, with a sensibly linear frequency response. Full output will then be obtained with an input of 1.3 mV peak. The more complex pickup pre-amplifier (Fig. 15) has a gain of approximately 250.

Noise Level.—With careful construction and by adjustment of R_{57} to give minimum hum, the noise level may be reduced to an equivalent input signal of 3-5 μV at the pickup pre-amplifier grid, excluding the noise due to the pickup transformer and auxiliaries.

Distortion.—The total harmonic distortion produced by the units when used up to the signal levels indicated is considerably less than 0.1 per cent.

Form of the Equipment.—The outward form which a complete domestic sound equipment takes is very much a matter of personal taste. The suggestions which follow have been found in practice to provide ease of operation combined with absence of troublesome feedback effects.

The equipment is best constructed in two units, one containing the loudspeaker and the other the turntable. This prevents mechanical and acoustical feedback.

The control unit may be a console of armchair height (overall dimensions about 18in × 14in × 20in high) easily movable on castors. This may contain the pickup and turntable, the pre-amplifier unit and, if desired, a radio receiver, complete with its power supply. The output from the pre-amplifier may be connected via a cathode follower to a multicore-screened cable, which connects the console with the amplifier and loudspeaker unit, and carries the mains and aerial connections.

The amplifier and loudspeaker unit may be a triangular corner cabinet, with the amplifier built into the lower portion, and the

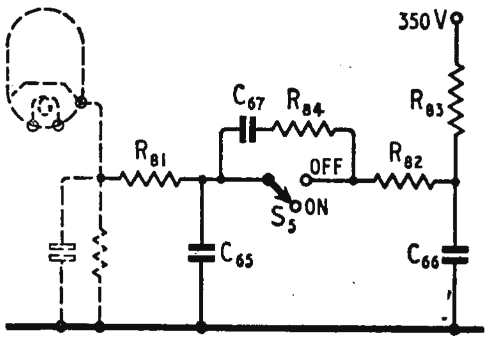


Fig. 18. Circuit of fading control.

List of Components for Fig. 18.

		Rating
R_{81}	0.22 MΩ	½W
R_{82}	0.22 MΩ	½W
R_{83}	47 kΩ	
R_{84}	100 Ω	

All resistors may be ¼W rating, tolerance 20% unless otherwise specified.

		Rating (V d.c. working)
C_{65}	4 μF	250
C_{66}	2 μF	350
C_{67}	0.1 μF	350

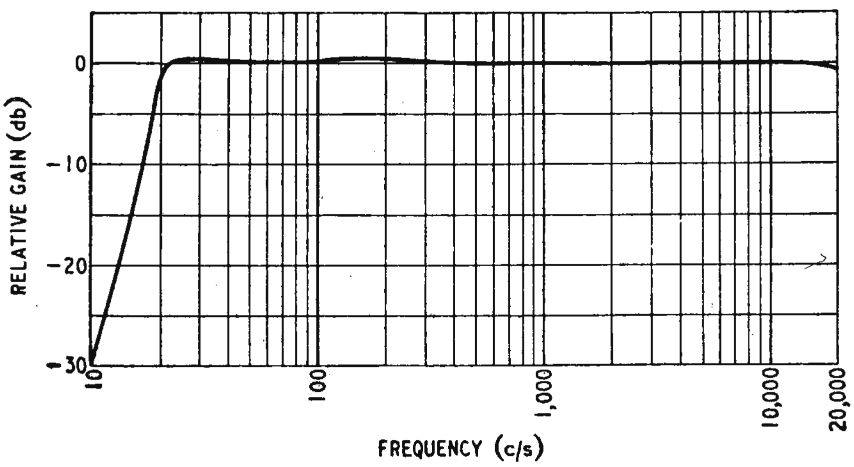


Fig. 17. Response curve of circuit of Fig. 15.

High-Quality Amplifier—

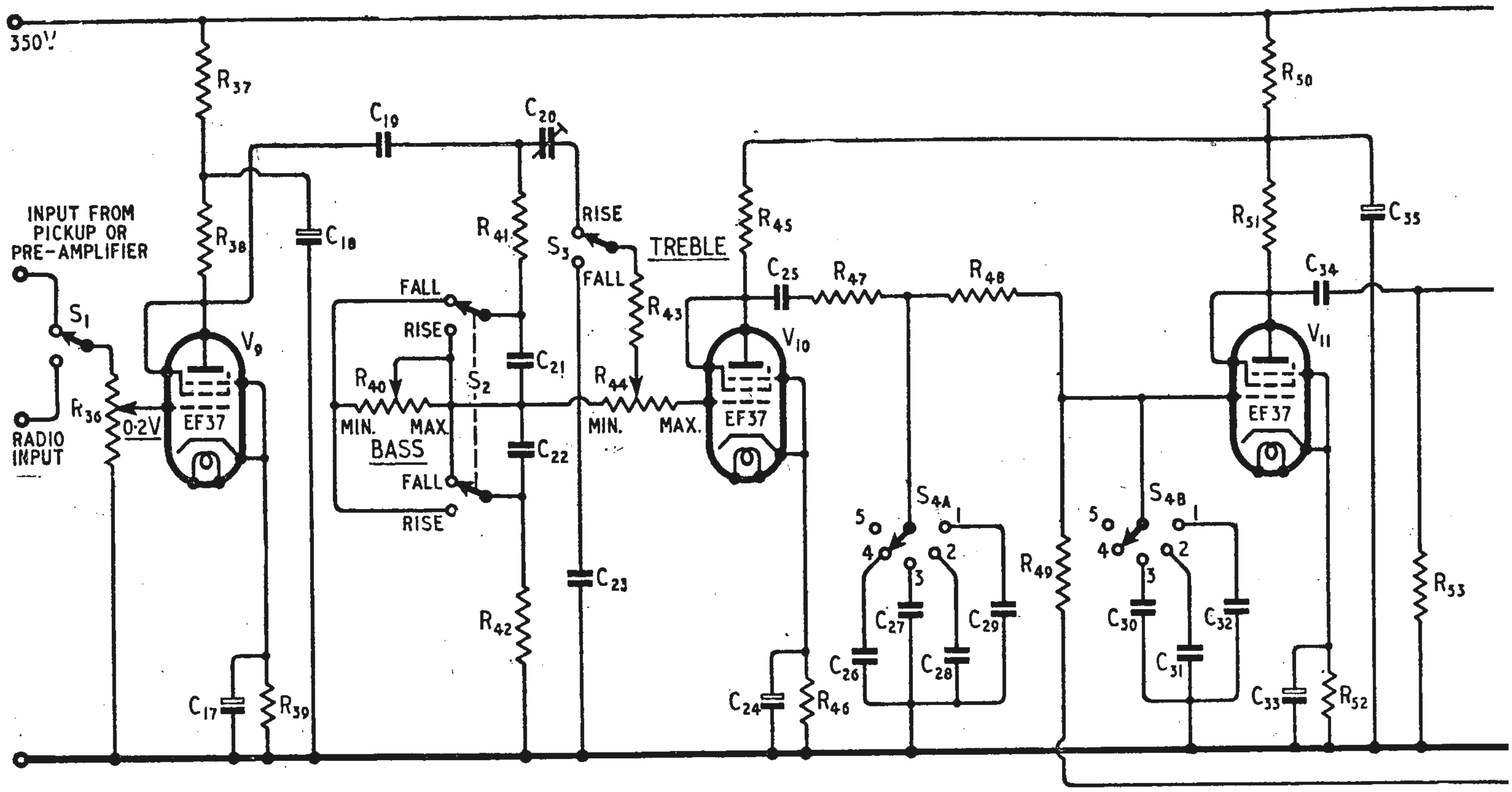


Fig. 19. Complete tone compensation and filter unit. The input and output voltages underlined are peak values for full output from the main amplifier.

List of Components for Fig. 19.

		Rating	Tolerance
R_{36}	0.25 MΩ log.		
R_{37}	47 kΩ	1W	
R_{38}	47 kΩ	1W	
R_{39}	3.3 kΩ		
R_{40}	0.25 MΩ log.		
R_{41}	100 kΩ		
R_{42}	6.8 kΩ		
R_{43}	10 kΩ		
R_{44}	0.1 MΩ linear		
R_{45}	100 kΩ	1W	
R_{46}	2.2 kΩ		
R_{47}	0.1 MΩ		10%
R_{48}	0.47 MΩ		10%
R_{49}	0.47 MΩ		10%
R_{50}	33 kΩ	1W	
R_{51}	100 kΩ	1W	
R_{52}	3.3 kΩ		
R_{53}	1 MΩ		
R_{54}	0.1 MΩ	or	1%
R_{55}	0.1 MΩ	matched	1%
R_{56}	50 kΩ		1%
R_{57}	100 Ω		

All resistors may be ¼W rating, tolerance 20% unless otherwise specified.

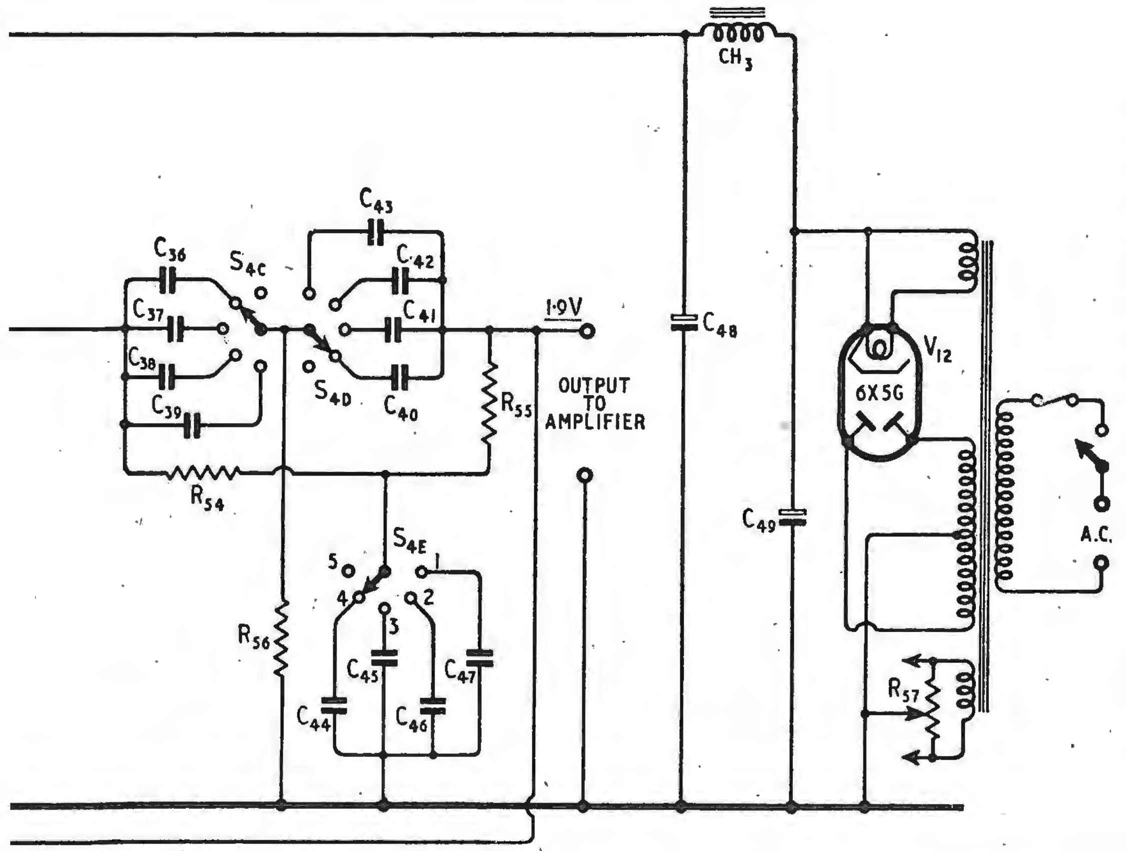
		Type	Rating (V d.c. working)	Tolerance
C_{17}	50 μF	Electrolytic	12	
C_{18}	8 μF	Electrolytic	450	
C_{19}	0.25 μF	Paper	500	20%
C_{20}	150 pF max.	Preset		
C_{21}	0.01 μF	Paper	250	20%
C_{22}	0.05 μF	do.	250	20%
C_{23}	1000 pF	Silvered mica		20%
C_{24}	50 μF	Electrolytic	12	
C_{25}	0.05 μF	Paper	500	20%

		Type	Rating (V d.c. working)	Tolerance
C_{26}	100 pF	Silvered mica		5%
C_{27}	200 pF	do.		5%
C_{28}	300 pF	do.		5%
C_{29}	500 pF	do.		5%
C_{30}	50 pF	do.		5%
C_{31}	100 pF	do.		5%
C_{32}	250 pF	do.		5%
C_{33}	50 μF	Electrolytic	12	20%
C_{34}	0.05 μF	Paper	500	
C_{35}	8 μF	Electrolytic	450	
$C_{36,40}$	75 pF	Silvered mica		1%
$C_{37,41}$	100 pF	do.		1%
$C_{38,42}$	150 pF	do.	or	1%
$C_{39,43}$	200 pF	do.	matched	1%
C_{44}	150 pF	do.		1%
C_{45}	200 pF	do.		1%
C_{46}	300 pF	do.		1%
C_{47}	400 pF	do.		
C_{48}	16 μF	Electrolytic	450	
C_{49}	16 μF	do.	500	

Choke.
CH_3 50H at 20 mA. Resistance about 1,500 Ω.

Mains Transformer.
Primary : 10-0-200-220-240 V, 50 c/s.
Secondaries : 1. 325-0-325 V, 20 mA d.c.
2. 6.3 V, 0.6 A.
3. 6.3 V, 1.5 A.

Switches.
S_1. Single pole single throw.
S_2. Double pole single throw.
S_3. Single pole single throw.
S_4. 5 bank, 5 position selector switch.



POST OFFICE RADIO

G.P.O. Exhibits at Olympia

A REPLICA of a Coast Radio Station, shown below, gave visitors to the Post Office stand at Olympia the opportunity of seeing and hearing the procedure when a distress signal from a ship at sea is received at one of the eleven stations round our coasts. These stations, which are, of course, also used for commercial marine traffic, maintain constant radio communication with coast-wise shipping and the fishing fleets.

The use of 3-cm lens-horn aerials to provide a radio-relay link for television was also demonstrated. As shown at the foot of the page, visitors were able to compare the picture on the monitoring tube of the transmitter with that at the receiver. The signal was reflected from the copper sheet on the wall between the aerials. Among the other G.P.O. exhibits was one showing the effectiveness of suppressing car ignition interference so far as television reception was concerned.

loudspeaker occupying the upper section, arranged at a convenient level for listening.

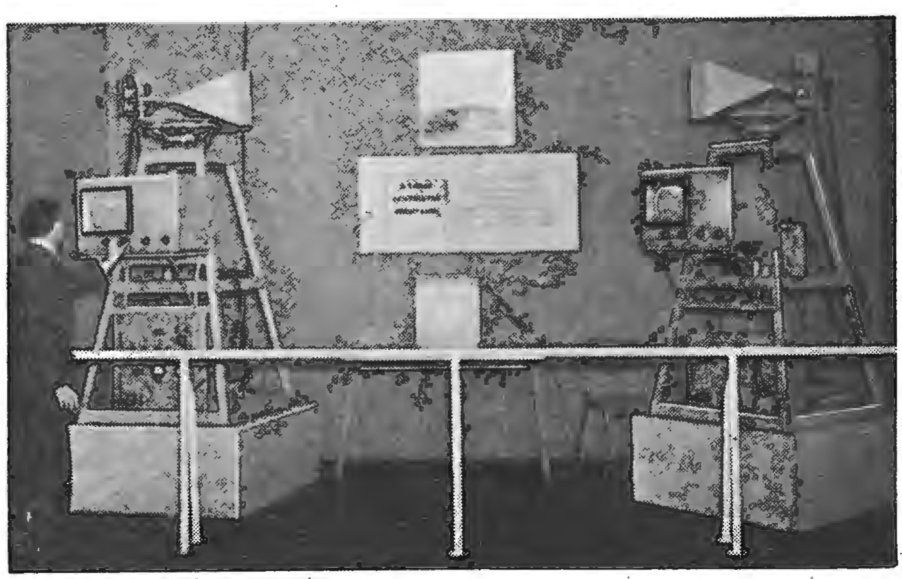
This arrangement gives great ease of manipulation, avoiding the necessity of rising from one's comfortable seat to attend to the controls or change a record. The main amplifier may be included in the console, but this tends to make it heavy and bulky, and gives rise to problems of heat dissipation which are not easily solved.

Acknowledgment.—The writer is greatly indebted to Ferranti, Ltd., for permission to publish the results of work undertaken on their behalf, and wishes to thank his colleagues for help freely given.

OUR COVER

The alignment of the grids in a Mullard QY2-100 valve forms the subject of this month's cover illustration. This beam-power tetrode, which has a maximum anode dissipation of 100 watts, is primarily intended for use as a Class "C" radio-frequency amplifier at frequencies up to 120 Mc/s.

Two of the many displays exhibited by the Post Office at Radiolympia.



RADIOLYMPIA

Trend of Design and Some Highlights

We present herewith the reports of the *Wireless World* team of observers on the things that most impressed them during their tour of stands at the second post-war National Radio Exhibition

TELEVISION EQUIPMENT

OUTSTANDING among the television receivers at Radiolympia were the projection models. The different makes vary somewhat in detail and in the precise size of picture obtained but all operate on the same principle. A Mullard $2\frac{1}{2}$-in c.r. tube is used with some 25 kV applied to the final anode and a Schmidt optical system. The resulting picture appears on a flat screen and has a size of the order of 15in by 12in.

The viewing screen is built into the cabinet housing the whole equipment. To a casual glance this screen has the appearance of ground glass, but often it is actually a plastic. In some cases arrangements are made to hide it when the set is not in use. The methods range from simple doors or a sliding panel to a screen folding within the lid of the cabinet. This last arrangement is adopted by R.G.D. Raising the lid switches on the set and brings the viewing screen, which is hinged to the front part of the lid, into position. This set has a lenticular screen which gives an extremely wide viewing angle.

The optical system is sketched in the figure. The tube passes through a hole in an inclined plane mirror A and faces a 6-in spherical mirror B. The light from the tube face is reflected by the spherical mirror to the inclined mirror A and from there it passes through a corrector plate C to the viewing screen, which is, of course, illuminated from the back. Further mirrors may be interposed between the corrector plate and the screen if this is desirable in order to secure a convenient arrangement of the parts. It is chiefly in minor points of this kind that the various makes of set differ from one another. The spherical mirror is usually made of glass, but the corrector plate is plastic.

The 25-kV e.h.t. supply is taken from a "ringing choke" pulsed at about 1,000 c/s. A power valve is used to control the choke and is itself controlled by a blocking oscillator. An extra winding on the "ringing" choke feeds a diode which provides a undirectional output voltage proportional to the e.h.t. voltage. This is used as bias on the power valve and in this way provides a

REVIEW

regulated output. The output on the choke is about 9 kV and a voltage-tripler rectifier is used to obtain 25 kV.

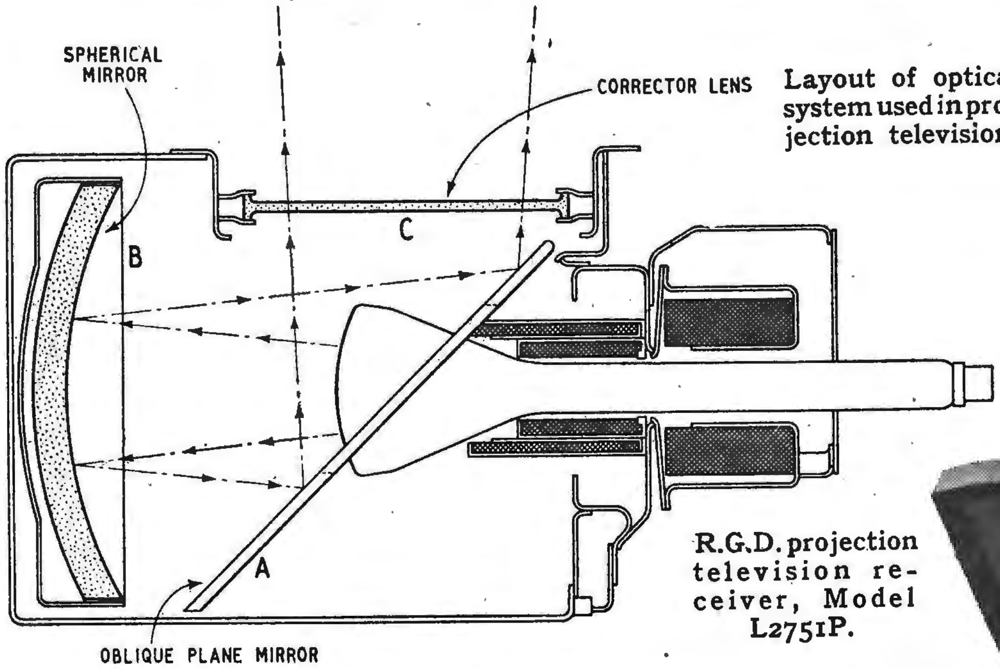
Apart from the tube, e.h.t. supply and optical system, the projection television sets differ little from the directly-viewed type. They may vary a little in detail, but not basically. Among

very rough classification for there are plenty of console types with a 9-in tube.

E.H.T. supplies range from about 4–6 kV for 9-in tubes to some 8–10 kV for the 15-in types and the favourite method of obtaining voltages under about 7 kV is from the line fly-back using a valve rectifier. The

current generators which feed the deflector coils directly and those with saw-tooth voltage generators which feed the deflector coils through intervening amplifiers. Ferranti remain faithful to the former type of circuit, which they have now used for many years, but the vast majority of sets employ the second category. This itself is divisible into two, for the rivalry between the blocking oscillator and the thyratron as a saw-tooth voltage generator persists and there were probably as many sets shown using the one as the other.

In the receiver proper most firms exhibit a marked preference for the straight set. If it were not for the Birmingham station, the straight sets would almost certainly greatly have outnumbered the superheterodynes. However, many manufacturers seem to doubt the suitability of the straight set for Birmingham and have adopted the superheterodyne principle for the Midland area sets but retained the straight set for London. Some, of course, use



Layout of optical system used in projection television.

R.G.D. projection television receiver, Model L2751P.

the firms showing projection sets may be mentioned Alba, Decca, Ekco, Etronic, Ferguson, Ferranti, Regentone, R.G.D. and Vidor. The R.G.D. model has remote control for focus, brightness, contrast and volume.

Most manufacturers have adhered to direct viewing and even those who have adopted projection still market direct-view models. Ekco have a model with a 12-in tube viewed through a mirror, but this is distinctly unusual. The large sets have 14-in or 15-in tubes, the medium 12-in, and the small ones 9-in or 10-in. The main differences between them, apart from the tube size, lie in the e.h.t. supply, the cabinet work, and in subsidiary equipment. The big tube models tend to be mainly console and radiogramophone types, and often include a broadcast receiver as well, whereas the small tube sets are mainly table models for television only. This is, of course, only a

method is almost universal in the smaller sets, and in the transformerless types the "damping diode" economy circuit is generally adopted for the line scan. Magnetic deflection is universal and the use of a permanent magnet for focusing is very popular. The usual procedure is for the magnet to be in two parts which are movable with respect to each other by a screw adment. This forms the focus control and really amounts to an adjustable air-gap. In the Sobell set, however, the whole magnet assembly is moved along the tube neck.

Scanning circuits are of two main types—those with saw-tooth

the straight set for both and some employ the superheterodyne for both.

The usual practice is to market separate models for the two sta-

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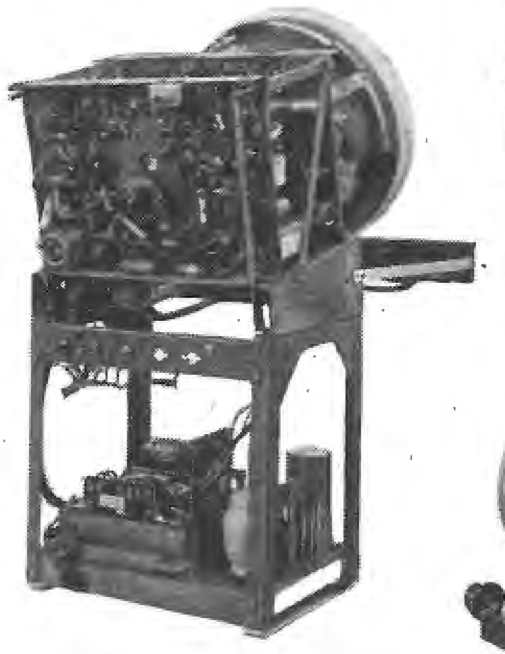
tions which differ only on the signal side. Some form of unit construction is often adopted and a set can be converted from one station to the other by replacing a unit. In some cases this is the whole receiver chassis, in others it is a sub-chassis carrying the signal-frequency and frequency-changer stages of a superheterodyne. One firm, Murphy, has a superheterodyne which can be tuned to either station by re-trimming certain circuits.

There is no doubt at all that the single-sideband system adopted for the Birmingham station has upset the trend which has been evident for some years towards a standardized design of straight set, designed to accept the side-bands remote from the sound carrier.

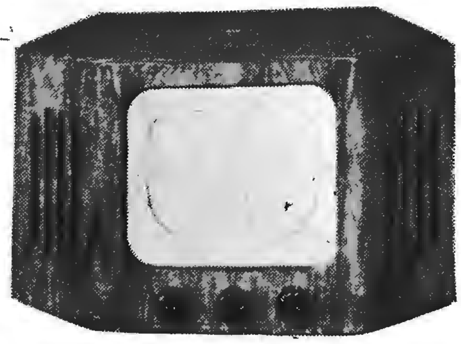
The use of noise suppression circuits on both sound and vision channels is now almost universal and it is noteworthy that great efforts are being made to simplify equipment. Pre-set controls are tending more and more to be at the front of the set and concealed by a sliding panel or trap-door, instead of at the rear of the set where they are accessible only to a contortionist! Chassis layouts are much cleaner and the accessibility for maintenance is greatly improved.

In the small sets, such as the Pye LV20, and the Baird, to mention only two, the chassis is removable as a unit with the c.r. tube and then everything can be got at easily. In the larger ones, removable panels are sometimes fitted to the cabinet so that access to a chassis is possible without removing it. Various elaborations of the scheme exist. In the R.G.D. projection set the loud-speaker grille at the front drops down, while in their directly-viewed model, which has a 12-in aluminized tube operating at 10 kV, the centre part of the front and top of the cabinet lifts in one piece for access to the interior.

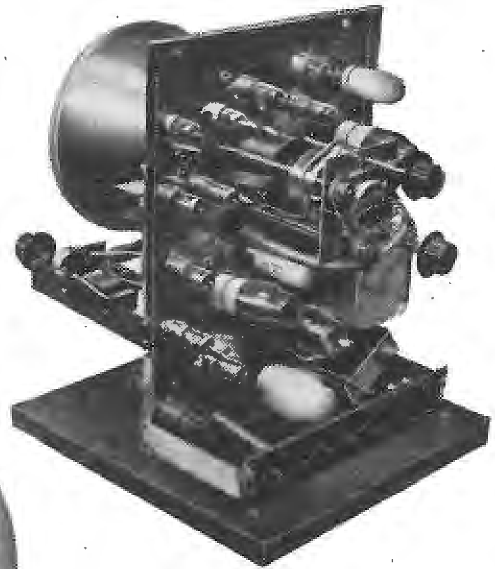
Dynatron adopts a form of rack mounting. A simple metal frame-work holds all the chassis and enables them to be removed as a unit from the cabinet. The set is available in this form for building into an existing cabinet. It is of the straight type for the London area model, but a superheterodyne for the Midland region. A 12-in tube



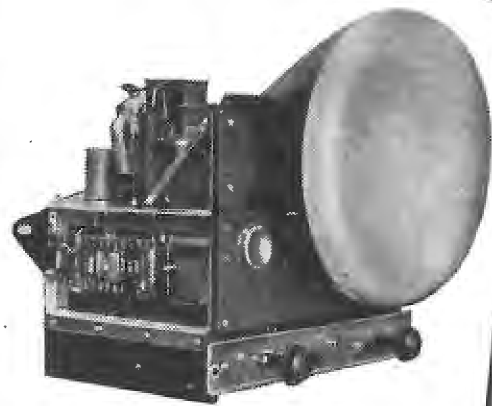
Television chassis of Murphy set.



E.M.I. Relays H.F. terminal unit for use with a central receiver in blocks of flats.

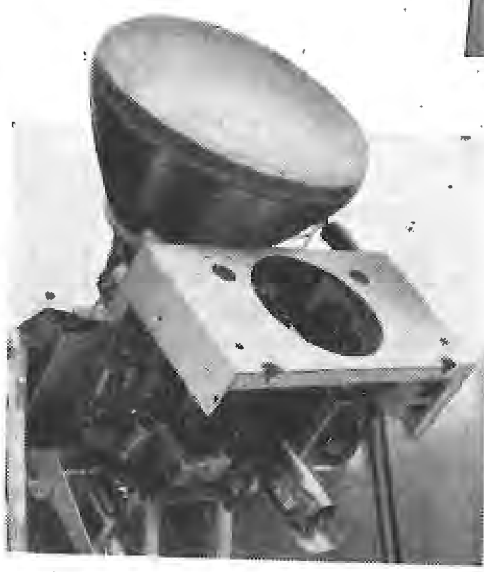


Sobell television chassis.



Bush transformerless receiver.

H.M.V. Model 1806 with 15-in tube.



(Left) Ekco TS114 receiver chassis.

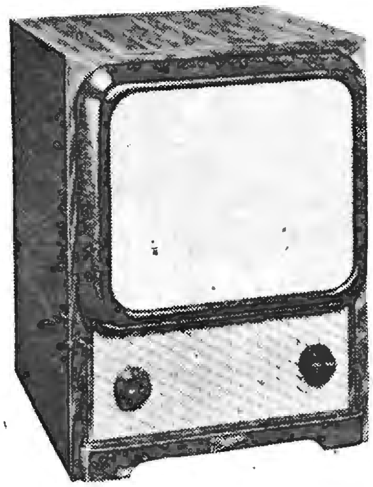
is employed and the e.h.t. supply is taken from the line flyback using a voltage-doubler rectifier. Valves are used for this and an unusual feature is that their filaments are heated from the 50-c/s supply instead of from windings on the line-scan transformer. Another unusual feature is the use of a deflector-coil assembly with an internally slotted iron circuit.

