

Wireless World

RADIO AND ELECTRONICS

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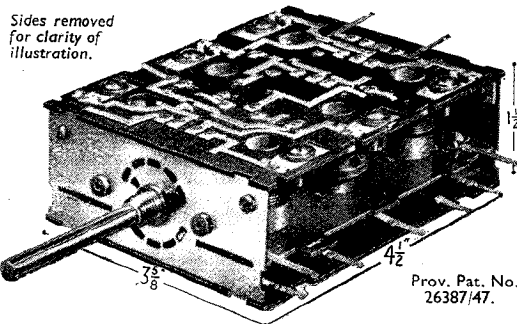


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Valves and their applications

R.F. Oscillator E.H.T. Supply* derived from AC/DC Mains

Fig. 1 shows a practical circuit of an R.F. oscillator E.H.T. supply using a PL33 as an oscillator valve and an EY51 as a high voltage rectifying diode. The circuit is of the tuned anode oscillator type, except that the feedback winding L3 is coupled to the high voltage secondary winding L2, which in turn is coupled to the primary winding L1. The secondary high

voltage winding L2 is tuned by the effective capacitance appearing across it, which comprises the diode, coil and stray capacitance. The resonant frequencies of the primary and secondary circuits are approximately equal. Class C operation of the PL33 is employed, resulting in high efficiency. The hold-off bias on the control grid is provided by the capacitor included in the grid circuit, this being charged negatively with respect to earth by the flow of grid current during the periods of positive grid excursion.

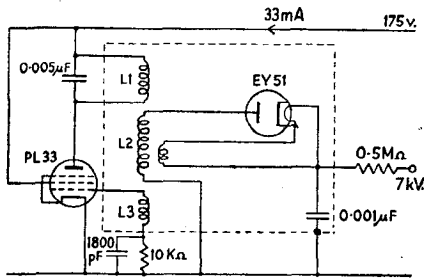


FIG. 1

The R.F. voltage appearing across the primary winding is stepped up by the square root of the ratio of secondary to primary impedance. The resulting R.F. voltage is rectified by the EY51 in a conventional half-wave circuit. In an efficient design, the Q of the secondary circuit should be as high as possible. This may be achieved by π -winding in about five wave-wound sections. If the operating frequency is kept low (50 Kc/s) Litz is not necessary and single strand wire may be used with economical advantage. Due care must be exercised in winding the secondary to ensure that spacings are adequate to avoid corona and breakdown. The secondary should be wound on a low-loss former, this requirement excluding most bakelised tubing.

The primary winding may be wound on a separate former mounted inside the secondary former, thus obtaining the high

coefficient of coupling necessary for the maximum transfer of energy from primary to secondary. The feedback winding is coupled to the secondary rather than the primary to avoid trouble with Ziehen Effect (or frequency jumping) which would result in the output voltage jumping between two values.

The EY51 heater supply is derived from a further winding which should be insulated to withstand the high peak voltage appearing on it. The position, or number of turns, on this winding should be adjusted until the colour of the EY51 heater is the same as that of a similar diode fed from a 6.3V, 50c/s supply.

In order to prevent the R.F. field interfering with the receiver, the whole coil assembly should be screened in a box of low-loss material such as brass or copper.

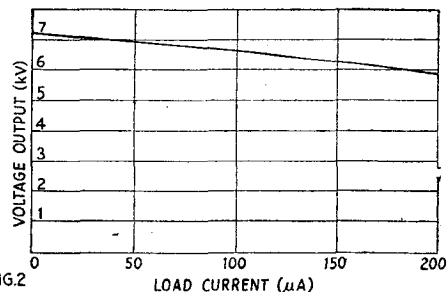


FIG. 2

Fig. 2 shows the regulation curve obtained with a practical R.F. oscillator. It will be noted that the effective source impedance is about $5 M\Omega$ over the range of load current 0—100 μA . This is suitable for operation with a television picture tube.

* For an introductory article on E.H.T. supplies for Television Receivers, see "Wireless World," October, 1948.



Reprints of this report from the Mullard Laboratories, together with additional circuit notes and full coil assembly details, can be obtained free of charge from the address below.

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(MVM83)

Wireless World

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FEBRUARY 1949

RADIO AND ELECTRONICS

Comments of the Month

LEGAL INTERFERENCE

THE Wireless Telegraphy Bill has not at the time of writing become law, but even at this early stage our attention has been drawn to an apparent omission which might have embarrassing consequences. The Bill envisages only positive injections of interference from emissive or reflecting sources, whereas in fact serious interference can be caused by absorption of electromagnetic energy. Though one has every sympathy with those called upon to draft a highly technical measure like this, it does seem strange that the third fundamental property—absorption—has been overlooked.

That this is not a mere academic criticism is proved by the fact that a concrete example of absorption interference with broadcast reception has just been brought to our notice.

As the Bill stands in the stage as amended in committee, sufferers from this kind of interference would, as we see it, have no legal redress. According to the restrictive definition of Clause 18, Subsection (4), there would seem to be no obligation to suppress interference due to absorption. It is interesting, though perhaps not very profitable, to speculate on how the absorption principle might be used—presumably with impunity—by ill-disposed persons in producing deliberate interference.

A.M. versus F.M. WE have urged for some time that this country should not be stampered into committing itself to a large-scale f.m. broadcasting service until the alternative methods of modulating e.h.f. were fully explored. We were consequently gratified when the B.B.C. decided that the first high-power e.h.f. station should provide for experimental parallel transmissions by alternative systems. The wisdom of this decision was emphasized when the ever-recurring topic of f.m. *versus* a.m. was debated early in

January by the Radio Section of the Institution of Electrical Engineers. The discussion of this vexed topic covered a very wide field.

H. L. Kirke (B.B.C. Research), who opened the discussion, rightly stressed from the start that this was not a matter that could be decided from severely technical considerations. He and subsequent speakers laid great stress on comparative receiver costs but, rather disappointingly, little in the nature of factual information on this highly important subject was forthcoming.

As an outcome of the meeting, we were all the more convinced that a process of trial and error is most likely to provide the right answer to the many problems involved.

ANGLO-AMERICAN TERMINOLOGY

YET another example of the regrettable failure to achieve anything approaching uniformity in British and American radio terminology is brought to light in a pamphlet "Standards on Television; Definitions and Terms," published by the Institute of Radio Engineers.

"Tube" and "valve," "plate" and "anode," "ground" and "earth" are so well known that they cause no trouble; and none of these words are used in a conflicting sense in either country. But, in television, "frame" is defined in U.S.A. as "the total area, occupied by the picture, which is scanned while the picture is not blanked." In this country that is called a picture and frame is what the Americans call a field—"One of the two (or more) equal parts into which a frame is divided in interlaced scanning."

The dangers of misconception through errors of translation from one language to another are well known. When the same word is used technically in the same language in two countries with two different meanings the possibility of confusion is very serious.

This article is based on a paper read before the International Television Convention, Zurich, by A. G. D. West, Managing Director of Cinema-Television Ltd., and Vice-President of the International Television Committee, by whose courtesy the accompanying illustrations are reproduced.*

TELEVISION IN THE CINEMA

Distribution Methods Described

RECENT announcements in the Press regarding the installation by Cinema-Television of large-screen television equipment in a London cinema have focused lively attention on a conception which has, in the past, been relegated to the background because of its apparent remoteness. It has always been realized that the ability of television to give a presentation of an event simultaneously with its occurrence constitutes a formidable advantage over conventional film reproduction. Until recently, however, the disparity of quality in pictures of cinema size has been too great to justify the exploitation of this attractive feature. The implication that this disadvantage has been overcome arouses natural interest in the means whereby it has been achieved.

Before proceeding to technicalities, however, it is desirable to indicate the character of the ultimate project which Cinema-Television has in view. This is outlined in Fig. 1, a diagram which is more or less self-explanatory. It is a long-term project, embodying a very high definition system which will link up cinemas all over the country with a variety

of television programmes, not necessarily associated with any B.B.C. service. A short-term project, with which we are more immediately concerned, is indicated in Fig. 2, and here it will be observed that programmes are to

selected London cinemas. The standard B.B.C. 405-line system will, of course, be used here and it is anticipated that this temporary service will enable a number of debatable factors to be settled and so pave the way for the detailed specification of the long-term project. We will now proceed to consider some of these factors.

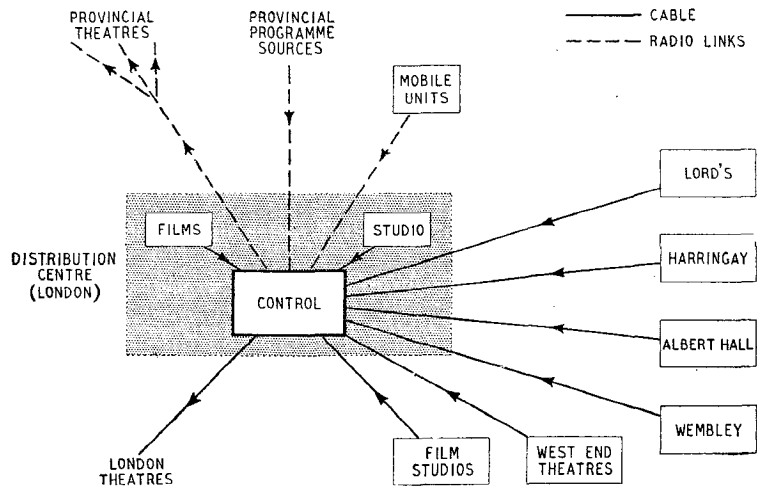


Fig. 1. Proposal for nation-wide theatre television network.

be received at the Crystal Palace direct from near-by studios and from the Alexandra Palace and Pinewood studios by radio link for beam radiation to a few

* Since this article was written a demonstration of cinema equipment of the type described was given at Bromley, Kent, the programme being taken partly from the normal Alexandra Palace transmission and partly from a studio in the Cinema-Television factory at Sydenham and relayed via the Crystal Palace by 480-Mc/s radio links. The screen was 16ft by 12ft and a cathode-ray tube operating at 50 kV was used with a Schmidt optical system embodying the plastic lens system developed by I.C.I.

The demonstration was most impressive and results obtained were outstandingly good. The picture was a true black and white with a good contrast range. Definition was at least as good as the normal directly viewed picture and the line structure was no more evident, though brightness appeared rather less. Compared with a normal cinema picture both definition and brightness were poorer, but were very definitely adequate for public entertainment.

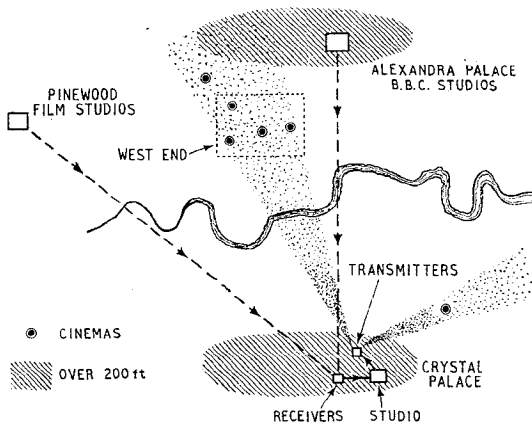
The demonstration greatly surpassed our expectations and has proved two things: first, that large-screen projection television has reached the stage of practical utility, and secondly, that the 405-line system is capable of providing really good pictures even under these conditions. We consider that all concerned with the development of the equipment are to be congratulated on their success.—Ed.

With regard to picture detail and definition, much has been written from time to time on the equivalent line structure of normal film reproduction in the cinema and figures ranging from 600 to 1,200 lines per picture have been suggested. Now, as the result of extended investigations carried out by a number of observers, Cinema-Television have reached the conclusion that for direct viewing 900 lines are adequate, but for recording on film with a view to subsequent reproduction, the figure should be raised to 1,200. Such figures would at first sight appear to demand bandwidths of the order of 20 Mc/s. It is argued, however, that there is still room for considerable improvement in the B.B.C. 405-line service within the

present 3-Mc/s bandwidth. A careful study and correction throughout the whole transmission chain of such factors as response, phase and gamma* have brought about a measure of improvement beyond all expectations. Of these

is 7-14ft-lamberts, a comparable figure of 8ft-lamberts is obtainable, at any rate down the centre line of the cinema, with the latest type of projection tube and opti-

Fig. 2. Proposed experimental cinema television distribution plan in the London area.



characteristics, gamma is looked upon as of particular importance and it is felt that, along with the other improvements, attainment of a constant value throughout the range from black to white will so raise the standard of picture quality that, by the same token, a bandwidth of about 12 Mc/s will be found to suffice for the later higher definition system.

Interlacing

To interlace or not to interlace is another matter that has been hotly debated. Interlaced scanning at 50 frames per second has, it is true, certainly reduced "lineness" and eliminated 25-c/s flicker with an economy in bandwidth requirements. Interlacing does, however, produce a flicker of its own in addition to line crawling and a subjective stroboscope effect, all of which are difficult, and some impossible, to eliminate. Which, therefore, of the two scanning methods is to be preferred for the ultimate system still remains undecided. At the same time, consideration has to be given to the optimum relationship of vertical and horizontal resolution and to the desirability, or otherwise, of some form of line broadening to reduce "lineness."

As regards brightness, it is gratifying to note that, while the standard accepted high-light level for film on a 16ft by 12ft screen

cal system, as is discussed more fully below. The maintenance of a constant gamma up to maximum brightness is, however, a more difficult problem and one which has yet to be solved. On the other hand, as an alternative to the projection tube there is the intermediate-film projector. The use of this equipment involves a processing delay time of 90 seconds but brightness and gamma are, of course, comparable with those of normal film projection. Storage tubes, it is recognized have not yet reached a standard where they can be considered seriously for this purpose.

In designing the presentation system, an important factor is the choice of screen. A variety of viewing screens, superior to the normal matt-white screen, either in reflection coefficient or directional properties, or both, can be selected for use with the projector. These include beaded or silver screens, screens coated with a combination of matt white and silver and others of the lenticular type. Total vertical and horizontal reflecting angles of 40° and 104° respectively are approved.

Turning to the transmitter end, there arises immediately the question of choice of camera. All types have their weaknesses: the definition of the iconoscope is offset by spurious shading effects which, though less pronounced, still exist in the more sensitive image iconoscope. At present, the

definition of the orthicon is inferior, though shading is absent, while the image orthicon, which offers higher sensitivity, is a difficult manufacturing problem. On balance, the image iconoscope and image orthicon would appear to be the preferable types.

For film scanning, the cathode-ray flying spot scanner, and the Farnsworth image-dissector are put forward as alternatives. Of these the first named is preferred on the grounds of good definition, quality and freedom from shading.

Wire v. Wireless

Interconnections and distribution requirements inevitably involve the familiar controversy of radio link versus cable. Radio has the advantage of lower cost, wider bandwidth accommodation and greater flexibility, while the use of cable ensures freedom from interference and "piracy." Furthermore, a radio link can generally be completed and established more quickly, but, to offset this, allocation of a desirable frequency band is often difficult to obtain.

Let us now turn to a consideration of the actual equipment intended for the immediate London

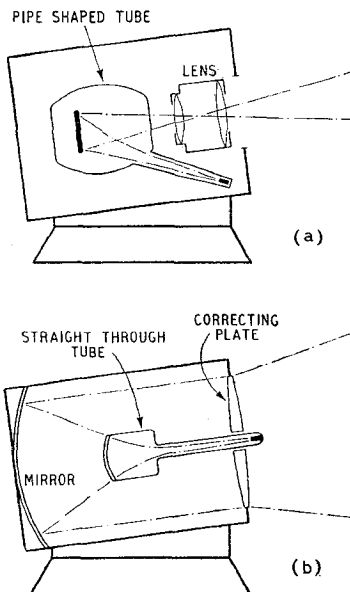


Fig. 3. Lens and mirror electronic projectors.

project. At the transmitter end, either the image iconoscope or the image orthicon will be used for indoor studio or exterior

*Expresses the relationship between contrast of image and contrast of original subject.

Television in the Cinema— scenes, while the C.R.T. flying spot scanner will be employed for films and captions.

Distribution will be effected by radio links of a few watts just above and below 480 Mc/s and these are expected to operate satisfactorily up to a distance

lumen for an effective lens aperture of $f/1$. Measurements of the normal screen brightness give a figure of 8ft-lamberts, which for a 2:1 reflection factor corresponds to an illumination of 4ft-candles. The screen dimensions are 16ft by 12ft so the total incident flux is $16 \times 12 \times 4 = 800$ lumens, a figure

Such then, is the scheme which is being put into operation to test public reaction and to act as a forerunner of the system whose standard of quality is intended to be on a par with that of normal film production. Apart from problems in other directions, much work remains to be done before a fully satisfactory standard of presentation is reached. This work will be directed towards the development of more efficient optical systems, the elimination of defocusing in the high lights, and the development of improved fluorescent materials.