Deflector coils in general follow a uniform pattern. Low-inductance transformer-fed coils with bent-up ends and an external iron ring are usual. The iron ring is often a stack of laminations square outside, but having a circular inner hole. In a few cases the quantity of the material in the iron circuit has been greatly reduced and in some, also, the "bend-up" of the coil ends is only very small. A few firms adopt a so-called toroid winding, which is also sometimes called counter winding. Instead of the iron circuit enclosing the middle part of the coils, the winding is actually around the iron. When the laminations are circular the actual process of winding is like that of winding a toroid, but the connections are different.

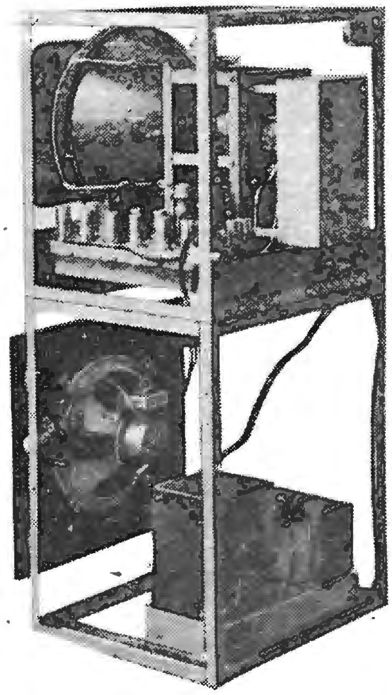
This type of coil has been used quite often for frame deflection, the iron circuit being rectangular and forming a core to the frame coils and an outer ring to the normal-type line coils. Its use for both deflections is rare.

Some firms employ high-inductance frame-deflector coils,—some H.M.V. and Marconiphone models have them, for instance, and two firms, at least, use high-inductance coils for the line scan. They are Ferranti and Haynes. The reason is, of course, to improve efficiency, for the transformer losses are avoided. It is now, however, an unusual practice and there is no doubt at all that the general trend is to low-inductance coils of the bent-up end type with transformers.

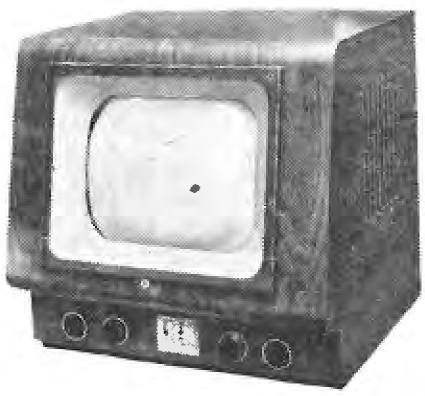
Although most of the sets at Radiolympia were intended for the home market and were designed for the British television standards, Masteradio and Romac had sets for export constructed for the American standards. Pye also had an extremely compact table model designed for the U.S.A. and arranged for twelve - signal channels.



Marconiphone VT53A table-model.



Chassis of Dynatron television receiver.



Pye export set for U.S.A. standards.

E.M.I. showed relay equipment for flats, comprising a central receiver giving a v.f. output which is taken to the individual receiver by cable. Murphy had a similar equipment but with an r.f. output in the region of 10 Mc/s and intended for longer cable runs. The receiver is fitted with a.g.c. operating off the black-level of the signal.

Extension viewing units—analagous to extension loudspeakers but much more complicated, were shown by Cossor. Each comprises a complete television set minus its r.f. side. It is connected by a multicore cable to the main television set from which it derives the v.f. and a.f. signals.

A large range of television transmitting equipment was shown, including cameras and associated apparatus. E.M.I., Marconi's and Pye showed this type of gear and the last-named firm was also demonstrating colour television on a closed circuit. Using 405-lines, 150 frames, with three-colour rotating discs at transmitter and receiver the system requires a 9-Mc/s bandwith. It is not intended for broadcasting but for commercial usage.

Quite a number of television accessories were shown. Aerials predominated and ranged from compressed dipoles for indoor use to multi-element types for fringe areas. Aerialite, Antiference, Belling and Lee and Wolsey showed a wide range. It was evident that it is now realized that the H-dipole is unnecessary for short-range reception and that something better is desirable for long ranges. Simple dipoles and bent dipoles for loft or outdoor use cater for the local viewer, and arrays of dipole, reflector and one or more directors help reception in the fringe areas.

Several firms market pre-amplifiers for use in such areas. In many cases the set maker can provide a pre-amplifier, and a neat point about the R.G.D. one is that it is designed for connection in the aerial feeder and has a gain control. It can, therefore, be placed alongside a viewer so that he can adjust the gain to counteract any fading without getting up.

For the other end of the receiver several firms showed plastic magnifying lenses. Acrylite and Magnavista both showed a range

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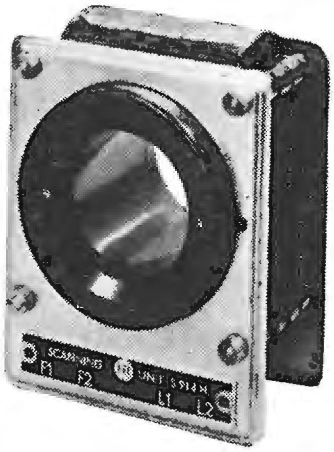
suited to most types of receiver—even for those including 12-in tubes.

Comparatively few special television components were shown. Haynes had a good selection, comprising a deflector coil in which the coil is enclosed in a special moulding to hold it precisely in the correct shape, focus coils, permanent-magnet focus rings, blocking-oscillator transformers, line-scan and e.h.t. transformers, r.f. tuning coils, and e.h.t. supply units. One of these is an r.f. oscillator type for outputs of 5-8kV.

Hazlehurst was showing a wide range of r.f. oscillator e.h.t. units giving d.c. outputs of 5.5 kV and over.

Houghton and Osborne also showed deflector coils, focus coils and a line scan transformer, while Long and Hambly had a range of c.r. tube masks.

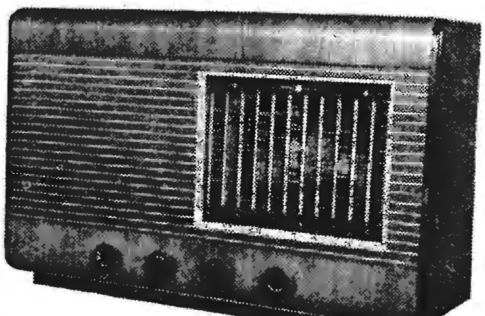


Haynes deflector-coil assembly.

BROADCAST RECEIVERS

It is gratifying to be able to report that, in spite of the natural tendency to focus attention on contemporary developments in television, the industry has not neglected the ordinary broadcast listener.

Those who now appreciate and others who will subsequently find that television is complementary to rather than a substitute for sound broadcasting, will have no cause to complain of lack of variety in the large number of new receiving sets which were introduced at the Show. Every shade of taste is catered for, not only in external appearance, but in the degree of complexity of circuit and controls. A significant trend is the reappearance of pre-set tuning for home and light programmes in the simpler sets, and at the other end of the scale the provision of really first-class quality of reproduction in combination with improved signal/noise ratio and ease and stability of tuning on short waves for those who take a serious interest in broadcasting in all parts of the world.



Pye 39J/H bandspread receiver.

Since the last Show the number of manufacturers offering portable receivers has trebled, and many of these will operate from a.c. or d.c. mains, or from internal batteries. Another welcome development is the return in force of the table radio-gramophone, which provides a wide variety of entertainment without putting an undue strain on the limited living space with which so many of us have to make do these days.

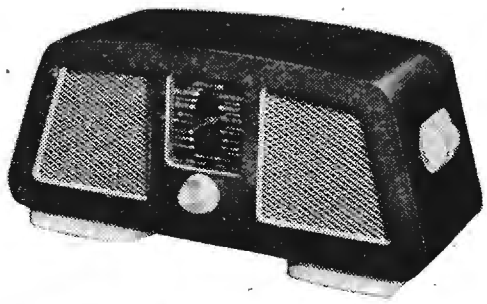
The five-valve superheterodyne (4 receiving valves + rectifier) is still the economic optimum as far as circuits are concerned, and table models of this type form the backbone of most firms' programmes. To bring prices (including tax) below the £20 level, basic three-waveband sets with the minimum number of "frills" have been introduced. A good example is the Cossor "Melody Maker" which has a moulded cabinet and a chassis of simple design. G.E.C. have standardized a five-valve circuit throughout. The cheapest model (BC4940) has a moulded cabinet, simple tuning controls and a single loudspeaker; in the Model BC5060 twin loudspeakers, flywheel tuning, "piano key" waverange and pre-set station controls are added for those prepared to pay a little more. Incidentally, twin speakers are also used in the Regentone 353 and the McMichael 498U receivers.

The Ferranti 149 and 248 receivers make use of the same circuit but in cabinets of different styles and prices; an interesting feature is the provision of two extra positions on the waverange switch giving instant selection of the Home and Light programmes on pre-tuned circuits. The Ekco "Connoisseur" dispenses with variable tuning altogether and gives a choice of four stations, three on medium and one on long waves. Special attention has been given to quality of reproduction, and in keeping with the general policy of simplicity of operation an internal frame aerial is fitted. Many table models are now provided with internal aerials, which are satisfactory in areas of high field strength.

Emphasis on quality of reproduction is also to be found in the Murphy 130 and A122M sets which have "baffle" type cabinets free from acoustic resonances; compensation for comparative loss of bass is effected electrically by correction circuits. In the Model A146C, Murphy have gone the whole hog and fitted a baffle of large area, standing on the floor and reminiscent of the heyday of quality reproduction which was ushered in by the first introduction of the moving-coil loudspeaker. Another example of this trend towards better acoustic cabinet design is to be found in the Ultra "Minstrel" receiver.

Provision of a waveband covering the trawler radio-telephone services is on the increase, and examples are to be found in the Pye T19D, in many of the Invicta sets, and in the Ambassador 849.

The latter receiver belongs to the very well-represented class of luxury sets for serious all-round

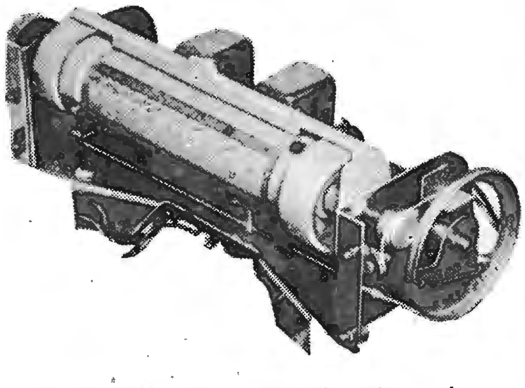


McMichael 498U receiver with twin speakers.

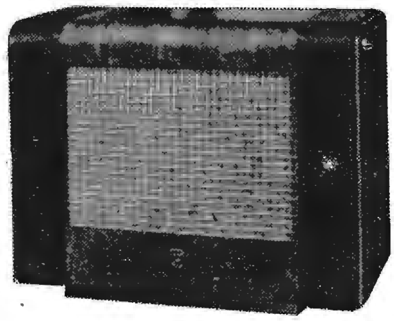
listening. It has seven valves plus rectifier, a push-pull output stage and twin loudspeakers. The Ace Radio "600" series (8 valves + rectifier) has seven bandspread s.w. ranges, a 14-watt push-pull output stage and twin speakers; particular attention has been given to sensitivity, signal/noise ratio and tuning stability. In the Beethoven range there is the A1188 with a total of nine valves, 11 wavebands and 6-W push-pull output. The Philips 681A and Mullard MAS231 (the latter for export only) both employ double superheterodyne circuits for short-wave reception on eight band-spread ranges. Last, but by no means least, in the examples typifying this class we may quote the Pye 39J/H eight-valve (including rectifier), eleven-wave-band receiver, fully bandspread on eight of the short-wave ranges and including the trawler band.

Table-model battery sets are in general fitted with quiescent push-pull output stages to provide volume and quality comparable with their mains equivalents. Typical examples are the Murphy B141, G.E.C.4956, H.M.V.1407 and Mullard MBS147, the last two being provided with battery economy switches for cutting down current consumption to a lower datum when full volume is not required. Many manufacturers are now producing sets with vibrator h.t. supply to run from 6-volt car accumulators. Sets in this category include the Mullard MBV258 and Eddystone 710. Bush make a vibrator unit to fit into their EU4 a.c./d.c. receiver and the new Masteradio D350 works off a.c. or d.c. mains as well as from a 6-V source.

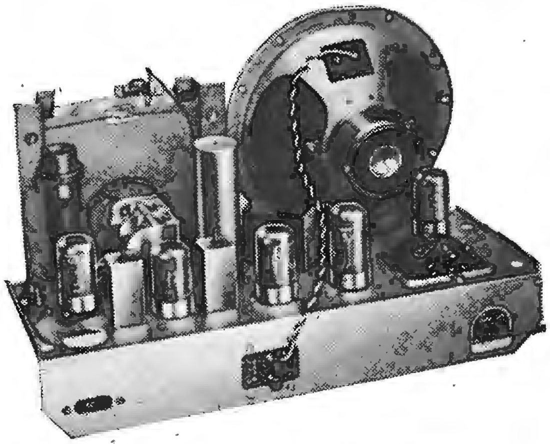
The smallest portable in the Show was the Auratone, a superhet compressed into the size of a pocket hearing aid and giving excellent volume in a single earpiece when used with a short length of aerial. Among other "personal" portables the Marconiphone P20B and the Romac 306 were noted.



Bush BP10 portable chassis. A moulded cover for the drum dial incorporates an on-off switch.



Variable tuning is dispensed with in the Ekco "Connoisseur," which gives a choice of four pre-set stations.



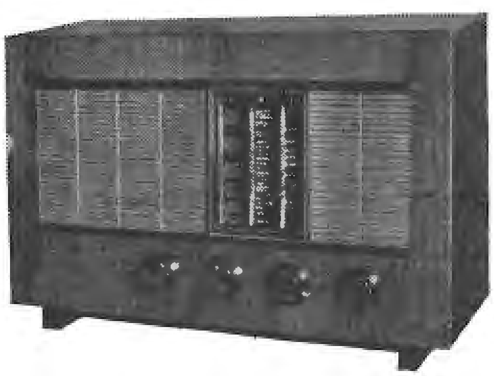
Chassis of the new Cossor "Melody Maker."

Auratone vest-pocket superheterodyne receiver.

The latter can now be supplied with a battery-eliminator base for use on a.c. mains. New all-dry portables of intermediate size include the Cossor 499, Bush BP10, Philco E2601 and the range of Vidor portables including a small attaché type. Roberts portables were notable for their variety and high standard of finish.

There has been a big increase in the number of a.c.-d.c.-battery sets shown. The "Double Decca" is now available for short and medium waves as an alternative to the standard long- and medium-wave model, and new additions to this class include the Ultra "Twin," Pye P27UBQ, Invicta "Twinvicta," Ekco "Stroller," Champion "Sky-master," and Alba "Rover." The latter measures only $7\frac{1}{2}$in × 7in × 5in, and weighs $6\frac{1}{2}$ lb with battery. In the Ekco "Stroller" particular attention has been given to foolproof switching and isolation of the battery compartment; it operates on three wavebands with separate frame aerials for each range.

Most manufacturers have added a table radio-gramophone to their range of sets. The general layout is a flat horizontal cabinet with a narrow chassis and controls at the front, loudspeaker at front or side and the turntable or record changer in a well behind. Examples include the Alba B731, Ambassador 548, Decca 303, Ferguson 228RG, Marconiphone RG22A, Regentone RG99, and Sobell 419TG. There were also a fair number of portable electric gramophones of which the Collaro "Microgram" is representative.



Direct selection of Home and Light programmes is included in the waverange switching of the Ferranti Model 129.

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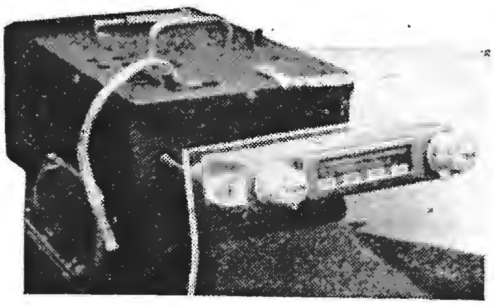
Among the big radio-gramophones, which do not appear to be suffering any signs of austerity, the R.G.D., Dynatron and Ace were noted as typical examples of the trend towards unit construction, with separate loudspeaker and record storage cabinets and provision for the inclusion of television units. The inevitable cocktail cabinet appears in the e.g., a slot-type loudspeaker aperture to give better diffusion of high audio frequencies. In other K.B. sets hum bucking in the output transformer is used to reduce ripple without loss of h.t. volts, and a bridge feedback network, including the diode load and volume control, is designed to reduce feedback and increase overall sensitivity on weak stations.

button, and there is a four-position tone control; the set includes a noise limiter. General coverage on short and medium waves is given in the Ekco CR61 as well as expansion of the 19-, 25- and 31-metre bands. Four pre-set stations are available, and a "clipper" valve is included to suppress interference from passing cars. Masteradio, in addition to their standard car radio sets, were

Record changer in the Mullard MAS235 radio-gramophone.

(Below) Radiomobile short-wave car radio, Type 4050.

Grampian "Schools Console" receiver.



Ekco CR61 car radio with short-wave ranges.

(Left) Marconiphone Model RG22A table radio-gramophone.

H.M.V.1612, which justifies mention here by virtue of the inclusion of automatic tuning control, an electric clock for programme switching, motor tuning, twin 13½in elliptical loudspeakers and a total of fifteen valves. The Mullard MAS235 is notable for a new design of record changer taking ten 10in or 12in records mixed, and the "Defiant" (C.W.S.) for the inclusion of sockets with separate volume control for a hearing aid. The Kolster Brandes DRP20 is available either as an electric gramophone, or with the addition of a radio receiver. It incorporates many interesting technical features,

Chassis for incorporation in custom-built radio-gramophones formed the basis of the exhibits of Peerless Radio and Armstrong Wireless and Television. Haynes Radio were showing a 2 r.f. tuner unit and amplifier chassis for the quality enthusiast.

Car radio receivers are now available with short-wave ranges—bandspread of necessity for ease of tuning by the driver. In the Radiomobile 4050, in addition to the medium-wave range there are seven principal s.w. broadcast bands, each with separate indication on the drum-type tuning scale. Four stations on medium waves can be selected by push-

showing a new portable—the "Carholme"—designed for car or home use. It covers medium and long waves and works off the car battery or a.c. mains. Consumption on battery is 18 watts.

Two receivers for the reception of the experimental frequency modulation transmissions on the 90-Mc/s band were shown. In the H.M.V.1250 automatic frequency correction is used and the tuning range is 87.5 to 94.5 Mc/s. The 10-watt output stage feeds a 13½in elliptical loudspeaker. The set shown by Kolster Brandes relies on crystal control for frequency stability with switching to the appropriate station in the range 90-94 Mc/s. An adaptor for use with existing sets is also available; the circuit is the same except that there are no a.f. stages.

To round off this review of receivers for broadcasting, mention should be made of two interesting special-purpose receivers — the "Schools Console," made by Grampian, which is a neat embodiment of all the features called for in educational broadcast equipment, and the Eddystone Model 670 marine receiver designed specifically for broadcast reception on short and medium waves on board ship in any part of the world. Tropical grade components are used throughout.

SOUND REPRODUCING EQUIPMENT

AMONG the products which come under this heading, greatest activity, since the last Radiolympia, seems to have been in recording—disc, wire and tape. Many improvements were noted in the equipment associated with disc recording, and several firms have now gone into production with tape recorders. Three firms were showing magnetic wire recorders.

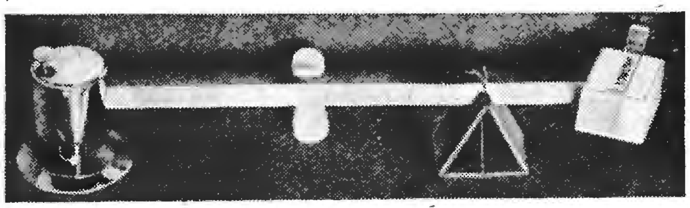
Microphones. Cosmocord were showing two new crystal microphones, the Mic16—a sound-call type with a flat response from 30 to 10,000 c/s, and the Mic22 of higher sensitivity with a flat response from 40 to 6,000 c/s. The latter microphone incorporates a sintered porous acoustic screen to give the correct response.

Cosmocord Mic 16 sound cell microphone.

A new studio ribbon microphone was exhibited by A. R. Sugden ("Connoisseur"). The size of this instrument is above the average and a large Alcomax III magnet is incorporated. A sensitivity increase of 15-22 db over normal types is claimed.

Pickups. Diamond styli can now be supplied in the Decca lightweight pickup, and as an alternative to tungsten carbide in the new moving-coil pickup introduced by Lowther. The latter incorporates a brush device which prevents damage to the record if the pickup is dropped, and also continuously removes dust from the groove in advance of the stylus. Needle pressure is adjustable from 7 to 27 grams on standard records, and from 3 gm on long-playing records.

On the Cosmocord stand, the principal exhibit was the GP20 "Microcell" crystal pickup with interchangeable head for standard or microgroove records. Working on the piezoelectric principle, this pickup gives a high voltage output compared with other lightweight types.



The Lowther moving-coil pickup can be supplied with either a tungsten carbide or diamond stylus.

Interchangeable heads are also a feature of the Goldring "Headmaster" pickup which is of the moving-iron type. Three stylus radii are available including one of 0.0035in radius for increasing signal/noise ratio on old and worn records. The "Three-Way" pickup by the same firm (Erwin Scharf) is designed for 78, 45 and 33⅓ r.p.m. long-playing records.

Murphy Radio were showing a large-scale working model of the new moving-coil pickup incorporated in their latest radio-gramophone.

Amplifiers. High-powered rack equipment for factories was shown by a number of firms including G.E.C. and E.M.I. In the G.E.C. 500-watt equipment, which incorporates a priority feature for urgent announcements, the source of music is now a tape recorder. E.M.I. were also showing an interesting dual playing desk, designed for background effects in theatres, with large dial indicators for cueing.

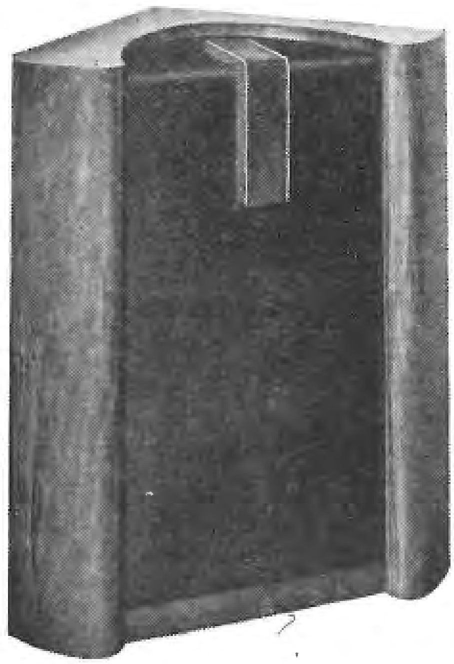
Another interesting exhibit among the large equipments was an experimental automatic train announcer shown by Westinghouse with wire recording as the basis.

Among new amplifiers for domestic quality reproduction were noted a new range (5, 10 and 25 watts) by A. R. Sugden with 0.5 per cent max. distortion, and two new Grampian amplifiers for record reproduction—Model 491, 10 watts, and Model 492, 4 watts. All these units incorporate bass and treble tone controls.

The Haynes quality amplifier with push-pull PX4 output valves obviates the used of high-resistance leaks by using a centre-tapped choke in the grid circuits of the output stage. The windings are inter-mixed to preserve balance.

Loudspeakers. A representative if not complete selection of quality reproducers was available for inspection, and although the listening rooms were not available at the opening of the exhibition it was hoped to have them ready in the second week.

Among tried favourites were noted the Goodmans Axiom, Ediswan Senior R.K., Lowther-Voigt and the comprehensive Wharfedale range. Goodmans have increased the flux density in



Corner cabinet reproducer with ribbon-diaphragm h.f. unit by the Acoustical Manufacturing Co.

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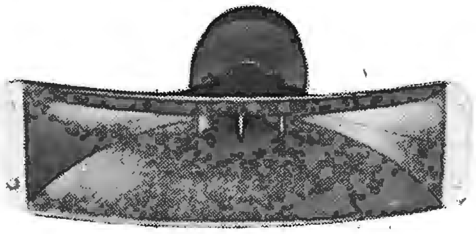
their latest Axiom 22 to 17,500 gauss and similar flux densities are available in the Wharfedale range, which can be supplied in many cases with an alternative diaphragm with soft cloth surround in place of the standard one-piece corrugated moulding. Wharfedale were also showing a new corner cabinet design incorporating heavy concrete or brick construction. Truvox have introduced a new high-fidelity 12-inch

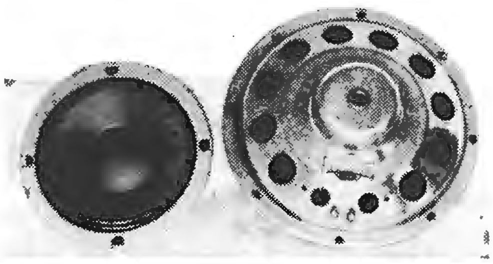


Vitavox Type 1150 h.f. horn loudspeaker.

unit with aluminium - wound speech coil and a 17,500-line magnet. The new Vitavox type 1150 horn tweeter for frequencies above 1,000 c/s is designed for use in 10-20-watt combinations and has a die-cast horn with internal diffuser webs.

Whiteley Electrical Radio ("Stentorian") were showing their "Duplex" speaker with concentric horn tweeter and an 18-inch diaphragm type—the S1814—in which a free-edged h.f. diaphragm with smaller diameter voice coil works in a separate air gap in series with the main gap.

The Acoustical Manufacturing Co. showed a new corner-cabinet loudspeaker with ribbon - diaphragm h.f. unit and two-stage acoustic chamber loading for the l.f. cone diaphragm. Considerable



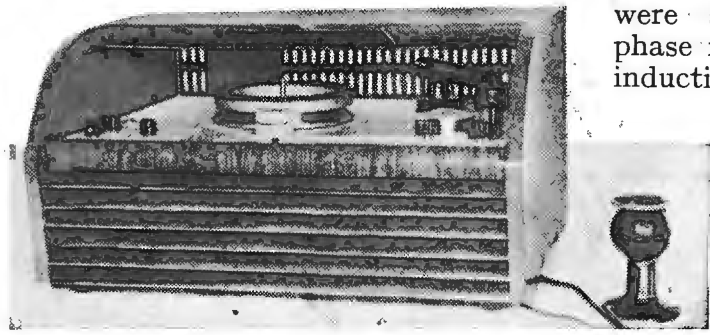
"Lectrona" units for television receivers have $1\frac{3}{8}$in pole pieces.

attention has been given to sound distribution in the design, which has been developed on the basis of extensive subjective listener research.

Among units for the set manufacturer notable examples were the "Lectrona" (Acoustic Products) 5-in and $6\frac{1}{2}$-in models for television receivers. These employ Alcomax III magnets with the unusually large pole diameter of $1\frac{3}{8}$in, and have a low external field. A domed dust-cover functions also as a non-directional h.f. radiator.

Recorder unit used in the M.S.S. radio-gramophone showing the new "Rotacol" swarf collector.

Disc Recorders. Equipment for disc recording was shown by B.S.R., A. R. Sugden ("Connoisseur"), Grampian, H.M.V., M.S.S. and Simon Sound Service. The new "Connoisseur" recorder has a moving-coil head of large dimensions in which the coil is allowed vertical movement to follow inequalities in the record. A comprehensive range of equipment—studio and portable—was shown



Kolster Brandes Type EWR60 wire recorder.

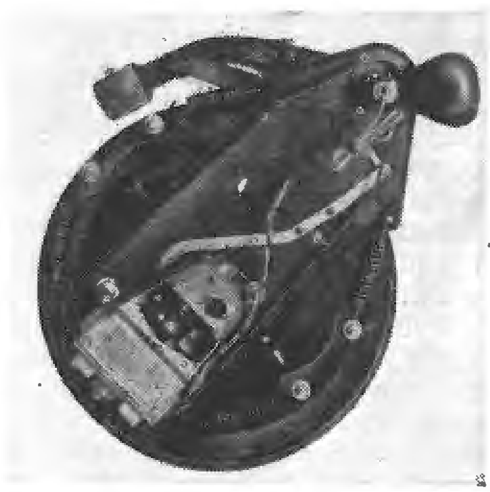
by M.S.S. and included a radio-gramophone with recording for 78 or $33\frac{1}{3}$ r.p.m. with groove pitches of 96 and 160 per inch. The latter gives 18 min playing time on a 12-inch record. An interesting new swarf collector—the "Rotacol"—is a new accessory introduced by M.S.S. It takes the form of an inverted bell with internal wire spider, and has a felt rim which is friction-driven by the record. A new range of "Popular" discs for adjustment and experimental work have also been introduced by M.S.S. at 4s 6d for the double-sided 12-in size.

Tape and Wire Recorders. Complete magnetic tape recorders in first-class cabinet work were exhibited by G.E.C. and R.G.D. The "Tape Deck" made by Wright & Weaire was also demonstrated. This unit will be made available to constructors as a separate component (price in the region of £25) or as a complete portable instrument with amplifier, loudspeaker, etc.

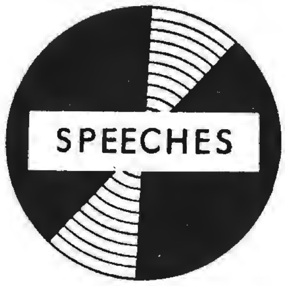
Instruments using wire as the magnetic recording medium were shown by Kolster Brandes and Simon Sound Service. A design for home construction was shown by Park Radio.

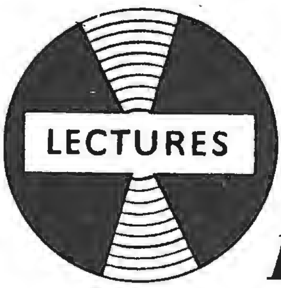
Gramophone Motors and Record Changers. The Electrical and Radiological Instrument Co. were showing their two-phase motor variable speed induction motor in turntable form and also in a radio-gram unit. A. R. Sugden have introduced a new two-speed (78 and $33\frac{1}{3}$ r.p.m.) motor of substantial construction and a three - speed version including 45 r.p.m. is under development.

Garrard were demonstrating



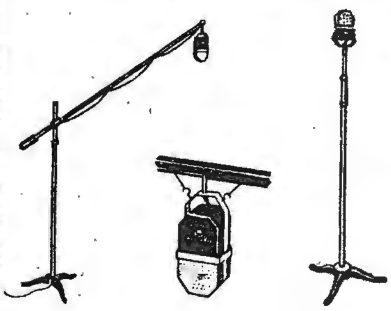
Underside of Garrard Type V/AD radio-gram unit with counterbalanced tone arm for use on board ship.



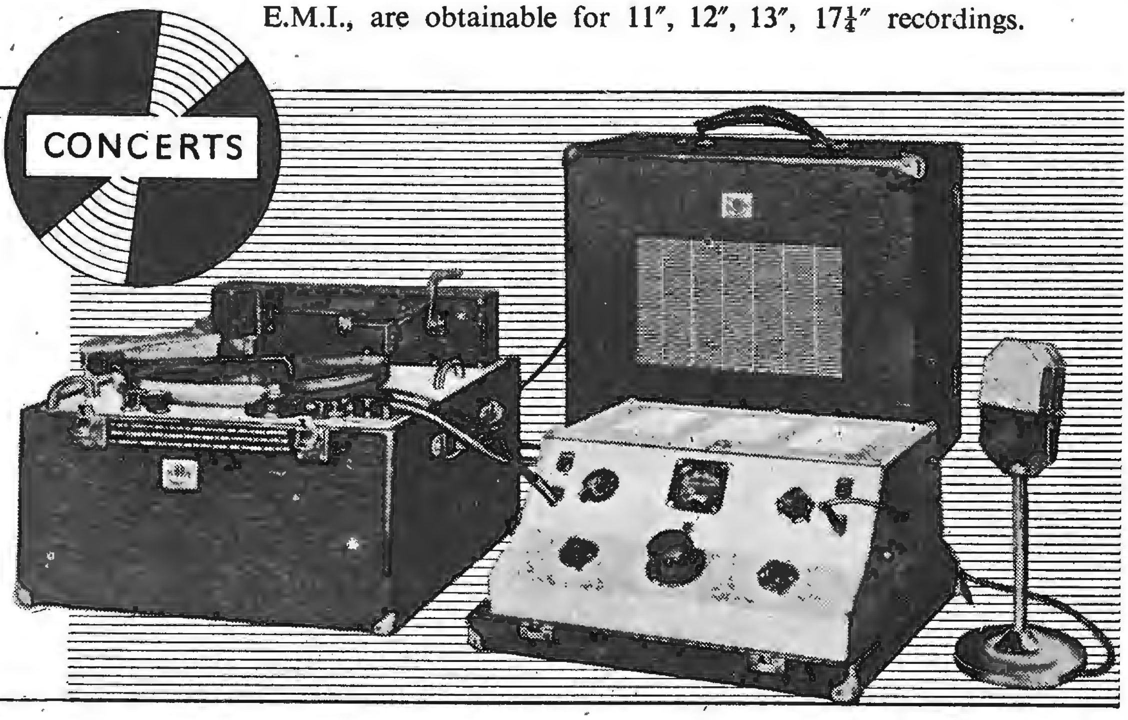


If they are worth hearing . . .
they are worth recording!

Simple to operate and readily portable, the E.M.I. Portable Disc Recorder enables brilliant "on the spot" recordings to be made of outstanding events. Produced by E.M.I. technicians with 50 years' experience in recording, this new E.M.I. Portable Recorder is a remarkable technical achievement. Here in transportable form is a complete recording and play-back equipment designed to produce high quality recordings on lacquer blanks without demanding expert knowledge of recording technique. Operation is extremely easy and the equipment which is contained in three transportable cases needs 200/250 volts 50 cycles A.C. mains supply or a Car Battery and converter. Facilities for play-back and for sound amplification form an integral part of the Recorder. **RECORDING BLANKS:** EMIDISC Recording Blanks are ready for playback immediately after cutting. They are available in the following sizes—6″, 10″, 12″, 16″. **PROCESS BLANKS**—enabling the recording to be pressed in quantity, by E.M.I., are obtainable for 11″, 12″, 13″, 17¼″ recordings.



MICROPHONES: Alternative types of microphones are available. **Model 2350** on a heavy chrome stand (detachable). **Model 2351** with hooks, equally adaptable for suspension, mounting on a boom or floor stand.



A descriptive leaflet giving full details of Model 2300, extra Microphones and Recording Blanks is available on request.

E.M.I. PORTABLE RECORDER No. 2300

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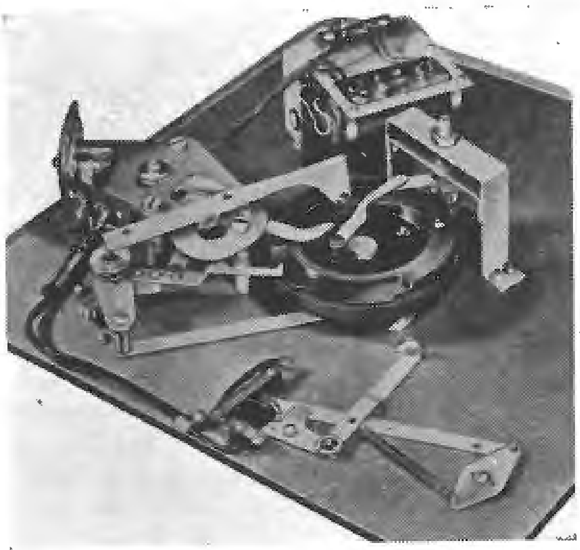
S.S.7



Simplified mechanism including moulded plastic cam used in the Marconiphone AC100M record changer.

their new Model V/AD—a marine version of the Model V radio-gram turntable unit—in which a counterbalanced mechanism enables the pickup to track unperturbed at angles of tilt up to 90 degrees.

In record-changers the latest designs, e.g., the Collaro RC500 and Marconiphone AC100M, exemplify the considerable simplification in the underside mechanism and consequent reduction in price that are possible when mixing is not required and 10in or 12in records are grouped separately.

COMPONENTS

THERE was not a great number of new components at Olympia this year but those that did appear were mainly of the miniature kind. Some have obviously been designed specially for use in the latest v.h.f. equipments where physical size is almost as important as the electrical characteristics. Others will find their main applications in the new very small portables and hearing aids.

The new miniature metallized paper capacitors shown by Hunts come within the second category. They are known as the Type W99 and some 200 of them can be stacked on an ordinary matchbox. Although the overall size is but $\frac{7}{16}$in long and $\frac{3}{16}$in in diameter, the actual capacitor element itself does not exceed $\frac{1}{4}$in × $\frac{1}{8}$in, yet it has been possible to squeeze 10,000 pF in this small compass. Up to 0.003 μF the working voltage is 350 and over and up to 0.01 μF it is 150 V d.c.

Dubilier were showing some capacitors of a very similar kind and of about the same size. Capacitance range is the same and so are the working voltages, but in this make there are two varieties, one has a resin-based moulding, the other is coated in a hard wax.

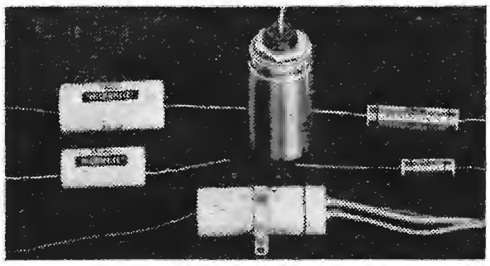
Improvements and additions continue to be made to the Dubilier "Drilitic" range of capacitors, and these are now available with either insulated or metal adaptor plates for use where it is inconvenient to provide the special slots in the chassis for the new-type fixing lugs.

A safety vent is now embodied in the majority of aluminium-cased electrolytic capacitors, and it was noticed that both Dubilier and T.C.C. adopt this feature. It is no indication that any kind of danger attends the use of these capacitors, it is merely an insurance that in the event of a heavy overload any gas liberated in the electrolyte can escape easily. The vent is self-closing.

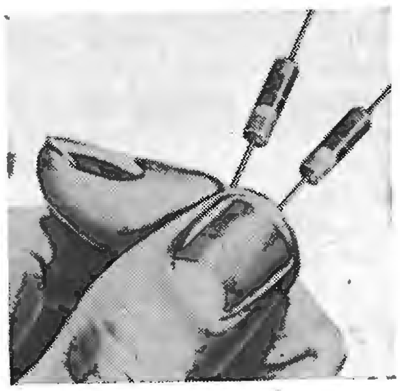
The very great reduction in size of electrolytics that is apparent at every turn is, in the main, due to the wider adoption of the etched-foil technique. By chemically roughening the surface of the aluminium foil a greater effective area is exposed to the electrolyte, and as a higher capacitance results from a given superficial area, the size is reduced.

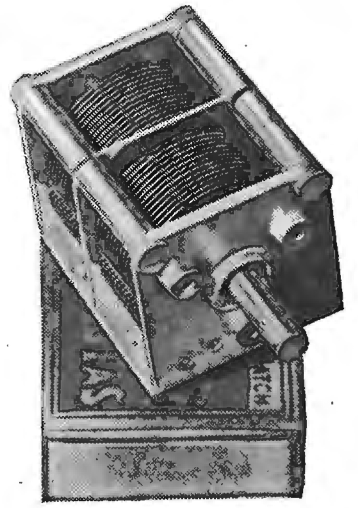
The etched-foil capacitors, of which many examples were shown by Dubilier, Hunt and T.C.C., have definite ripple-voltage limitations and they are consequently best suited for decoupling, bypass and h.t. smoothing after the smoothing choke. The plain foil variety are included by all makers for use as reservoir capacitors.

A reintroduction by T.C.C. of some earlier pattern electrolytics in aluminium cases, with the once familiar threaded insulated fixing bush, will probably be welcome news to service technicians wanting replacements for pre-war receivers. This revived pattern is known as the "Lectroboss" range and contains all the usual capacitances. A revived series in cardboard tubes, described as "Microtubes," was also included among the T.C.C. exhibits. It was seen also that Hunt had a large selection of replacement-type electrolytics that should satisfy all demands for capacitance and voltages. There have been some extensions in the capacitances available in existing types, for example, T.C.C. have added several new sizes to their "Plastapack" and "Micromite" ranges and introduced some



Group of T.C.C. capacitors including new Micromite, Plastapack and Lectroboss models.





This Polar two-gang midget variable capacitor (0.0005μF each section) is actually smaller than a match box.

(Left) Dubilier type BTS half-watt miniature insulated resistors.

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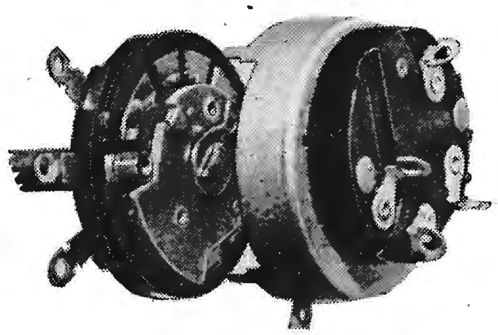
"Multi-Picopack" capacitors and also expanded the "Cathodray" series with models especially designed for line flyback e.h.t. generators.

In general there was little new in the design of variable capacitors except that greater prominence was given to all the miniature patterns. By this is meant the physically smaller types of two- and three-gang capacitors for broadcast receivers. One two-gang model shown by Polar measured $1\frac{1}{2} \times 1\frac{1}{2} \times 2\frac{1}{4}$in only, yet each section gave a capacitance change of 523 pF. It exemplified the high precision now achieved in mass production, as the vane spacing is 0.009in only. Taken in conjunction with the all-round reduction in size of components, it is not so surprising that makers of portables and car radio sets have been able to bring the size and weight down to the extent they have.

Few new resistors made their appearance at this exhibition, although detail improvements could be discerned in some cases. It was seen that Dubilier had a new range of insulated resistors in $\frac{1}{2}$-W and 1-W sizes. It did appear that there was a disproportionate difference in the physical sizes of



Erie stud-potentiometer with switch plate removed.

the two ratings, but apparently in the $\frac{1}{2}$-watt models the lead-out wires are relatively large in area compared with the resistor element and so radiate a greater part of the heat generated. The insulated case is to some extent a heat insulator as well, and so the 1-W models have had to be made physically larger to radiate heat at an adequate rate. The $\frac{1}{2}$-W range measure $\frac{3}{8}$in long and $\frac{1}{8}$in in diameter only, and they are known as the type BTS.

A means of utilizing ordinary miniature resistors in a variable potentiometer has been evolved by Erie. It takes the form of a 9-step stud switch, and any combination of resistors can be used, so imparting to the potentiometer any desired law. In appearance it resembles an orthodox volume control and can even be fitted with a switch on the back cover. In this form, however, seven contact studs only are available.

Among the less common uses of resistors must be mentioned the motor car ignition suppressor. Generally it is an essential fitting when any form of radio is used in a car, and it is also the most satisfactory means of suppression for interference with television. In most cases a resistor of about 5 kΩ inserted in the h.t. lead between the coil and the distributor will suffice. All the leading resistor manufacturers now include a suppressor of this kind made up in a convenient form for fitting to the distributor. The lead is removed, the suppressor fitted in its place and the lead inserted into the suppressor. Both screw-in and plug-in types were shown by Belling-Lee, Bulgin, Dubilier and Erie.

A component of which very little is heard, but which nevertheless plays a most important role, is the illuminated indicator. Nearly every type of test equipment includes one or more, but its greatest field of usefulness is in communications equipment. So much of this is remote controlled that visual indication of the state of the apparatus for immediate use is well-nigh essential. The range of signal lamps and fittings shown by Bulgin gave some idea of the wide use to which illuminated indicators can be put.

ACCESSORIES

FROM a strictly scientific point of view the Vidor-Kalium cell is not new; a technical description of it was given in *Wireless World* a year ago,* but interest is again focused on it in view of its appearance as a production article at Radiolympia this year. It was a combined Vidor-Burndept exhibit. Unfortunately the whole of the present output is absorbed by the armed services, although a small quantity of cells for the Government hearing aids may soon be available. It will be some time before supplies permit its use in ordinary portable receivers.

So far the Kalium cell is being produced for l.t. purposes only as it has such a marked advantage over the Leclanché type at relatively heavy discharge rates, but its potential advantages for other uses is not being ignored.

Cells shown ranged in size from the B.S.S. types U1 to U7, the Vidor counterparts having the type numbers V0101 to V0107 respectively. Broadly speaking, the Kalium cell has a life four to seven times greater than the ordinary dry cell of comparable size, there is no appreciable drop in voltage over the full life of the cell (on load it is between 1.2 to 1.3 V) and its shelf life is exceptionally good. As the watt-hour output is so greatly increased, the size and weight of the cell, or battery, for a given output becomes very much smaller than an equivalent Leclanché pattern.

This was not the only development of interest in the battery field, as Exide was showing a new unspillable l.t. accumulator known as the type JSP2. One special feature is the use of a moulded polystyrene case, which is light in weight, completely acid-proof, also free from discoloration and not dangerously inflammable.

Another feature of the new cell, and one which is also employed in other Exide accumulators, is the

Vidor-Burndept Kalium cell compared with a Leclanche pattern of comparable watt-hour capacity.

* "Fresh Progress in Dry Batteries," *Wireless World*, October, 1948, pp. 352-354

use of very absorbent "Lignex" separators, which hold in suspension almost all the electrolyte and if the cell is inverted only a teaspoonful of free acid runs into the special acid trap in the lid of the case.

Exide JSP2 unspillable accumulator for which a moulded polystyrene case is used.

The considerable reduction in size of h.t. batteries made possible by the further developments of the layer-type of construction is not always apparent as most makers now include quite large l.t. sections, which, being housed in the same container, tend to give a mistaken idea of the real size of the h.t. portion. In many cases half, or more, of the box is taken up with l.t. cells (this point would have been much better appreciated if more firms gave prominence to enlarged cut-away views of a typical battery). Drydex, Ever Ready, Oldham and Vidor among others were showing batteries of this kind with and without l.t. sections, the range of models now available being very impressive indeed.

Amplion were showing an extended range of complete battery eliminators to enable portable sets to be used on a.c. mains in the house. A number of models have been designed to fit into the battery compartment of "all-dry" portables and the newest addition is a midget "Convette," measuring $4\frac{1}{4} \times 3\frac{1}{4} \times 1\frac{1}{4}$in overall and intended for personal portables. It replaces both h.t. and l.t. batteries, contains a mains transformer, two metal rectifiers, one for h.t. and one for l.t. and smoothing equipment for both supplies. Fourteen days' operation costs about 1d

Apart from batteries, power supply equipment does not lend itself very well to miniaturization, although, as just shown, Amplion have found a way for one particular application. Reduction in the size of the selenium types of rectifiers for l.t., h.t. and e.h.t. is progressing and this was exemplified by some new models shown by Westinghouse. As the bulk of the space is taken up by cooling fins, the smaller sets, which are usually the more economical in current demands, can have smaller rectifiers. One example was the HT54 rectifier designed for operating midget receivers from 110-V a.c. mains. The surplus volts, where they exist, can be dropped in a line cord resistor or its equivalent. This is a half-wave rectifier and measures $\frac{5}{8}$in in diameter and $2\frac{11}{16}$in long. This firm now has a range of full-wave rectifiers as substitutes for the valve types; they cover 300-0-300 V to 500-0-550 V r.m.s. input and 40 to 200 mA d.c. output.

For television e.h.t. supplies Westinghouse was showing a range of voltage multiplier units for obtaining from 1.7 to 5 kV from a 350-volt a.c. transformer and a new 6-kV output pulse-driven unit for obtaining e.h.t. from the line fly-back transformer. This is fitted with three of their 36EHT35 rectifiers. This rectifier is one of 21 in the 36EHT series rated for operation with peak inverse voltages ranging from 800 volts to 19,200 volts. This e.h.t. unit is sold as a kit of parts for assembly in the receiver.

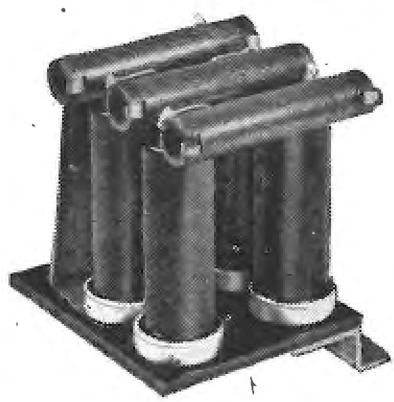
Amplion midget Convette for operating persona portables from the a.c. mains.

Few really new valves were seen at this exhibition, but many introduced earlier in the year but not generally available, can now be obtained. The indications are that before long more types on the B9A base will be forthcoming, although so far the newest models in the miniature class, and most of them are miniatures unless it is physically impossible to make them so, are B7G based.

Brimar had a new triode hexode on the B9A base with a centre-tapped heater for either 12.6 or 6.3 volts operation, the current taken being 0.15 A at 12.6 V. It is thus suitable for a.c. or a.c./d.c. operation in the most economical form. The conversion conductance is 0.69 mA/V and the mutual conductance of the triode section is 3.6 mA/V.

Another new Brimar valve is the 19BG6G, which is a line time base ouput tetrode taking 19 volts at 0.3 amp and thus suitable for series operation in a.c./d.c. television sets. Used with a suitable transformer and a single R12 rectifier, an e.h.t. supply of 10 kV can be obtained direct from the fly-back pulses. It is similar to the 6BG6G, which is a 6.3-volt version and, like this valve, is mounted on an octal base.

Some new valves for a.c./d.c. television receivers were seen also on the Mazda stand. There was an r.f. pentode designed especially for t.r.f. sets and having a mutual conductance of 9 mA/V with an input impedance of 15 kΩ at 45 Mc/s. Quite a good performance can be obtained with a "straight" set at the Birmingham frequency of 63 Mc/s as its input impedance will be of the order of 8 to 10 kΩ. There are two versions of this valve, the 6F1 for 6.3-volt operation and the 10F1 for 22-volt operation taking 0.1 A so that series connection of heaters is possible.



Westinghouse Unit for obtaining e.h.t. from the line output transformer.

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Also for use as an r.f. amplifier in t.r.f. sets is the Mullard EF80, which is an r.f. pentode on a B9A base. Its input impedance is 11.5 kΩ at 50 Mc/s. It is in the 6.3-volt series.

A range of Mazda 0.1-A valves for a.c./d.c. operation is now available, including a new rectifier having four anodes and four cathodes. The anodes are brought out to separate base pins, but the cathodes are joined in pairs. The reason that four anodes are used is to enable a low effective series resistor, necessary in a.c./d.c. operation, to be used. As the normal value adequate to protect the valve is about 100 Ω the four in parallel place only 25 Ω of idle resistance in the h.t. circuit, yet provide the protection of 100 Ω series resistance.

Mazda had also a new power valve for use as a self-excited line-scan oscillator. It is the 20P1 and is rated at 20 W anode and 5 W screen dissipation. The normal cathode current is 100 to 120 mA. The valve has a very low a.c. resistance and will thus pass heavy cathode currents with low anode and screen voltages.

Nineteen volts is also the heater

G.E.C. disc-seal transmitting tetrode with forced air cooled anode.

supply for some new Osram valves on B7G bases. They take 0.1 A and are for series running in a.c./d.c. sets. There is a frequency changer, the X108, an r.f. pentode, W107 and a double diode triode, the DH107. A power pentode giving 4 watts output, the N108 and the U107 half-wave rectifier, while also taking 0.1 A require 40 volts each.

With the exception of a few minor details there was nothing new to be seen in cathode ray tubes. The aluminized screen is becoming more widely used, Brimar, Mazda and Mullard were each showing some examples of this type, which in general require a somewhat higher final anode voltage, it ranges from about 7 kV to 12 kV and 9-, 12- and 15-in sizes were seen. One of the advantages claimed is better contrast, especially in the black which is definitely black and not a greyish-black. The tube is also brighter.

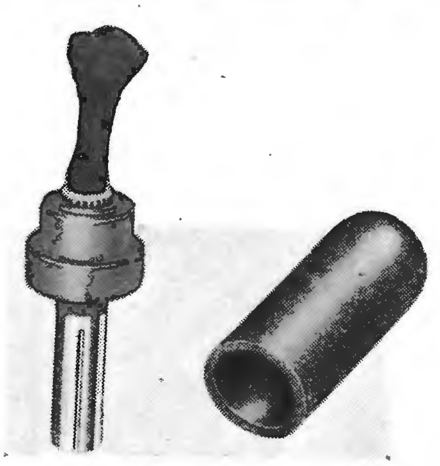
Cossor have made some useful improvements in their 3½in flat-screen double-beam electrostatic c.r. tube for instrument use and it is now possible to get very good focusing indeed with a final anode voltage of 2 kV or less.

Developments in transmitting valves, especially for the higher frequencies, continue as Brimar had a v.h.f. tetrode for mobile sets with duplicated input grid leads to reduce input inductance and also to give better heat dissipation. It is mounted on a B9A base and is rated at 12 W anode dissipation with maximum rating up to 150 Mc/s. A double tetrode, the TT17, was shown by Osram. One of its interesting features is a 19-volt heater, so it is apparently developed primarily for aircraft equipment. Its upper frequency is 250 Mc/s and the combined anode dissipation is 40 watts. It is very like the American 829B in its electrical characteristics even to including a built-in screen-cathode bypass capacitor of 100 pF.

A new development in disc-seal technique is the Osram A1824 transmitting tetrode for operation up to 400 Mc/s at which frequency an output of 150 watts is possible. At 100 Mc/s it gives about 185 watts output. Although the construction is of the disc seal type it does not have co-planar electrodes, but they follow the more orthodox pattern of concentric cylinders. The anode is of copper and heavily ribbed to assist cooling as a blower will normally be used.

Apart from television aerials, which are dealt with elsewhere, there was little new to be seen in aerial design. The vertical rod pattern has been better engineered and the fixing brackets and insulation generally improved. Aerials of this kind were shown by Aerialite, Antiference, Belling-Lee and New London Electron Works; the last-mentioned firm had a model with an integral earthing rod that acts as the support for the aerial.

At certain times of the year, particularly when thundery con-



Belling-Lee "Corronette", a static discharge device for rod aerials.

ditions are prevalent, well insulated aerials are liable to acquire a static charge that discharges in rapid bursts to the surrounding air from the thin pointed top of the rod. This produces static noise not unlike motor car ignition interference. To cure it Belling-Lee have introduced a discharging device which, when fitted to the top of the aerial rod, changes the mode of discharge from a sudden burst to a slow leakage. It is tantamount to inserting resistance in the discharge circuit.

COMMUNICATIONS

THE increasing use of the radio telephone by smaller craft, such as trawlers, has induced a number of firms to turn their attention to this class of equipment. One example was the Mullard type GNE510 for use in the band 1.6 to 3.7 Mc/s. The transmitter provides the choice of eight crystal-controlled spot frequencies and gives about 9 watts r.f. output into a typical ship's aerial. The receiver gives the choice of seven spot frequencies, also crystal controlled, and in addition has a limited free-tuning range for reception of B.B.C. programmes on 261 metres and for stations close to this wavelength. All operating power is obtained from a 12-volt battery and a rotary convertor.

Equipment of a similar kind, and with the appropriate name "Dolphin," was shown by Pye. The transmitter operates on eight spot frequencies, crystal controlled, in the band 1.5 to 3.8 Mc/s, while the receiver covers 530 kc/s to 3.8 Mc/s. It operates from 6- or 12-volt batteries and gives between 8 and 10 watts r.f. output.

High-power marine transmitters designed on modern lines with the whole of the equipment, including the controls, hidden behind plain steel doors were shown by Marconi and Standard, while some smaller sets of 1-kW output and below were among the latest marine equipment seen on the stands of G.E.C. and Mullard.

There was a wide choice of mobile equipments for use in all types of vehicles, including the heavy kind that may have to operate over large tracts of sparsely populated country where construction or other development work is going on. H.F. communication equipment for this purpose was shown by G.E.C. It is assembled in a strong teak box and the various units, comprising transmitter, receiver and power supplies, are mounted on shockproof fittings. The transmitting range of frequencies is 2 to 9 Mc/s and reception can be effected over 2 to 20 Mc/s.

Some experimental radio installations for trains appear to have been carried out here, although very little has been heard of the results obtained. There was a typical equipment shown by G.E.C. which utilized their standard 20-watt mobile v.h.f. transmitter-receiver, but housed in a very massive watertight iron case. Heavy ribbing is used to assist radiation of heat, as any form of open ventilation is impracticable. Either f.m. or a.m. systems can be used.

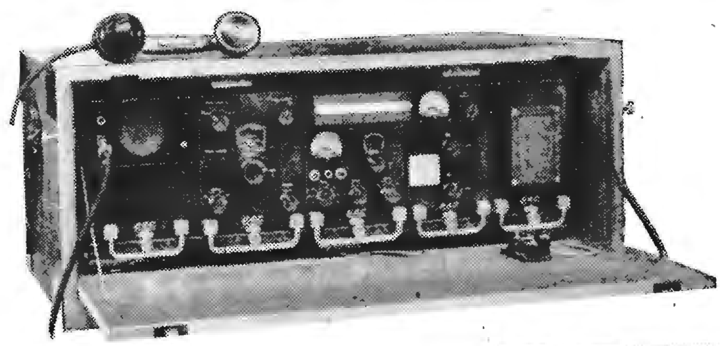
The similarity that at one time existed between ground mobile and aircraft v.h.f. equipment is becoming far less marked as the two services are finding their requirements more and more divergent. The latest sets for aircraft tend towards providing the maximum possible number of channels selected by simple switching.

A set of this kind was shown by Murphy and it provides 140 channels in the band 118 to 132 Mc/s, the transmitter and receiver being automatically lined up on the selected frequency. Another set achieving a similar result was seen on the Ekco stand, this was somewhat more ambitious and gave the choice of 300 channels in the band 100 to 156 Mc/s.

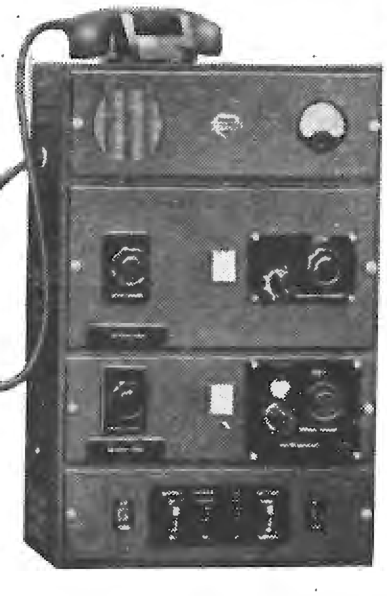
Romac have developed a versatile aircraft installation which is extremely compact yet provides v.h.f. send and receiver facilities on twelve spot frequencies, d.f. reception on 165 to 500 kc/s and reception of SBA marker and beacon signals. It is contained in four small units, the whole weighing just under 28 lbs.

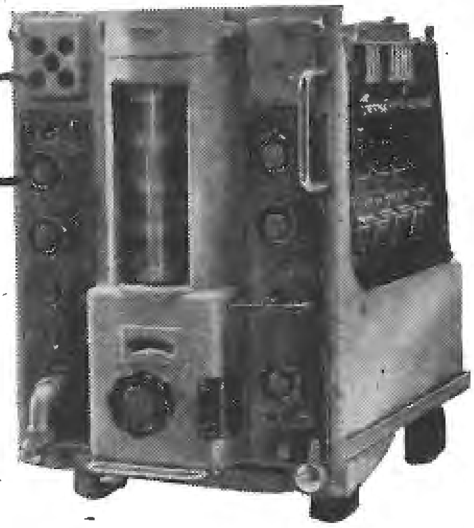
Quite a number of new applications appear to have been found for the mobile type v.h.f. radio telephone, and the operating bands are extending higher into the radio spectrum. Marconi was mobile equipment for taxis and other services covering 156 to 184 Mc/s. This is the Model BTR78.

Although the double superheterodyne principle is often used in v.h.f. receivers operating on a fixed frequency, it is less common among sets that cover a wide waveband. With two oscillators, or rather three including the b.f.o., heterodyne whistles can be very troublesome, but these appear to have been solved by Stratton in their latest communications receiver, the Model 750, which is a double superhet. The first i.f. is 1,600 kc/s and the second 85 kc/s. It covers 480 to 1,465 kc/s and 1.7 to 32 Mc/s in four ranges. A large rectangular scale is used and it has mechani-



Mobile h.f. equipment for heavy vehicles, shown by G.E.C.





Murphy MR56A marine communications receiver with cover removed. The coil turret is just visible on the right.

(Left) Mullard GNE510 radio telephone for trawlers.

showing its application for short-range picture transmission, Ekco exhibited a radio telephone set for a motor cycle, G.E.C. had a lightweight set for general use on frequencies up to 180 Mc/s (the BRT360), and Murphy had a cal bandspread. This set has many of the features of the Model 680 and is actually an inexpensive version of that set.