It remains to refer briefly to the political and human considerations which, regardless of technical excellence, can make or mar this ambitious enterprise. General co-operation and the harmonious inter-change of programme material between the three main interested parties, the B.B.C., the promoters of sporting events and the cinema authorities, are essential for the success of this venture. Finally there is the question of public reaction to this marriage of television and the film. Will both be accepted in the same programme or must the two techniques be separated, either in time, by providing different programme hours, or in space, by providing distinct television theatres? Perhaps the next few months will indicate the trend, at any rate, of the cinema goers and of those who join them, attracted by the additional vital and intimate element which television alone can provide.

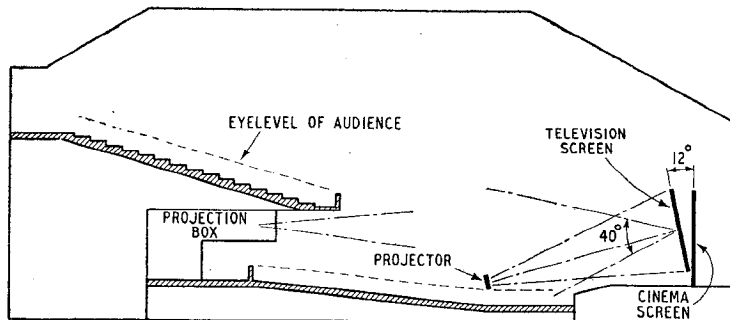


Fig. 4. Elevation of average theatre showing the angle required for screen reflection in the vertical plane.

of about 30 miles. The risk of interference, referred to above, is recognized, but it is hoped that legislation will help materially in reducing this risk.

The television projector is shown diagrammatically in Fig. 3, a photograph of the complete unit appeared on the cover of last month's *Wireless World*. The C.R. tube is provided with an aluminium-backed screen and operates with a peak current of 5 mA at 50,000 V. Its optical system consists of a centre-masked mirror of 27in diameter and an 18in diameter plastic correcting lens of the Schmidt type. A directive type of viewing screen will, of course, be provided and one possible form of installation is indicated in Fig. 4. As an alternative to the projection tube, an intermediate-film projection unit will be included.

It is of interest to study in some detail the present capabilities of the television projector. As regards illumination, the light flux from the equipment in lumens—(luminous intensity \times solid angle) which equals (power consumption \times luminous efficiency \times solid angle) where the luminous efficiency is given in candles/watt, in this case 5, and the solid angle is derived from the expression: solid angle = $(\pi/4) \times (1/\text{aperture})^2$.

Then, the light flux = $50,000 \times 5 \times 10^{-3} \times 5 \times (\pi/4) \times (1/1)^2 = 900$

in reasonable agreement with the computed value, particularly as no account has been taken of the losses in the optical system.

Turning to other factors, further brightness measurements indicate a contrast range from black to white of 50:1 with a constant gamma up to $\frac{2}{3}$ maximum brightness. At an angle of 30° to the normal the maximum brightness is found to be 5ft-lamberts, a value which admits of some improvement. On the other hand, definition leaves very little to be desired, 3-Mc/s vertical bars being resolvable without visible phase shift, indicating a standard adequate for a 405-line system.



FERRANTI TELEVISION receivers undergoing an operating test during which a synchronized raster is focused on to the cathode-ray tube continuously for about four hours. This is done after all production tests have been carried out.

THE WARNING WINKER

Economical Indicator for Battery Sets

By "DIALLIST"

Everyone who uses a battery radio set, stationary or portable, must have had on more than one occasion the mortifying experience of finding the battery run down because the last user of the receiver had at the end of the programme inadvertently turned the switch to "L.W." or "G" instead of "OFF." The device described, though costing little to instal and placing a microscopically small extra load on the h.t. battery, gives a visual warning that the set is switched on of such a striking kind that it cannot fail to attract attention.

SOME time ago I suggested in "Random Radiations" that there was a very real need for a device which would call attention to the fact that a battery radio set was switched on, even if no sounds were coming from its loudspeaker. It is so easy—and so expensive with h.t.bs at their present price plus purchase tax—to believe that you have switched off when actually you have done nothing of the kind. This is particularly true if the set contains, as so many do, a combined on-off-wavechange switch of the continuously rotatable type. You are listening, let us say, to the home programme on the medium waves; the desired item having come to an end, you *ought* to turn

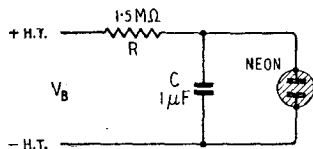


Fig. 1. The simple circuit of the warning device. C must be a high-grade capacitor with negligible leakage at 100–150V or the circuit will not work.

the knob one "click" clockwise in order to switch off. In a moment of abstraction you turn anti-clockwise. The set becomes silent because, though you have actually turned to "L.W." instead of "OFF," there may happen to be no long-wave station receivable at audible strength at that setting of the tuning capacitor. Still more deceptive and costly is "G," the gramophone pickup position of the switch, for there no warning noises due to atmospherics or to man-made interference are usually observable.

My note produced in the following month's issue of *Wireless World* a letter from D. A. Bell, suggesting that a neon lamp in some form of time-constant circuit might provide the answer—if only neons with a lowish striking voltage were available. Next came a letter to me from a reader of

Wireless World,* who not only told me that he had acquired a large stock of apparently suitable neons, but also sent me some samples to play with.

Not knowing much of the peculiarities of low-voltage neons, I tried out the first by connecting it across an 80-V d.c. source of supply. A brief glow of typical "neon" colour was followed by the proverbial "blue flash" inside the bulb, and I realized that in less time than it takes to describe it, I had written off neon No. 1. Clearly a limiting resistor was called for, and subsequent experiments made with resistors with values of thousands of ohms showed that the current needed to produce a bright orange glow was minute.

The circuit shown in Fig. 1 was rigged up from components taken from the junk box. It did not work, and for a moment I could not quite see why. Then I tested the capacitor and found that with an applied e.m.f. of 100V the leakage was some 250 μ A. On substituting a high-grade capacitor rated at 1,000V d.c. working I found the neon behaving as in theory it should by "winking" at intervals of about one second.

The next step was to incorporate the "winker" in a battery re-

ceiver. Clearly it must be brought into action at any "ON" position of the switch and cut out in the "OFF" position. A small modification of the wiring of the set had to be made on the lines shown in Fig. 2. This was a fairly simple matter and, incidentally, it is about the best form of on-off switching for any kind of battery set since, if the insulation is as it should be, all components are relieved of electrical strain when the receiver is not in use. The necessary small alterations having been made, the device was found to function most satisfactorily. A $\frac{1}{2}$ -in hole was drilled in the panel close to the knob of the switch. The neon was then mounted inside the set with its electrodes immediately behind the hole. The effect is that brilliant orange flashes at intervals of about a second compel even the most absent-minded of

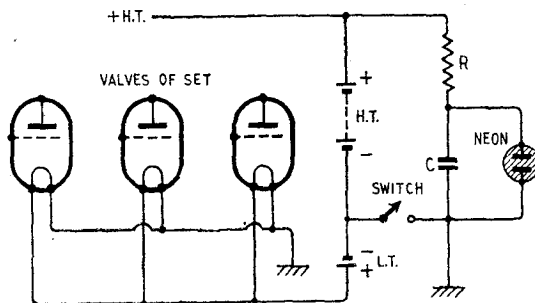


Fig. 2. In some sets minor alterations in the wiring of the on-off switch SW may be necessary. The arrangement illustrated is in every way satisfactory.

users to realize that his receiver is still switched on. Not until he moves the switch to the "OFF" position do the "winks" cease to insist upon his attention.

* F. R. Lucas, 22, Hengrove Road, Knowle, Bristol, 4.

The Warning Winker—

So far so good; but what sort of price do we have to pay for this insurance against carelessness? We are putting an extra load on the h.t.b., and the h.t.b. is one of the most expensive sources of power ordinarily used by mankind. It happens seldom in wireless that any amenity can be obtained without one's having to pay handsomely for it; generally it is a case of "nothing for nothing and darned little for half a crown." In this respect the warning device is quite exceptional; it comes, in fact, nearer to giving something for nothing than any wireless gadget that I can bring to mind, except the crystal detector.

If the battery e.m.f., V_B , in Fig. 1 is 100V, the maximum current at any instant through R cannot exceed $100/1.5 \times 10^6 A = 67 \mu A$. But the time constant of CR is 1.5 seconds, and the charging current of C falls off exponentially as shown in Fig. 3. The striking and extinguishing voltages (V_s and V_E) of these little neons vary slightly; but, generally speaking, V_s is close to 73V and V_E close to 48V, if the proper connections are made. At the instant of switching on V_C (the voltage across the plates of C) may be taken as zero. I_C therefore starts at $67 \mu A$. As

current from the battery flows into the capacitor a counter-e.m.f. is built up and at any instant the e.m.f. driving current through R

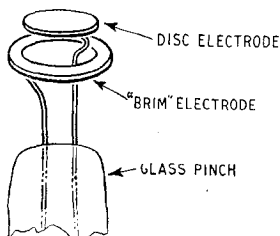


Fig. 4. Electrode assembly of low-voltage neon used. To obtain the lowest striking and extinguishing voltage the disc electrode should be negative.

is $V_B - V_C$. Until the striking voltage is built up across C the neon passes no current: it may be regarded as offering infinite resistance. By the time that V_s is reached I_C has dropped to about $18 \mu A$. At that moment the neon "fires" and the capacitor discharges through the almost negligible resistance that it now offers. Once started, the neon continues to conduct until V_C has fallen to about 48V. It then closes down and ceases to conduct until V_s is again reached.

Under working conditions I_C

falls, as Fig. 3 shows, from about $34.25 \mu A$ to approximately $18 \mu A$ whilst the neon is quiescent. The average current drawn from the h.t.b. by the warning device is some $25 \mu A$ —and there should be few h.t.bs that cannot stand up to such a minute extra load! When I had made the preliminary calculations I could hardly believe them, for they seemed too good to be true. A kind friend, however, who has a splendidly equipped laboratory (including a calibrated c.r.o.) at his disposal was good enough to make a series of actual measurements, and his figures confirm mine. Here they are:

V_B	I_B
85V	$20 \mu A$
100V	$25 \mu A$
110V	$30 \mu A$
130V	$40 \mu A$
150V	$50 \mu A$
175V	$70 \mu A$

All figures are approximate for several reasons:

(1) V_s and V_E vary slightly with individual specimens of the same type of neon lamp.
 (2) The accepted tolerances mean that R is unlikely to be of precisely $1.5 M\Omega$ or C of precisely $1.0 \mu F$.

(3) The leakage across C varies with climatic conditions and may be considerable in damp weather, even if negligible in dry air.

Several other points of interest emerged during the tests. The first concerns the way in which the neons are connected to the source of e.m.f. These particular neons are constructed in the way shown in Fig. 4. One electrode is a disc about $\frac{1}{4}$ -in in diameter; the other is rather like the brim of a hat from which the crown has been removed; its overall diameter is rather less than $\frac{1}{2}$ in.

Now, which electrode is connected to + and which to - makes a great deal of difference to V_s and V_E . All the figures given so far are for the disc electrode connected to *negative*. If the connections are reversed V_s goes up to about 85V and V_E to 73V. Hence, if the h.t.b. is 100-120V when new, it is advisable to connect the disc electrode to negative; if, however, the nominal

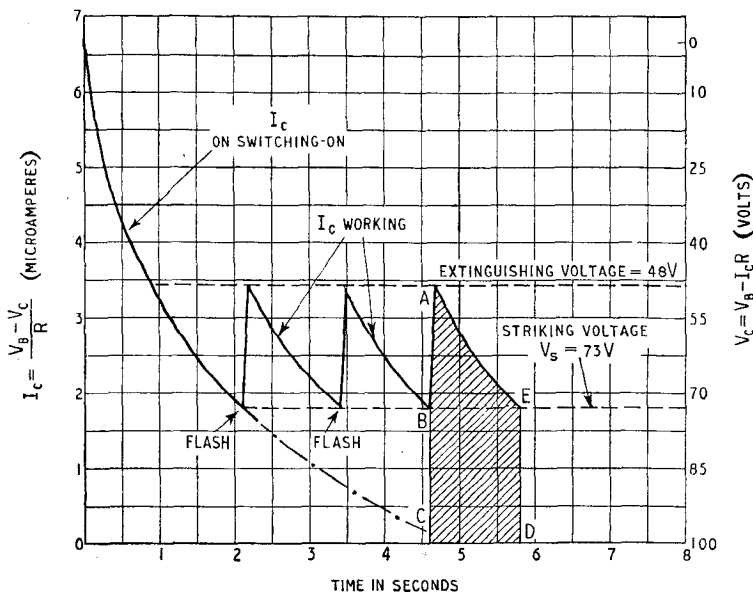


Fig. 3. Showing I_C and V_C on first switching on and under working conditions, where $V_B = 100V$; $R = 1.5 M\Omega$; $C = 1.0 \mu F$; $V_s = 73V$; $V_E = 48V$. Current drain from the battery can be determined from the shaded area.

battery e.m.f. is over 120V, the opposite connection should be made in order to cut down current.

The interval between flashes grows longer as the h.t.b. runs down; it would, in fact, be possible to construct a graph from which the battery e.m.f. at any time could be read off with the aid of a stop-watch! The current drain on the battery, by the way, is easily determined from a graph such as that of Fig. 3, if this is accurately drawn on good graph paper. The area ABCDE represents microampere-seconds. Since

$$ABCDE = I_C \times t, I_C = \frac{ABCDE}{t}$$

Count the small squares in the area and divide by the number of small-square divisions of the part of the time scale included.

Some may raise the objection that the device goes automatically out of action when the e.m.f. of the h.t.b. falls below about 75V. To that I can only reply that it does *not* go out of action: it continues to give warning—and this time its warning means that it is high time that you installed a new h.t.b.!

SHORT-WAVE CONDITIONS

December in Retrospect : Forecast for February

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

DURING December maximum usable frequencies for this latitude decreased both by day and night. The daytime decrease, which was mentioned in this column for December, was due to the "Midwinter Effect," while the nighttime decrease was due to the normal seasonal trend.

As the month was stormy, working frequencies were rather lower than expected, and, so far as is known, very few long-distance contacts were made on the exceptionally high frequencies which became usable during the winter of 1947/48. However, the U.S.A. transmissions in the region of 40 Mc/s have been frequently received. The reception of the transmissions in the 28-30-Mc/s band from Australia, New Zealand and America was fairly good. The night-time frequencies were usable at unexpectedly low values, and occasional contacts have been reported at night with Australia, United States and Hong Kong on frequencies as low as 3.5 Mc/s.

Again, an abnormally high rate of incidence of Sporadic E for this time of the year was recorded, this value being, however, somewhat less than in November.

Long range tropospheric propagation was observed on very few occasions.

Sunspot activity in December was greater than in November. Two fairly large groups were observed, which crossed the central meridian of the sun on 14th and 24th.

The month was again exceptionally disturbed, disturbances usually lasting for a long period. Ionospheric storms were observed on 1st-

5th, 7th, 9th-13th, 15th-19th, 22nd-28th and 31st, those occurring on 9th and 11th being particularly violent.

The few "Dellinger" fadeouts recorded in December were very severe. They were observed on 9th, 11th and 23rd.

Forecast.—The "Midwinter Effect," which in the Northern Hemisphere causes a decrease in the daytime F₂ layer ionisation, usually comes to an end by February. Consequently the daytime m.u.f.s may increase considerably. Owing to a seasonal trend there should also be an appreciable increase in the nighttime m.u.f.s as compared with those for January.

Daytime working frequencies should thus again be very high, and of the same order as those which prevailed last November. Consequently, long-distance communication on exceptionally high frequencies should be possible quite often in all directions from this country. The 28-Mc/s amateur band should be regularly usable for long periods over daylight paths, and considerably higher frequencies than in January may be workable over certain circuits. Night-time working frequencies will be higher than during January, though frequencies as low as 7 Mc/s will still probably be necessary for many night-time circuits.

Below are given, in terms of the broadcast bands, the working frequencies which should be regularly usable during February for four long-distance circuits running in different directions from this country. (All times G.M.T.) In addition, a figure in brackets is given for the

use of those whose primary interest is the exploitation of certain frequency bands, and this indicates the highest frequency likely to be usable for about 25 per cent of the time during the month, for communication by way of the regular layers:—

Montreal :	0000	7Mc/s	(11Mc/s)
	1000	11	(15)
	1100	15	(21)
	1200	21	(26)
	1400	26	(32)
	1800	21	(27)
	2000	15	(21)
	2100	11	(17)
	2200	9	(14)

Buenos Aires :	0000	11Mc/s	(16Mc/s)
	0100	9	(14)
	0800	15	(21)
	0900	21	(27)
	1100	26	(32)
	1900	21	(29)
	2000	17	(25)
	2100	15	(21)
	2200	11	(16)

Cape Town :	0000	9Mc/s	(14Mc/s)
	0600	11	(17)
	0700	17	(23)
	0800	26	(35)
	1700	21	(27)
	1900	17	(24)
	2000	15	(20)
	2100	11	(16)

Chungking :	0000	7Mc/s	(10Mc/s)
	0500	9	(16)
	0600	17	(26)
	0700	21	(28)
	0900	26	(34)
	1100	21	(27)
	1200	17	(23)
	1300	15	(19)
	1400	11	(15)
	1600	9	(13)
	1900	7	(10)

February is not often a particularly bad month for ionosphere storms, though those which do occur are likely to be troublesome over dark transmission paths. At the time of writing it would appear that such disturbances are more likely to occur within the periods 7th-11th, 15th, 18th-19th and 26th-28th than on the other days of the month.