Another set with unusual features was the Mullard Model GFR520, which has the excep-

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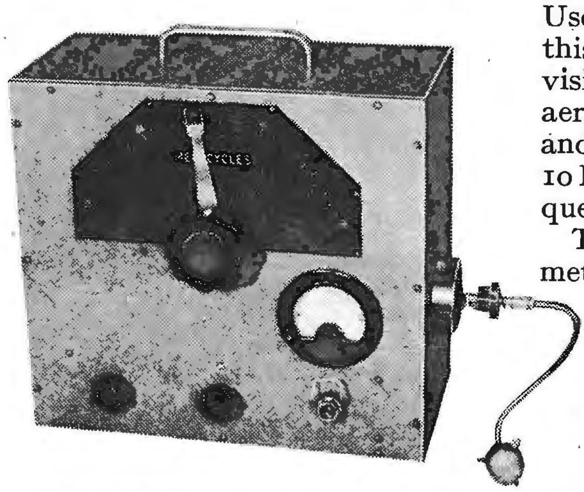
tionally wide coverage of 54 kc/s to 110 Mc/s. This receiver has two i.f. amplifiers, one of 10.7 Mc/s, which is wide-band (±50 kc/s) and is used on 27 to 110 Mc/s with provision for a.m. or f.m. reception. The other is of 455 kc/s and is variable in bandwidths from 25 k/s to 10 c/s, the last-mentioned is with a crystal filter.

Two receivers designed and constructed to meet the Post Office specification for use on merchant ships have been introduced by Murphy. Known as Models 56A and 56B they are slightly modified versions of the Naval receivers B40 and B41 and cover the same wavebands, namely, 640 kc/s to 30 Mc/s and 15 to 700 kc/s respectively, each in five bands. A massive coil turret is employed and the workmanship throughout follows the best Naval practice.

TESTING AND MEASURING GEAR

EQUIPMENT in this category, which showed substantial progress, might be divided into three classes—for laboratory, factory, and service depot. In practice, of course, there is a good deal of overlapping. Some of the instruments now offered to the serviceman give facilities which a few years ago were available only in the form of a laboratory set-up. The rapid development of television, with its increased technical demands, has undoubtedly stimulated an all-round rise in the standard. As might have been expected, many of the new instruments catered specifically for television.

A good example was the Pye signal generator Type 940226, covering 40-70 Mc/s with an exceptionally large clear scale calibrated every 0.25 Mc/s. Sound-



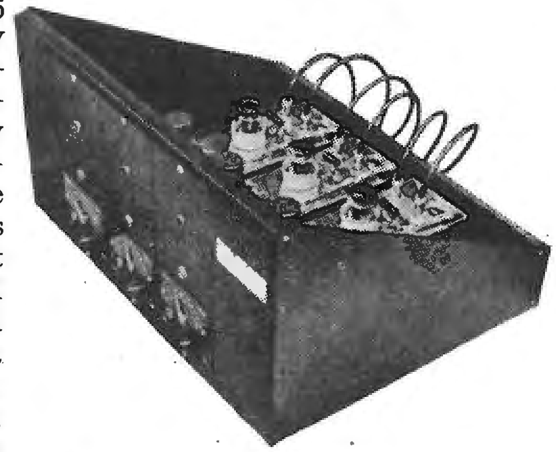
Pye television signal generator, Type 940226.

channel tests are provided for by 30 per cent modulation by 400 c/s sine wave, and vision by 100 per cent modulation by 400 c/s and 60 kc/s square wave, giving a pattern of eight white bars on "Frame" and six on "Line." Variation of carrier output is by piston attenuator calibrated over a range of 100 db with reference to a metered maximum of 0.1 V. The latest addition to the Windsor (Taylor) range of instruments mainly for the serviceman was the Model 240A television pattern generator, covering the same r.f. range as the Pye and providing outputs at approximately 50, 5 and 0.5 mV. For the entirely different requirements of television receiver production, Burndept showed a sample assembly of signal generator units, any desired number of which can be rack-mounted and the signals piped to the factory test bays, at each of which would be installed a unit containing a 12-way coaxial switch, an attenuator and a crystal-rectifier monitoring meter. Lastly, a laboratory interpretation — the Marconi Instruments TF923 television sweep generator. Used with a suitable oscilloscope, this enables the responses of television and other v.h.f. receivers, aerials and feeders to be checked and aligned over any band up to 10 Mc/s wide around pre-set frequencies in the range 40-190 Mc/s.

The same firm's field-strength meter Type TF930 includes many communication channels as well as television and f.m. broadcasting frequencies in its range of 18-125 Mc/s. It is of the type in which the incoming signal, received on an aerial of known effective height, is compared with a reference oscillator. The alternative technique, in which first-stage noise is the standard of reference, was exemplified by the Murphy FSM.22, intended particularly for measuring interference in the range 30-150 Mc/s. A more widely experienced and rapidly growing need is for means of tracking down interference in the v.h.f. band, and the Murphy portable Type TS.71 was designed to meet this. It consists of a sensitive superhet covering 30-100 Mc/s, fitted with alternative aerials—a vertical rod and a semi-stiff screened loop—and the total weight is only 22 lb. For rendering unmodulated carriers audible, the second i.f. valve can be made to oscillate at a.f.

An interesting exhibit was the Belling-Lee television mobile research unit—a van containing a field-strength measuring set of the firm's design (reference-noise type), signal generator, aerial-impedance measuring gear, oscilloscope, television receivers, and an extensible aerial with angular scale for plotting polar diagrams.

For the still higher frequencies corresponding to 3 cm wavelength,



Rack-mounted television test signal generator for factories (Burndept).

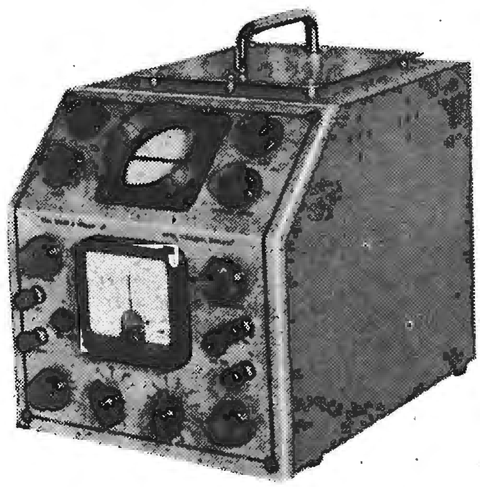
Metro-Vick showed examples of their precision test gear, including an oscillographic standing-wave indicator and waveguide equipment characterized by constancy of probe penetration within ±0.0001in.

Of special interest to the amateur was the Eddystone modulation-level indicator, in which the carrier picked up by a small rod aerial is adjusted to give full-scale reading on a germanium-rectifier meter. The instrument is then switched to indicate the modulation amplitude relative to it, on a direct-reading percentage scale. Other Eddystone items included an externally similar signal-strength meter, an absorption wavemeter for ±1 per cent frequency checks, and a crystal calibrator for ±0.01 per cent interpolation. Six crystal-controlled frequencies are provided by a generator which was among a large variety of specialized instruments shown by E.R.I.C.

Coming now to audio generators, an addition to the well-known B.S.R. beat-frequency oscillators was Type LO400/100, covering the range 10 c/s to 100 kc/s on two dials without switching. The latest Advance generator, Type H1 covering 15 c/s to 50 kc/s in three ranges, is of the RC type, and provides both sine and square waveforms, controlled in amplitude by attenuators from 200 μV to 20 V accurate to within $\pm$1 db.

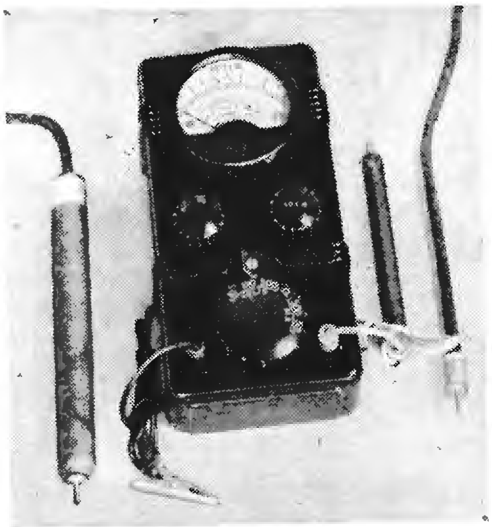
The E.M.I. Sales and Service stand was devoted almost entirely to test instruments, many of them shown for the first time. The Q/D041 a.f. test set is more than an audio generator, for it incorporates an independently usable valve voltmeter, amplifier and attenuator, making it a suitable source and detector for a wide-range bridge and a distortion bridge, also shown. The automatic monitor, Q/D231, was one of the most interesting examples of equipment designed for servicing—a 1-kc/s multivibrator supplying a test signal over the whole r.f. spectrum up to 10 Mc/s, available through three channels for connecting to receivers suspected of intermittent faults. The outputs of the receivers are fed back to the monitor unit, which gives warning of any decrease in level. A feature of the new oscilloscope, Q/D101, is a valve voltmeter arranged to give accurate measurement of the whole or any part of a waveform seen on the c.r.t.

Among separate valve voltmeters were new models by B.S.R.



E.M.I. oscilloscope, Type Q/D101.

and E.R.I.C., the former notable for high sensitivity (down to 10 mV full-scale) and the latter for voltage ranges up to 1,000 V a.c. and d.c. The Mullard valve



Amplion multi-range test set.

volt-ohmeter Type E7555, new to Radiolympia, seemed to hold the record for ranges, covering from 3 V to 10 kV f.s. as well as resistance from 20 Ω to 2 MΩ mid-scale.

An extreme example of the use of valve-voltmeter technique for measuring resistance was the Burndept high-resistance test set, in which the drop across a known resistance in series with the unknown is applied to a pair of electrometer valves in push-pull. The range of measurement is 1 to 100 million megohms.

The scope for development in conventional types of meter continues to dwindle. Of the few new types, two multi-range meters at opposite extremes in the price range were the pocket Amplion at 67s 6d and the Sangamo-Weston at £65. Two features notable in such an inexpensive model as the Amplion were the fairly high sensitivity (1,800 Ω/V) and the prod for measuring up to 5 kV. The Weston was a beautiful instrument, with 53 ranges controlled by a pair of 20-way switches, a sensitivity of 20,000 Ω/V, and self-contained measurement up to 500 MΩ at 500 V.

To keep pace with the trend towards higher voltages the Airmec ionization-voltage tester, previously variable up to 5 kV, can now be obtained up to 25 kV. Units providing e.h.t. up to 25 kV from rectified 180 kc/s were shown by Hazlehurst. And among the E.R.I.C. equipment was a generator giving 1 Mc/s a.c. at 30 kV.

In an entirely different field, Cosmocord showed a new range of piezoelectric acoustical measuring instruments, using stable crystals of lithium sulphate and ammonium dihydrogen phosphate to give calculable electrical output over extreme ranges of frequency and sound pressure.

An example of how measurements that usually required a special laboratory set-up can now be carried out with tidy portable instruments was the Avo electronic test unit (not to be confused with the electronic test meter). Used in conjunction with a signal generator and valve voltmeter, it provides for measurements of r.f. inductance, capacitance, Q, and low values of voltage. Basically it is an amplifier, aperiodic from 30 c/s to 2 Mc/s and flatly tuned to 20 Mc/s. The variable capacitor is calibrated for measuring L, C and Q.

In the industrial field, the Airmec tester Type 719 enables materials to be compared against a standard for size, conductivity, permeability, etc., within very close limits, simply by placing it within a suitable coil connected in a bridge circuit. Amplitude-and-phase balance is indicated by a c.r.t.

Although not offered for sale, the automatic capacitor tester shown on the T.C.C. stand was an interesting example of production test-gear. Capacitors fed in at one end were subjected successively to a voltage test, an insulation resistance test, and anything up to ten capacitance selection tests to pre-set limits. The number of capacitors thrown out as rejects by the first two and accepted by the remaining stages was indicated by counters.

SCIENTIFIC, INDUSTRIAL AND MEDICAL APPARATUS

ALTHOUGH equipment under this heading might seem out of place in a radio exhibition, constructionally much of it was indistinguishable from radio apparatus proper, and exemplified the way in which techniques originally introduced for radio have

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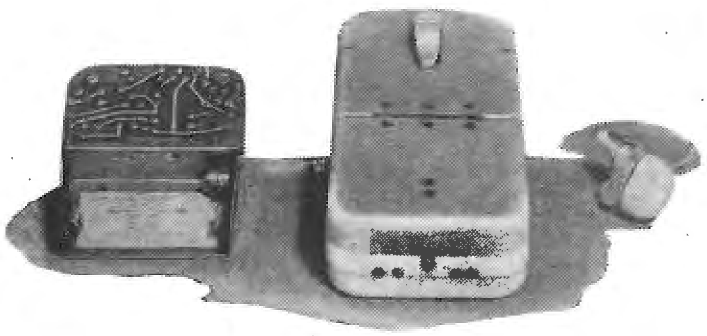
been adopted for a variety of other purposes.

So much does this apply to hearing aids that at least two of the models shown were available with radio facilities. Auratone models included straight hearing aids, superhet broadcast receivers of similar form and size, and combinations of both. The hearing aid was described as "calibrated," that is to say provided with a control by which the frequency characteristic can be adjusted to meet the particular deficiency of the wearer. Radio and combined models incorporate a 4-valve receiver with a tuning range of 200-400 metres. The Belclere Radio Monopack shown by John Bell and Croyden was an adaptation of that firm's hearing aid, which was interesting as an example of a printed circuit, using the colloidal silver process. Radio reception of one station is pre-set, and there is automatic volume compression. The same firm exhibited their audiometer and associated gramophone equipment as used for comprehensive tests of schoolchildren's hearing in groups of up to 24 at a time. Also on show was the Ministry of Health hearing aid manufactured by Kolster-Brandes and offered for export under the name Kolsterphone.

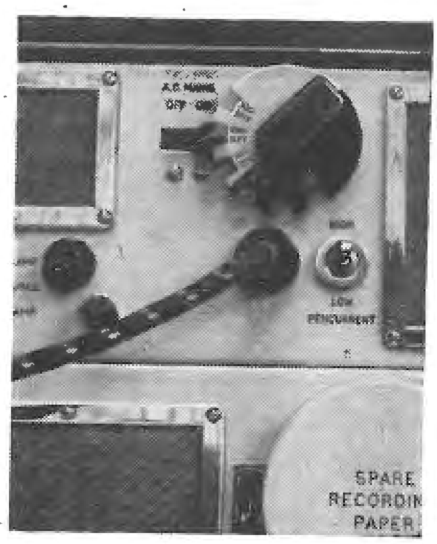
A fine example of portable medical apparatus was the Cossor electrocardiograph, available in the outer form of a small suitcase. One of the difficulties of mains-driven equipment of this kind is the variety of voltages that may be encountered in daily practice. A neat mains-voltage switch is fitted in full view on the front panel of the Cossor instrument, so that it is operable in an instant, but is also slotted so that it cannot be turned without switching off.



Belclere hearing aid and radio receiver.

No outstanding innovations were to be seen in the field of industrial r.f. heating. A number of valve-operated control devices were shown, ranging from infra-red burglar alarms to automatic voltage regulators rated up to 30,000 kW. The latter, by B.T-H, made use of a bridge with two temperature-sensitive arms (lamps) to control a bank of thyratrons feeding the machine exciter.

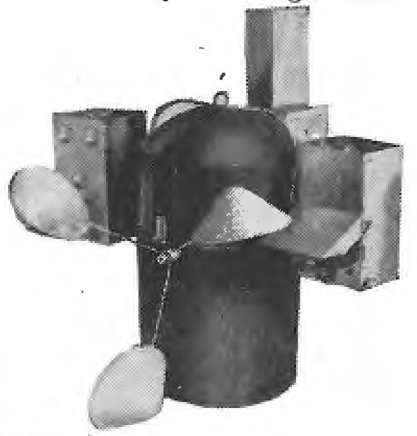
A vibration meter, consisting of a moving-coil probe in a weighted holder, followed by a 4-stage amplifier, for peak vibratory accelerations up to 40g in the range 20-2,500 c/s, was shown by B.S.R., along with a wave analyzer which can be used in conjunction with it.



Mains voltage adjustment in the Cossor electrocardiograph.

The science of meteorology was represented on the W.B. stand by demonstration of a radiosonde—automatic balloon-borne radio transmitter—and associated ground equipment. As the balloon rises, three modulation frequencies are successively switched in by the rotation of a wind vane, these frequencies being controlled by the action of the three instruments carried, indicating height, temperature and humidity.

But the most active science served by the radio industry seems undoubtedly to be atomic research, judging from the number of radioactivity measuring instruments to be seen; and one was struck by the high state of development of much of this equipment, shown by Airmec, Dynatron, Ekco, G.E.C., and Marconi Instruments. A particularly comprehensive display was shown by Ekco, including a whole range of "pistol" type radiation monitors, used, among other things, for ensuring that laboratory workers are not exposed to unhealthily intense radioactivity. A typical research equipment consists of a Geiger-Muller tube followed by a counter, and in some cases a timer to enable the period during which the impulses are counted to be accurately measured, and a c.r.t. monitor and stabilized power supplies. The Marconi counter, for example, can register up to 100,000 per second and time any period from 10 microsecs to 10 secs. The Ekco "scaler" is a counter only, but a "ratemeter" is available to give continuous direct reading of the mean rate of impulses up to 100,000 per sec.; its principle is similar to that of the "charge/discharge" frequency meter. In some of these instruments, developed for the Atomic Energy Research Establishment, extraordinary precautions had to be taken to ensure stability and low noise level; even in such an apparently straightforward unit as a power pack, for example, leakage had to be reduced far below what is tolerable in normal practice. The need for such care may be judged from the fact that, using the Ekco vibration electrometer, in certain circumstances it is possible to detect the discharge of a single electron.



Radio-sonde transmitter made by Whiteley Electrical Radio.

WORLD OF WIRELESS

Licence Record ✦ F.M. Broadcasting ✦ Television Plan ✦ U.S. Radio Slump

12,000,000 *Licences*

ANOTHER milestone in British broadcasting has been passed. It is announced by the Post Office that at the end of August the number of broadcast receiving licences in force was 12,017,500. This figure included 162,150 television licences. The month's increases in "sound" and "vision" licences were 52,250 and 7,000 respectively.

Having passed this milestone, it is not without interest to recall the passing of others. The first million listeners were licensed in 1924—two years after broadcasting began in this country. Eight years later the five-million mark was reached. The total reached ten million in January, 1946, and eleven million in December, 1947.

European F.M.

IN view of the limited number of frequencies allocated to Germany under the Copenhagen Plan, recourse has been made to the introduction of f.m. on ultra-short waves. Standards for transmitters have been fixed and plans made for the erection of 54 transmitters in the American Zone, varying in power from 0.25 to 10 kW. In the British Zone three transmitters are planned—at Hamburg, Hanover and in the Ruhr. The reason for the difference in the number of transmitters is due to the vastly different dispositions of the population. In the U.S. Zone there are a great many small centres of population, whereas the British Zone contains large thickly populated towns.

CAR TELEVISION.—**A possible future development of television was demonstrated by H.M.V., in co-operation with the Standard Motor Co., at Radiolympia and the Motor Show. A television set was fitted between the front seats of a car. Power was supplied by a rotary convertor.**

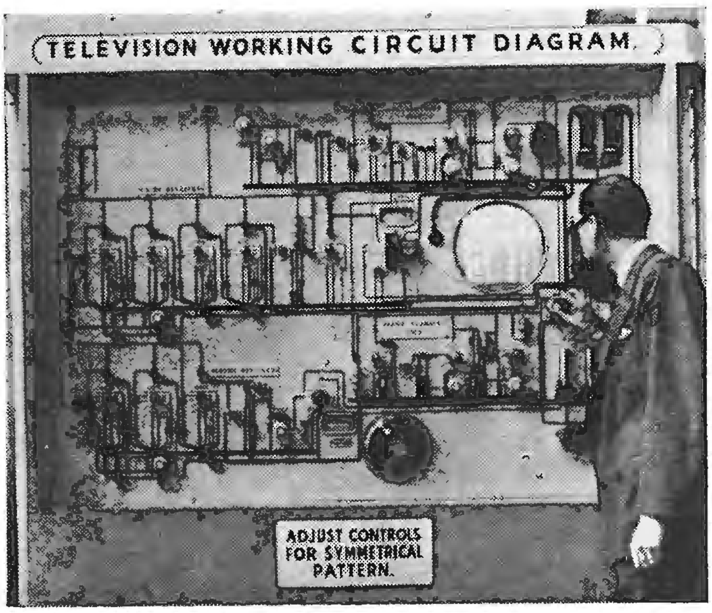
Eleven carrier frequencies will be available for stations in the 88-100 Mc/s band to be employed.

Italy is also planning to employ f.m. to overcome the difficulties of providing an adequate broadcasting service with her limited number of frequencies. Experimental stations have been erected in Turin and Milan. Five transmitters have been ordered from America under the European Recovery Programme.

Nation-wide Television

WHEN opening Radiolympia, Mr. Morrison, Lord President of the Council, announced that the Midland television station, at Sutton Coldfield, would be in service before Christmas. The B.B.C. subsequently announced that the station would open on December 17th.

Mr. Morrison also stated that it was hoped to begin work on the next station in the chain—at Holme Moss, near Huddersfield — in 1950. It should be completed during 1951. Plans were also announced to make the television service available to about 80 per cent of the country's population by 1954.



EDUCATIONAL.—**An example of the type of educational exhibit at Radiolympia to which we referred Editorially last month was provided by Sobell Industries. Visitors were invited to adjust the controls on a "bread-board" layout of the Sobell T120 television receiver for a symmetrical pattern on the c.r.t.**

American Radio Trade

THE radio industry in the United States is being hit heavily by the reluctance of listeners to buy new broadcast set. It is attributed to the fact that they have been led to believe that very soon there will be a nation-wide chain of television stations. Moreover, television sets are not selling, even at reduced prices, because prospective viewers are reluctant to buy receivers in view of the proposed reallocation of frequencies which, if introduced, will mean that the majority of the new stations will operate on frequencies not covered by existing sets.

There are at present seventy television stations operating in the 54 to 216-Mc/s band in forty-four cities. The new plan provides for 2,245 stations; 1,700 of which will be operating on frequencies above 470-Mc/s.

The sale of ordinary domestic broadcast sets is said to be below that of car receivers. Even f.m. has not made the anticipated strides, which is attributed by some to the patent situation.

New Patents Act

THE new Patents and Designs Act, 1949, comes into effect on 1st January, 1950. Under the new Act, a patent application may be filed by an assignee providing the inventor has agreed in writing. New grounds of opposition are included in the Act, one being that the invention is obvious and does not involve any inventive step. With regard to legal proceedings, the Court may declare whether a specific act would constitute an infringement of a patent or not, provided that the party concerned has applied to the patentee, and he has neglected or refused to state whether he contends that the prospective act is an infringement of

World of Wireless—

his claim or not. The definition of a patentable invention has been extended to cover any method or process of testing applicable to the improvement or control of manufacture.

The detailed application of many of the provisions of the new Act will depend on the wording of the new Rules to be issued by the Comptroller later.

Licences for "Appro" Sets

A RECENT case in which a man was summoned for operating a television receiver—installed on approval—without a licence, prompted *The Wireless Trader* to seek a re-statement from the G.P.O. of the licensing position. In reply the Post Office stated that "It is not the practice of the Post Office to institute proceedings for the installation and working of wireless apparatus, sound or vision, without a licence when the period of unauthorized working is of comparatively short duration. In the case in question [in which the summons was dismissed] there were other considerations which influenced the decision to prosecute.

"Under a long-standing concession, dealers holding a broadcast receiving licence for their premises may supply a set on approval for a prospective buyer for a period not exceeding fourteen days without covering its use by a separate wireless licence, provided that the dealer keeps a record which must be open to inspection, if required, by an authorized officer of the Post Office. The concession was granted originally for sound sets, but is now applied equally to television receivers."

OBITUARY

It is with regret we record the death of **Professor C. L. Fortescue,** O.B.E., M.A., Emeritus Professor of Electrical Engineering at the Imperial College of Science and Technology, at the age of 68. Prior to his appointment to the Chair of Electrical Engineering at Imperial College in 1922, which position he filled until 1946, he was from 1911 Professor of Physics at the Royal Naval College, Greenwich. In 1942 Professor Fortescue was elected president of the I.E.E.

We also record with regret the sudden death of **T. W. Morgan,** M.B.E., works manager of Marconi's, at the age of 53. He had been associated with the company since 1922.

PERSONALITIES

Sir Robert Watson-Watt, a vice-president of the Institute of Navigation, has been nominated for election as president. The Institute, which was formed in 1947 as a scientific society concerned with both air and marine navigation, has a membership of 1,000.

S. S. Eriks has been appointed managing director of Philips Electrical Industries, Ltd., the holding company controlling the Philips group of companies in this country. He has resigned the managing directorship of Philips Electrical, Ltd., which handles the sale of Philips products, and is succeeded by **G. Hofman.**

A. C. King has joined Philco (Overseas), Ltd., as home sales manager in succession to Alec Linton who died recently. Prior to re-joining Philco, with which he was associated as far back as 1931, Mr. King was with Romac Industries, Ltd.

IN BRIEF

Radiolympia. — Attendance during the ten days of the show totalled 395,465, a decrease of 45,000 on the 1947 total. This year's figure included 1,122 visitors from some 70 overseas countries.

Interference.—Figures given at the Interference Bureau on the G.P.O. stand at Radiolympia showed that 28 per cent of the 47,000 complaints received by the Post Office during 1948 were due to poor aerials or defective sets.

French Licence Fees.—From September 1st broadcast licence fees in France have been increased. The fee for a crystal set is now 200 Fr.; for a domestic valve receiver, 1,000 Fr.; for a set used in a place open to the public without charge, 2,000 Fr. and for a set installed where a fee is charged for admission, 4,000 Fr. The licence for a television receiver is three times as much as those for valve broadcast receivers.

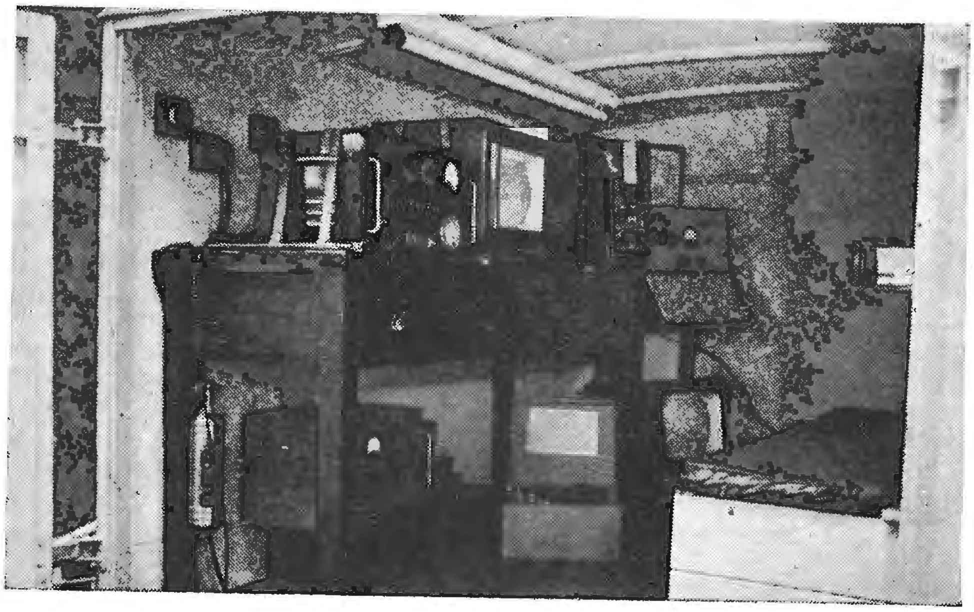
Imports.—Radio and television receivers and transmitters; radar and radio navigational aids; and radio communication equipment are included in the list of goods which it is now permissible to import into the United Kingdom from most of the "hard currency" countries without a licence.

Canadian Standards. — For the guidance of intending exporters of electrical equipment to Canada the British Standards Institution has compiled a list of Canadian Standards with which apparatus must comply before being accepted for import. Copies of the Standards, some of which relate to radio, are obtainable from, or may be inspected at, the British Standards Institution, 24, Victoria Street, London, S.W.1.

I.S.W.C.—Special transmissions from the world's short-wave broadcasting stations are being radiated to mark the 20th anniversary of the formation of the International Short-wave Club. Details are obtainable from the Secretary, 100, Adams Gardens Estate, London, S.E.16.

Basic Mathematics.—The second edition of F. M. Colbrook's book "Basic Mathematics for Radio Students" is now available from our Publisher, price 10s 6d (postage 4d). This 298-page book, with 77 diagrams, gives in the first six chapters the basic mathematical ideas which in the last chapter are applied to radio problems.

Notts Radio Show.—A five-day radio and television show is being held in the Albert Hall Institute, Derby Road, Nottingham, from October 25th to October 29th

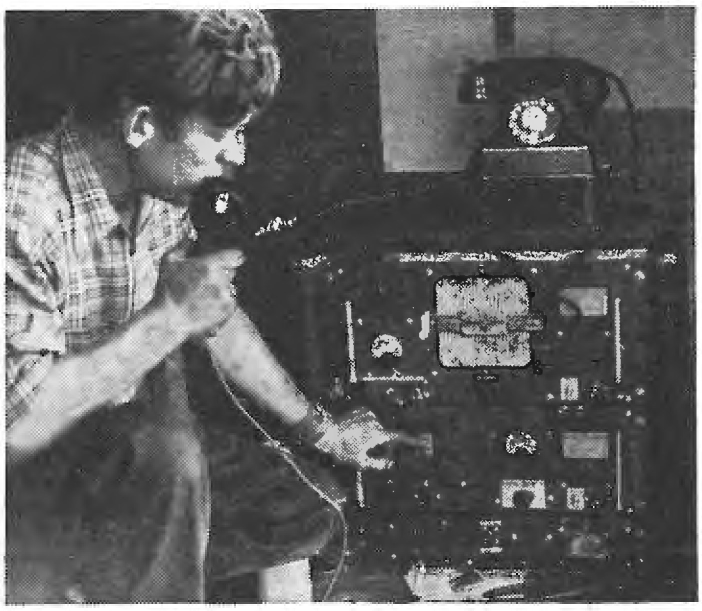


TELEVISION RESEARCH.—Interior of the television research van exhibited at Radiolympia by Belling and Lee and used by them for investigating reception problems. On the table are, left to right, field strength measuring set, check television receiver, oscillograph and variable frequency oscillator. The equipment also includes aerial impedance measuring gear and a signal generator.

"Television For All" is the title of a little book by L. Marsland Gander which gives a concise and non-technical description of the history, development and possibilities of television. Published by Alba Books, Ltd., 80, Fleet Street, London, E.C.4, it costs 2s.

Canadian Licences.—It is proposed by the Canadian Broadcasting Corporation to increase the licence fee on broadcast receivers from \$2.50 to \$5. At present the C.B.C. obtains 70 per cent of its revenue from licences, the remainder coming from commercial programmes.

Radar Maintenance.—Among the courses offered by the Marine School of South Shields is one on radar maintenance. The eight weeks' course, which costs £5, consists of instruction in the basic theoretical principles of radar and the application of these principles to the maintenance and servicing of radar sets. Particulars of this and other courses are obtainable from the Principal, Dr. J. Hargreaves.



RADIO COMMUNICATION.—During the replacement of the insulators on the 487ft towers which carry the electricity power lines over the Thames, Pye 2-way v.h.f. radio equipment was used to maintain communication between the men working aloft and those working at the base of each tower on either side of the river.

INDUSTRIAL NEWS

Electronic Tubes, Ltd.—The chairman of A. C. Cossor, Ltd., stated at the annual general meeting that the company had disposed of its interest in Electronic Tubes, Ltd., manufacturers of valves and cathode-ray tubes. The company was formed in 1946 as a result of an agreement between Cossors and Sylvania Electric Products Inc. of America. It is understood that Cossors are continuing to draw the bulk of their valve and c.r.t. supplies from Electronic Tubes, Ltd. The factory is at High Wycombe, Bucks.

Pye-R.C.A. Agreement.—A cross-licensing agreement has been concluded between Pye, Ltd., of Cambridge, and the Radio Corporation of America covering patents, designs and developments in the fields of broadcast and television receivers, television transmitters, studio pickup equipment, camera tubes and cathode-ray tubes.

Ericsson-Pye Agreement.—The technical, engineering and manufacturing resources of Ericsson Telephones, Ltd., and Pye, Ltd., in the field of telecommunications are to be pooled under an agreement between the two companies.

G.E.C.—The Osram Valve Department of the G.E.C. will in future be known as the Osram Valve and Electronics Department as it now handles the sales and technical enquiries regarding such electronic equipment as magnetrons, Geiger-Muller tubes and thyratrons as well as transmitting and receiving valves.

Aerialite, Ltd., have started an aerial fitting service and announce that firms wishing to become registered installers under the scheme should communicate with the company at Castle Works, Stalybridge, Cheshire.

Sobell.—A depot for the distribution and repair of radio and television receivers has been opened by Sobell Industries, Ltd., at 36, Dalton Street, Birmingham, 4 (Tel.: Central 8039). Requests for spare parts for the "Sobellette" should continue to be sent to Langley Park, Slough, Bucks.

MEETINGS

Institution of Electrical Engineers

Radio Section.—"Some Considerations in the Design of Negative-Feedback Amplifiers," by W. T. Duerdoth, B.Sc. (Eng.), on November 16th.

Discussion on "Achievement of Reliability in Radio Equipment," opened by G. W. Sutton, Ph.D., B.Sc., and F. E. McGinnety, M.Sc., on November 28th.

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

Cambridge Radio Group.—"Some Recent Advances in the Design of High-Energy Electron Accelerators," by D. W. Fry, M.Sc., at 8.15 on November 1st at the Cavendish Laboratory.

Joint meeting with the Cambridge University Wireless Society at 8.15 on November 21st at the Cavendish Laboratory.

North-Eastern Radio Club.—"Some Considerations in the Design of Negative-Feedback Amplifiers," by W. T. Duerdoth, B.Sc. (Eng.), at 6.15 on November 7th at King's College, Newcastle-on-Tyne.

North-Western Radio Group.—"Hot-Cathode Thyratrons: Practical Studies of Characteristics," by H. de B. Knight, M.Sc., at 6.30 on November 16th at the Engineers' Club, Albert Square, Manchester.

South Midland Radio Group.—"The Observation of Ionospheric Interaction," D. A. Bell, M.A., B.Sc., F. J. Hyde, B.Sc., and C. C. Newton, at 6.0 on November 28th, at the James Watt Memorial Institute, Great Charles Street, Birmingham.

Rugby Sub-Centre.—"Magnetic Amplifiers," by A. G. Milnes, M.Sc. (Eng.), and "The Theory and Design of Magnetic Amplifiers," by H. M. Gale, B.Sc. (Eng.), and P. D. Atkinson, M.A., at 6.30 on November 29th at the Electricity Showrooms, High Street, Rugby.

Television Society

London Meeting.—"Modern Developments in Phosphors for Television," by Dr. Leonard Levy, at 7.0 on November 25th, at the Cinema Exhibitors' Association, 164, Shaftesbury Avenue, London, W.C.2.

Constructors' Group.—"The View Master—a new receiver for the home constructor," by W. I. Flack, at 7.0 on November 16th, at the Cinema Exhibitors' Association, 164, Shaftesbury Avenue, London, W.C.2.

Midlands Centre.—"The Relaying of Broadcasting and Television," by L. E. C. Hughes, Ph.D., at 7.0 on November 7th, at the Lecture Hall, The Crown Restaurant, Corporation Street, Birmingham. (Joint meeting with the Institution of Electronics.)

Radio Society of Great Britain

"Design and Applications of the Cathode-Ray Oscillograph," by O. H. Davie, on October 28th.

"The Radio Control of Models," by Lieut. (L) G. C. Chapman, B.A., R.N., and Peter Cummins, on November 18th.

Both meetings will be held at 6.30 at the I.E.E., Savoy Place, London, W.C.2.

British Kinematograph Society

"The Cine-Sound Master Magnetic Tape Recording for the Amateur," by R. I. T. Falkner, at 7.15 on November 16th, at the Gaumont British Theatre, Film House, Wardour Street, London, W.1.

British Institution of Radio Engineers

London Section.—"Measurement of F.M. Transmitter Performance," by D. R. Willis at 6.30 on November 17th at the London School of Hygiene, Gower Street, W.C.1.

Merseyside Section.—"Electronics in Aircraft Design" by A. L. Whitwell at 7.0 on November 2nd at the Accountants' Hall, Derby Square, Liverpool.

North-Eastern Section. — "Dielectrics" by Mrs. E. Laverick at 6.0 on November 16th at Neville Hall, Newcastle-on-Tyne.

Scottish Section.—"The Performance and Stability of Permanent Magnets," by A. J. Tyrrell at 6.45 on November 3rd at the Heriot Watt College, Edinburgh.

Institution of Electronics

North-West Branch.—"The Application of Infra-red Detectors," by B. N. Watts at 6.30 on November 18th at the Reynolds Hall, College of Technology, Manchester

Institute of Physics

Electronics Group.—"The Generation and Launching of Ultra-sonic Waves," by G. Bradfield at 5.30 on November 15th at the Institute's House, 47, Belgrave Square, London, S.W.1.

Electron Microscopy Group.—Symposium of papers on "Electron Microscopy" on November 15th and and on "Metallurgical Applications of the Electron Microscope" on November 16th in London. Further details from the Secretary, 47 Belgrave Square, London, S.W.1.

Guild of Radio Service Engineers

Edinburgh Branch. — "Electronics for the Radio Service Engineer," by A. M. Turnbull on November 17th, at 7.30 in Unity House, 4, Hillside Crescent, Edinburgh.

Unbiased

By FREE GRID

"Restless Murmurings."

Television Realism

IT has been said that the road to Hell is paved with good intentions, a statement which most of us hope never to be in a position to confirm or deny. But, whatever doubt we may have about this, few of us can gainsay the fact that this world is thickly populated with well-meaning people whose intentions are good but who fail to use common sense when carrying them out.

I well recollect when Mrs. Free Grid and I were setting out on our honeymoon and were being bidden farewell at the railway station, a well-intentioned guest came staggering up to the door of our reserved compartment under the weight of an abundant supply of magazines with which he said that he hoped we might be able to beguile the tediums of the journey. Yet he was perfectly well aware of the fact that neither Mrs. Free Grid nor myself would have time for such frivolities as magazine reading. I was hoping to establish radio communication between the moving train and a fellow experimenter on *terra firma*, and would need Mrs. Free Grid's efforts to turn the crank of the hand-generator for the crude spark transmitter I had in my suitcase.

A further illustration of good intentions gone astray was brought home to me recently when being taken for a ride by Mrs. Free Grid. I was unable to take the wheel myself owing to a touch of car driver's cramp brought on by excessive driving as a result of the doubled petrol ration we had in June, July and August. We were approaching the back of a slow-moving pantechnicon of Brobdingnagian proportions; overtaking seemed a hazardous proceeding on such a busy but narrow road. Fortunately the owner of the vehicle was one of our foremost radio manufacturers who had thought of a happy way in which to advertise his wares and at the same time prevent other road users being held up by this moving monstrosity.

He had, therefore, fitted a large television screen at the back, fed obviously from a closed - circuit transmitting system situated somewhere in the front of the van. The result was a clear view of the road ahead. Well-intentioned as he was, however, he had reckoned without the complete lack of technical gumption displayed by the average W.D. (which appropriately enough stands for woman driver as well as War Department). The picture on the screen was so real that as soon as a clear road ahead was shown Mrs. Free Grid's foot went down with the joyous abandon which an open road inspires and the next moment we found ourselves precipitated into the van amid the tumult of breaking glass and what the poet calls "the restless murmurings of man's troubled spirit."

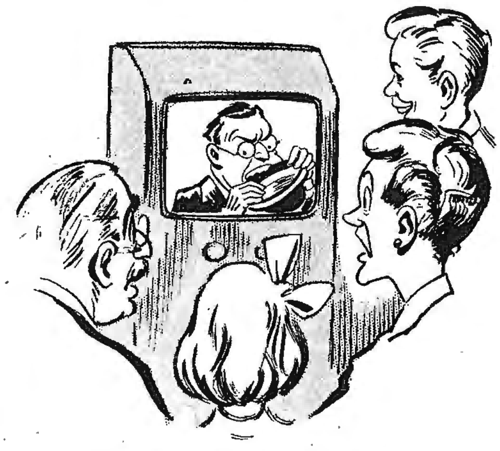
Historical Hash-up

I DON'T know what they do nowadays at our great universities but if some of the answers given by their graduates and passed as correct in certain of the B.B.C.'s quizzes are a fair criterion they don't devote a great deal of time to education. The time given to the study of English history, for instance, seems so taken up with learning apocryphal anecdotes like that of Alfred and the cakes that other aspects of "our rough island story" which have greater veridical foundations seem neglected.

One of the most glaring examples of this occurred a little time ago when the question propounded concerned certain aspects of our ancient constitution of King, Lords and Commons. It was desired to know at what date or dates since the year 1600 had our system of Monarchy been legally suspended and replaced by something else. The question was, in the first place, obviously a trap; it was realized that the vision of Oliver Cromwell would be conjured up in everybody's mind and they would at once give the answer 1649-1660.

The catch was in the word legally and after a lot of argument we were informed that the suspension of the monarchical system in that period had no true legal basis. It was also suggested that in some ways the situation was much the same in the Kingdom of Hungary in the years between the wars when Admiral Horthy fulfilled the functions of Cromwell. Personally, I am of the opinion that the parallel drawn was an extremely misleading one but it was not stressed, and, in any case, that is not what I want to talk about. Having decided that the Monarchy was not in abeyance *de jure* in the Cromwellian epoch I naturally expected the learned gathering to pass on to that period of English history when it really was in abeyance, but to my intense surprise it was then decided that the correct answer was that the monarchy had never been in abeyance since 1600.

Apparently these "grave and reverend seigneurs," these scions of



I shall solemnly eat my hat.

the Isis and the Cam were so taken up with their expert juggling with the Cromwellian regime that they forgot all about the six years between 1688 to 1694 when the monarchy in Great Britain went into abeyance and was replaced *de jure* and *de facto* by a diarchy in the persons of William and Mary who reigned as joint sovereigns but obviously not as joint monarchs, if there be any meaning in words at all. When the unfortunate Mary succumbed to smallpox in 1694 the diarchy lapsed and the monarchy once more came out of cold storage. If I am wrong in this I shall be prepared solemnly to eat my hat before the B.B.C. television cameras.

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A 1	74	1.7	0.11	0.36	HIGH POWER FLEXIBLE
A 2	74	1.3	0.24	0.44	
A34	73	0.6	1.5	0.88	

LOW CAPAC TYPES	CAPAC. mmf/ft	IMPED. OHMS.	ATTEN db/100ft 100Mc/s.	O.D."	
C 1	7.3	150	2.5	0.36	
PC1	10.2	132	3.1	0.36	PHOTOCELL CABLE
C 11	6.3	173	3.2	0.36	
C2	6.3	171	2.15	0.44	
C22	5.5	184	2.8	0.44	
C 3	5.4	197	1.9	0.64	
C33	4.8	220	2.4	0.64	VERY LOW CAPACITANCE
C44	4.1	252	2.1	1.03	

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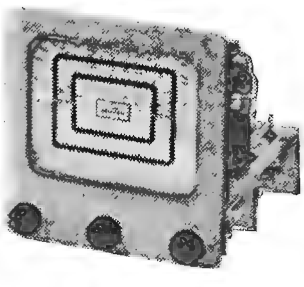

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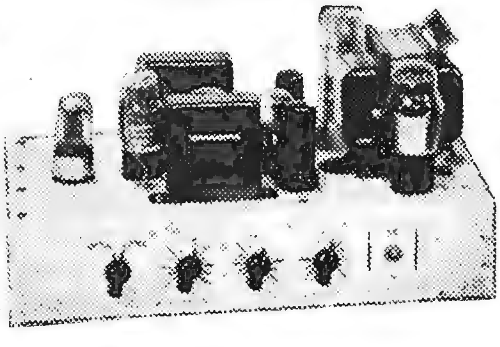

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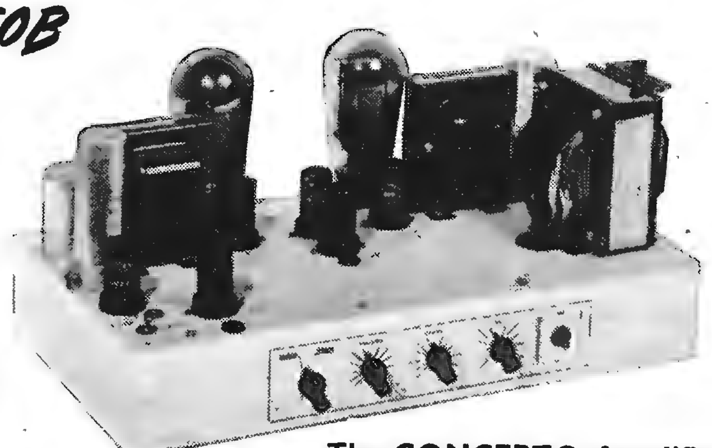

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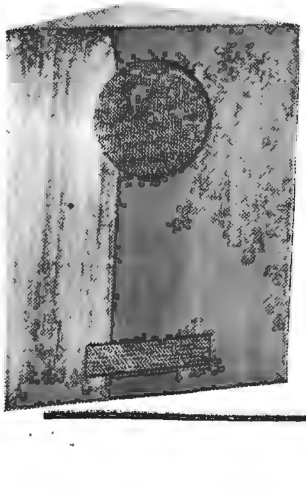

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Q and L MEASUREMENTS

Detuning Methods

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

ALTHOUGH the Q meter has been widely used for many years there has been very little published information about it until quite recently. H. G. M. Spratt started the ball rolling and his article[1] aroused the interest of others.[2] Then "Cathode Ray"[3] showed how Q and circuit magnification factor are related and explained the principle of the frequency-detuning method of measuring Q.

It seems to be generally accepted that a Q meter is an instrument which is directly calibrated in Q and usually one in which Q is indicated by the reading of a pointer-type meter. Instruments which operate on the detuning principle, therefore, are not apparently entitled to the name Q meter, for the measurements are made in terms of frequency or capacitance and Q is obtained by subsequent calculation.

The detuning methods are very old, so old in fact that they are probably new to many! They were in common use in the early days of wireless for the measurement of r.f. resistance and decrement—long before the term Q was invented.

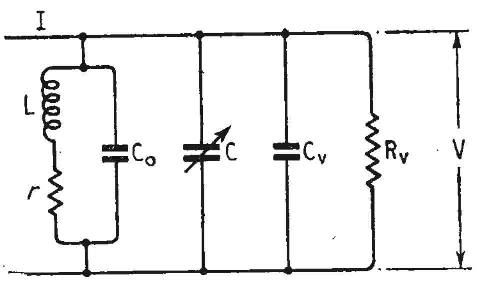


Fig. 1. The basic circuit for Q measurement; the coil under test is represented by L, r, C_0, while R_V and C_V indicate the input resistance and capacitance of the valve voltmeter.

When a Q meter is not available the detuning methods form the most convenient ways of measuring Q, and also the inductance and self-capacitance of coils. The actual measurement is not carried out as quickly as with a Q meter and so the latter is a much more suitable method when many measurements have to be made.

The detuning methods are particularly suitable when Q measurements are required so infrequently that the cost of a Q meter cannot be justified. They have the great advantage that they can be carried out with apparatus which is already available in most laboratories.

In spite of the fact that they are extremely simple in theory the detuning methods require great care in their practical application if they are not to be grossly inaccurate. In this connection, the writer feels that "Cathode Ray" has been rather misleading in saying that "frequency is the most accurately-measurable quantity there is." Because this may be true in itself, it must not be inferred from it that a determination of Q based on the measurement of frequency is equally accurate. Further, it must not be inferred even that a frequency measurement made with ordinary simple apparatus is more accurate than a measurement of some other quantity again made with simple apparatus. The superior accuracy of frequency measurement is probably true only of the best equipment.

The accuracy with which Q can be determined by the frequency-detuning method is normally considerably less than the accuracy of the frequency measurements. It will be shown later that the error in Q measurement can be as great as 2 Q times the error in frequency measurement.

It is important to notice that the operative words are "can be as great," not "is as great." By taking suitable precautions and adopting the proper technique, quite good accuracy is obtainable, but the unthinking use of the method is likely to give very misleading results.

The discussion will be based on the parallel-resonant circuit of Fig. 1, in which L, r, C_0 represent the inductance, series resistance and self-capacitance of the coil under test. The circuit is tuned by the variable capacitor C and it is fed with current I from a signal source of very high impedance compared wih that of the circuit. The voltage across the circuit is measured by a valve voltmeter having an input capacitance C_v and an input resistance R_v, and the voltage is denoted by the symbol V.

It is convenient to represent L and r by an equivalent parallel combination L_1 and R as in Fig. 2 and it is shown in Appendix that as long as Q is independent of frequency $L_1 = L(1 + 1/Q^2)$ and $R = \omega LQ(1 + 1/Q^2)$. Here $Q = \omega L/r$ and is the true Q of the coil alone, while ω is, of course, 2π times the frequency. Usually Q is much greater than unity and so the approximate relations $L_1 = L$ and $R = \omega LQ$ are nearly always sufficiently accurate. In terms of L_1 and R, $Q = R/\omega L_1$ exactly.

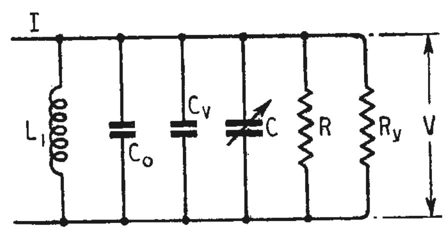


Fig. 2. An equivalent of Fig. 1, in which the coil resistance r is replaced by a parallel resistance R introducing the same loss.

In the following it is assumed that the current I fed to the circuit is constant over the range of frequencies concerned and is

[1] "Q Meters," by H. G. M. Spratt, *Wireless World*, January 1949, p. 7.
[2] "Q Meter Controversy," *Wireless World*, June 1949, p. 216: July 1949, p. 276.
[3] "Q," by "Cathode Ray," *Wireless World*, July 1949, p. 267.

Q and L Measurements—

also independent of the impedance of the measuring circuit. The voltage V, indicated by the valve voltmeter, is $V = IZ$, where Z is the impedance of the whole circuit.

In making a measurement the signal source is set at the required frequency f_r and the circuit is tuned to it by C for the maximum reading of the valve voltmeter. Let this value of C be C_r, so that the total circuit capacitance is $C_{Tr} = C_r + C_v + C_0$. Call the voltmeter reading V_r.

Alternative Methods

In the frequency-detuning method the signal source is now detuned to a higher frequency f_2 for which the voltmeter indicates a lower reading V (it is common practice to make $V = 0.707V_r$). A note is made of the frequency, and the source is detuned to a frequency f_1 lower than f_r, so that the voltmeter again reads V. Then, as shown in Appendix 2,

$$Q_T = \frac{f_r}{\Delta f}\sqrt{(S^2 - 1)}.$$

where $S = V_r/V$, $\Delta f = f_2 - f_1$ and Q_T is the total Q; that is, the Q of the coil in circuit and as modified by losses other than those inherent to the coil.

In the capacitance-detuning method the procedure is much the same, but the capacitance of C is varied instead of the frequency of the source. The first step is the same—to tune the circuit to the signal source, thus obtaining C_r and V_r. The circuit capacitance is then increased to C_2 to obtain a voltmeter reading V and is then reduced below C_r to C_1 to obtain the same reading V. Then

$$Q_T = 2\,\frac{C_{Tr}}{\Delta C}\sqrt{(S^2 - 1)}$$

where $C_{Tr} = C_r + C_v + C_0$, $\Delta C = C_2 - C_1$ and $S = V_r/V$.

As mentioned already, the detuning is usually carried out so that $V = 0.707\ V_r$. This is purely for simplicity of calculation, for then $S = 1.414$ and $\sqrt{(S^2 - 1)} = 1$. With this value it is clear that the total change of frequency is $1/Q$ (or of capacitance is $2/Q$) times the resonance value of frequency or capacitance. Q is commonly 100 to 200 so that the change of frequency or capacitance involved is under 1% of the resonance frequency or capacitance. Now this change must obviously be measured with an accuracy of the same order as Q is required to be known. This is the real difficulty with the detuning methods.

It is shown in Appendix 3 that in the frequency-detuning method the frequency accuracy must be 2Q times the required accuracy for Q. It is worth considering this in more detail. It is obvious from the form of the equation for Q that if the three frequencies f_r, f_1 and f_2 are all known with the same percentage error and the errors are all in the same direction, they cancel one another and there is no error in the determination of Q. Calibration errors in the signal source are not necessarily all in the same direction, but they quite commonly are, and as the frequencies are very close to one another the errors are likely to be of the same magnitude. In general, therefore, calibration errors may not have a serious effect on the accuracy of the Q determination.

It is errors in reading the scale of the signal source or in setting it to frequency which are important. These can be in either direction and, as a result, enormous errors in Q are possible. As an example, suppose it is required to measure a Q of 200 at 40 Mc/s. Then $\Delta f = 0.2$ Mc/s. If one succeeds in setting the signal source accurately to 40 Mc/s, then in detuning it will be set in turn to 40.1 Mc/s and 39.9 Mc/s. (The frequencies will actually be very slightly different from these because f_r is not precisely one-half of $f_1 + f_2$, but the difference is negligible.)

Suppose now that in reading these frequencies from the scale, errors of 1% in opposite directions are made and f_2 is taken as 40.5 Mc/s and f_1 as 39.5 Mc/s. The difference Δf will be 1 Mc/s and Q will be calculated as 40 instead of its real value of 200!

A signal generator is the kind of signal source which, because of its convenience, many might be tempted to use, but it is quite useless for the determination of Q by the frequency-detuning method. Even when the calibration accuracy is much better than 1%, which is not always the case, the scale provided is far too cramped to be read even to 1%.

This applies, of course, to reading the scale generally, for which interpolation between the marks on the scale may be necessary. When a scale marking coincides with the cursor, the reading accuracy is much higher. A considerable improvement in accuracy would be obtainable if the signal generator were used set only to definite marks on its scale. This is not possible with the method of Q measurement described, but it can be done by modifying it somewhat. The procedure is to detune the signal generator by a fixed amount and determine the change in voltage across the circuit instead of detuning so that the voltage falls by a fixed amount and noting the change of frequency. A different and slightly more complicated formula is then used to compute Q.

While this is an improvement, it is still inadequate, because few signal generators permit small enough amounts of detuning. A typical piece of apparatus has scale marks at 0.2-Mc/s intervals at 10 Mc/s and so would be useless for the measurement of Q values exceeding about $10/0.4 = 25$.

Wider Voltage Ratios

All this applies as long as the detuning is carried out for a voltage drop to 0.707 of the resonance value; that is, for $S = \sqrt{2}$. If a larger value of S is adopted, the detuning is increased and the change of frequency can be more accurately determined. The accuracy of the Q measurement is, therefore, increased. It is shown in Appendix 3 that the accuracy of the Q measurement is proportional to $\sqrt{(S^2 - 1)}$.

Practically, there is a limit to the magnitude of S, for the larger it is made the more difficult does it become to measure the voltages accurately. The practical limit to S is probably about 10 using an ordinary valve voltmeter. It is, of course, possible to change S by changing the r.f. input to the circuit and if an accurate attenuator is available this is probably the best way. The accuracy will usually fall off considerably at very-high frequencies, however. Apart from this, the improvement of accuracy by increasing S is limited to about 10 times and is not enough to permit the use of a simple and inexpensive signal source.

If high accuracy is to be obtained in the measurement of high Q values it is necessary to adopt a method by which the frequency of the signal source can be changed by a known amount with very high precision. The best, and probably the simplest, way of doing this is by setting the signal source to zero beat with a harmonic of a crystal oscillator.

The test frequency f_r must then be an integral multiple of the crystal frequency f_x. The circuit is tuned to resonance with it and the signal source is then offset in any desired number of steps of magnitude f_x, by beating it with the harmonics of f_x, until the voltmeter reading has fallen a reasonably large amount.

The Q can then be calculated, but the formula is somewhat different from the one of Appendix 3; it is

$$Q_T = \frac{f_r}{\delta f} \cdot \frac{1 + \delta f/f_r}{2 + \delta f/f_r} \cdot \sqrt{(S^2-1)}$$

where δf is the change of frequency above resonance. If the signal source is set precisely to zero beat, all frequency errors disappear, including errors in the basic crystal oscillator. In practice, it is not possible to set precisely to zero beat without adopting double-beat methods, which are relatively elaborate. If set to the nominal zero beat by listening in phones the errors may amount to 250 c/s or so. They are negligible for ordinary purposes.

In view of the fact that the frequency accuracy of the reference oscillator does not affect the accuracy of measurement of Q it might be thought that quite a simple oscillator would suffice. In fact, a fairly accurate crystal-controlled oscillator is needed if the order of harmonic used is to be easily identifiable. Thus, if a Q of 200 is to be measured at 40 Mc/s, the 400th and 401st harmonics of a 100 kc/s oscillator would probably be used and must be identifiable.

The direct calibration of the signal source is probably not sufficiently accurate to do this directly and is certainly not if there is any appreciable error in the fundamental frequency. When employing this method it is necessary to have an additional 1-Mc/s crystal oscillator mainly to help in harmonic identification.

Test Procedure

When the highest accuracy is not necessary it is not essential that precisely the right harmonic should be used for the initial resonance tuning, an error of 1% in determining f_r will affect Q by only 1%. The crystal oscillator is then essential for accurate detuning. The procedure then is to set the signal source to the desired frequency by its dial, adjust it slightly so that it comes to zero beat with the nearest harmonic of the crystal oscillator and tune the test circuit to resonance. The signal source is then detuned to an adjacent harmonic, or two, or three harmonics away, as the case may require, and δf is known to the crystal accuracy plus perhaps 250 c/s due to errors in setting to zero beat.

If the maximum value of S is 10 and Q values up to 400 are to be measurable $f_r/\delta f$ must not be less than 80. If the crystal frequency is 100 kc/s, measurements cannot be made at frequencies lower than 8 Mc/s. If a 10-kc/s oscillator is provided, and it should be a multivibrator locked by the 100-kc/s oscillator, the range can be extended down to 800 kc/s. In practice, Q values of 400 are rare at such frequencies and the useful range would be lower, perhaps to 600 kc/s. For measurements at still lower frequencies a second locked multivibrator at 1 kc/s would become necessary.

The method clearly becomes too elaborate to be satisfactory. For high frequencies, where a single 100-kc/s oscillator will serve the arrangement is useful, although it will be necessary to provide a simple receiver to produce the beats between the signal source and the crystal-oscillator harmonics. This can usually be a diode detector and an a.f. amplifier.

It is now necessary to consider the capacitance-detuning method. In general, conditions are much the same, but there is one very important difference. It is possible to measure small changes of capacitance very easily and with considerable accuracy. As a result, the capacitance-detuning method enables Q to be measured much more accurately than the frequency-detuning method when only simple apparatus is used.

The way in which accurate capacitance detuning can be obtained is simply by providing the calibrated main tuning capacitor with a second calibrated variable capacitor in shunt with it and of very small capacitance. It provides a total capacitance change of, perhaps, 10 pF and its scale is such that it can be read to at least 0.1 pF.

Initially, this detuning capacitance is set to its mid-value and the circuit is brought into resonance by the main tuning capacitor. The detuning is then carried out on the small capacitor only and so the change of capacitance can be taken from its scale with quite good accuracy. The frequency accuracy does not enter into the accuracy of measurement at all, which is governed only by the errors in the voltmeter and in the calibration of the capacitors.

Simplicity

It is in this simple way of detuning that the superiority of the capacitance method lies. The equivalent in the frequency method is to use harmonics of a crystal oscillator as a detuning reference. This necessitates a considerable amount of apparatus if a wide frequency range is to be covered and just does not bear comparison with the small-capacitance variable capacitor of the alternative method.

From now on only the capacitance method will be considered. From the formulae in Appendix 3,

$$Q_T = \frac{2C_{Tr}}{\Delta C}\sqrt{(S^2-1)}.$$ For all but very-high-frequency work C_{Tr} will usually be 50-500 pF, S can range from $\sqrt{2}$ to 10 and Q_T will generally be within 50 to 300. Let $S = \sqrt{2}$ [i.e., $\sqrt{(S^2-1)} = 1$] when $C_{Tr} = 500$ pF and $S = 10$ [i.e., $\sqrt{(S^2-1)} = 10$] when $C_{Tr} = 50$ pF, then throughout the range $2\,C_{Tr}\sqrt{(S^2-1)} = 1000$ and $\Delta C = 1000/Q_T$. If $Q = 50$,

Q and L Measurements—
$\Delta C = 20$ pF ; if $Q = 300$, $\Delta C = 3.3$ pF.