"TRANSMITTER INTERFERENCE"

THIS is the title of a new booklet issued by The Radio Society of Great Britain. Addressed to transmitting amateurs it gives really helpful advice on the suppression of interference with broadcast and television services.

Design data for a variety of filters and traps to cope with all foreseeable types of interference is given together with details of a useful harmonic indicator for use at the transmitter.

The list of television sets with their oscillator, intermediate and second channel frequencies provides some enlightening information and will be found invaluable when investigating reports of interference with television.

The price is 1s 3d (1s 6d by post from the R.S.G.B., New Ruskin House, Little Russell Street, London, W.C.2).

SIMPLE TONE CONTROL CIRCUIT

Bass and Treble, Cut and Lift

By E. J. JAMES, B.Sc.

THE tone control system described here has the merit of requiring only resistors and capacitors. As a result it is unusually easy to fit to an existing amplifier, particularly as the absence of an inductance reduces the likelihood of trouble from hum pick-up.

While the circuit does not give the large amounts of lift which can be obtained by more complicated designs or by the use of resonating circuits, it is sufficient for normal requirements. The bass lift is not intended to compensate for the falling record characteristic below 300 c/s. This

distortion consists of the introduction of frequencies 2, 3, 4, etc., times the fundamental frequency, a rising frequency characteristic emphasizes any which is present in the signal prior to the tone-control stage. The higher order harmonics, which are the most disturbing to the ear, are the ones which receive the greatest amplification. This limit to the useful degree of top lift applies to all forms of top lift circuit, and is inherent.

The basic bass-lift circuit is shown in Fig. 1(a). The capacitor C_1 , has a reactance which increases as the frequency decreases, so that the output increases at lower frequencies. By shunting it with a variable resistor, Fig. 1(b), the degree of bass lift can be controlled. In the same way Fig. 2(a) shows the circuit for bass cut, and in Fig. 2(b) a variable resistor controls the amount of bass cut.

The two circuits of Figs. 1(b) and 2(b) can now be combined to give that of Fig. 3, where bass lift

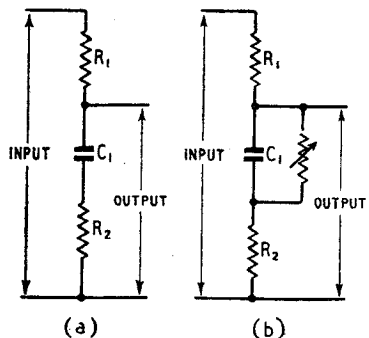


Fig. 1. The basic bass lift circuit is shown at (a). The lift is controllable by a variable resistor (b).

should be dealt with separately, so allowing the tone control to give extra lift for records abnormally deficient in bass or for listening at low volume. If required, however, a fair measure of compensation can be obtained.

It is not always realized that large amounts of bass lift cannot be achieved in a simple single-stage non-resonating circuit without lifting the lower middle register as well. The maximum rate of lift is fixed and it is only by starting at a higher frequency that greater lifts can be obtained. The amount of top lift which can be satisfactorily used is limited by amplitude distortion. Since this

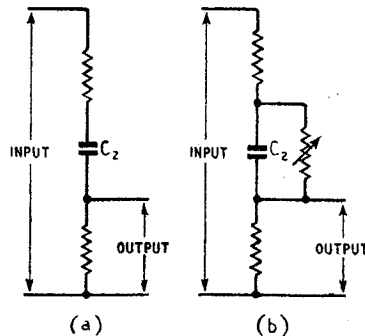


Fig. 2. Bass cut can be obtained with this circuit (a) and is controllable by a variable resistor (b).

and cut are controlled by the potentiometer R_3 .

Fig. 4(a) shows a circuit giving top lift. Here the reactance of the capacitor C_3 decreases as frequency increases, so that the output rises with frequency. In this case a variable resistor in

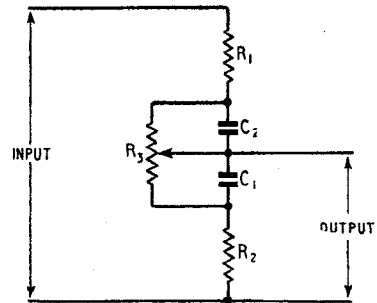


Fig. 3. This diagram shows the bass cut and lift circuits combined and controlled by the potentiometer R_3 .

series with C_3 , as shown in Fig. 4(b) gives control of top lift.

Similarly Figs. 5(a) and 5(b) show top cut and controlled top cut respectively. Once more the two circuits can be combined, Fig. 6, to give control of top lift and top cut by means of the potentiometer R_4 .

The treble and bass controls can now be combined into the circuit shown in Fig. 7, and will normally be used as part of the coupling between two valves. For signal current the resistance, $R_1 + R_2$, is in parallel with the anode load resistance of the previous valve. R_1 and R_2 should therefore be as high as possible so that the valve does not work into too low a load. The minimum load should be about twice the valve impedance. On the other hand they must not be too high or the valve output capacitance and stray capacitances will affect response at high frequencies.

A simple method of finding

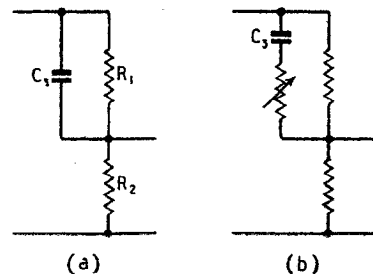


Fig. 4. Top lift is given by this basic arrangement (a) and can be varied by a series resistor (b).

suitable values is to use an anode resistor of at least 4-5 times the valve impedance and to make the sum of R_1 and R_2 rather larger than this. A ratio for R_1/R_2 of 10/1 is suitable for normal tone control requirements. For a medium resistance triode of 7,000-10,000 ohms impedance, an anode resistor of 56,000 ohms could be used with R_1 and R_2 100,000 and 10,000 ohms respectively. The total anode load will then be about 35,000 ohms. This will vary, of course, as the controls are used to give lift or cut, but the only time any appreciable drop will occur in anode load will be at high frequencies when maximum top lift is used.

This type of tone control circuit should always be placed as far forward in the amplifier as possible so that the input to the valve preceding the control is low. There is then little chance of distortion being introduced by

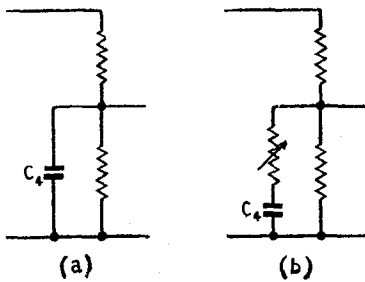


Fig. 5. Top cut is obtained from circuit (a) and controlled by a variable resistor as in (b).

the valve on account of the possible low load resistance. A smaller bias voltage than that normally employed will help to reduce distortion to a minimum. If the input to the valve is x volts, the optimum bias is $(1 + x)$ volts since this is the least bias which will safeguard us from grid current. Thus, a bias of 1.3 volts is required if the input is 0.3 volts. The value of the cathode resistor required for this bias is best determined by trial and error, using a high-resistance voltmeter for measuring bias voltage, or measuring the anode current I , and calculating the bias voltage from IR , where R is the cathode resistance. A 1,000-ohm wire-wound potentiometer of the preset type is easily and cheaply obtainable these days and

would be a very suitable cathode resistor. The resistance in circuit can be estimated with sufficient accuracy from the degree of rotation.

A complete circuit suitable for feeding from a medium impedance triode such as the MHL4 is shown in Fig. 8. The values given provide a satisfactory degree of control. On test a similar circuit gave the following results:—

Bass control:— + 10 db to - 12 db at 50 c/s. Treble control:— + 10 db to - 16 db at 6,000 c/s.

If it is felt that more or less change would be an advantage, it is easy to alter the characteristics of the circuit by using different capacitor values. In-

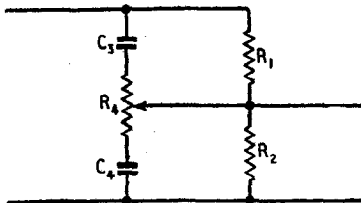


Fig. 6. Here the top cut and lift circuits are combined and controlled by R_4 .

creasing the values of C_3 and C_4 , Fig. 7, will increase the amounts of top lift and top cut respectively, while a decrease in their values will reduce the amounts of control. Bass lift and bass cut can be increased by decreasing the values of C_1 and C_2 , and vice-versa. For example, if a greater bass lift is required, so that it can be used as compensation for the falling bass characteristic of gramophone records, the value of C_1 should be reduced from 0.02 μ F to 0.01 μ F. The great ease with which the circuit characteristics can be altered in this way is one of the outstanding merits of the design.

The variable cathode resistor need only be used if it is required to introduce the very minimum of distortion, such as before one of the modern low-distortion amplifiers.

There is little point in reducing the distortion of the main amplifier to less than 0.1% and then introducing anything up to 0.5% or possibly more in a previous stage. In fact, some tone control stages using normal bias for the valve can introduce from 3% to 5% harmonic distortion. Where the variable re-

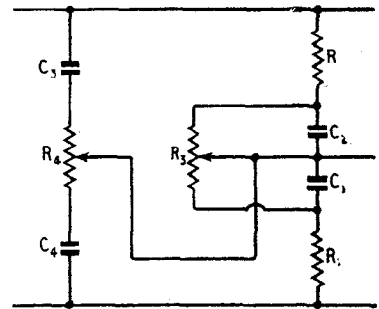


Fig. 7. The combination of the bass and top circuits is shown here.

sistor is not used a bias resistor of 100 Ω -1,000 Ω is suitable. In either case care should be taken to see that anode current does not exceed the manufacturer's stated maximum.

The amplification of the valve before the tone control circuit is reduced by the ratio $\frac{R_2}{R_1 + R_2}$ so that little gain is obtained from the valve. This generally means that another valve must be added to an amplifier unless there is some reserve gain. If there is no room on an existing chassis for another valve, or if a compact lay-out is required, one of the double triodes such as the 6SN7 or ECC32 can take the place of one of the present valves and the

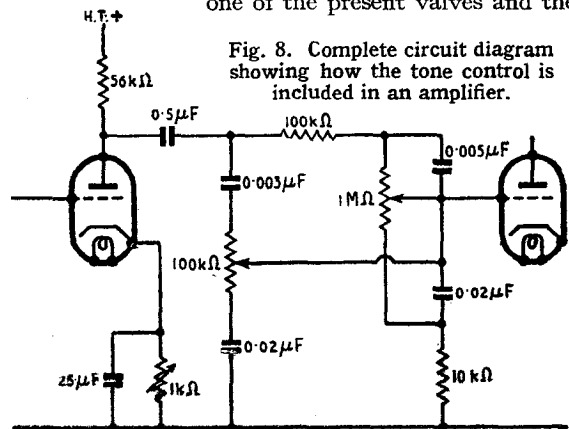


Fig. 8. Complete circuit diagram showing how the tone control is included in an amplifier.

Simple Tone Control Circuit— tone control circuit used as the coupling between the two halves of the double triode. Where 6-volt heaters are used this provides an easy method of introducing the tone control with the minimum of interference with the rest of the amplifier. If 4-volt heaters are used and there is a spare 4-volt winding on the mains

transformer, it is possible to obtain a 6-volt supply by connecting half the spare winding, giving 2 volts, in series with a 4-volt winding already in use. The two must be connected so as to give 6 volts and not 2 volts, as will be the case if the extra half-secondary is connected so as to oppose the 4-volt secondary. The right connection is most easily found by

trial, using the glow of the valve heater as an indicator. There is no difficulty whatsoever in determining by this means the correct coupling between the two secondaries.

If a double triode is used in place of a normal medium impedance triode it will generally be found that gain is about double that of the original.

ELECTRONIC CIRCUITRY

Selections from a Designer's Notebook

By J. MCG. SOWERBY (Cinema Television Ltd.)

IN the July, 1948, issue some notes on the cascode circuit were presented, and as these aroused some interest it seems worthwhile to amplify the information originally given.

The "Cascode" Again

A recent paper¹ has described a modification of the original cascode circuit and the elements of the new arrangement are shown in Fig. 1. This circuit was specifically designed as a low-noise r.f.

anode and screen. In a triode this splitting is absent and the noise is less; but if a grounded-cathode triode is used directly as an r.f. amplifier, neutralization must be employed to ensure stability. To avoid this difficulty grounded-grid triodes have been widely used, but then the input impedance is low.

At the expense of another valve the foregoing difficulties are overcome in the circuit of Fig. 1, because (a) provided the grid of V_1 is negative with respect to its cathode, its input impedance is high; and because (b) the Miller

effect on V_1 is small since the cathode of V_2 presents a low impedance to V_1 . In fact if the mutual conductances of V_1 and V_2 are the same, the gain from grid to anode of V_1 is nearly unity. The second valve V_2 contributes little to the noise, because any fluctuations occurring in it are reduced by a factor approximately equal to the amplification factor of V_1 when referred to that valve's grid. The gain obtainable is approximately the product of the load (Z_L) and the working mutual conductance of V_1 . There seems no reason why V_1 should not be a triode-connected variable- μ valve (to permit the application of a.v.c.) and then such a stage could be

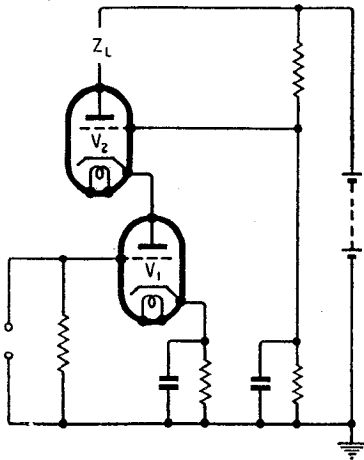


Fig. 1. Low-noise cascode circuit.

amplifier, the shot noise generated being virtually that of the triode V_1 . Readers will remember that the shot noise in a pentode is much greater than in a triode—largely because of the splitting of the cathode current between

¹ H. Wallman, A. B. Macnee and C. P. Gadsden, *Proc. I.R.E.*, June, 1948, Vol. 36, No. 6, page 700.

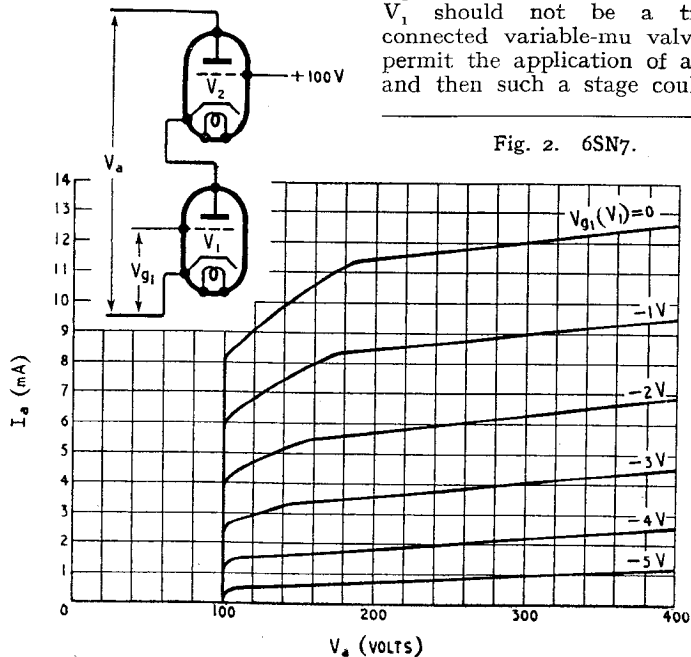


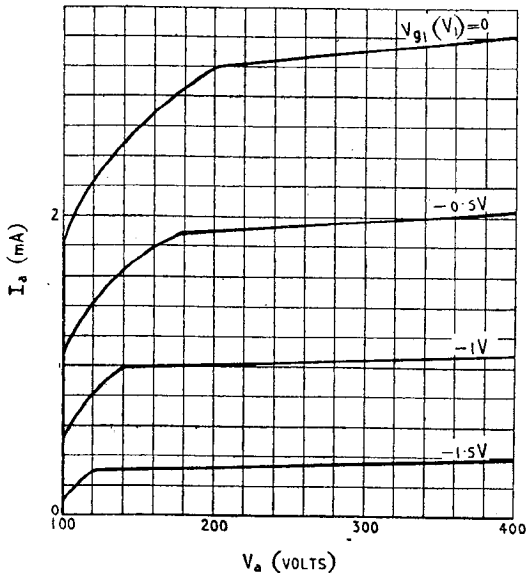
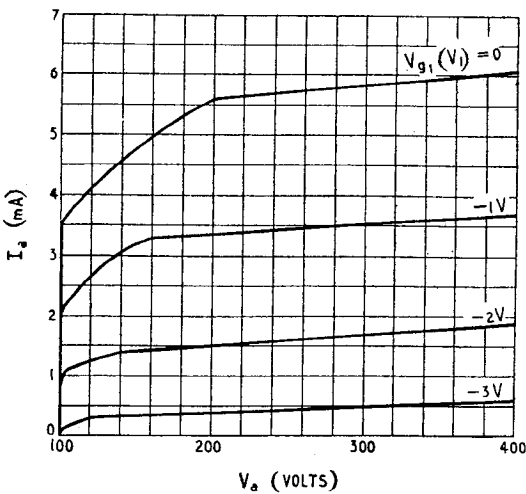
Fig. 2. 6SN7.

used as the r.f. amplifier in the first stage of a normal receiver. The writer has not yet done any experimental work on these lines, however.