The usual run of coils which are tuned by a 500-pF capacitance are used at moderate frequencies and generally have Q values around 100-150, for which ΔC is some 10-6.6 pF. Much higher Q values are not common. It can be seen, therefore, that a 20-pF detuning capacitor is about right for use with a 500-pF main tuning capacitor.

For very high frequencies, a tuning capacitor of 100 pF will suffice and is generally advantageous. Q values at these frequencies may also be higher and a range of 50-500 is desirable. The maximum and minimum values of C_{Tr} may be 100 pF and 20 pF. If S is varied over a 5 : 1 range, $2\,C_{Tr}\sqrt{(S^2 - 1)} = 200$ and $\Delta C = 200/Q_T$. This makes ΔC rather small, but S can be doubled to make $\Delta C = 400/Q_T$. For $Q = 50$, $\Delta C = 8$ pF ; for $Q = 500$, $\Delta C = 0.8$ pF.

If ΔC is given a maximum value of 10 pF, then with a 180° scale, a change of 0.8 pF corresponds to an angular movement of 14.4° and so is not impracticably small.

Coil Self-capacitance

It will have been noticed that in the capacitance-detuning method it is necessary to know C_0, the self-capacitance of the coil. It is, therefore, necessary to measure it independently. This is no great disadvantage, however, for one usually wants to know the inductance of the coil and C_0 must also be known to determine this Both L_1 and C_0 can be measured with the same apparatus as that used for Q.

The necessary formulae are given in Appendix 4. The procedure is to set the signal source to a convenient frequency f_2 to which the coil can be tuned with a low-capacitance setting of C ; call this C_2. The signal source is then set at a lower frequency f_1 such that the capacitance C_1 required to tune the circuit to resonance is considerably larger.

Then $L_1 = \dfrac{\Delta f}{f_1} \cdot \dfrac{2 + \Delta f/f_1}{\omega_2{}^2\,\Delta C}$, where Δf and ΔC are the changes of frequency and capacitance, and

$$C_0 = \frac{1}{\omega_1{}^2\,L_1} - C_1 - C_v.$$

At first sight one might expect the errors in measuring L_1 to be serious since the procedure is not unlike that of the frequency-detuning method of measuring Q and accuracy depends on determining a change of frequency.

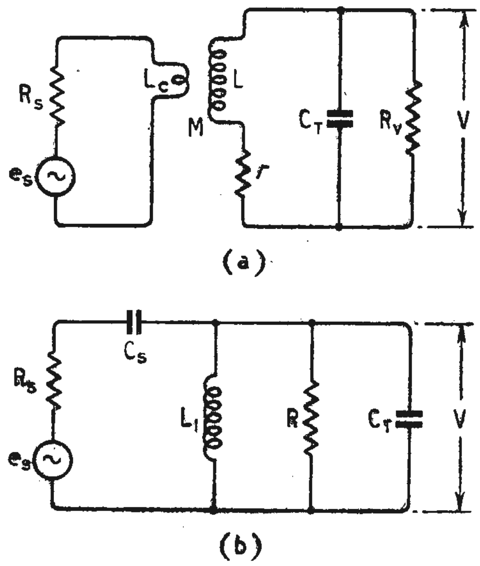


Fig. 3. Inductive coupling to the signal source is shown at (a) and capacitive coupling at (b).

However, this is not so, because the magnitude of the change of frequency can be so much greater.

As in all other measurements, it is necessary to correct the results obtained for the residual parameters of the circuit. Capacitance effects have already been covered, for all strays can be included in C_v. At high frequencies the inductance of the wiring may have to be taken into account. It is important, in order to minimize such corrections, to make the leads to the variable capacitors and valve voltmeter very short. Wiring inductance which comes in series with L_1 is much less important for the correction is a simple subtraction of its value from the measured value of L_1.

The resistance losses of the circuit, apart from the coil, are denoted by R_v. The simplest way of allowing for them is to determine the dynamic resistance of a whole circuit from the formula $R_T = 2\sqrt{(S^2 - 1)}/\omega\Delta C$. Then the true dynamic resistance of the coil is $R = R_T R_v/(R_v - R_T)$, and the true Q is $Q = \omega C_T R$.

So far nothing has been said about the method of feeding the test circuit from the signal source, One of the simplest methods is to put the circuit in the anode circuit of a valve the grid of which is fed from the signal source. The valve must be so operated that its internal a.c. resistance is very high. The method is simple because the output capacitance of the valve can be included with C_v and the a.c. resistance with R_v and so no additional corrections are necessary. It is, however, difficult to secure a sufficiently high a.c. resistance while still keeping the valve operating under linear conditions and so the method is not often used.

Coupling to the Source

If the coil under test is not screened it is common to couple it very loosely to the coil of the signal source, either directly or through some intermediate network. It is not possible to consider all possible arrangements in detail but a typical one is sketched in Fig. 3 (a). The signal source is represented by a generator e_s and internal resistance R_s and it is coupled to the coil under test L by the coupling coil L_C with mutual inductance M between the two. An alternative which is sometimes more convenient is the "top-end" capacitance coupling of Fig. 3(b).

If the transferred impedance of the source is to have a negligible effect on the resistance and reactance of the circuit under test it is necessary that the coupling between the two be very small. This in turn means that the power in the source must be much larger than the power in the tuned circuit. If x is the fractional error in the measurement of Q it is easy to show that with any reactive coupling

$$x = \frac{V^2/R}{P_s}$$

where P_s is the source power.

If it is required to measure tuned circuits with dynamic resistances down to 10 kΩ with an error due to the transferred source impedance not exceeding 1%, then the power needed in the source must be at least $P_s = V^2/100$. If V is 1 volt, then P_s becomes 10 mW.

Many signal generators have an output of 0.1 V in 72 Ω, a power of only 0.14 mW, and this is obviously much too small. Even when the output is 1V, the power is only 1.4 mW. Some generators, however, give 1V in 10Ω, and this power of 100 mW is ample.

Of course, if measurements can be made with V less than 1 volt a smaller source power can be used, but it is often impracticable to do this. In general, it is advisable to provide a special signal source which can take the form of a simple oscillator to the tuned circuit of which the test circuit can be very loosely and controllably coupled.

Appendix 1

Parallel Representation of Series L and r.

Let L_1 and R be the equivalent parallel values, then

$$\frac{1}{R}+\frac{1}{j\omega L_1}=\frac{1}{r+j\omega L}=\frac{r-j\omega L}{r^2+\omega^2L^2}$$

Therefore,

$$R=\frac{r^2+\omega^2L^2}{r}=\omega LQ(1+1/Q^2)$$

$$L_1=\frac{r^2+\omega^2L^2}{\omega^2L}=L(1+1/Q^2)$$

where $Q=\omega L/r=R/\omega L_1$.

Appendix 2

Determination of Q.

Referring to Fig. 2, let $R_T = RR_v/(R+R_v)$ and $C_T = C + C_0 + C_v$ then the impedance Z is given by

$$\frac{1}{Z}=\frac{1}{R_T}+\frac{1}{j\omega L_1}+j\omega C_T$$

$$=\frac{1-jQ_T(1-\omega^2L_1C_T)}{R_T}$$

where $Q_T = R_T/\omega L_1$. The magnitude of the impedance is

$$|Z|=\frac{R_T}{\sqrt{[1+Q_T^2(1-\omega^2L_1C_T)^2]}}$$

The voltage across the circuit is $I|Z|$ and so is proportional to $|Z|$. If V_r is the voltage at resonance ($\omega^2L_1C_T = 1$) and V the voltage at some other frequency, let $S = V_r/V = |Z_r|/|Z|$. Then

$$Q_T^2=\frac{S^2-1}{(1-\omega^2L_1C_T)^2}=\frac{S^2-1}{(1-f^2/f_r^2)^2}$$

There are two frequencies, f_1 and f_2 ($f_1<f_r<f_2$) for any value of S. Let $\Delta f = f_2 - f_1$, then

$$Q_T=\frac{f_r}{\Delta f}\sqrt{(S^2-1)}\Big/\sqrt{\left(1+\tfrac{1}{4}\frac{\Delta f^2}{f_r^2}\right)}$$

$$\approx\frac{f_r}{\Delta f}\sqrt{(S^2-1)}$$

Similarly, if the frequency is constant and the capacitance is varied

$$Q_T^2=\frac{S^2-1}{[1-C_T/C_{T_r}]^2}$$

where C_{T_r} is the total capacitance at resonance and C_T is the total capacitance at other frequencies. There are two values of C_T for any value of S, calling them C_{T1} and C_{T2} ($C_{T1}<C_{T_r}<C_{T2}$) and letting $\Delta C = C_{T2} - C_{T1}$ we get

$$Q_T=2\frac{C_{T_r}}{\Delta C}\sqrt{(S^2-1)}$$

Also, since $Q_T = R_T/\omega L_1 = \omega C_{T_r}R_T$, we have

$$R_T=\frac{2\sqrt{(S^2-1)}}{\omega\Delta C}$$

Appendix 3

Frequency Accuracy

Let x and y be respectively the fractional errors in frequency and Q. Then assuming equal and opposite errors in determining f_1 and f_2

$$Q(1+y)$$

$$=\frac{f_r}{f_2(1\pm x)-f_1(1\mp x)}\sqrt{(S^2-1)}$$

where Q, f_r, f_1 and f_2 are the real values of the quantities.

Solving for y gives

$$y=\frac{\mp1}{\dfrac{\sqrt{(S^2-1)}}{xQ}\cdot\dfrac{f_r}{f_2+f_1}\pm1}$$

$$\approx\frac{\mp1}{\dfrac{\sqrt{(S^2-1)}}{2xQ}\pm1}$$

from which

$$x=\mp\frac{y}{1+y}\cdot\frac{\sqrt{(S^2-1)}}{2Q}$$

$$\approx\mp\frac{y}{2Q}\sqrt{(S^2-1)}$$

Appendix 4

Inductance and Self-capacitance Measurement.

Let the circuit be tuned to resonance at one frequency f_1 with capacitance $C_1 + C_v + C_0$ and then to a second frequency f_2 with capacitance $C_2 + C_v + C_0$; ($f_2>f_1$; $C_1>C_2$). Then

$$\omega_1^2L_1C_{T1}=\omega_2^2L_1C_{T2}=1 \text{ and}$$

$$C_v+C_0=\frac{1-\omega^2L_1C_1}{\omega_1^2L_1}$$

$$=\frac{1-\omega_2^2L_1C_2}{1-\omega_2^2L_1}$$

Therefore,

$$\frac{1}{\omega_1^2}-\frac{1}{\omega_2^2}=L_1(C_1-C_2)=L_1\Delta C$$

and

$$L_1=\frac{\Delta f}{f_1}\cdot\frac{2+\Delta f/f_1}{\omega_2^2\Delta C}$$

$$C_0=\frac{1}{\omega_1^2L_1}-C_1-C_v$$

where $\Delta f = f_2 - f_1$

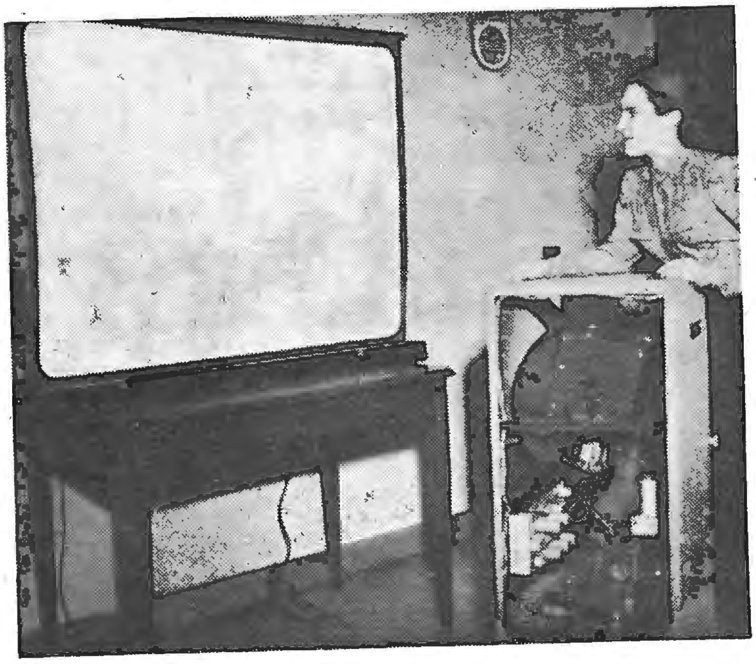
LARGE SCREEN TELEVISION

Good Viewing for Seventy People

A PROJECTION television system capable of producing a picture on a screen 3ft×4ft has been developed by Philips Electrical and was demonstrated recently.

The basis of the equipment is an orthodox television set and an optical system using a Mullard projection c.r. tube, the image of which is reflected on to the large screen by means of a spherical lens, an inclined mirror and a corrector plate. The basic principal is not unlike that used in some of the world's largest terestrial telescopes.

Any good quality ciné screen of the home type can be used and it is estimated that approximately 70 people can view the picture in comfort.



Philips large-screen projection television equipment.

PICKUP DESIGN

By T. S. MARSHALL

GREAT strides have been made in recent years in the art of disc recording. The frequency range recorded has steadily widened and to-day the majority of British-cut discs extend upwards to 15 kc/s. This widening of the recorded frequency band has challenged the designers of pickups, who have responded with an impressive array of new models.

Whilst there is no doubt that the results obtainable from a well-designed lightweight pickup, used in conjunction with a good amplifier and wide-range speaker system, are very good on the latest recordings, the results on many older discs are most discouraging. At best, reproduction is accompanied by a noise resembling a high-pressure steam jet, and at worst the noise and distortion is so bad as to destroy completely the entertainment value of the record. The same is true, to a degree, of many recent issues as well. The result is that many record lovers, who have old and cherished recordings in their collections, cannot be induced to invest in apparatus that makes these records unplayable.

This is a very undesirable state of affairs, and the purpose of this article is to examine the factors affecting the quality of reproduction of records, with particular reference to surface noise and harmonic distortion, and to show how this has led to the design of a pickup that is able to deal both with the full range of the latest discs and, at the same time, get the very best out of the most difficult old recordings.

The primary cause of surface noise is lack of homogeneity in the record substance. Even in a lightweight design the needle-point pressure, owing to the small area of contact with the groove wall, may be 5 tons per sq inch at rest, and many times this when the stylus is being accelerated. Under these conditions the groove wall suffers elastic deformation, and to prevent it becoming permanently deformed, it is necessary to reinforce it with a solid filler incorporated in the record material. This compliance in the groove wall enters into the armature resonant system, a fact which is illustrated in Fig. 1, which shows the response at two different stylus pressures.

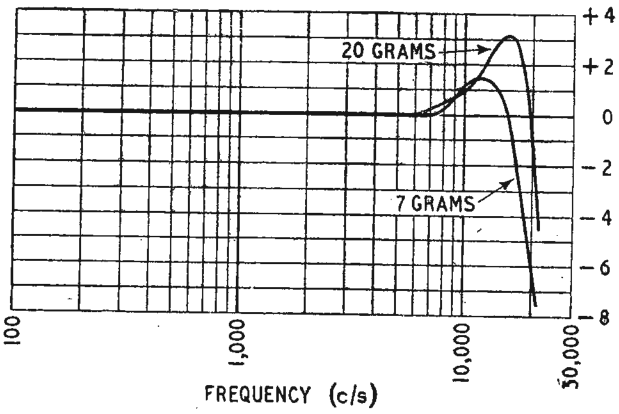


Fig. 1. Effect of stylus pressure on armature resonance.

The effect of this lack of homogeneity is to impart a series of pulses to the stylus as it traverses the groove. These will excite oscillations in any resonant parts of the reproducing system. The most vulnerable point is the pickup armature. In Fig. 2 is seen the effect using a pickup with a rather heavy armature and tracing a 400-c/s note. The oscillations of the armature are seen superimposed on the 400-c/s trace. Most current lightweight designs have an armature resonance around 7 to 10 kc/s, which is well within the audible spectrum. The pulses received by the armature from the record material cover a broad frequency band, and the effect of the armature resonance is to raise the output level of scratch at the resonant frequency above the general level. If the pickup system were non-resonant, the scratch level would be lower.

There are three methods available for the general reduction of surface noise. The first is to reduce or remove everything above a certain frequency with a low-pass filter. The second is to insert a filter tuned to the armature resonant frequency, and the third is to place the armature resonance above the limit of audibility. The first is usually accomplished with a conventional top-cut circuit that badly multilates quality before it has much effect on surface noise. Sometimes it is done by means

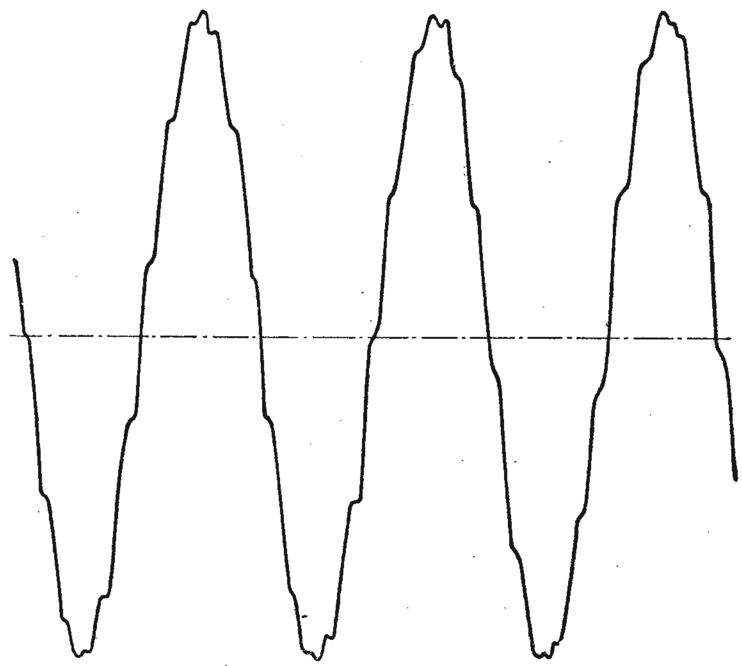


Fig. 2. Oscillogram of pickup with 4,500 c/s resonance when tracing 400 c/s note.

Problems of Surface Noise

(Goldring Service Dept.)

of a shunt capacity, but this merely tunes the pickup coil and brings the predominant scratch frequency lower down. Method three is the only one that does not entail a loss of quality.

There still remains the problem of variations in surface noise between different discs. Fig. 3 is taken from a shadowgram of a section of record with various sizes of stylus resting in the grooves. At A is shown a large-radius stylus, whilst C shows an under-fit this particular groove over part of the cycle, whilst C is not likely to fit at all.

Practical results seem to show that, where the armature resonance lies within the audible range, increasing the stylus tip size reduces surface noise, and there has been a tendency to fit lightweight pickups with styli larger than the optimum dictated by other considerations. When the armature resonance lies beyond the audible limit, this no longer holds and there appears to be an optimum size above or below which surface noise is increased.

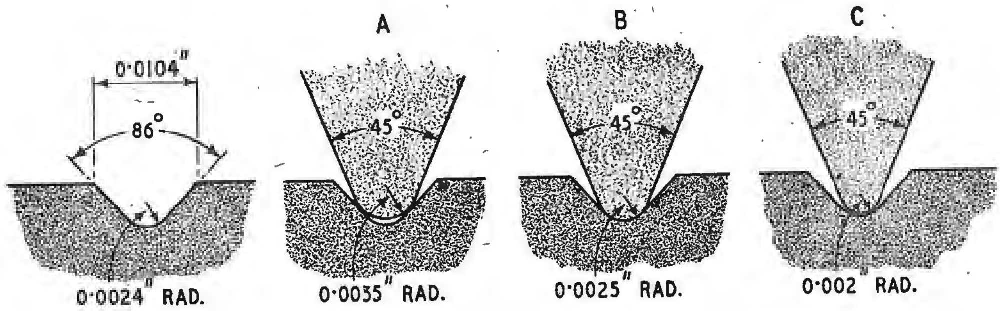


Fig. 3. Section of sample recor . (left) with three differently shaped stylus tips.

sized one. Now the groove is cut with a chisel-shaped edge and as a result has the shape of Fig. 4(a), so that as far as a spherical reproducing point is concerned, the width of the groove varies throughout the cycle. This is descriptively known as the "pinch" effect: so that where the stylus is too small, over at least part of the cycle the stylus will lose contact with the groove walls. As explained in connection with Fig. 1, the groove walls are part of the armature system, and help to control its resonant frequency and damping. When the groove walls do not grip the stylus, the armature resonance becomes more pronounced and lower in frequency, so intensifying surface noise. The remedy here is to ensure that the stylus tip is always a good fit in the groove. Referring back to Fig. 3, which is of a groove shape met within practice, it will be seen that the point B, which has the tip radius now recognized as standard in this country, will only just

In Fig. 4(b) is shown, to scale, a portion of one form of groove modulated with a 14 kc/s signal, and a 2.5-thou radius reproducing point in comparison. It will be apparent that the point cannot follow this groove accurately, either in waveform or amplitude,

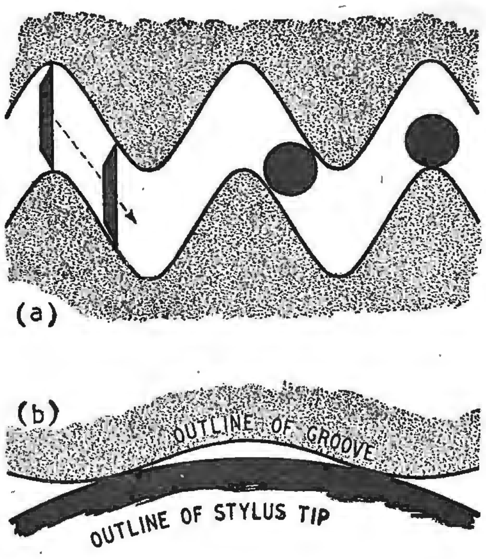


Fig. 4. (a) Variation of groove width developed by flat-fronted cutter. (b) Relative sizes of 0.0025 in stylus tip and 14 kc/s wave at inner radius of disc.

and the resultant frequency and amplitude distortion increases rapidly with tip size and inversely with groove speed, i.e., at low recorded radii.

The frequency distortion is compensated during recording by "radius compensation," in which the high-frequency level is raised as the cutter approaches the centre of the record. The tracing distortion is thereby markedly increased, an effect too well known to need further stressing.

In designing a high-fidelity pickup, first consideration must be given to the armature and stylus system. To secure minimum surface noise, the stylus must be an optimum fit in the groove, and remain so for as long as possible, a requirement dictat-

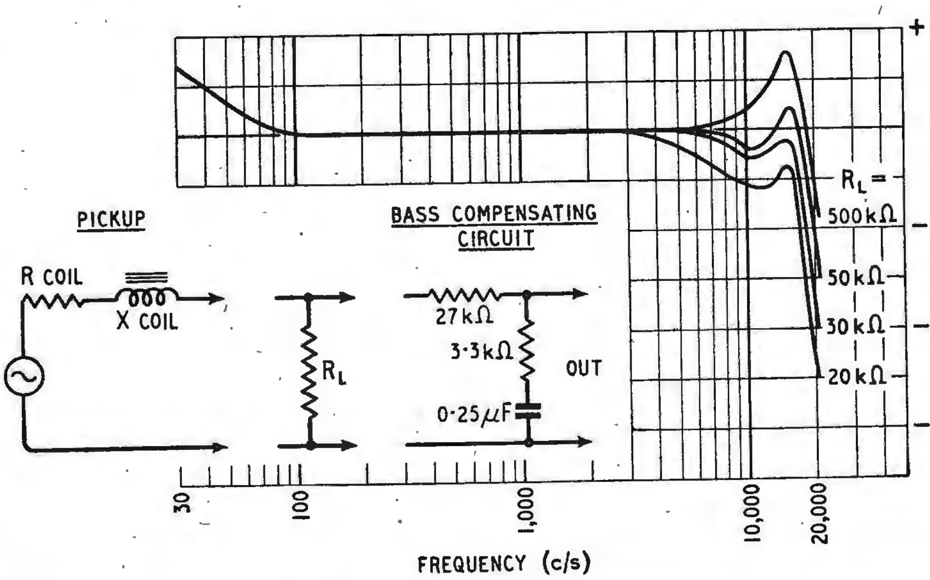


Fig. 5. Effect of load resistance on high-frequency response of the Goldring "Headmaster" pickup with bass compensating circuit.

Pickup Design—

ing a permanent point. At the same time the armature resonance should lie as high as possible, which rules out a separate armature and stylus system. In practice it is found that more than one stylus size will be needed to deal with the records currently available, which, taking these other considerations into account, suggests interchangeable heads. As the currently available lightweight pickups are quite expensive enough for the average pocket, without involving spare heads, manufacturing costs have to be drastically reduced.

A new design fulfilling these conditions has recently become available (Goldring "Headmaster" pickup). It is of moving-iron construction, with a half rocker armature and fixed sapphire point, and three interchangeable heads are provided with fixed styli of 0.002in, 0.0025in and 0.0035in radius. The armature resonance has been raised beyond 15 kc/s, and is well controlled.

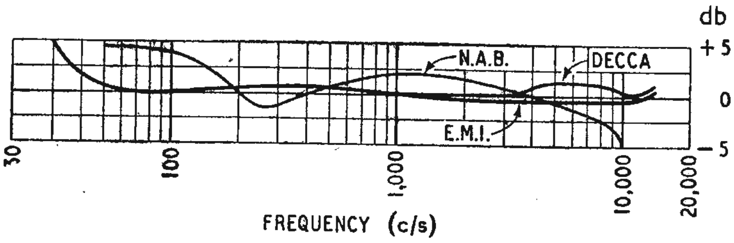


Fig. 6. Response of "Headmaster" pickup and "Tonaliser" correction circuit to principal recording characteristics.

Another fact of importance is to keep the ratio of downward pressure to inertia, at the needle point, as high as possible, so as to maintain good tracking on warped records, and it has been found possible to achieve a ratio of unity with this design, dispensing with any form of counterbalance, at a needle pressure of only 20 grams.

The associated circuits are important in getting the optimum performance. Fig. 5 shows the effect on high-frequency response of the load resistance, from which it will be seen that by correct choice of load it is possible virtually to eliminate the effect of the armature resonance. The result on the bass response of correct choice of bass compensation constants is shown as well.

If the high-frequency response of a pickup is sufficiently well maintained, it becomes possible to take advantage of the pre-emphasis used on certain British and American recordings to gain a further reduction in noise level. An R-C circuit has been developed for this which incorporates the correct values for load and bass compensation as well, and Fig. 6 shows the response of this, with a sample pickup, to the principal recording characteristics. Another important point is not to have a wider frequency range available than is present on the record, and Fig. 7 shows a useful tone control circuit which cuts top response in half-octave steps, ranging from a perceptible drop in scratch level to a distinct cutting of the higher musical frequencies.

The effect on noisy records of changing to a larger stylus is dramatic to a person accustomed to conventional lightweight pickups: records giving very bad noise, even with pre-war pickups using soft steel needles, yield to this treatment.

No less marked is the effect on harmonic distortion of reducing the tip size with certain records, and it is interesting in this connection to note that the records of one manufacturer may play satisfactorily with any tip size from 2 to 3.5 thou. radius, whilst those of another will give excessive noise at 2 thou., unbearable distortion at 3.5 thou. and just tolerable results with 2.5 thou.

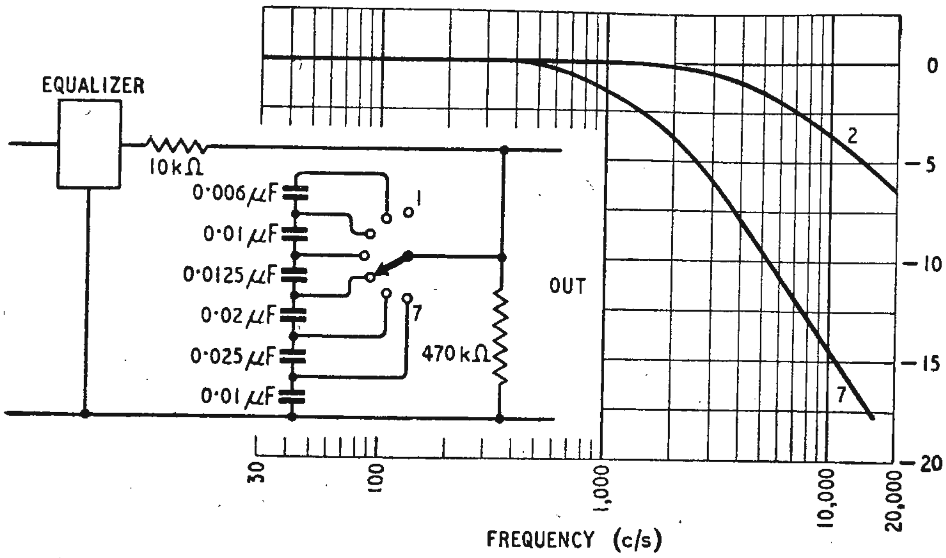


Fig. 7. Low-pass filter, variable in half-octave steps.

This suggests that further improvements are possible in recording technique.

Using the optimum tip size and the optimum amount of top-cut allows the extraction of the maximum entertainment value from old records which are otherwise quite unplayable; at the same time the wear is so low that there is no danger of damaging a valuable record.

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VALRADIO, Ltd., 57, Fortess Road, Kentish Town, London, N.W.5, inform us that they produce a unit similar to that described in an article which appeared under the above heading in our last issue. It employs a vibrator specially designed for the purpose and provides an a.c. output of 30 W.

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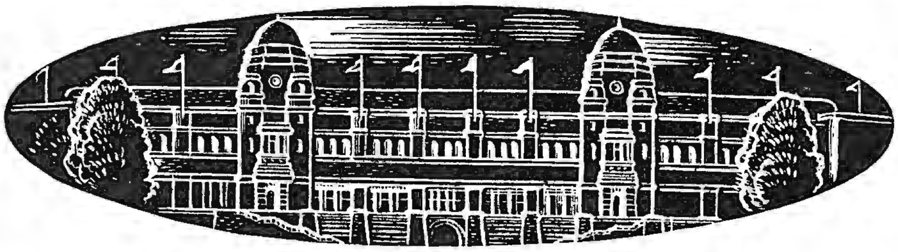

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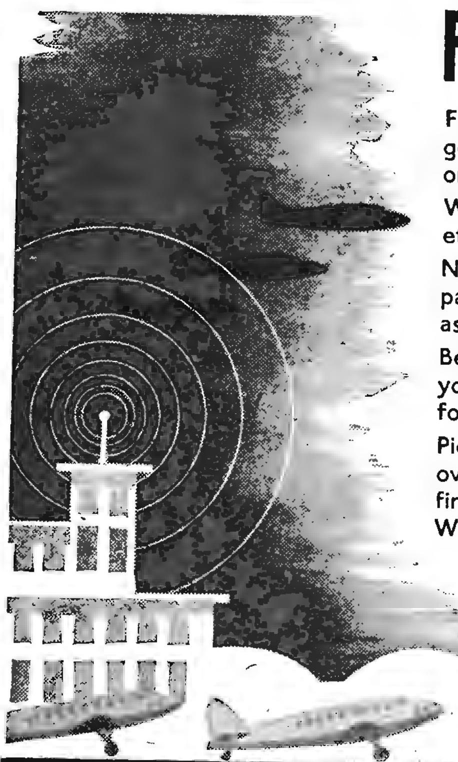

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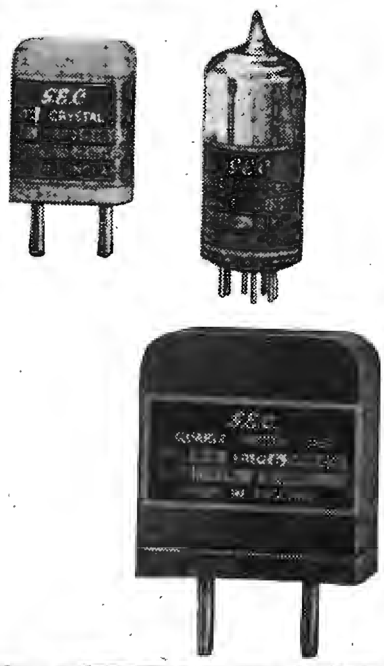

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TEST REPORT

MURPHY MODEL A138R

Radio-gramophone with the Emphasis on Record Reproduction

The projecting Perspex tun ng scale is indirectly illuminated.

IN designing this instrument the makers have given particular attention to gramophone reproduction to take full advantage of recent advances in recording technique. A special moving-coil pickup using miniature steel needles has been developed by Murphy, and makes its first appearance in this model. The record changer handles eight 10in or 12in records mixed.

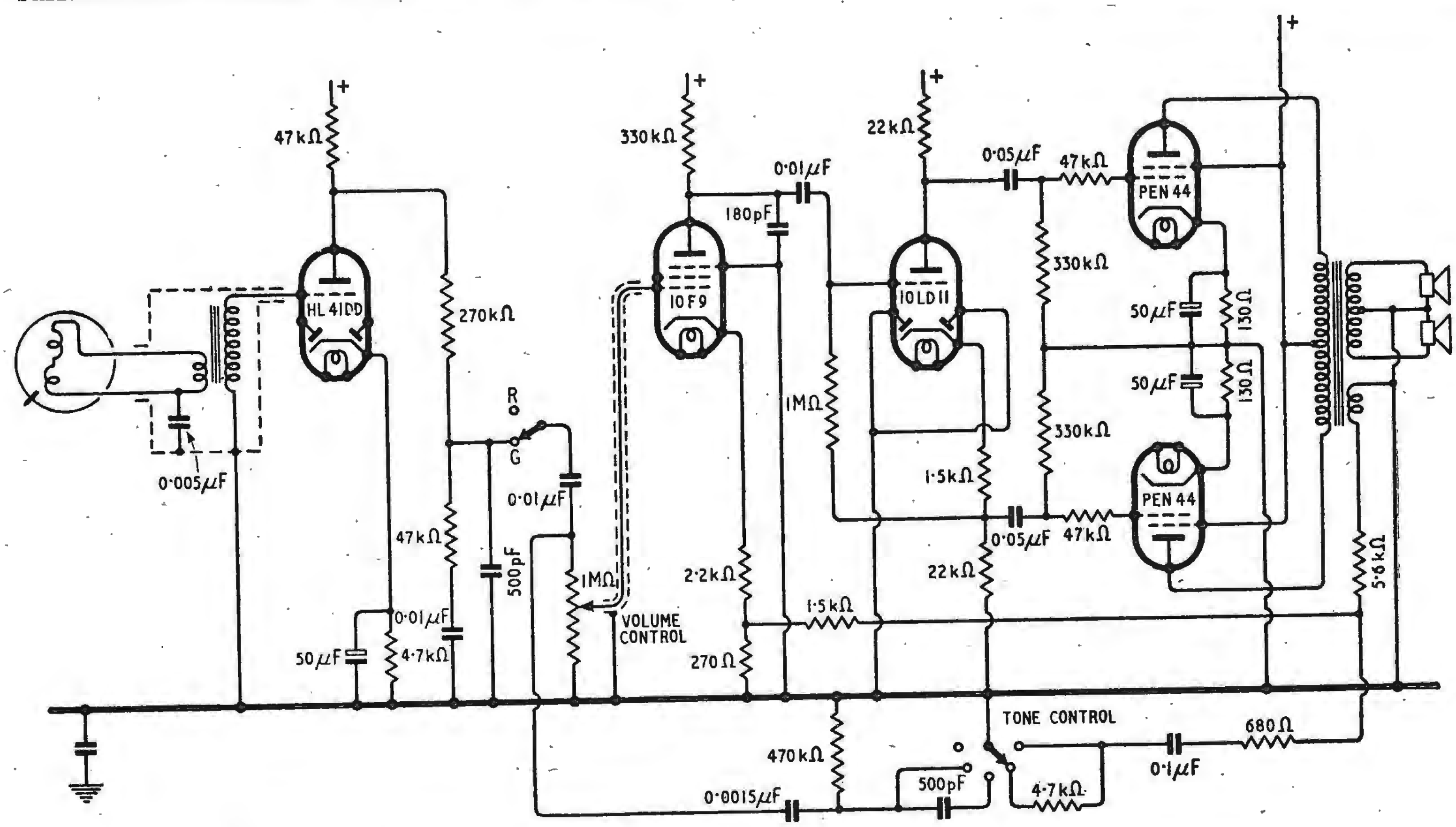
The cabinet work is of modern design and breaks with the traditional appearance of solidity usually sought after in radio-gramophones. We say "appearance" advisedly; in practice large surfaces are difficult to control acoustically, and the heaviest-looking cabinet may not necessarily be the most efficient from this point of view.

Ease of servicing has been carefully considered and the hinged front panel gives ready access to components on the inverted receiver chassis.

FEATURES

Waveranges: Short, 16.9—52.2 m.
Medium, 190—555 m.
Long, 970—2050 m.
Intermediate Frequency: 465 kc/s
Power Output: 12 watts
Mains Supply: 200-250v, 50-60 c/s
Dimensions:
33½in high, 28½in wide, 17in deep
Price (including tax): £92.8.11

Circuit.—Provision is made in the aerial input circuit for the insertion of local-station filters where the instrument is installed close to a transmitter. The triode-hexode frequency changer is of the 0.1-amp heater type, and together with most of the early stages is connected in series across the mains auto-transformer. Valves with four-volt heaters are used in the output stage, because their other characteristics are best



Circuit of audio-frequency stages associated with the new Murphy moving-coil pickup.

Murphy Model A138R—

suited to the design, and in the pickup pre-amplifier stage from considerations of hum level.

The screen of the mixer section of the frequency changer is fed from a potential divider to obtain a better a.v.c. characteristic; the slightly reduced signal-handling capacity is not a source of embarrassment provided the local-station filters are fitted where necessary.

Transformers of standard design and moderate bandwidth are used in the i.f. stage and top cut is offset in the second detector by connecting a small capacitance across the top section of the tapped load resistance. Additional top lift is provided by selective feedback in the a.f. stages.

The triode section of the second detector and a.v.c. rectifier stage is used as the gramophone pre-amplifier. This is necessary as the output from the moving-coil pickup is only of the order of 700 μV. The pickup transformer and all leads are well screened, and particular care has been taken to neutralize hum paths through stray capacitance. A hum-bucking coil is incorporated in the pickup head, and the second a.f. amplifier—a pentode—is deliberately under-run to reduce hum induced from the heater.

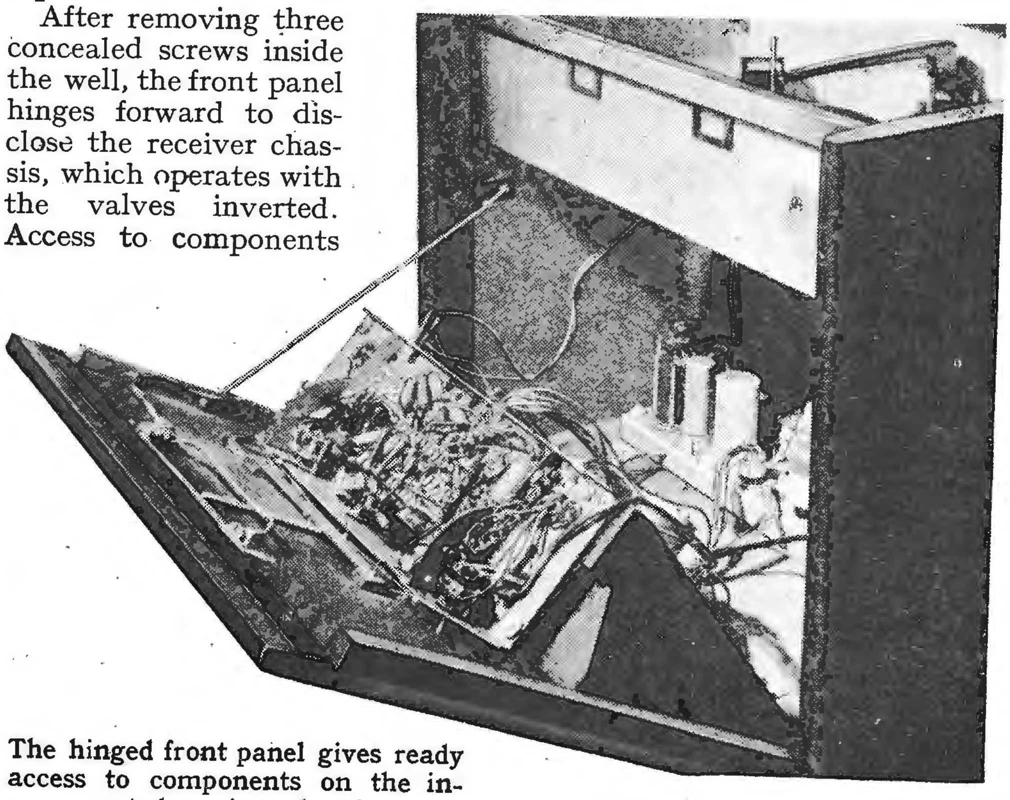
A slightly falling characteristic in the upper register has been permitted in the gramophone circuit by making a virtue of the capacitance of the leads from the pickup transformer and the input capacitance of the pre-amplifier. This is just sufficient to compensate for pre-emphasis in some modern recordings; further top cut is available when playing older and worn records by the four-position tone control in the feedback circuit. Permanent bass compensation for the falling recording characteristic below 300 c/s is effected in the anode circuit of the pre-amplifier.

The second a.f. amplifier feeds a resistance-coupled phase-splitter before the two Pen44 output valves, which are rated to deliver 12 watts. A separate tertiary winding on the output transformer provides the feedback voltage, which is applied to the cathode circuit of the stage preceding the phase-splitter.

Two permanent-magnet loudspeakers are used, one 10in and the other 8in in diameter. Their speech coils are fed from a separate winding with centre-tap earthed.

Constructional Features. — A shallow sunk lid covers the record-changer well, which has boldly rounded sides for ease of cleaning. The record-changer mechanism is freely sprung and continues to oscillate for some time after a record has dropped, but this does not seem to have any effect on the reproduction.

After removing three concealed screws inside the well, the front panel hinges forward to disclose the receiver chassis, which operates with the valves inverted. Access to components normally on the "underside" of the chassis is obtained by lifting a dust-cover after removing two more screws. The record changer can be inspected easily from back or front when the panel is hinged forward.



The hinged front panel gives ready access to components on the inverted receiver chassis.

The power pack, which like the receiver chassis, is mounted on rubber grommets, is on the floor of the cabinet and carries also the output valves and their associated components.

In the design of the cabinet, reinforcement has been judiciously applied to give rigidity with the use of the minimum amount of wood, and the simple design is to our eye well proportional and pleasing, but in such matters of taste the buyer is the final arbiter.

Performance.—A test of acoustic output seemed to be the first item on the agenda in view of the rather unpretentious appearance of the loudspeaker units and the lightness of the cabinet construction relative to established radio-gramophone standards. Choosing a modern orchestral recording with wide dynamic range we set the volume control at a reasonable level on a quiet passage and sat back to await results on the next climax. Output stage, loudspeakers and cabinet withstood the test without any audible wilting though the sound level was too high for comfort in a small room. There can be no doubt that those who like their orchestral performances at realistic levels will not be disappointed by this instrument. Reproduction was clear up to 7/8 maximum on the volume control and if the last 1/8 produced a little turgidity, the transition over the threshold was not accompanied by any distressing harshness.

The bass response is free from boom and well balanced with the rest of the audio spectrum at medium and high volume levels. High-frequency response was just right, and gives brilliance and attack without emphasizing surface noise. Only on a few old records, played as a test, was it necessary to reduce the top response by means of the four-position tone control. The on-off switch is combined with this tone control, and in an effort to tame a particularly worn record, we inadvertently turned the set off altogether. We took the hint and thereafter played only records of a quality worthy of the instrument.

Hum is negligible and no trace can be detected under normal listening conditions. With the volume control at maximum and the pickup at rest one can just hear a trace by kneeling down and putting one's head a few inches from the loudspeaker aperture.

We liked the feel of the spin-wheel tuning control and the appearance of the projecting indirectly illuminated Perspex scale. The sensitivity of the radio receiver is sufficient to bring in every worthwhile station and the selectivity is adequate. There were a number of self-generated whistles between stations on all wavebands, and the tuning seemed a bit cramped on short-waves after having handled several bandspread receivers recently. The quality on powerful medium-wave stations, however, was in every way comparable with the high standard achieved on the best gramophone recordings.

The makers are Murphy Radio, Welwyn Garden City, Herts.

NEW COLOUR TELEVISION SYSTEM

R.C.A. Sampling Process

A METHOD of colour television which calls for no increase of bandwidth over that of an ordinary black-and-white picture has been developed by the Radio Corporation of America. It is claimed that in a 525-line 60-frame system the usual channel of 6-Mc/s width is not exceeded and that a colour transmission can be received in colour on a special receiver or in black and white on any ordinary receiver.

The initial and final stages of the system are the same as in the previous R.C.A. system. The studio scene is viewed with the colour camera and provides three outputs simultaneously corresponding to the three primary colours—red, green and blue. At the receiving end these three signals are fed to three c.r. tubes which have on them identical and synchronized rasters and red, green and blue screens. The three separate coloured pictures are superimposed optically to produce the final colour picture.

Three channels between transmitter and receiver are needed in this original system to convey the three colour signals. The new development comprises a method of conveying the essential information by one channel only. This is done by sampling the colour signals in sequence and transmitting only information relating to colour at these instants of sampling. What might be termed colour interlace is also used.

The basic sampling frequency is 3.8 Mc/s, and each colour signal is sampled every 0.263 μsec ($=1/3.8$). The duration of each sample is short compared with the time between successive samples and the samples of the three colours are staggered in phase with intervals of 0.0877 μsec between colours. This is shown in Fig. 1. At (a) two samples of the green signal 0.263 μsec apart are shown and at (b) and (c) samples of the red and blue signals respectively. The amplitudes are proportional to the amplitudes of the signals at the instants of sampling. In Fig. 1 the green, red and blue signals are shown in descending order of amplitude, but this is merely to enable them to be distinguished easily in the composite signal (d). In reality the amplitudes will depend on the picture being transmitted.

If a train of pulses, having a repetition frequency of 3.8 Mc/s,

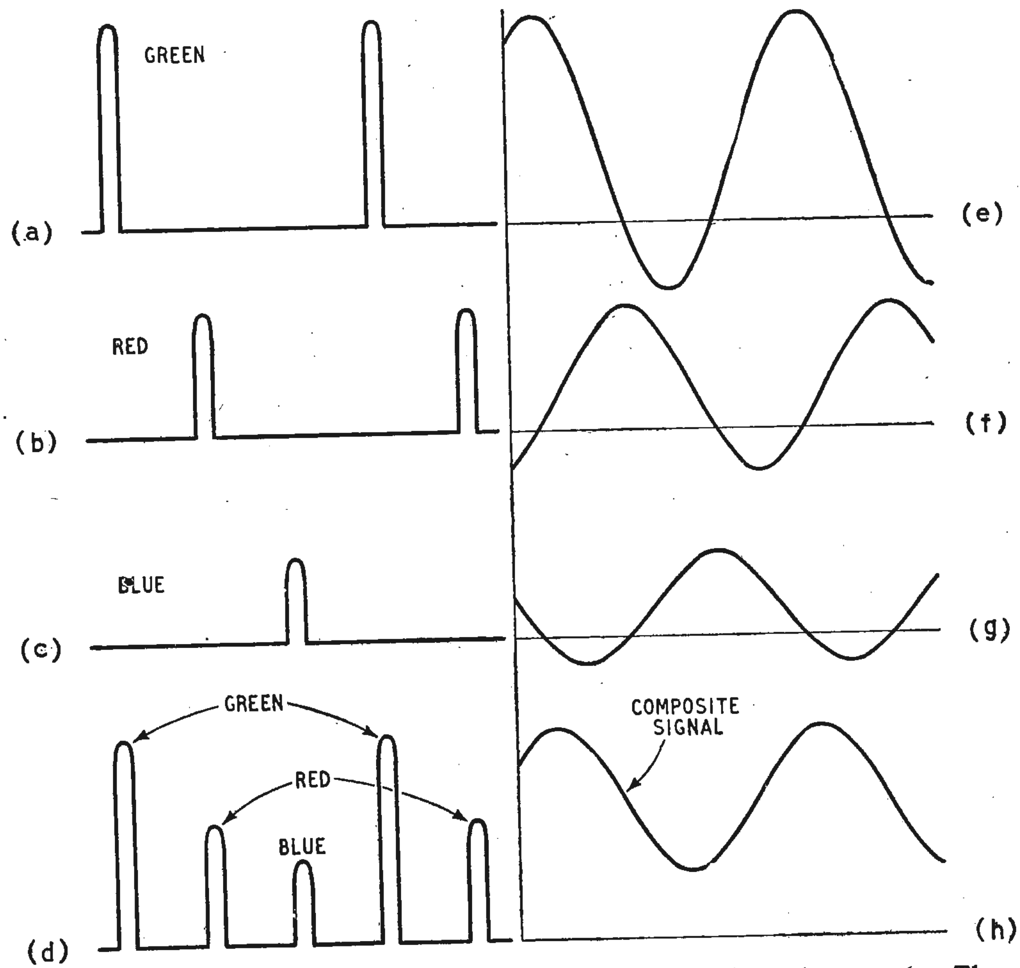
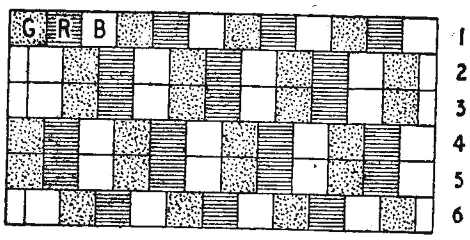


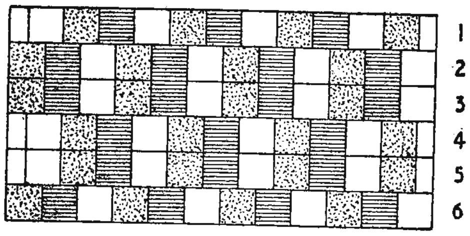
Fig. 1. This diagram illustrates the method of sampling the signal. The resulting pulses are turned into sine waves of proportional amplitude by means of low-pass filters *Courtesy R.C.A.*

New Colour Television System—

is put through a low-pass filter with a cut-off frequency of 4 Mc/s only the fundamental and d.c. components of the signal will pass. The output is then of sine waveform with an amplitude depending on the input pulse amplitude, and a d.c. component depending on the mean amplitude



FIRST AND SECOND FRAMES



THIRD AND FOURTH FRAMES

Fig. 2. This diagram shows the colour sequence in building-up the picture in the receiver. Four frames are required for one complete colour picture. *Courtesy R.C.A.*

of the pulses. The sets of pulses corresponding to the three colour channels produce three sine waves which differ only in phase, corresponding to the staggering in time of the three pulse trains, if the pulse amplitudes are all the same, but which differ also in amplitude and in their d.c. components if they are not alike. These three sine waves are shown in (e), (f) and (g) in Fig. 1. It is particularly to be noted that the maximum of any of these waves always occurs when both the other two are zero and coincides with the pulse. The addition of the three waves gives a sine wave of different phase and with a combined d.c. component. This is the wave used to modulate the transmitter, when the usual sync pulses have been added, and it is the waveform in the output of the detector at the receiver.

The sampling times correspond relatively (that is, except for the uniform transmission delay which applies to the whole signal) to the original sampling times in the transmitter. Therefore, every time the composite signal is sampled its amplitude at that time corresponds to a maximum of one of the component sine waves and to zero in the other two and so represents one colour. A set of pulses corresponding to the original pulses is thus produced; they are sorted out into the three colour groups and passed to three c.r. tubes—one group to each.

Colour Sequence

If this were all, a satisfactory picture would not be produced. With simple and uniform sequential scanning the transmission of a blank white raster would be reproduced as a set of spaced coloured dots. The green tube, for instance, would show on its first line, 'green, blank, blank, green, blank, blank' and so on. The red tube would show 'blank, red, blank, blank, red, blank,' and the blue 'blank, blank, blue, blank, blank, blue,' and so on. Their composition would thus give, 'green, red, blue, green, red, blue.'

In order to avoid this the colour sequence is varied in successive repetitions of the same line and the colour areas are made to overlap. The arrangement is shown in Fig. 2. Ordinary interlacing of lines is used and in the first and third frames odd lines are scanned and in the second and fourth frames the even lines. Four frames are needed for a complete colour picture. The letters represent the colours. The first, fifth, ninth, etc., lines follow a straightforward scan of green, red, blue in sequence, the third, seventh, etc., lines follow the order blue, green, red, and are staggered half-a-colour-element sideways. When the frame interlacing is taken into account the first and third lines of the third frame have the colour sequence of the third and first lines of the first frame.

In line 1, for instance, blue of the third frame appears superimposed on half the green of the first frame and on half the red. Green is superimposed on half of the red and half of the blue, while red comes on top of half of the blue and half of the green.

In the preferred arrangement of the system some additional complication occurs because the sampling rate is halved and signals up to 1.9 Mc/s only are transmitted in colour, the high-frequency components up to 4 Mc/s being separately mixed and being without colour.

The system is extremely ingenious. It has the advantage not only of providing colour within the normal bandwidth of a black-and-white picture, but of enabling a black-and-white picture to be obtained with any ordinary unmodified receiver. The adoption of the system at the transmitter would thus not affect existing receivers.

ELECTRONIC FLAME-CUTTER CONTROL

Obviating the Need for Engraved Metal Templates

AN automatic template-tracing head has been developed by Metropolitan Vickers and is used in the oxygen flame plate cutting machines made by Hancock & Co., Progress Way, Croydon. In principle, a photoelectric cell in conjunction with auto-following mechanism is used to trace the outline of the template, which is merely drawn on paper and placed on a flat bed below the photoelectric head. The machine obviates the need for engraved metal templates and the drawings can be used for an indefinite production run.

MINIATURE MICROPHONE

Developed by Cosmocord for the Air Ministry Medical Research Dept. this miniature crystal microphone is used to explore sound levels inside the helmets of air crews under actual flying conditions. It is claimed to have a response substantially flat from 10 c/s to 20 kc/s.

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LETTERS TO THE EDITOR

Problems of the New Broadcast Plan ✦ Television and Women's Fashions ✦ Dangerous Wiring ✦ Broadcast Quality

"Intermediate Frequency and the Copenhagen Plan"

I MUST thank Mr. Bishop for his criticism of my findings, because as he appears to have arrived at some erroneous conclusions, it would seem that a number of points should have been made clearer.

All the interference possibilities within the scope of the article were included in Table II for the sake of completeness, and some of them could be ignored. I thought I had indicated this by my remarks on the International Common Frequencies on pages 323-4. Why need Mr. Bishop have stressed the same point?

I cannot emphasize too strongly that my qualifying remarks (page 324, paragraph 4), attached to Table II regarding the geographical position and aerial powers of the relevant transmitters are of the utmost importance. This was my sole object in constructing Table I. This question of aerial powers is one of the most serious aspects of the Copenhagen Plan and the extension of the m.w. band only makes the situation more dangerous. Under the Lucerne Plan, the system of power allocations was technically sound: 550-1,100 kc/s, 100 kW max.; 1,100-1,250 kc/s, 60 kW max.; 1,250-1,500 kc/s, 30 kW max. A comparison between this and the new plan must give grounds for misapprehension; e.g., Channel 63, 150 kW; 86, 150 kW; 91, 150 kW; 104, 60 kW.

Regarding my use of the full ±9-kc/s bandwidth, I agree that this does produce a somewhat exaggerated result in view of the type of receiver under discussion. Nevertheless, domestic receivers do show wide variations in cut-off frequencies, and anything between 3 and 7 kc/s is fairly common. I therefore do not think I was unjustified in using the full ±9 kc/s, particularly as caution was indicated by my terming the rejected i.f. bands "unsuitable" and *not* "unusable" as Mr. Bishop mistakenly states.

Mr. Bishop is correct regarding second-channel as long as the carrier is unmodulated, but directly modulation takes place, a different set of conditions arises. Given a strong enough input, interference can be experienced at peak modulation even with the image carrier 18 kc/s removed from the desired carrier, provided the receiver responds to ±9 kc/s or better. This modulated condition applies to oscillator second harmonic interference, too, and accounts for the 877-kc/s transmitter interfering with the 200-kc/s channel in certain areas when the receiver has an i.f. of 456 kc/s. Surely Mr. Bishop is mistaken when he refers to the interfering carrier being 6 or 18 kc/s away from the *oscillator second harmonic frequency*.

Under the present distribution of frequencies there are only two forms of interference shown by the graphs to be produced by i.fs of between 456.5 and 465.5 kc/s. These are the one mentioned above and second-channel interference from the 1,122 kc/s transmitter on the 200-kc/s channel. As in both cases the affected areas are outside the Midland Region, and are therefore served by the 1,149-kc/s relays, I am at a loss to understand why Mr. Bishop should assume that this makes these i.fs unusable. Incidentally, as we are still supposed to be operating under the Lucerne Plan, I think it is relevant to point out that under the *original* plan the following i.f. bands were reasonably clear: 329.5-333.5; 406.5-424; 443-482; and 492-500 kc/s.

I do not know on what grounds Mr. Bishop bases his hopes of a better service, but the fact that the B.B.C. intends to use two valuable frequencies, one of which is exclusive, for foreign propaganda broadcasts, and that for this purpose two 150-kW transmitters are to be used at a most dangerous part of the m.w. spectrum from the point of view of interference, the fact that the power of the 200 kc/s transmitter is presumably to be raised to 400 kW, and that France has been permitted the use of a 450-kW transmitter in the l.w. band with the consequent danger of increased "Luxembourg Effect" gives me the impression that they cannot be too secure. I find it difficult to understand how Mr. Bishop can refer to "the orderly distribution of wavelengths in Europe," when Radio Luxembourg is adamant about holding on to a position in the l.w. band; when the seven countries who did not sign the convention will do just as they please, and the seventeen who made reservations will presumably do likewise should they feel so disposed, not to mention the two that were not even present.

Finally, I wish to state how sorry I am that Mr. Bishop has chosen to ignore my suggestion about the 200-kc/s channel, but instead has recommended the use of rejectors, as this rather weakens his case. Even if I have been unduly pessimistic, it is hardly practicable to use an i.f. of 498.3 kc/s, with a guaranteed maximum deviation tolerance of ±700 c/s, as is suggested in one example. As it seems likely that the B.B.C. are going to sit back and hope for the best, I should like to recommend to your readers the i.f. of 475 kc/s as the best of a bad job, but trouble may be expected in certain parts of the North and West of England, Northern Ireland and Wales. I sincerely hope I am proved wrong, but if not, then the best i.f. for these areas is anybody's guess, but would seem to be around 365 kc/s.

G. H. RUSSELL.

London, N.W.5.

"Televising Moving Images"

IN connection with R. W Hallows' article, the following may be of interest. I have noticed that where an artist is wearing a narrow horizontally striped dress, there is considerable flutter or flicker, due no doubt to the frequent omission of scanning lines of the horizontal stripe of the dress.

In fact, until the problem of the number of frames and lines is resolved the B.B.C. would do well to censor dresses of narrow horizontal striped material A. YOUNG.

Chingford, Essex

Reversed Power Leads

WITH reference to "Diallist's" note on reversed power leads, causing the whole of the otherwise correct installation to become dangerous, I met a similar case in which, due to a change in tenancy, an existing supply meter was removed and later replaced. Both the tails were red, and the re-connection was done by a woman employee of the supply authority (shortly after the war). Some months later one plug after another was found to be live when switched off, and it was not until several

Letters to the Editor—

had been blamed on the original wireman that the true cause was spotted.

Large numbers of such re-connections were made after the war in the big re-settlement of evacuated persons, and probably many such cases may still remain undetected.

F. GRISLEY.

Leigh-on-Sea, Essex.

Quality of B.B.C. Transmissions

IN the October issue, page 366, while discussing a high-quality amplifier, the author states:—

"The majority of medium-wave broadcast transmissions, when reproduced with wide-range equipment, exhibit a most objectionable form of non-linearity distortion. This takes the form of a rattle or buzz often accompanying transient sounds such as pianoforte music. This type of distortion is commonly caused by minor discontinuities in the transfer characteristic and is frequently associated with Class 'B' amplifiers."

In view of the above comments, I feel it only right to say that in the London area, on the Home Service (342.1 m), the B.B.C. have in recent months succeeded in clearing up the distortion referred to.

I gather that the existence of the distortion was largely due to the operation of an "austerity" war-time transmitter, but, judging by results, they seem to have cleared the trouble completely.

Distortions, of course, still occur occasionally on programme items in which the recording is below standard, but a direct transmission is now substantially free from "cracked piano effect."