The usefulness of the circuit does not

Fig. 3. ECC 32.

end here, and it will be of considerable use in d.c. amplifiers. If an attempt is made to design a high-gain d.c. amplifier, then the obvious choice



A clear picture of the behaviour of the circuit is perhaps best given by the characteristic valve curves² of Figs. 2, 3 and 4, which have been

Fig. 4. ECC 35.

plotted for three common double triodes. In each case the grid of the upper triode was taken to a positive supply of 100 volts, and the anode current plotted against anode voltage for various values of grid bias on the lower triode (V_1).

of valve is a pentode. To realize the high gain the impedance of the screen-grid supply must be small, for otherwise screen feedback will be introduced. This low impedance is normally obtained with a by-pass condenser, but this becomes inoperative at zero frequency, so that some other device (cathode follower, neon stabilizer, etc.) has to be employed in a d.c. amplifier. From this point of view the circuit of Fig. 1 can be loosely regarded as a sort of pentode in which the screen grid is replaced by the grid of V_2 . As it is a simple matter to arrange for this grid to take no current, the impedance of its supply circuit at l.f. is immaterial.

² Kindly supplied by the writer's colleague, F. L. Hill, B.Sc.

WHEN using mercury vapour thyratrons and rectifiers it is necessary to apply heater or filament power to the valve(s) for a considerable period before the anode supply is switched on. For example the minimum recommended heating time for the B.T.H. Type

B.T.5 thyatron, is five minutes. Consequently a relay is needed which will close five minutes after the heater supply is switched on. Furthermore—and this is perhaps controversial—it is desirable

that on the removal of the supply for a few seconds the relay should be de-energized only to close again after the pre-set delay time.

A circuit which meets the foregoing requirements is shown in Fig. 5. This presupposes that sufficient power to operate one valve is available from the instant the thyatron heater is switched on—for example the circuit might obtain its power from the same transformer as that which supplies the thyatron heater. Let us now consider one cycle of operation of the circuit of Fig. 5.

Initially C is uncharged, and h.t. and heater power are applied to V. The grid is therefore at earth potential and the cathode positive with respect to earth by the drop across R_c . Consequently current flows through R, and C begins to charge up, taking the grid (and cathode) in a positive direction. Provided R_c is not too low, there will be a considerable range of grid potential for which the cathode is positive with respect to the grid, so that current continues to flow through R. As the potential across R is always small (2-10 volts with a high-slope valve), the current through it is also small and consequently the grid and cathode potentials rise slowly. As the cathode potential rises the cathode current rises with it and eventually the relay operates, applying the anode supply to the thyatron.

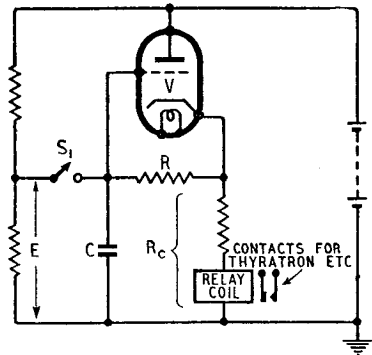


Fig. 5. Relay time-delay circuit.

A desirable but not essential feature is the inclusion of an extra pair of contacts S_1 on the relay, which on closing hold the grid potential at E as long as the supply is maintained. This

Electronic Circuitry—

simply holds the valve under fixed conditions as a cathode follower. If the supply is interrupted, although the h.t. and heater supplies cease, the cathode will remain hot and emitting for several seconds by virtue of its thermal capacity. The grid-

cathode path of the valve then acts as a diode and C is rapidly discharged through R_c , so that even if the supply is re-applied at once, almost the full delay must elapse before the relay can operate again.

The writer has found no difficulty in obtaining a delay of five

minutes with $C = 2.25 \mu F$ and $R = 10 M\Omega$, the valve being an EF91 (CV138). Informed readers will recognize this circuit as being but one more variant of the "bootstrap" circuit.*

* O. S. Puckle, *Time Bases* (Chapman and Hall), page 94.

QUALITY APPRECIATION

B.S.R.A. Discuss Physiological Aspects

AT a London meeting of the British Sound Recording Association on December 17th, 1948, E. A. Vetter read a paper on "Some Physiological Factors in Quality Appreciation." He thought that many people engaged in the reproduction and recording of sound would agree that success resulted from a combination of 75% art and 25% science. For the purpose of his argument the measurement and interpretation of the electrical performance of amplifiers and other physical components of the recording chain, representing 25% of the problem, would be taken as read.

With the aid of diagrams he explained the structure of the ear and showed how the non-linearity of coupling between the drum and the cochlea was adapted to afford protection from shock waves of large amplitude. He also stressed the variations which exist between individuals, and differences in structure in other animals.

Not only was the perception of sound modified by physical differences, but it could also change as the result of conditioned reflexes, much in the same way as visual appreciation of colour depended on preceding stimuli. Those who had experience of flying in noisy aircraft knew that some time after landing there was an almost complete cut-off of low frequencies, though high-pitched sounds could be heard quite well. Conversely, composers often wrote *pianissimo* passages before a *fortissimo* climax to enhance the effect. Although the total dynamic range of the ear was of the order of 120 db there was reason to believe that no more than 60 db was available at any one time.

Aural appreciation of surrounds, due to coloration of reverberation by frequency discrimination in the reflexing surfaces, was a keen subconscious faculty developed against a background of conditioned reflexes which had been built up from birth. The process was similar to that by which a good craftsman performed without effort the routine skilled

operations of his trade, thus leaving his conscious mind free to cope with the new or unusual in his work.

We had now reached the stage where it would be more profitable to discover the significant elements in sound than to strive for greater perfection in equipment. When we knew more about the world of sound to which our ears were accustomed and could establish standards showing how far the significant elements could be displaced, it would be a comparatively simple matter to provide apparatus which would perform within the permissible tolerances. To the pure scientist, there was no such thing as dirt; only a matter out of place. Translating this into terms of acoustic engineering, we should say: "There is no such thing as distortion; only phenomena out of place."

In the discussion which followed, several speakers gave examples confirming the accommodation of the ear to its acoustic surroundings, and it was generally agreed that the "memory" of the ear was much shorter than that of the eye.

It was thought that the modern

pianoforte with its equally-tempered scale had done much to destroy the appreciation of true pitch and that primitive peoples still making use of simple five-note scales had a keener sense of intonation.

Appreciation of auditory prospect was largely a matter of the different reverberation patterns associated with individual instruments and their positions relative to the microphone. Two channels, or even two ears were unnecessary to convey this quality.

"Scale distortion," which was generally discussed in relation to the balance of different parts of the frequency spectrum, had an even more important aspect. Musical instruments when played loudly gave out a much wider range of harmonics than when played softly. When reproduced at a level differing from the original, the effect would be immediately detected as untrue, however free from distortion the reproducing chain might be. Similar effects could be produced by distortion in the amplifier, or bad playing by the instrumentalist. Obviously, it was necessary to find which effect was out of place, and to resist the first impulse to reach for a soldering iron and do things to the amplifier.

OUR COVER



CATHODE-RAY TUBES undergoing a 1,000-hour life test at Ediswan's Ponders End factory forms the subject for this month's cover illustration and twelve-inch tubes are here shown being tested for spot centrality, cathode emission, modulation sensitivity, heater current, and heater-cathode insulation, etc. They are also subjected to an over-voltage test for possible flash-over.

Two valves - very rare
★ BRIMARIZE
 - don't despair.

TYPES 35Z5GT and 45Z5GT are half wave rectifiers commonly used in American AC/DC receivers. Both of these valves employ tapped heaters, across a section of which the dial lamp is usually connected.

Direct substitution by type 35Z4GT will render the lamp inoperative, the rest of the set functioning as before.

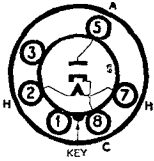
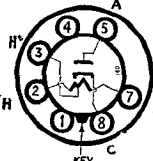
If dial illumination is necessary, the lamp may be connected directly in series with the heater chain provided it is shunted with a suitable resistor.

Alternately a 0.3 amp. lamp may be employed, wired in series with the negative mains lead i.e., between mains switch and chassis.

**35Z5GT
45Z5GT**

PUNCH HOLES HERE

INSTRUCTIONS: Punch holes where indicated and cut away this portion. Cut out and file them in the order in which they appear. This column will then give you a quick reference index.

		CHARACTERISTICS	
		35Z4GT	45Z5GT
	Type 35Z4GT		
	Type 35Z5GT 45Z5GT		
Heater Voltage		35	45 volts
Heater Current		0.15	0.15 amp.
R.M.S. Input		250	235 volts
Rectified Current		100	100 mA

CHANGE VALVE		CHANGE SOCKET		OTHER WORK NECESSARY	PERFORMANCE CHANGE
FROM	TO	FROM	TO		
35Z5GT	35Z4GT	Int.	Octal.	Disconnect lamp leads from valve socket and connect in series with the lead to pin 7. Shunt lamp with suitable resistor. See note.	NONE
		NO CHANGE			
45Z5GT	35Z4GT	AS ABOVE		1. As above. 2. Increase line cord by 50 ohms.	

Note:—A 6.3 volt 0.2 amp. lamp requires a shunt resistor of 25-50 ohms 2 watt.

BRIMAR says...
 Reprints of these data sheets are now available.

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RADIO ARITHMETIC

How to Take Short Cuts Without Loss of Accuracy

By **GEOFFREY STEDMAN, B.Sc.**

The height of a cylinder is 2.1 in; the radius of the base is 3.2 in. Find its volume.

$$\begin{aligned} \text{Volume} &= \pi r^2 h \\ &= 3.1416 \times (3.2)^2 \times 2.1 \\ &= 67.5569664 \text{ cu in.} \end{aligned}$$

THIS is a problem and solution which I saw recently in the exercise book of a pupil of a junior technical school. The answer was marked right and full marks awarded by the teacher, so that here was one more potentially good engineer having his taste for mathematics nipped in the bud. Intelligent approximation is based not upon the number of decimal places, but upon the number of significant figures.

The proper answer to the above problem is 68 cu in, for since the data are given only to two significant figures, there can be no knowledge of the answer beyond that degree of accuracy. If the teacher had wanted 67.6 cu in for an answer, he should have quoted 2.10 in as the height and 3.20 in as the radius. Now radio engineering is peculiar in that while its theory is very mathematical in form, arithmetical results are seldom required to within $\pm 1\%$; indeed, more often than not $\pm 10\%$ suffices, since if the value of almost any component of a receiver is altered by as much as 10%, the effect upon overall performance is imperceptible except by the use of instruments. This means that if the radio engineer will so far overcome the pernicious habits implanted in him by his mathematical miseducation as to use suitably approximate methods of calculation, his arithmetic adventures will be more efficient, more pleasant and more frequent, which will reduce the wear and tear on his slide rule. It is usually difficult to persuade a student who has been through the usual school arithmetic course to dare to make approximate calculations. He is

ill at ease with arithmetic, and, instead of feeling that he is conducting the calculation himself, he feels rather as if he were invoking, by strange and imperfectly acquired magic rites, the awesome demon of mathematics to do the work for him, and that therefore the slightest variation of the rites may result in quite incalculably severe mutilations of the answer.

Let us calculate the volume of the above cylinder by approximate methods.

$$\begin{aligned} \text{Volume} &= \pi r^2 h \\ &= \frac{22}{7} \times 3.2 \times 3.2 \times 2.1 \\ &= 22 \times 3.2 \times 3.2 \times 0.3 \\ &= 22 \times 3.2 \times 0.96 \\ &= 22 \times 3.2 \text{ less } 4\% \\ &= 70.4 \text{ less } 4\% \\ &= 70.4 - 2.8 = 67.6 \text{ cu in.} \end{aligned}$$

Alternatively, volume = $\pi r^2 h$

$$\begin{aligned} &= \frac{25}{8} \times 3.2 \times 3.2 \times 2.1 \text{ plus } \frac{1}{2}\% \\ &= 25 \times 0.4 \times 3.2 \times 2.1 \text{ plus } \frac{1}{2}\% \\ &= 32 \times 2.1 \text{ plus } \frac{1}{2}\% \\ &= 67.2 \text{ plus } \frac{1}{2}\% \\ &= 67.2 \text{ plus } 0.3 = 67.5 \text{ cu in.} \end{aligned}$$

In the second case the value of π is taken as $3\frac{1}{8}$ plus $\frac{1}{2}\%$ which is an extremely useful alternative to $3\frac{1}{7}$ since π usually associates itself with even numbers in radio arithmetic, and a sufficient number of multiplications of $25/8$ by 2, will cause it to assume the innocuous value of 100.

EXAMPLE: Find the capacity of a parallel plate condenser whose plate area is 7.5 sq cm and whose dielectric is 0.10 mm thick, and has a dielectric constant of 4.2.

$$\begin{aligned} \text{Capacity} &= \frac{kA}{4\pi d} \\ &= \frac{4.2 \times 7.5}{4 \times \frac{25}{8} \times 0.01} \text{ electrostatic units} \\ &= \frac{4.2 \times 7.5 \times 8}{100 \times 0.01} \quad \text{"} \quad \text{"} \\ &= 4.2 \times 60 = 252 \quad \text{"} \quad \text{"} \end{aligned}$$

This result is correct to two significant figures; had we wanted three significant figures it would have been necessary to deduct $\frac{1}{2}\%$

(since π is in the denominator) and the final result would be $252 - \frac{1}{2}\% = 251$ electrostatic units.

If the reader now complains that I am choosing specially simple examples to exhibit my method to advantage, I would point out that *any* examples may be so treated by *making* them simple. Thus, had the radius of the cylinder of the first problem been 3.1 in, the working would have been

$$\begin{aligned} \text{Volume} &= \pi r^2 h \\ &= \frac{25}{8} \times 3.1 \times 3.1 \times 2.1 \text{ plus } \frac{1}{2}\% \\ &= \frac{25}{8} \times 3.2 \times 3.0 \times 2.1 \text{ plus } \frac{1}{2}\% \\ &= 10 \times 3.0 \times 2.1 \text{ plus } \frac{1}{2}\% \\ &= 63 \text{ plus } \frac{1}{2}\% = 63.3 \text{ cu in.} \end{aligned}$$

If the condenser of the last example had had an area of 73 sq cm we should have written $73 = 75 - 2 = 75 - 3\%$.

Efficiency in this kind of calculation depends upon a suitable modification of the actual numbers to near numbers which are easier to work with, and either noting the appropriate correction to be made to the result, or else effecting two contrary modifications whose corrections cancel each other to within the degree of accuracy aimed at. After very little practice the method has the ease of habit. Thus, $4.4 \times 4.6 = 4.5 \times 4.6$ less $2\% = 9 \times 2.3$ less 2% . Also, $4.4 \times 4.6 = 4.5 \times 4.5 = 4.2 \times 4.8$. Which of these or of the many other ways of writing the product, we choose, will depend upon the other factors of the calculation.

Powers and roots are easily extracted on sight to 2 or 3 significant figures, by a simple application of the binomial theorem. For this purpose, all we need to know about the binomial theorem is, that if a small fractional part of a number is added to that number, approximately double that fractional part is added to its square, and half the fractional part to its square root. Three times the fractional part is added to the cube, and so on. Readers familiar with the binomial theorem will know that we are taking the first and second terms

Radio Arithmetic—

only of the binomial expansion in this approximation. Thus—

$$10^2 = 100$$

$$10.1^2 = 102.01 \text{ i.e. } (10 + 1\%)^2 = 100 + 2\% \text{ approx.}$$

$$10.2^2 = 104.04 \text{ i.e. } (10 + 2\%)^2 = 100 + 4\% \text{ approx.}$$

$$9.9^2 = 98.01 \text{ i.e. } (10 - 1\%)^2 = 100 - 2\% \text{ approx.}$$

Similarly

$$\sqrt{101} = 10.0499 \text{ i.e. } \sqrt{100 + 1\%} = 10 + \frac{1}{2}\% \text{ approx.}$$

and so on. As examples.

$$\sqrt{50} = \sqrt{49 + 1} = \sqrt{49 + 2\%} = 7 + 1\% = 7.07$$

$$\sqrt{60} = \sqrt{64 - 4} = \sqrt{64} \text{ less } 1/16\text{th} = 8 \text{ less } 1/32\text{nd} = 8 - 0.25 = 7.75$$

Alternatively

$$\sqrt{60} = \sqrt{49 + 11} = \sqrt{49 + 22\%} = 7 + 11\% = 7.77$$

This result is not quite so good since the correction is larger, but is still within about 1/4% of the truth.

The number π occurs so frequently in radio calculations that a variety of ways of dealing with it are useful. We have seen that $\pi = 25/8$ plus 1/2%. Also, $\pi^2 = 10$ less 4/3% so that $\pi = \sqrt{10}$ less 2/3%. Since $\sqrt{10} = 3.16$, we have the following trio of easily remembered numbers:

$$\pi = 3.14, \sqrt{10} = 3.16, \frac{10}{\pi} = 3.18$$

Multiples and Submultiples

Let us now consider a simplified way of dealing with the prefixes milli, micro, kilo and mega. When one reads "2mA" one usually makes a mental division between the "2" and the "mA"; the number is 2 and the units are milliamperes. This is strange, because if the quantity is written 2×10^{-3} A, the whole of 2×10^{-3} is usually thought of as the number. Let us, then, take 2m as the number, and amperes as the units. The advantage of this in calculating is twofold. First, the letters m, μ , k and M are more convenient to write and work with than 10^{-3} , 10^{-6} , 10^3 and 10^6 , and second, only one unit of any quantity will be used,—amperes for current, henrys for inductance, cycles per second for frequency and so on, so that the final business of the orthodox method of many computations, e.g.

expressing 5.6×10^{-5} amperes in terms of some more convenient submultiple, is entirely avoided. To pay for these advantages, all one needs to do is to become familiar with the following relationships which are obviously true, and place no strain on the memory as soon as one accustoms one's self to regard the symbols as numbers:

$$m = 1/k, \mu = 1/M, m^2 = \mu, k^2 = M.$$

EXAMPLES:

(i) Find the resistance of one metre of wire of diameter 0.0040 cm and specific resistance 50.7 microhm-cm.

$$R = \frac{\rho l}{\pi r^2} = \frac{50.7\mu \times 100}{\pi(2m)^2} = \frac{50.7\mu \times 100}{4\pi\mu} = \frac{50.7 \times 100}{2^2} \text{ plus } \frac{1}{2}\% = 50.7 \times 8 \text{ less } \frac{1}{2}\% = 405.6 \text{ less } \frac{1}{2}\% = 404 \text{ ohms.}$$

(ii) At what frequency will 50 microhenrys and 0.000030 microfarads resonate?

$$f = \frac{1}{2\pi\sqrt{LC}} \text{ cycles per sec.} = \frac{1}{2\pi\sqrt{50\mu 0.00003\mu}} = \frac{1}{2\pi\mu\sqrt{0.0015}} = \frac{1}{2\pi\sqrt{0.0016} \text{ less } \frac{1}{16}\text{th}} = \frac{M}{2\pi \cdot 0.4} \text{ plus } \frac{1}{32}\text{nd} = \frac{0.8 \text{ } \frac{2^5}{3} \text{ plus } \frac{1}{2}\%}{4} \text{ plus } \frac{1}{32}\text{nd c/s} = 4 \text{ M c/s plus } \frac{1}{32}\text{nd less } \frac{1}{2}\% = 4.00 + 0.125 \text{ less } \frac{1}{2}\% \text{ Mc/s} = 4.125 - 0.02 \text{ Mc/s} = 4.10 \text{ Mc/s.}$$

(iii) What inductance will resonate at 5.0 Mc/s with 300 micro-microfarads?

$$f = \frac{1}{2\pi\sqrt{LC}} \text{ c/s} \therefore L = \frac{1}{4\pi^2 f^2 C} = \frac{1}{4\pi^2 (5M)^2 300\mu\mu} \text{ henry} = \frac{1}{4\pi^2 25 \times 300} = \frac{1}{1000 \times 300} \text{ henry} = \frac{1}{300k} \text{ henry} = \frac{1}{300} \text{ mH} = \frac{1m}{0.3} \text{ mH} = 3.3 \mu\text{H}$$

This needs 1/3% added to correct

for writing 10 for π^2 , if, as is unusual, the value of an inductance is needed to such a degree of accuracy.

(iv) What current will dissipate 1/2 watt in a 250,000 Ω resistor?

Since Watts = $I^2 R$,

$$I = \sqrt{\frac{W}{R}} = \sqrt{\frac{\frac{1}{2}}{250000}} \text{ amperes} = \sqrt{2\mu\text{A}} = \sqrt{2} \text{ mA} = 1.4 \text{ mA.}$$

I.E.E. STUDENTS

TO provide a forum for students where they could discuss technical matters in a less formal atmosphere than that which generally prevails at meetings of learned societies, the Institution of Electrical Engineers formed a Students' Section some 60 years ago. Instead of the original small section in London there are now fourteen operating in different parts of the country with a membership of over 9,200.

Anyone up to the age of 28 who is studying or engaged in any branch of electrical engineering may become a student member of the Institution. When he has obtained academic qualifications of degree standard he may transfer to the class of Graduate, and on completing a further period of practical training followed by holding a responsible position he can apply to become an Associate Member.

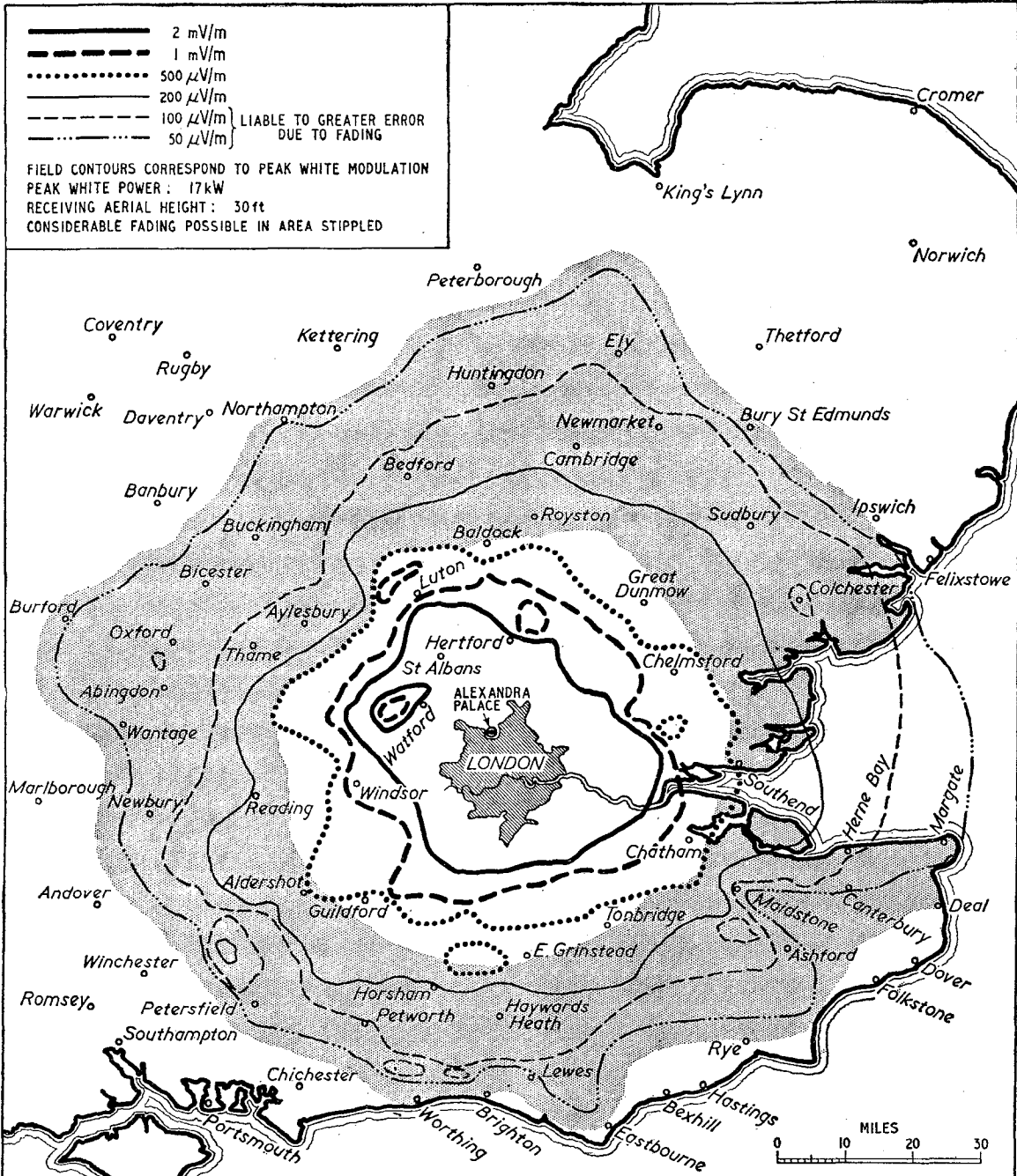
One advantage of the Section is that the discussions at its meetings are not reported, so that reputations are not endangered by incautious statements. Abstracts of papers read at the meetings, which embrace the various branches of electrical engineering covered by the sections of the Institution—Radio, Utilization, Measurements and Supply—are published in the Students' Quarterly Journal.

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A NEW range of totally enclosed iron-cored components has been produced by the Plessey Co., Ilford, Essex, for use in industrial control gear, test and communications equipment. Protection is provided by bitumen-filled, heavy gauge steel cases, and the electrical and material specifications are in accordance with British Standards. The range includes chokes, auto-transformers, single and multi-secondary transformers, mains and output transformers.

B.B.C. TELEVISION MAP

Service Areas of the Alexandra Palace Transmitter



This map (based by courtesy on a larger one produced by a B.B.C. survey) shows approximate field strength contours of the London vision transmitter (45Mc/s). The contours give the average values in the areas concerned; probable degree of error is greatest in hilly or built-up areas and least in open flat country. A description of the map is on p. 74

IONOSPHERE REVIEW: 1948

Sunspot Cycle and Short-wave Propagation Survey, with Forecast for 1949

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

IN this article it is intended to review the course of the present sunspot cycle, giving special attention to the changes which took place during 1948, and to see what effects these had upon short-wave propagation during the year. We may then attempt to see how short-wave conditions are likely to vary during 1948. Since it is impossible to forecast accurately the variations in sunspot activity a long way ahead, and as the changes in short-wave conditions depend upon these variations, it follows that the prediction of a year's variations in short-wave propagation conditions is a somewhat difficult task. Nevertheless, from an examination of past and current trends, we may at least obtain an indication as to what 1949 may be like, from a short-wave propagation point of view.

Since there may be readers who are new to this subject and who have not followed these yearly *Wireless World* reviews of past conditions, a few brief explanatory words may not come amiss.

The ionization of the upper atmosphere—and thus the formation of the region there known as the ionosphere—is brought about in the main by the action of the sun's ultra-violet radiations, and, since the sun's activity, and hence the strength of its radiations, varies over a long period, which is the sunspot cycle, the condition of the ionosphere varies likewise. One property of the ionosphere is its ability to bend or refract radio-waves—particularly those in the short-wave range—and thus to guide them round the earth and, if its ionization level should vary over the sunspot cycle, the conditions for short-wave propagation will also change.

Among other evidence of the variations in the sun's activity are the sunspots which appear

upon its surface, and these are regularly examined at the various astronomical observatories, the information there obtained being published in the form of "sunspot relative numbers." The observations made at the different observatories are correlated at Zurich and the final number published from there. The final numbers for 1948 are not yet available, however, so for this review we shall use the provisional sunspot numbers obtained from the Royal Observatory at Greenwich. Measurements of the atmospheric ionization are regularly made at ionospheric observatories in many parts of the world and in some cases records go back as far as 1749. The correlation between the two sets of phenomena, solar and ionospheric, has been well established and the ionosphere does, in fact, respond in a marked way to variations in the activity of its producing agent, the sun.

The critical frequency of a layer is the highest frequency returned by that layer when the radio wave is sent vertically upwards, and it is proportional to the ionization existing in the layer. For communication over a distance the corresponding value is the Maximum Usable Frequency, which depends on the critical frequency, and on the angle of incidence made on the layer in order for the wave to be returned to earth at a particular distance. The M.U.F. thus increases from the critical frequency as the distance over which it is desired to communicate increases and, as a rough guide, we could assume that the M.U.F. for the maximum distance it is possible to cover in one hop is about 3.3 times the critical frequency of the F_2 layer.

So far as radio-wave propagation is concerned 1948 was again a very interesting year during which the sunspot activity re-

mained, on the average, at an extremely high level. As a result the useful frequencies for long-distance communication were also of an extremely high order. In fact the general sunspot activity so far as we can yet tell was slightly lower than during 1947, yet it remained at a level which has been reached only very seldom since 1749. The last year—apart from 1947—when the activity was of a comparable value to that of 1948 was in 1870. So it is obvious at once that—whatever other conclusions we

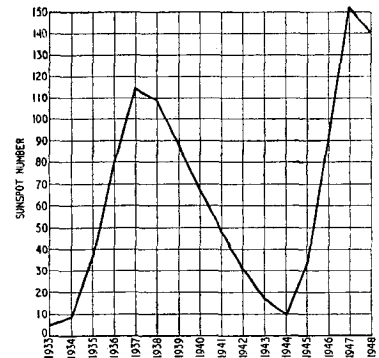


Fig. 1. Mean annual values of sunspot relative numbers.

may arrive at—1948 was an exceptional year for short-wave propagation; a year during which the usable frequencies were higher than usual and possibly higher than they may be for many years to come. Let us now examine things in a little more detail.

Course of the Sunspot Cycle.—

In Fig. 1 are plotted the mean annual values of the sunspot relative numbers for a period covering the whole of the last and present cycles, it being stressed that the values for 1948 are provisional only. It is interesting to note that the publication of the final sunspot numbers for 1947 has not altered a fact which was pointed out in last year's review, namely, that the sunspot activity during 1947 has been exceeded once only during the 199 years covered by the continuous records and that was 170 years ago, in 1778. It would appear from the curve that the year of maximum

activity in the present cycle was 1947, although the activity during 1948 was only slightly less than during the previous year. We cannot, however, be absolutely certain about this until the final sunspot numbers for 1948 are published. It does seem to be strongly indicated, however, that the maximum in the present sunspot cycle is now past and that, for some years to come, we may expect the solar activity to go on decreasing. However, even when the final numbers for 1948 are available, and even supposing they do show a decrease in activity, we still cannot be quite confident that the statement at the end of the last sentence will be true, for sometimes the activity, after decreasing for a time, unexpectedly begins to increase again so as to bring about a subsidiary maximum.

We see, from Fig. 1, that so far the present sunspot cycle has been markedly different to its predecessor, notably in the time between the epoch of maximum activity and that of the preceding minimum, and also in the magnitude of the activity at the maximum. Even if 1948 was the first year of the decreasing phase in the present cycle, we see that the general activity was nevertheless greater than that during the maximum year of the preceding cycle, which itself was higher than that reached during the five preceding cycles. So that 1948, considered over a long period of time, was a year of exceptionally high sunspot activity and, consequently, one of very high usable frequencies for long-distance radio communication. During 1949 we should, always with the reservations already alluded to, expect the usable frequencies to decrease, and perhaps to do so somewhat more rapidly than they did during 1948, but still to be, on the average, relatively high.

Ionospheric Variations.—In Fig. 2 are plotted (top curve) the monthly means of the sunspot relative numbers for each month of the years 1945-1948, and (bottom curve) the monthly means of the noon critical frequencies of the F_2 layer for the same period, as measured in England.

There are some interesting things to note about these two curves and about the correlation

between them, especially during 1948. The sunspot activity varied erratically month by month, of course, but showed a gradually increasing tendency from 1945—the year of minimum activity—towards 1947 and 1948. As to these two latter years it should be noted that although the general activity for the year was higher during 1947 than 1948, the actual sunspot maximum may have occurred during the latter year, for we see that the sunspot number for April, 1948, was greater than that for any previous month in the present cycle. There is, however, an element of uncertainty about this as the 1948 values are, as yet, only provisional.

It is interesting to observe that after a very considerable decrease lasting some months towards February, 1948, the sunspot activity then increased to very high values again, and remained exceptionally high for several further months. It is to be noted that the sunspot activity during

was 206.2, and in May, 1947, when it was 201.3.