P. G. A. H. VOIGT.

London, S.E.19.

Beacon Interference

I FEEL I must protest most strongly against the continued use of the medium-wave broadcast band for m.f. beacons operated at Air Ministry and M.C.A. airfields. The heterodyne whistles perpetrated by these transmitters completely remove all entertainment value from many interesting continental stations, and in most parts of the country at least six such interfering transmissions are present on domestic receivers. In the London area, particularly intolerable interference is caused on the Hilversum 416-m transmitter by beacon WK (West Malling?) whilst reception from the 301-m Hilversum transmitter is similarly ruined by another beacon in the Midlands.

I should be interested to know whether other people feel similarly about the matter, and whether any reader could say what the position is with regard to international frequency allocations. Surely navigational aids occupy sufficient space in the spectrum without encroaching into the broadcast bands in peacetime. I wonder whether the Post Office will be able to take action under the new Wireless Telegraphy Act against the authorities concerned for causing interference with broadcast reception.

"MIKEROBE."

"The Phasitron"

IN your issue of May, 1948, page 168, there is an article dealing with phase differences between the suppressor grid G_3 and the working grid G_1 of a pentode when a radio-frequency voltage is applied to this suppressor grid. Phase modulation with a condenser microphone based on this principle is furthed discussed.

This method was first described by Dipl. Ing. I. Zakarias in *Tungsram Technische Mitteilungen* for August, 1938.

A test set to control the quality of coils in service work also based on this principle was described by me in the Dutch journal *Radio Bulletin* for 1947, number 9.

P. BICKES

Nijmegen, Holland.

City and Guilds Certificates

MANY radio and electronics engineers specialize for their profession through the 4-5 year courses for City and Guilds Examinations, with the knowledge that Radio Communications Grade III, plus Technical Electricity Grade II, has at least the equivalent academic status of, and is recognized in lieu of, Higher National Certificate for Part "B" of the I.E.E.'s associate membership examination, and for the graduate examination of the Brit. I.R.E.

Why then, does the Technical and Scientific Register not recognize this equivalent value of C. & G. examination certificates?

This waste of skilled and experienced manpower is aptly illustrated by advertisements which appeared in *Wireless Engineer* (p. 34, March, '49, and p. 26, Aug., '49), also in *The Times* ("Public Appointments," 30/8/49), which invited applications from electronic and electrical engineers for positions as Senior, Experimental, and Assistant Experimental Officers, for radio, radar and electronic work at Farnborough and other establishments. It was stated that candidates should have experience, and "at least Higher National Certificate, *Higher School Certificate* or equivalent in mathematics, or a science or engineering subject." Applications were to be made to the Technical and Scientific Register.

I hardly like to suggest that City and Guilds Certificates, or Corporate Membership of the British Institution of Radio Engineers is "equivalent" to Higher School Certificate, but unless you can help stop this disfranchisement of qualified Radio and Electronic Engineers, I am at present obliged to accept the position that the thorough training required for a C. & G. man is to be counted as inferior to the qualifications of an 18-year-old straight from secondary school with Higher School Certificate.

"UNEMPLOYED
A.M.Brit.I.R.E."

"Shared Television Aerials"

WITH reference to the article on page 287 of *Wireless World* for August, I feel that it is desirable to utter a word of caution on the use of these matching circuits.

The characteristics of each of the circuits described depend on the individual feeders being closed with their characteristic impedances. These closing impedances are normally provided by the input circuits of the receivers connected to them. Should a receiver be disconnected from its feeder cable and the cable left open-circuited, then the insertion loss of the matching network will be altered, affecting the level of the signal transmitted to the other receivers. This, of course, can be corrected by an adjustment of the "contrast" control but a more serious form of interference may result in that the impedance of the network looking from the aerial will be changed and serious "ringing" may result, particularly if the feeder cables concerned are of appreciable length, giving rise to a very undesirable form of interference on the picture.

Where two or more receivers sharing an aerial are situated in the same premises this difficulty may easily be avoided, but where an aerial feeds receivers in different houses or flats, such that the user of one set has no control over the actions of other users, a considerable amount of trouble and annoyance can be caused.

K. J. EASTON.

Wembley Park,
Middx.

SHORT-WAVE CONDITIONS

September in Retrospect : Forecast for November

By T. W. BENNINGTON (Engineering Division, B.B.C.)

DURING September the average maximum usable frequencies for these latitudes increased considerably during the daytime and decreased somewhat by night. This was in accordance with the normal seasonal trend. The daytime increase was not at all marked until the end of the second week, when a sudden rise in daytime m.u.fs occurred, and persisted throughout the remainder of the month. Daytime working frequencies thus became higher and those for night-time lower than during the previous month. Daytime communication on 28 Mc/s became more frequently possible during the latter part of the month. At night 9 Mc/s was the highest frequency regularly usable. Sunspot activity was about the same as during August.

Sporadic E decreased very considerably in its rate of incidence and medium-distance h.f. communication was much less frequent that of late.

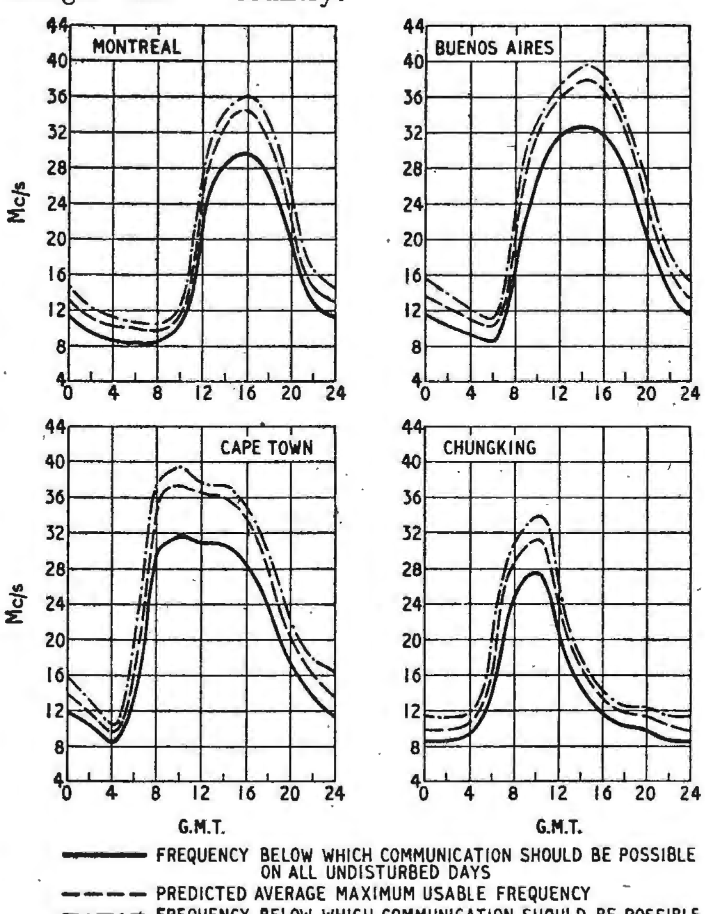
Conditions were somewhat less disturbed than might have been expected, though ionospheric storms did occur during the periods 1st-4th, 8th-9th, 12th-13th and 25th-28th, the most severely disturbed days being 3rd, 4th, 13th and 26th. No less than eighteen Dellinger fade-outs were reported as occuring during the month, the most intense of these being on 5th (two), 12th and 13th.

Forecast.—During November, daytime m.u.fs should be even higher than during October, and should, in fact, be the highest to be reached during the present winter season. Night-time m.u.fs, on the other hand, should continue to decrease, and will probably be *considerably* lower than during October. Long-distance working frequencies should, therefore, be high during daytime, and frequencies like the 28-Mc/s band should be regularly usable in most directions from this country. At night the lower frequencies in the short-wave bands will have to be used, and while 9 Mc/s may remain workable over some circuits, frequencies lower than this may be necessary in order to maintain communication over high-latitude transmission paths.

It is unlikely that the E or F_1 layers will control transmission over any distance at any time of day, and, since Sporadic E should not be very prevalent, medium-distance communication on high frequencies is not likely to be possible except on very infrequent occasions.

It is probable that there may be some decrease in the number of ionosphere storms during November, though, because of the normally light night-time ionization, the storms which do occur are likely to be particularly troublesome during the hours of darkness. Ionosphere storms are more likely to occur within the periods 2nd-3rd, 6th-7th, 18th-20th, 23rd-25th, and 29th-30th, than on other days.

The curves below indicate the highest frequencies likely to be usable, at every hour of day, over four long-distance circuits running in different directions from this country.



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

RANDOM RADIATIONS

By "DIALLIST"

Good Work!

IT WOULD BE DIFFICULT to overpraise the drive, the organizing ability and the herculean work which made it possible for Radiolympia to open in pretty complete form on the advertised day. One realized that the bulldog spirit was there right enough when, soon after the first strike announcement, Admiral Dorling said that the show would open, even if the exhibits had to be laid out on the floor! The work put in by the organizers, the exhibitors and the Press Officer approached what our American friends would call "an all-time high." It went on day and night at full stretch. Unfortunately, it couldn't save one of the most important days from the export point of view; the pre-view on September 27th had to be cancelled and that was a loss indeed. It's on the pre-view day that the overseas buyer is normally most active. As there are no great crowds, he can examine the stands at his leisure, without having to battle his way to them. Nor has he usually to wait until some of the technical people on the stand at which he has arrived can attend to his enquiries. Unfortunately, no one has yet discovered a way of making an hour contain more than sixty minutes; hence some overseas buyers, whose visits had been planned in advance to include just the pre-view day and the opening day, were faced with the alternatives of taking in fewer stands, or of spending less time than they had originally intended on the stands showing apparatus that made the strongest appeal to them. A pity, but there it is.

Error of Judgment?

It was said widely that television stole the show. To a great extent it did; and in my humble view it should never have been allowed to do so. It's easy to attract the man in the street and his better half by any demonstration of visual entertainment than by plain, simple radio. They come, they see, they marvel, they covet. But how many of them live in the present television service area or in that to be served by the new station? And even if they do, there are still large numbers of homes in those areas which have no mains supply of electricity, whilst others have a supply unsuitable for television. For at least five years to come the lifeblood of the radio industry must be concerned with the plain radio receiver, dealing with sound alone. To my mind, then, Radiolympia should concentrate on being *Radio*lympia whilst things are as they are and should not be allowed to go gay by becoming Televisiolympia!

The Television Scheme

IN HIS OPENING SPEECH the Lord President of the Council outlined a television broadcasting system for this country which won't be completed, even in skeleton form, for another five years. His words made me go cold all over. Here we are, the first country in the world to develop practical television, being left far behind, certainly by the United States and possibly by other countries, in the provision of a nationwide television system. Our problems are far simpler than those of most other countries because (1) the bulk of our population is concentrated in or around a few comparatively small areas; (2) the distances from area to area are far shorter than those found in other lands; (3) it is a simple and not very costly matter to bring the necessary radio or coaxial-cable links into being; and (4) we are not handicapped by the presence of great deserts or by large residential areas in territories of the mountain-and-narrow-valley kind. If we want to keep our position as leaders in the television field, we must go all out for a rapid expansion of the service.

It's Got to be Done

There are, one realizes, big difficulties in the way of shortages of materials and labour. But television offers an enormously important channel for exports to a large part of the world. Most civilized countries are eager to start television services. Few have the means of manufacturing their own transmitting apparatus, or the receiving gear for which their people will clamour. Marconi, E.M.I., Pye and possibly other British firms have developed 405-, 525-, 605- and 625-line transmitting systems. Further, any of these systems is, within reason, readily adaptable to whatever number of scanning lines any particular nation may select as its standard. In a word, our manufacturers are all set to provide a large portion of the world with its television equipment as soon as it is wanted. But look at the handicap under which they are likely to find themselves. Prospective buyers may say to themselves, reasonably or unreasonably, that, as Britain has only one transmitting station, our makers don't on the face of it appear to have got very far: would they not be better advised to buy from a country in which a wide television network is a reality and not just a pious aspiration? We're losing face through our national go-slow in television and we can ill afford to do that.

The Home Market

There's another point, too, of very great importance. A thriving and vigorous export industry can be based only upon a large home market. At the moment our home market for television is very restricted. Little more than one quarter of our people live in the genuine service area of the London station. The opening, a week before Christmas, of the Birmingham transmitter will bring the total up to about 40 per cent of our population. But the industrial districts of Yorkshire, Lancashire, Durham, Northumberland, South Wales and South Scotland will, despite their enormous purchasing power, still be (in more senses than one) out of the picture. Our manufacturers can hardly count on selling at home more than 150,000-200,000 television receivers in the next twelve months and that isn't enough to enable mass production to be developed as it could and should be developed. I'd like to see the construction of the main television network made a matter of the highest priority. If that were done, I believe that we'd reap a rich reward in the export markets of the world. Notwithstanding the war, is it, when all is said and done, good enough that our second television transmitter will come into action 13 years after the first: or that 18 years will pass, should present plans materialize, between the opening of the Alexandra Palace station and that of the transmitter which completes the skeleton of the national network? The rest of the world may well feel that, though we were first in the field, we couldn't stay the course. An understandable attitude in the circumstances, but a pretty poor return for the outstanding contribution to television development that our physicists and technicians have made and continue to make.

Soldering-iron Rests

HAVING GOT THAT OFF my chest, I feel better, though there's a heap more I could say. Let's turn to a less controversial subject; that of rests for soldering irons. I've always maintained and shall go on maintaining that designers of soldering irons should bear in mind not only the brief periods during which the bit is applied to the work, but also the much longer periods in which it is laid down and expected to keep hot enough (though not too hot) for the next job it has to perform. Few designers supply the iron with any kind of rest, though I feel that this should be an integral part of it. The result is that we cuss them and improvize our own. I've described already several rests which are progenies of what I like to call my brain, or those of the brains to which readers of *Wireless World* can more justly lay claim. Here's one from a Manchester reader, which strikes me as particularly good. Ingredients: the chassis and magnet of an old P.M. loudspeaker. Scrap the cone and fix the magnet the wrong way up to the chassis. Lay the chassis face downwards on the bench and there you are. The average electric soldering tool has enough iron in its make-up to cause it to stick like glue to the magnet, even if you score a rather poor shot at the rest in laying it down. With an iron which has no temperature control (and that goes for most of them), this kind of rest dissipates the surplus heat. I know it works, because I've tried it. In fact, the iron I switched on half-an-hour ago for a particular job and then forgot about whilst I was writing this paragraph is no more than just nicely hot. You'll forgive me, I'm sure, if I break off to do the job.

MANUFACTURERS' LITERATURE

ILLUSTRATED catalogue of extension loudspeakers (including console types) and record players made by Richard Allen, Caledonian Road, Batley, Yorks.

Leaflet covering additions to service trade catalogue of capacitors (C262) from A. H. Hunt, Garratt Lane, Wandsworth, London, S.W.18.

The following additional sections to their list of publications have been received from Marconi's Wireless Telegraph Co., Chelmsford: SL102, Receiver Type CR150/3; SL103, High-speed Undulators; SL201, Type F10 Portable Field Equipment; SL401, Commentator's Microphone; SL301, V.h.f. Direction Finder Type AD200; SL309, Lower Power MF Beacon, Type AD501; SP16, Lightweight Aircraft Radio.

"Behind the Scenes with Mullard"—an illustrated description of the background of the television service; also a descriptive leaflet covering all the radio and television receivers in the 1949-50 programme, from Mullard Electronic Products, Century House, Shaftesbury Avenue, London, W.C.2.

Catalogue "Standard Ranges of Alcomax Loudspeaker Centre Poles" from James Neill & Co., Napier Street, Sheffield, 11.

Illustrated folder describing the Type P.T.R.61 light aircraft v.h.f. transmitter-receiver, from the Plessey Co., Ilford, Essex.

List of "Kabi" moulded connectors from Precision Components Co., 13, Byng Road, Barnet, Herts.

Leaflet describing the "Scope" six-second soldering iron made by Scope Laboratories, 25, Duffy Street, North Essendon, Melbourne, W.6, Australia.

Three illustrated leaflets describing television sets, table-model radio receivers and radiogramophones from Sobell Industries, Langley Park, nr. Slough, Bucks.

Catalogue of toolroom tempering furnaces, from Wild Barfield, Watford By-pass, Watford, Herts.

HIGH-QUALITY PICKUP

The H.M.V. No. 12 moving-iron pickup for miniature needles, supplies of which have been restricted to research and experimental organizations, is now available to quality enthusiasts and costs £2. 6. 4d. including tax A 100 : 1 matching transformer is available at 12s. 6d.

RECENT INVENTIONS

A Selection of the More Interesting Radio Developments

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

Ribbon Microphone Construction

IN ribbon microphones where directional characteristics are required it is desirable to provide ventilating passages in the pole pieces for allowing free circulation of air around the ribbon.

This result is obtained by making the pole pieces of laminar construction, the laminations being in groups of different shapes to provide air passages near the pole tips. The latter are continuous and are formed in part by small and thin elements fixed to the tips of other elements of larger size shaped to provide the required air passages around the thin elements to give air communication between the two sides.

The British Thomson-Houston Co., Ltd., and W. A. Bocock. Application date, November 7th, 1946. *No.* 625,291.

Feedback and Amplification Control

VOLUME control of a simple-type receiver such as a superheterodyne reflex receiver is secured by means of a potentiometer which is at least partially in the aerial circuit, and which also regulates negative feedback derived from the speech coil of the loudspeaker.

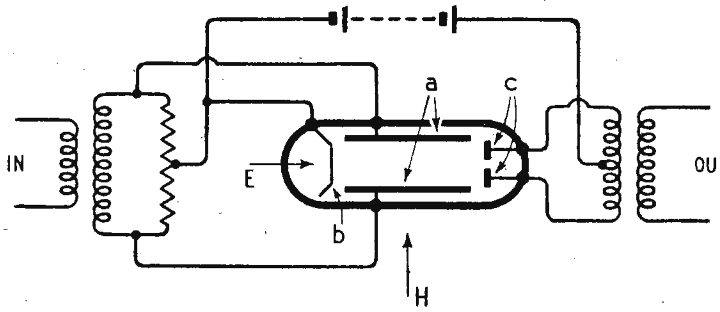
In the circuit described a triode-heptode is provided; the heptode serves as an oscillator and as a frequency changer and the triode as a neutralized i.f. amplifier (with a.g.c.) and also as an a.f. amplifier. The output valve is a double diode pentode. Feedback voltages are applied to the potentiometer, which thus varies the r.f. input and also the feedback voltages fed to the triode grid.

Philips Lamps, Ltd. Convention date (Netherlands), March 5th, 1943. *No.* 624,010.

Beam Deflection Valve

A THERMIONIC valve relying on the deflection of an electron beam so that spaced anode elements collect different quantities of electrons is described, wherein the average velocity of the electrons is reduced by causing the electrons to travel in a series of cycloidal or like loops or hops from the emitting surface to the anodes. This movement of the electron is produced by means of uniform magnetic and electric fields both at right angles to the electron path and at right angles one to the other.

The diagram shows the construction diagrammatically as well as the input and output circuits; deflector plates *a* are positioned to each side of the beam so that the electrons from the cathode *b* are deflected by the input signal relatively to the two anode sections *c*. A push-pull input is applied to the deflector plates and a push-pull output is derived from the anode sections *c*. The electric field E is obtained by



Beam deflection amplifier.

plates at right angles to the deflector plates and on opposite sides of the electron path, while the magnetic field H is produced by external means.

G. H. Metson. Application date, August 1st, 1946. *No.* 625,271.

Speed-of-Approach Detection

THE Doppler effect has been used to detect the approach of a moving object; in one form both the outgoing carrier frequency and a received reflection signal are converted to intermediate frequencies and intermodulated to produce beats when the received signal has a different frequency due to the approach.

In the new arrangement the transmitter and receiver are linked through a local oscillator circuit which mixes a local oscillation with the carrier frequency to produce upper and lower sidebands. The receiver modulates the carrier frequency, the received frequency as well as the sidebands, to produce an i.f. carrier with two i.f. sidebands spaced from the latter carrier by the difference between the r.f. carrier frequency and the received frequency. These i.f. signals are, in effect, a conventional amplitude - modulated i.f. wave and can be demodulated by normal methods; the Doppler beat note being reproduced from the wave envelope.

Sperry Gyroscope Co., Inc. Convention date (U.S.A.), November 21st, 1945. *No.* 624,725.

NATIONAL PHYSICAL LABORATORY REPORT

On tests of 12 watt amplifier

marked: "**POINT ONE**", **TL/12, H. J. LEAK & CO. LTD.**

Ref. E.388.150. Aug. 30th., 1949

Test Conditions. In all cases the input was applied to a 50,000Ω resistor connected to the amplifier by 3 feet of screened cable. The output load was in all cases a resistor of 18Ω and the output transformer secondary windings were connected for the "15Ω — 20Ω" condition.

HARMONIC DISTORTION.

0.03% for 10 watts output at 1,000 c/s.
0.1% for 10 watts output at 60 c/s.
2nd and 3rd harmonics predominated, and were approximately equal in magnitude.

HUM AND NOISE.

—80 db. referred to 10 watts.

SENSITIVITY.

148 mV.r.m.s. input gave 12 watts output at 1000 c/s.

LOAD DAMPING FACTOR. (Load impedance/output impedance).

42 for 10 watts output at 1,000 c/s. (Output impedance 0.43Ω).
45 for 2.5 watts output at 1,000 c/s. (Output impedance 0.40Ω).
The output impedance was found to be substantially resistive.

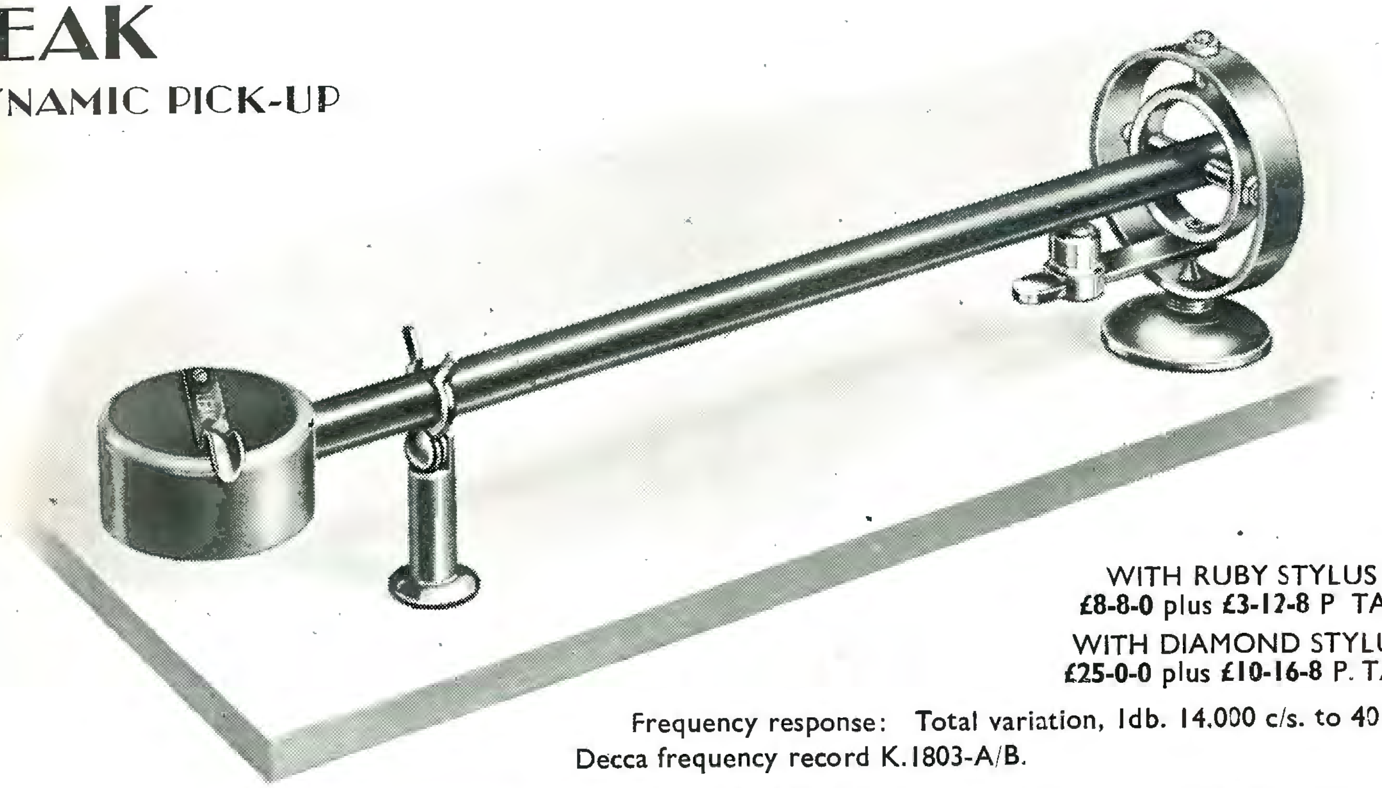
FREQUENCY RESPONSE.

Gain relative to that at 1,000 c/s. measured at 7.5 watts output, including the losses introduced at the higher frequencies by the capacitance of the input cable shunting the input resistance of 50,000Ω.

c/s.	db.
20	+0.1
60—1,000	0
5,000	—0.1
10,000	—0.3
15,000	—0.4
20,000	—0.7

WRITE FOR BOOKLET W/TL/12 which explains how these amazing results are achieved.

THE LEAK DYNAMIC PICK-UP



WITH RUBY STYLUS
£8-8-0 plus **£3-12-8** P TAX
WITH DIAMOND STYLUS
£25-0-0 plus **£10-16-8** P. TAX

Frequency response: Total variation, 1db. 14.000 c/s. to 40 c/s. from Decca frequency record K.1803-A/B.

In mechanical detail and electrical performance the LEAK DYNAMIC PICK-UP is as far ahead of other pick-ups as the LEAK "POINT ONE" TL/12 AMPLIFIER is ahead of other amplifiers.

WRITE FOR LEAFLET W/P.

BRUNEL ROAD, WESTWAY FACTORY ESTATE, ACTON, W.3

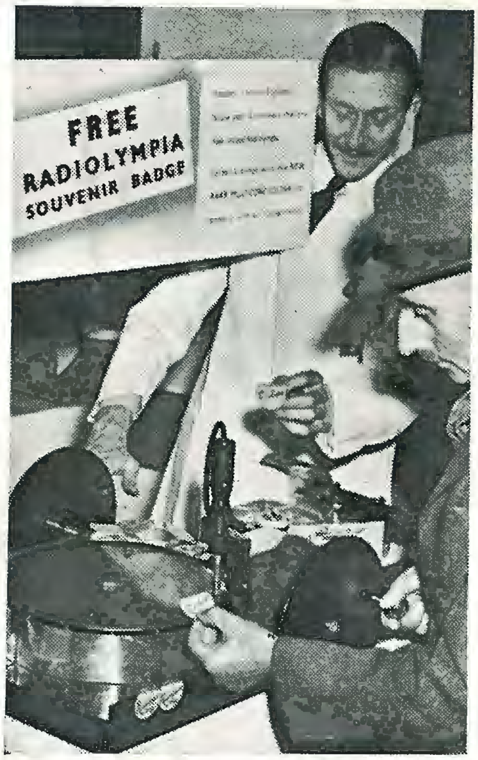
Phone: SHEpherds Bush 5626. Telegrams: Sinusoidal, Ealux, London. Foreign: Sinusoidal, London

MULTICORE AT RADIOLYMPIA

WORKING DISPLAYS INTEREST THOUSANDS

Visitors saw precision soldering of R.F. units of 'H.M.V.' television receivers with Ersin Multicore Solder by operatives from E.M.I. Factories Ltd. Only Ersin Multicore Solder with its 3 cores of non-corrosive Ersin Flux guarantees freedom from H.R. joints.

The ingenious automatic coil forming machine from Multicore Works showed how 840 coils of 4 ft. each of Ersin Multicore Solder are made per hour for inclusion in the new 2/- Multicore Solder Kits.



Radiolympia souvenir badges were soldered by visitors on this semi-automatic machine. The new Arax Multicore Solder "Model Makers Quality" 60/40 alloy 18 S.W.G. was used.

ERSIN MULTICORE

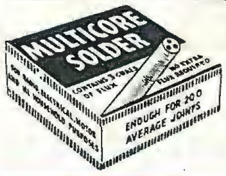
Contains 3 cores of non-corrosive extra active Ersin flux to guarantee flux continuity and sound permanent joints.
SIZE 1 CARTONS
5/- each.

HIGH TIN TELEVISION AND RADIO QUALITY

Catalogue Ref. No.	Alloy Tin/Lead	S.W.G.	Approx. Length per Carton
C16014	60/40	14	26 feet
C16018	60/40	18	60 feet

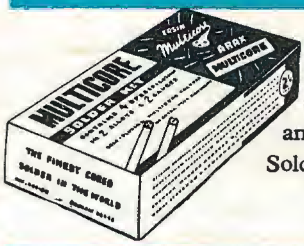
ELECTRICAL AND RADIO QUALITY

Catalogue Ref. No.	Alloy Tin/Lead	S.W.G.	Approx. Length per Carton
C14013	40/60	13	22 feet
C14016	40/60	16	42 feet



Size 2 cartons 6d. each contain 3 ft. 40/60 16 S.W.G. sufficient for 200 average joints.

MULTICORE SOLDER KITS

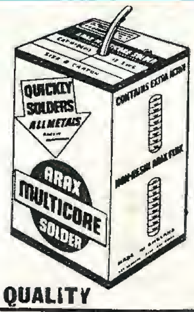


Contain 2 specifications each Ersin and Arax Multicore Solders.

Price 2/-

ARAX MULTICORE SOLDER

The new cored solder for "difficult metals". Flux residue removed with water. Replaces stick solder, fluid and paste fluxes.
SIZE 8 CARTONS
5/- each.



MODEL MAKERS QUALITY

Catalogue Ref. No.	Length	Alloy Tin/Lead	S.W.G.
AC86013	18 ft.	60/40	13
AC86018	60 ft.	60/40	18

METAL MENDING QUALITY

Catalogue Ref. No.	Length	Alloy Tin/Lead	S.W.G.
AC84012	18 ft.	40/60	12
AC84016	42 ft.	40/60	16

FACTORY SUPPLIES

Bulk supplies for factories of Ersin and Arax Multicore Solders are available on 7 lb. or 1 lb. reels in 5 alloys 9 gauges. Prices on application.

MULTICORE SOLDERS LTD.

MELLIER HOUSE, ALBEMARLE STREET, LONDON, W.1 • Tel.: REGent 1411