From the bottom curve of Fig. 2 it is seen that there was a general rise in the noon F_2 layer critical frequencies as the sunspot cycle progressed in its course, due of course, to the increasing power of the sun's ultra-violet radiations in ionizing the gases of which the layer is composed. Between the epochs of minimum and maximum activity the increase in the noon critical frequency is seen to be of the order of 3 Mc/s during the summer, and of 8 Mc/s during the winter, implying increases in the M.U.F. for longest distance transmission of about 10 Mc/s in summer and no less than 26 Mc/s in winter. If we were to examine the critical frequencies of the other layers, or of the F_2 layer for other times of the day, we should see that they all showed an increase in accordance with the increasing sunspot activity, although the actual degree of increase would be different for different layers and times

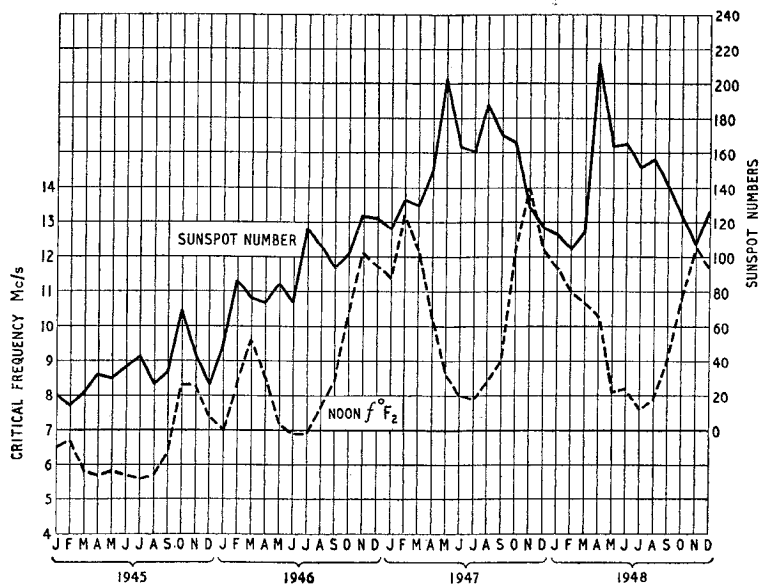


Fig. 2. (Top curve) Monthly mean values of sunspot relative numbers; (lower curve) F_2 critical frequencies for the past four years.

April, 1948, might well be described as being phenomenally high, for only three times before within the period covered by the continuous records (from 1749) has the monthly mean reached a value exceeding 200. These were in May, 1778, when it reached 238.9, in December, 1836, when it

of day. It is, in fact, greatest for the F_2 layer, and at noon.

In the bottom curve of Fig. 2 there are, of course, the large seasonal variations in the noon F_2 critical frequency superimposed on those due to the sunspot cycle. It is seen that, generally speaking, these are such as to cause low

Ionosphere Review : 1948—

values of critical frequency in summer, and high values in winter, except that there is a small fall in the critical frequency at the extreme mid-winter period. This mid-winter decrease in critical frequency has, in fact, occurred without exception during every year of the present cycle. Thus the highest values tend to occur each year about February and November.

It would appear, from the curve, that the highest critical frequencies—and thus the highest usable frequencies for long distance radio communication—occurred during the present cycle in November, 1947. In December there was a sharp fall in critical frequency, which would have been expected having regard to the mid-winter effect just mentioned, but early in 1948 there was no recovery from this depression in critical frequency values, as had been the case during each preceding year. There can be little doubt that the failure to recover from the mid-winter fall was due to the sharp decrease in sunspot activity which took place during the last few months of 1947, and which persisted during the first three months of 1948. During the summer of 1948 the sunspot activity was again at a high value, and the critical frequencies were but slightly lower than during the summer of 1947.

Towards the end of the year sunspot activity again decreased, and the critical frequencies were considerably lower than during the corresponding months of 1947. Nevertheless, the mean critical frequency for noon, which in November, 1947, was 14 Mc/s, had, by November, 1948, fallen to 12.3 Mc/s, implying a mean M.U.F. for longest distance working in these latitudes of about 41 Mc/s. Of course the M.U.F.s would have considerably exceeded this mean value on individual days, and they would, generally speaking, have been higher than this for places to the south of this country, because the ionospheric refracting point would then lie in latitudes where the critical frequency is often higher than it is in these latitudes. The above fall in critical frequency as between 1947 and 1948 was thus about what had been anticipated, for,

quoting from last year's "Ionosphere Review" (*Wireless World*, February, 1948, p. 47) "it would appear . . . that by November, 1948, the noon mean critical frequency would only have fallen to about 12.6 Mc/s" and "the mean noon M.U.F. for longest distance working in these latitudes should be of the order of 41.6 Mc/s.

Correlation between Sunspot and Ionospheric Measurements.— In Fig. 3 are given (full line curve) the twelve-months running average value of the sunspot number during the present sunspot cycle, and (dashed line curves) the twelve-month running average of the noon and midnight F_2 critical frequencies over the same period, as measured in England. The object of taking a twelve-month running average of these values is to smooth out the month-by-month fluctuations in the sunspot activity, and the seasonal variations in the critical frequencies, and thus to render more apparent the long period effects in both quantities. It is done by taking for the mean for the epoch at the centre of any month the average of the twelve monthly means having that month as the centre.

An examination of these curves shows that both the noon and the midnight critical frequencies responded to the changing sunspot activity relatively faithfully, the increase as between sunspot minimum and maximum being greater at noon—when the sun's effect upon the ionosphere is more direct—than at midnight. Although over most of the cycle the correlation between the sunspot curve and that for the critical frequencies was remarkably good, towards the maximum the critical frequency does not appear to have increased so rapidly as the sunspot number. Also, there appears to have been a lag of about three months in the reversal tendency of both critical frequency curves as compared with that for the sunspot activity. After the maximum there apparently occurred a subsidiary maximum in the sunspot activity, and then there was a definitely decreasing tendency. We must remember that all these later values are based on provisional sunspot numbers only. These variations resulted in a flattening out of the critical fre-

quency curves after their initial tendency to decrease, although towards the end of the period a decreasing tendency again appeared. Nevertheless there has, as yet, been a relatively small decrease in the average values of critical frequency since the sunspot maximum.

It is interesting to note that, as between sunspot minimum and maximum, the noon critical frequency increased by about 2.08 times and that for midnight by about 1.96 times, implying increases in the actual ionization of the layer of about 4.35 times for noon, and 3.84 times for midnight. In the case of the E layer the increase in critical frequency as between sunspot minimum and maximum was about 1.26 times, implying an increase in the actual ionization of this layer of about 1.59 times.

The fact that 1948 was a year of higher critical frequencies and higher M.U.F.s for radio communication than usual justifies us in classifying it as a year of relatively good short-wave conditions, particularly on the higher frequency bands. This is so because, while the ionization of the F_2 layer—the principal refracting layer for long-distance communication—was increased to an exceptional degree, that of the D layer—the principal absorbing region—would only have been increased to a moderate extent. Thus the M.U.F.s would be exceptionally high and L.U.H.F. (lowest useful high frequency) only moderately so, and the band of useful frequencies would therefore be exceptionally wide.

Practical Results.— An examination of the highest frequencies which were actually usable during 1948 shows that the high M.U.F. values indicated by the measured values of ionospheric critical frequencies were, in general, well borne out. The phenomenally high frequencies on which long-distance communication was effected in October and November of 1947 did not, apparently, again become workable, as might have been expected, during February and early March of 1948. A glance at Fig. 2 clearly shows the reason for this to have been the relatively low sunspot activity then prevailing and the failure of the critical

frequencies to rise again after the mid-winter fall. It is noteworthy that the highest frequencies usable in the early spring were lower than those which became usable in the late autumn of 1948. Nevertheless, in the early part of the year frequencies up to 35 Mc/s were occasionally propagated over long distances to this country, while communication on the amateur 28-Mc/s band was fairly common on a world-wide basis. In September communication on this band became much more extensive, and remained so throughout the remainder of the year. Reception of the Alexandra Palace television signals occurred in the West Indies during this time, and towards the end of October both sound and vision transmissions were received in South Africa. So far as is known

activity is likely to prevail during 1949, as towards the final months the future trend is by no means clearly indicated. Again, from Fig. 1 one cannot be certain that the decrease indicated by the 1948 annual mean will be maintained. However, all things considered, it does seem likely that during 1949 the activity will continue to decrease. We should even be justified in expecting, from an examination of past cycles, that the activity is likely to decrease somewhat more rapidly than it did during 1948, and in making an estimate for the running average sunspot number for the middle of 1949 to be about 113. It is probable that if this is the case the running average of the noon critical frequencies would only have fallen to about 9.6 Mc/s, and that for midnight

November, 1947, and about 41 Mc/s in November, 1948. The "Optimum Working Frequency" at this time should therefore be about 30.6 Mc/s.

The detailed specification of the predicted O.W.F.s for every direction from this country and for every month and time of day during 1949 is a very complex business, and is beyond the scope of this article. In general we should expect the daytime working frequencies for most circuits to increase somewhat from their present values towards the vernal equinox, as the daytime critical frequency is likely to rise after the mid-winter fall. At the same time the night-time working frequencies should be increasing. Then, about April, daytime working frequencies should begin to fall, rather rapidly for east-west directions, and slowly for north-south directions, and this effect should continue to about June. Night-time frequencies should continue their rise to a peak about June. From June towards November there should be a further increase in the daytime working frequencies, but of a smaller order than the fall from spring to summer. There should then be a slight fall towards mid-winter. The night-time working frequencies should fall from June towards mid-winter, and the fall should be greater than the increase from winter towards June. Thus one may anticipate that the year will close with somewhat lower frequencies being effective for long-distance communication than are generally usable at present.

There may, of course, be a good deal of medium-distance communication (up to 1,400 miles) on very high frequencies during the year, by way of the Sporadic E ionization, but this is not a dependable means of propagation, and is likely to be frequent only during the months of May to September. As to the 50-Mc/s amateur band, it is unlikely, if the expected decrease in sunspot activity occurs, to become workable for long-distance communication at any season of the year. It is quite possible that frequencies around 40 Mc/s may do so, both in the spring and autumn seasons. Summing up the prospects for 1949, therefore, since the sunspot

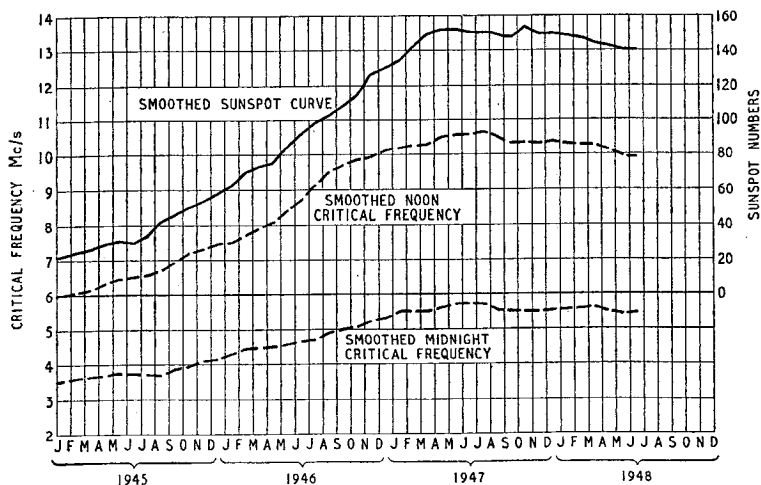


Fig. 3. The full-line curve shows the twelve-month running averages of sunspot numbers over the present sunspot cycle and the dashed-line curve the noon and midnight F_2 critical frequencies in England.

very few (if any) long-distance contacts on the amateur 50-Mc/s band were made during October and November, although American police signals on the 40-Mc/s band were frequently received in this country. Thus, as had been indicated in last year's review, the highest workable frequencies were somewhat below those which prevailed in the autumn of 1947. Nevertheless, as has been said, working frequencies were, on the whole, relatively high throughout the year for all circuits.

Forecast for 1949.—It is difficult to tell, from the top curve of Fig. 3, what degree of sunspot

to about 5 Mc/s. So the decrease in the usable frequencies during 1949 would not appear to be likely to be very great.

It is not possible here to give the actual values of critical frequency likely to be reached during each particular month. But it would appear, from a study of Figs. 2 and 3, that by November, 1949, the noon mean critical frequency would have fallen to about 10.9 Mc/s. This implies that the mean noon M.U.F. for longest distance working in these latitudes should be of the order of 36 Mc/s, as compared with about 46 Mc/s in

Ionosphere Review: 1948—

activity is likely to be of the order which occurred at the last sunspot maximum, good radio conditions should in general prevail, and conditions tend to favour the high, but not the exceptionally high, short-wave frequencies.

NEWS FROM THE CLUBS

Barnet.—The Barnet Radio Group of the R.S.G.B. has been renamed the Barnet Amateur Radio Society and continues to meet on the first Saturday after the 10th of each month at Bunny's Restaurant, 15, Station Road, New Barnet. Sec.: M. R. Jenkins (G3EIM), 1193A, High Road, Whetstone, London, N.20.

Barnsley.—Meetings of the Barnsley and District Amateur Radio Club are held twice a month at the King George Hotel, Peel Street, Barnsley. Sec.: R. Hickling, 179, Barnsley Road, Wombwell, Yorkshire.

Birmingham.—A lecture on test equipment will be given to members of the Slade Radio Society by W. F. Newall, of the Automatic Coil Winder Co., on February 4th. Meetings of the society are held on alternate Fridays at 8 in the Parochial Hall, Slade Road, Erdington, Birmingham. Sec.: C. N. Smart, 110, Woolmore Road, Birmingham, 23.

Bristol.—Although having been formed only four months, the Bristol and District S.W.L. Club has a membership of 44. Meetings are held every third Friday at 7.30 at the Redcliffe Community Centre, Guinea Street, Bristol, 1. Sec.: N. G. Foord, 71, Brynland Avenue, Bristol, 7.

Chester.—The recently formed Chester and District Amateur Radio Society meets on alternate Tuesdays at 7.30 at the United Services Club, Watergate Street, Chester. Next meeting is on February 8th. Sec.: S. H. Dutton, 17, Victoria Parkway, Queen's Park, Chester, Cheshire.

Esher.—The radio control of models will be discussed at the next meeting of the Thames Valley Amateur Radio Transmitters' Society on February 2nd at 8, at the Caernarvon Castle Hotel, Hampton Court. Sec.: A. Mears, (G8SM), Broadfields, East Molesey, Surrey.

Harrow.—A lecture on theoretical and practical circuit analysis will be given to members of the Radio Society of Harrow by S. W. Amos on February 8th at the Northwick Tea Rooms, 206-208, Kenton Road, Harrow. On February 2nd the society will hold a joint meeting with the Edgware and District Radio Club. Sec.: J. R. Pickett, 93, Whitmore Road, Harrow, Middlesex.

Worthing.—Meetings of the Worthing and District Amateur Radio Club are now held on the second Monday in each month at 7.30 at the Adult Education Centre, Union Place, Worthing. Sec.: F. T. Tooley, 62, Beckett Road, Worthing, Sussex.

BOOK REVIEW

A Textbook of Radar. By the Staff of the Radiophysics Laboratory, Council for Scientific and Industrial Research, Australia. Pp. 579 +v, with 31 plates and 347 diagrams. Chapman & Hall, Ltd., 37, Essex Street, London, W.C.2. Price 50s.

THIS is the Australian counterpart of the American M.I.T. Radiation Laboratory books on radar. Being all in one volume, even though a substantial one, the treatment of the whole of a subject which was due to an unequalled concentration of research on an international scale might be expected to be rather superficial. And being, as it is, the collective work of many authors, there was an obvious risk of overlapping and inconsistency. A third risk, which has certainly not been avoided in all books on radar, is that an organization engaged for so long on a war effort might be unable to generalize its outlook.

But all these three risks have evidently been recognized by the unnamed editor, and successfully averted. There are no recapitulations of radio engineering in general, or lengthy historical reminiscences, or details of obsolete systems—or indeed excessive details of any particular systems. Mathematics has been used as it should be, for conciseness and definiteness of treatment, and has not been misused in long theoretical by-ways. The standard of mathematics is, in fact, fairly advanced in places, but is presented very clearly. Overlapping hardly exists, and the consistency of style is remarkable when it is considered that each of the twenty chapters is the work of a different author, with collaborators.

The majority of the book is devoted to the principles of microwave radar, illustrated necessarily by war-time equipment and techniques, but not too closely bound to them. A very nice balance has been observed between theory and practice, and the faults of vagueness on the one hand and mere descriptiveness on the other have been skilfully avoided.

Judging from the fact that (except in the last chapter) none of the many references is dated later than 1945, the volume went to press some time ago. No doubt this accounts for the exceptionally high standard of proof reading and book production, but unfortunately it also means that the majority of the references are to unpublished reports, most of the published work on radar (especially in Great Britain) having appeared since 1945. It is presumably due to this that some important British

circuit techniques are either missing or rather inadequately treated.

Although a chapter is given to shipboard radar, it is exclusively from the naval point of view. Use on merchant ships is briefly referred to in the last chapter, on radar navigation, but harbour radar is not. This important post-war field is still marked by a gap in radar literature.

The use of symbols and terms is notably consistent and clear. A minor exception is that "concentric" is used by one contributor instead of "coaxial"; once erroneously in referring to the resonant cavities in a magnetron. The British nomenclature for waveguide and cavity modes is not given. A commendable feature is the adoption throughout of the rationalized M.K.S. system of units. Its value is particularly marked in the unified treatment of circuit and field impedance. M.G.S.

MANUFACTURERS' LITERATURE

Technical guide to "Aerialite" television aerials, and general catalogue of aerials from Aerialite, Ltd., Stalybridge, Cheshire.

New catalogue of acoustic baffles from Broadcast and Acoustic Equipment Co., Tombland, Norwich.

Leaflet describing demonstration audio-amplifier for schools from A. E. Cawkell, 7, Victory Parade, The Broadway, Southall, Middlesex.

Leaflet giving particulars of heavy-duty carbon resistors for transmitters from the Morgan Crucible Co., Battersea Church Road, London, S.W.11.

Brochure of electronic instruments, including c.r. oscilloscopes, valve voltmeters, a.f. oscillators and stabilized power supply units, from Furzehill Laboratories, Boreham Wood, Herts.

Catalogue of copper wire, strip and strand from E. and F. Kaye, Ltd., Ponders End, Enfield, Middlesex.

Illustrated leaflet describing the new Model P20B "personal" portable from the Marconiphone Company, Hayes, Middlesex.

Leaflets describing the "Williamson"-type amplifier and bass reflex loudspeaker cabinets made by the Rogers Development Co., 106, Heath Street, London, N.W.3.

Descriptive leaflet of magnetic-tape home projector sound conversion kit, and list of fractional h.p. motors, from Scopphony, Ltd., Wells, Somerset.

Catalogue of television aerials and brochure describing installation service offered by Wolsey Television, Ltd., 75, Gresham Road, London, S.W.9.

SUPERHETERODYNE TELEVISION UNIT

Long-range Receiver

WHEN the WIRELESS WORLD Television Receiver was described*, it was stated that it was suitable only for moderate-range reception and that a more sensitive receiver unit for long-range use would be described later. The original straight set has actually proved adequate for much greater ranges than were originally envisaged, and many reports of good reception at 30 miles and over have been received.

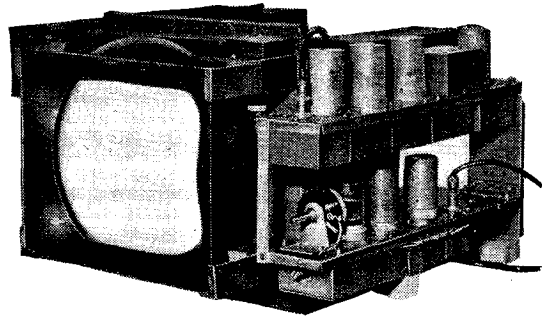
However, it was not intended for really long-distance reception and a great deal of time and effort has been put into the development of a suitable receiver. It is a superheterodyne. It is not the need for high sensitivity which has led to the adoption of this form of receiver, for it is easy to obtain all the gain needed from the straight set; it is the need for sound-channel rejection.

The problem of sound-channel rejection is quite a difficult one if the vision-channel response is maintained at the required value and it has been greatly increased by the standards chosen

considered it was decided that it should be of a type which would be basically suitable for the reception of this station. This decision alone was sufficient to justify the choice of the superheterodyne, for it demands changes to three coils only to make it suitable for Birmingham, whereas a straight set would need changes to at least sixteen.

The design of the set was started before the Birmingham standards were known. From the outset the use of single-sideband reception was decided on, partly because the bandwidth is halved and the stage gain doubled. The main reason, however, was that it enormously

The receiver is shown here in the normal position alongside the cathode-ray tube.



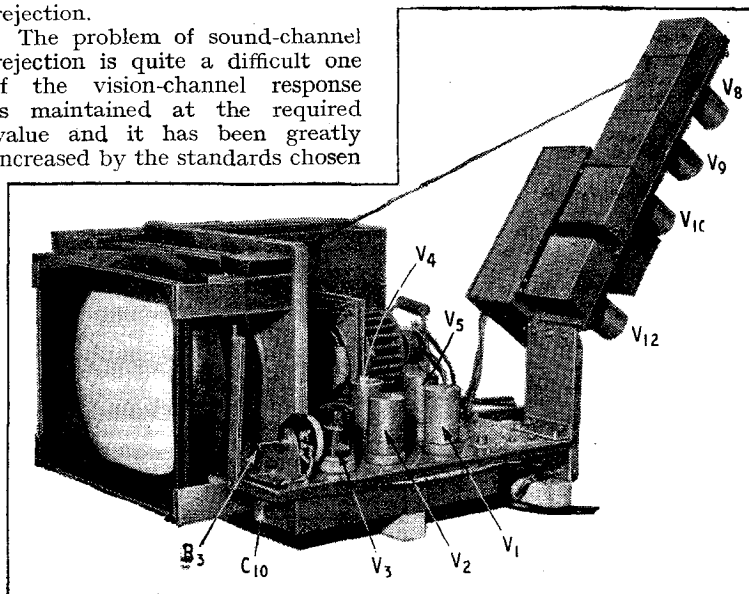
to obtain 40-db discrimination without using any rejector circuits.

When this receiver had been completed and was awaiting only final testing prior to being described, the Birmingham standards were announced and it was found that single-sideband transmission would be used, the sidebands retained being those nearer the sound channel. This is, of course, the natural choice for transmission, just as the alternative is the natural choice for reception.

The result of this choice of transmission standards was to make the receiver as developed useless for the Birmingham area. It also removed most, if not all, the advantage of single-sideband reception in easing the problem of sound-channel rejection, for it brought back the old problem of obtaining some 40-db discrimination for a 0.5-Mc/s change of frequency.

On the announcement of the Birmingham standards, therefore, it was necessary to redesign the i.f. and r.f. amplifier, and it is this which has in large measure been responsible for delaying the publication of this article beyond the date originally fixed for it. The main practical difficulty encountered in design has been that of securing adequate sound-channel rejection with the required bandwidth. In order to secure the necessary performance three rejector circuits have had to be included.

The receiver as now described is suitable for reception from Alexandra Palace. For Sutton



In this photograph the upper deck of the receiver is shown hinged up so that access to the underside can be obtained.

for the Birmingham station. When the design of the long-range receiver was first con-

helps sound-channel rejection. By picking the sidebands remote from the sound channel the spacing between sound and vision channels is 3.5 Mc/s instead of 0.5 Mc/s. It is then easily possible

* *Wireless World*, January, February, March, May, July, August, September, October, November and December, 1947.

Superheterodyne Television Unit— Coldfield changes to three coils—two signal and one oscillator-frequency coils—will be needed. No other changes are expected to be necessary, but as the precise single-sideband standards have not yet been announced there is a remote possibility that a modified trimming procedure for the i.f. amplifier might be required. Details of the three Birmingham coils

ated in the anode circuit of the mixer. The vision channel comprises three stages followed by a diode detector, v.f. stage, and a diode noise limiter. The sound channel has two i.f. stages followed by a diode detector and diode noise limiter; as in the previous receiver, no a.f. stages are included, since it is assumed that most people already have an a.f. amplifier, or at least a broadcast

— 3 db and the vision-channel pass-band is 3 Mc/s for — 6 db. The latter extends from 10 Mc/s to 13 Mc/s, the vision carrier being at the latter frequency 6 db below the maximum response. This is important if the proper overall characteristic is to be obtained in single-sideband operation.

The oscillator operates at 32Mc/s (= 45-13). This frequency was chosen instead of the alternative

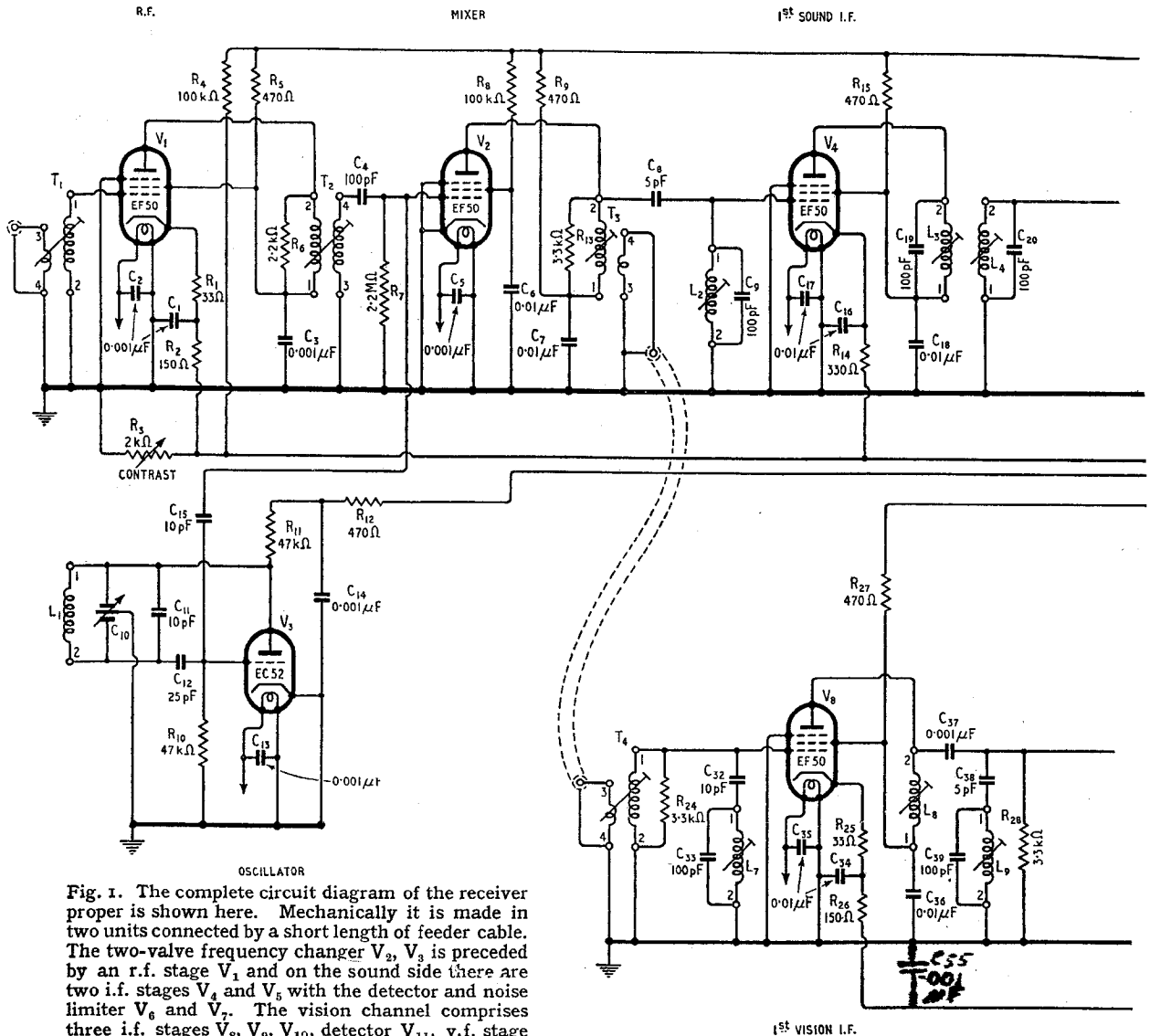


Fig. 1. The complete circuit diagram of the receiver proper is shown here. Mechanically it is made in two units connected by a short length of feeder cable. The two-valve frequency changer V_2, V_3 is preceded by an r.f. stage V_1 and on the sound side there are two i.f. stages V_4 and V_5 with the detector and noise limiter V_6 and V_7 . The vision channel comprises three i.f. stages V_8, V_9, V_{10} , detector V_{11} , v.f. stage V_{12} and noise limiter V_{13} .

will be given nearer the opening date of the station.

The receiver has an r.f. stage, mixer and oscillator which are common to both sound and vision signals. These signals are separ-

receiver with pick-up terminals, which can be used with it.

The intermediate frequencies are 9.5 Mc/s for sound and 13 Mc/s for vision. The sound-channel pass-band is about 100 kc/s for

of 58 Mc/s since it was considered that greater oscillator stability could be achieved. The only objection to it is the fact that the second channel interference band is 16-19 Mc/s instead of 68-71 Mc/s.

Because stations in this band are generally stronger there is a greater probability of interference for the same image rejection in the receiver. However, the selectivity of tuned circuits naturally tends to be greater below than above resonance, and this, at least, partially offsets it. In practice no trouble at all from second-channel interference has been found.

signals in the i.f. band. It must be remembered that in a television superheterodyne the intermediate frequency lies in the crowded s.w. band, and at high gain complete screening is necessary if the direct pick-up of signals is to be avoided.

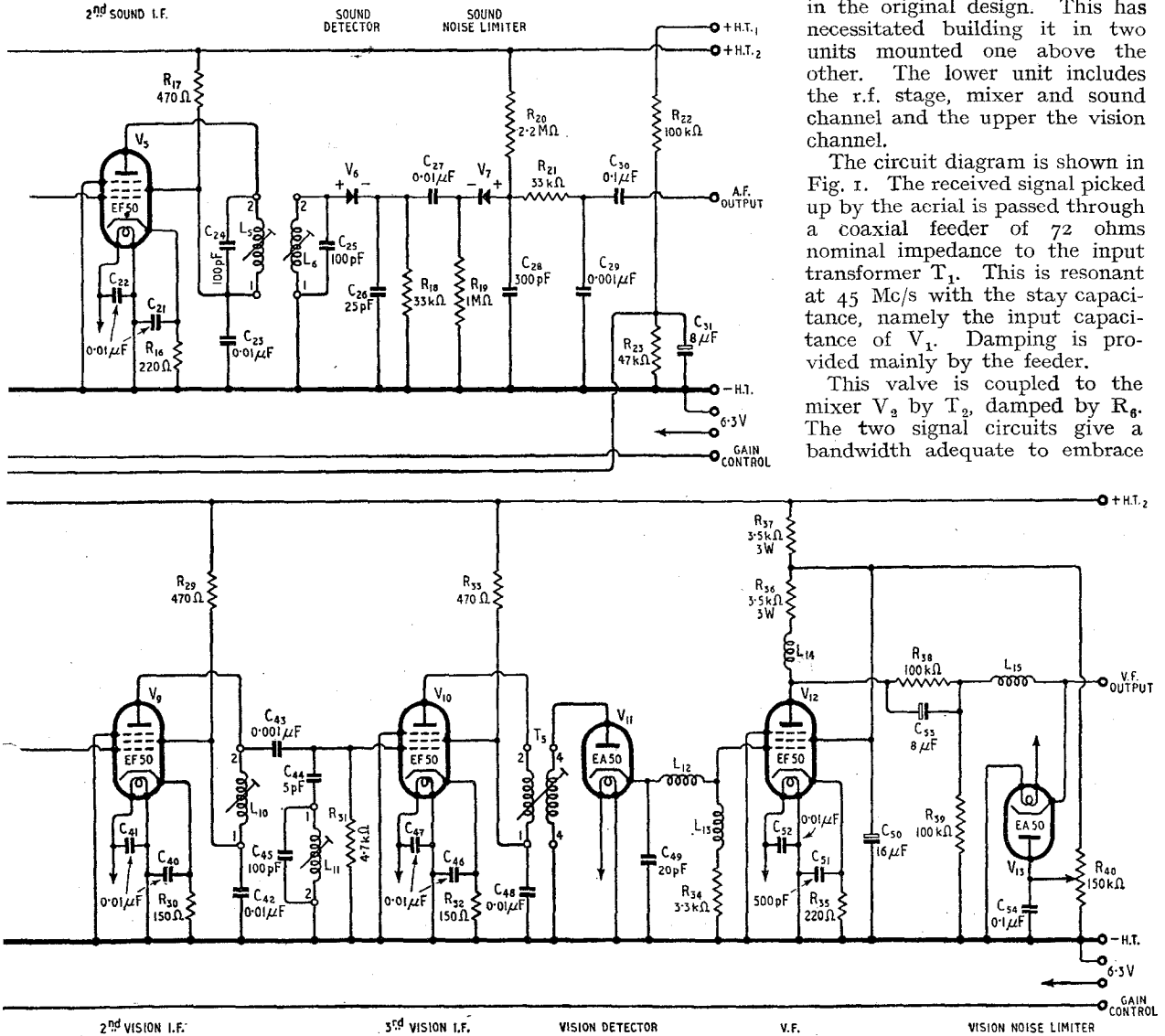
There is also the question of avoiding i.f. harmonic interference. In the superheterodyne harmonics of the intermediate

intermediate frequency enables this to be overcome for any given signal frequency, but it is impracticable to secure freedom from it in this way over the whole of the television band. For this it is necessary to use thorough screening and to include an adequate filter after the detector.

The receiver is so arranged in its mechanical form that it will fit into the space allocated to it in the original design. This has necessitated building it in two units mounted one above the other. The lower unit includes the r.f. stage, mixer and sound channel and the upper the vision channel.

The circuit diagram is shown in Fig. 1. The received signal picked up by the aerial is passed through a coaxial feeder of 72 ohms nominal impedance to the input transformer T_1 . This is resonant at 45 Mc/s with the stray capacitance, namely the input capacitance of V_1 . Damping is provided mainly by the feeder.

This valve is coupled to the mixer V_2 by T_2 , damped by R_8 . The two signal circuits give a bandwidth adequate to embrace



Very thorough screening of all parts of the receiver has been adopted. There is far more screening than is necessary for receiver stability, but it is needed to prevent the direct pick-up of

frequency are inevitably produced in the detector. If they are fed back to the signal-frequency circuits they may beat with the signal to produce a pattern on the picture. The correct choice of the

the sound and vision channels. A separate oscillator valve V_3 is used in the interests of stability. The coil L_1 is wound with heavy gauge wire on a polystyrene former and the turns are cemented

Superheterodyne Television Unit— in place. All the oscillator components are mounted on the lower chassis well away from anything hot and the H.T. supply is taken from the 480-V line via the potentiometer R_{22} , R_{23} . This is done because the direct load on this line is a stable one—the line and frame time-base valves, whereas the 250-V line varies to some degree with the gain- and focus-control settings.

The mixer output at 13.10 Mc/s for vision and 9.5 Mc/s for sound appears in the network T_3 , R_{13} , C_8 , L_2 , C_9 . T_3 is the vision coupling transformer tuned by the stray capacitance and damped by R_{13} . The coupling coil is connected to a short length of 72-ohm cable which conveys the vision signals to the upper chassis. The circuit L_2C_9 is tuned to 9.5 Mc/s and applies the

used, largely because of its small physical size, but there is no objection to the thermionic diode and the EA50 is an equally good alternative. The load resistor and by-pass capacitor R_{18} and C_{26} are made smaller than usual because it is imperative that the frequency response be good enough for the peaky waveform of ignition interference to be retained.

Another diode V_7 —again a crystal, but again the EA50 can be used—acts as a noise limiter. It is normally conductive and is maintained so by R_{20} returned to + h.t. If the voltage across R_{19} changes at an audio-frequency rate it appears with negligible drop across C_{28} and is passed through the filter R_{21} , C_{29} to the output. If the voltage changes very rapidly in the positive direction, however, as it does on an interference peak, the voltage

which in this case would be 11.5 Mc/s—and the coupling and damping adjusted to give the required bandwidth. With the type of coil used, however, it has been found impracticable to obtain sufficiently tight coupling between the two windings of T_3 and T_4 for adequate overall coupling.

About 1ft. of cable is used and its main influence is its capacitance of about 25pF. It is necessary to step-down at each end sufficiently to make this capacitance of negligible importance and with this step-down the coupling in the transformers is inadequate for the required bandwidth. T_3 and T_4 , therefore, have their resonance frequencies staggered somewhat. The bandwidth is obtained but the mixer—1st i.f. stage gain is reduced somewhat.

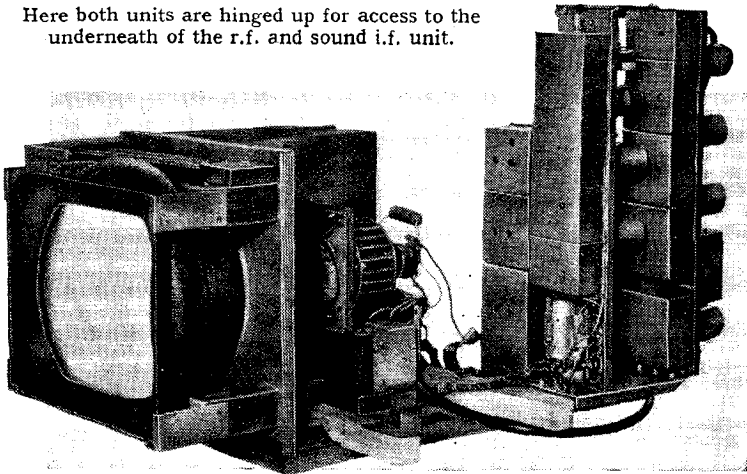
A trap circuit L_7 and C_{33} is coupled to T_4 by C_{32} . It is a sound-channel rejector and gives about 20db attenuation when adjusted so that C_{32} resonates with the combination of L_7 and C_{33} at 9.5 Mc/s. L_7 and C_{33} then exhibit parallel resonance at about 10 Mc/s and at this frequency they have negligible effect. The cut-off is thus very sharp. At higher frequencies the trap has the effect of loading the coupling capacitively so that R_{24} and T_4 must be lower than would otherwise be necessary.

The first and second and second and third i.f. stages are coupled by L_8 and L_{10} respectively, the circuits being tuned by stray capacitance and the resonance frequencies staggered. Traps comprising C_{38} , C_{39} , L_9 and C_{44} , C_{45} , L_{11} are connected across the couplings. They are similar to the first trap already described but are more loosely coupled and give about 10-12-db rejection apiece. The overall sound-channel attenuation is then about 40-45db, all provided by the three traps.

A double-wound coupling T_5 is used between the last i.f. valve and the detector V_{11} . This valve has a filter choke L_{12} which is wound to be self-resonant at the intermediate frequency and the load resistor R_{34} has a compensating inductance L_{13} in series with it.

The v.f. stage is V_{12} and this part of the circuit is identical
(Continued on page 65)

Here both units are hinged up for access to the underneath of the r.f. and sound i.f. unit.



sound signal to the first sound i.f. stage V_4 .

Coupled pairs L_3C_{19} , L_4C_{20} , and L_5C_{24} , L_6C_{25} are used between the two sound i.f. stages and for the 2nd i.f.-detector coupling respectively. The five circuits give a bandwidth of about 100 kc/s. This is adequate to prevent minor instability in the oscillator from affecting the performance and also to permit the peakiness of ignition interference to be retained so that the noise limiter can function. The selectivity is amply sufficient to avoid any trace of interference from the vision signals.

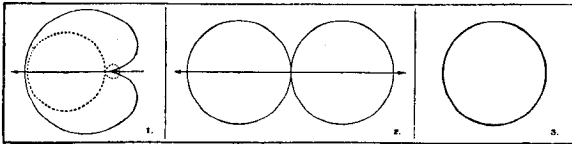
The detector is a diode V_6 . A germanium crystal is actually

used across C_{28} cannot change rapidly enough to follow it and V_7 becomes non-conductive. V_7 virtually disconnects the output from the detector while the interference peak lasts.

The circuit is very simple and quite effective in dealing with ignition interference. It should be understood, however, that it will do little or nothing to reduce other kinds of interference. On the vision side, the inter-unit cable feeds into T_4 which is tuned in the 10-13 Mc/s band and damped by R_{24} . T_3 and T_4 together form a coupled pair of tuned circuits. Normally each circuit of such a system is tuned to the same frequency—to about mid-band

THE "BELLING-LEE" PAGE

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



Polar Diagrams : 1. Dipole and Reflector. 2. Veeerod. 3. Dipole

"Veerod" Television Aerial to Combat Interference.

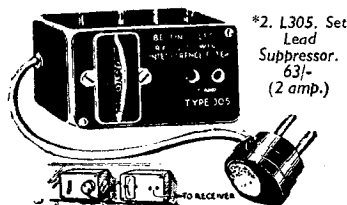
From correspondence received, there still appears to be doubt as to when a *1 "Veerod" inverted "V" television aerial should be used.

If reasonably well situated within 10-15 miles of a television transmitter, but in a bad location for interference, say from cars, remember that this aerial, although directional along its axis, has a polar diagram with a very well defined minima. Fig. 2 in illustration. There is an excellent example of its performance in connection with an installation carried out near the "Belling-Lee" factory at the "Half-Way House," Enfield, on the Cambridge Arterial Road. The inverted "V" dipole looks at Alexandra Palace right up the road, it is parallel to the road, but car interference is at an absolute minimum.

It is worth while remembering that a dipole and reflector looking at the transmitter, has its minima behind it, whereas in the case of the inverted "V," the minima is at right angles to its axis, but do not forget that the dipole and reflector is advantageous at long distances.

Suppression on Board Ship or elsewhere with 110 volts supply.

It is not a usual custom of ours to publish testimonials unless our



readers are likely to derive some benefit therefrom. Recently we had a letter from the Chief Officer of S.S. "Empire Aldgate" as follows:—

"I feel that I must write and congratulate you on your model L.300 Suppressor which I have recently fitted to my 110 V. D.C. radio. Previous to my fitting it, dynamo interference was such that

fitting condensers to the mains without success, the roar of interference being as strong as ever. You can imagine therefore that when a radio salesman claimed that the Belling-Lee L.300 would do the trick, I was, to say the least, sceptical.

The most that I hoped for was a reduction of interference but to my surprise, the interference was completely subdued after fitting your suppressor.

What a relief to tune from one station to another without having to almost switch off the set so that I wouldn't be deafened by inter-station roar and also to be able to listen to weak stations without interference.

Apart from the L.300 fulfilling the purpose for which it was designed, I am quite pleased with its compactness and workmanship. I would suggest that you could find a quick and ready sale for the L.300 to ship-board radio owners if you advertised in the appropriate publications."

Yours faithfully,

(Signed) J. Richardson,
Chief Officer.

Now in many cases the L.300*2 is not the most suitable suppressor to use on normal ships' mains (110 volts D.C.) due to the fact that it is designed for a maximum current loading of 1 ampere at 240 volts, and the current drawn may be such as to cause overheating or continual rupturing of fuses. For this reason we would normally recommend the L.305*2 suppressor which has a maximum current loading of 2 amperes.

Set Lead Suppression on Large Radiograms.

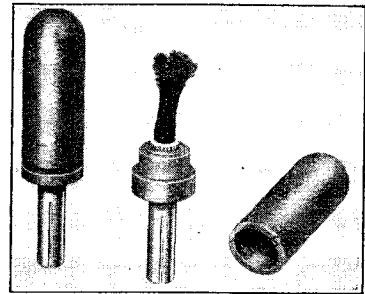
The L.305 suppressor is also generally recommended on large radiograms or any equipment which might require up to two amperes.

"Coronette" Silent Aerial Discharger.

Precipitation or rain static is rather a misleading term for the most amazing effect caused by rain under certain conditions, and in certain locations. The phenomenon was

I was unable to receive any of the medium wave stations unless they were close and powerful.

described by us very fully in this page and subsequently was subject of an article written by F. R. W. Stafford and published in the December 1948 issue of "Wireless World." The answer to most cases is the "Coronette"*3 which is in fact a silent discharger normally plugged into the top of the "Skyrod." This discharger is made up of a "wick" soaked in a partially conductive solution, the end of the wick is teased out and therefore presents a very large number of highly resistive points in parallel. It is not our object to re-print the article mentioned above, but we would add that if this conductive wick gets wet, it



*3. "Coronette" wick discharger L.643
U.K. Patent applied for.

would cease to function as desired, therefore it is enclosed in a plastic cover. An attenuation of nuisance noise of the order of 40 db is general on the control aerial. This cannot be guaranteed as conditions do vary and approximately similar noises may be due to entirely different causes.

Humming or Whistling of Television Aerials.

We have reports of a very small proportion of these aerials setting up noises in wind. The noises appear to be amplified down the chimney, and are not confined to our aerials.

We are thoroughly investigating the matter and encourage any user of our aerials so troubled to write, giving dealer's name, date of installation and all relevant information.

1.* "Veerod" Inverted "V" Television Aerial L.606 (London), L.635 (Birmingham). £4/10/-.

2.* Set lead suppressor L.300/3 (1 amp.) all wave, 59/6.

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 High stability. Small size, 3" x $\frac{3}{4}$ " overall excluding pins. Fits standard miniature deaf aid valve socket.

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Type JCF/200, 100 KC/S. Available from stock adjusted to 0.01%. Higher accuracies supplied to special order.

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A Happy New Year to our numerous supporters

assisted by

The New Eleven Valve

Polyphonic Console

which provides coverage for the Television Sound band, in addition to two Short, Medium, and Long Wave bands.

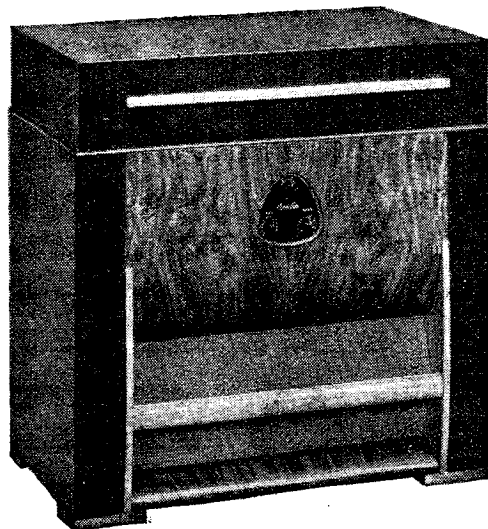
Circuit: R.F., Oscillator, two I.F. with Variable Selectivity, Diode Detection, Magic Eye indicator, two Tone Control Valves, terminated by our latest paraphase coupled push-pull amplifier with negative feedback, driving a Phase Inverter Dual Suspension Auditorium Speaker.

A combination that not only covers the Television Sound band, but provides the best possible reproduction, compatible with transmission.

PRICE **£80.2.6** including purchase tax

AGENTS: Barnes & Avis, Reading; Bowers & Wilkins, Worthing; Binns Ltd., Newcastle; Dalton & Sons Ltd., Derby; Clark & Sons, Isle of Wight; Hickie & Hickie Ltd., Reading (and branches); Holley's Radio Stores, London, S.E.5; Jewkes & Co., Birmingham; Thomas Lynn & Sons, Andover; Merriotts Ltd., Bristol; Needham Engineering Ltd., Sheffield; Pank's Radio, Norwich; Sound Ltd., Cardiff; Bernhard Smith, Barnstaple; Sound Services, Jersey, C.I.; Precision Services, Edinburgh; Seals Ltd., Southsea; G. E. Samways, Hazel Grove; Weybridge Radio Electric, Weybridge; West End Radio, Farnham; Vallance & Davison Ltd., Leeds (and branches).

Overseas Stockists in Canada, South Africa, Channel Islands, etc.



Sound Sales Ltd. WEST STREET, FARNHAM, SURREY

Telephone: Farnham 6461/2/3.

London Office: 57, St. Martin's Lane, W.C.2. Telephone: Temple Bar 4284.

Superheterodyne Television Unit— with that of the straight set previously described. A noise limiter V_{13} has been added, however. This comprises V_{13} , C_{54} and

R_{40} . The output signal is negative going and the control R_{40} is set so that over the whole range of normal output voltages the diode is non-conductive and does

nothing. A peak of ignition interference, however, which makes the output voltage drop below the peak-white level brings the diode cathode below its anode potential. It then conducts and prevents the output voltage from falling appreciably further.

Its main function is to prevent the worst effect of ignition interference, the defocusing of the scanning spot. The normal white blotches of interference are replaced by white pin-points which are much less noticeable. The circuit is effective, but it requires careful adjustment of R_{40} ; of this, noise later.

(To be continued)

COMPONENTS

The parts in this list are the ones employed in the original model. Any components of the same electrical specification and suitable physical dimensions can be used.

RESISTORS

($\frac{1}{2}$ watt unless otherwise stated)

R_1, R_{25} ..	33 Ω ..	Erie
$R_2, R_{26}, R_{30}, R_{32}$..	150 Ω ..	Erie
R_3 ..	2 k Ω , 3 W, variable wire-wound	Reliance Type T.W.
R_4, R_8, R_{38}, R_{39} ..	100 k Ω ✓ ..	Erie
$R_5, R_9, R_{12}, R_{15}, R_{17}, R_{27}, R_{29}, R_{33}$..	470 Ω ✓ ..	Erie
R_6 ..	2.2 k Ω ✓ ..	Erie
R_7, R_{30} ..	2.2 M Ω ✓ ..	Erie
R_{10}, R_{11}, R_{23} ..	47 k Ω ✓ ..	Erie
$R_{13}, R_{24}, R_{28}, R_{31}$..	3.3 k Ω ✓ ..	Erie
R_{14} ..	330 Ω ✓ ..	Erie
R_{16}, R_{35} ..	220 Ω ✓ ..	Erie
R_{18}, R_{21} ..	33 k Ω ✓ ..	Erie
R_{19} ..	1 M Ω ✓ ..	Erie
R_{22} ..	100 k Ω , 1 W ✓ ..	Erie
R_{31} ..	4.7 k Ω ✓ ..	Erie
R_{36}, R_{37} ..	3.5 k Ω , 3 W ✓ ..	Erie
R_{40} ..	150 k Ω , $\frac{3}{4}$ W, variable ..	Reliance Type S.G.

CAPACITORS

$C_1, C_2, C_3, C_5, C_{18}$..	0.001 μ F, mica ..	Dubilier Type 635
$C_{14}, C_{29}, C_{37}, C_{43}$..	CS.	
$C_4, C_9, C_{19}, C_{20}, C_{24}$..	100 pF, silvered-mica ..	Dubilier Type 5811W
$C_{25}, C_{33}, C_{39}, C_{45}$..	5 pF, ceramic ..	T.C.C. Type CC31a
C_8, C_{38}, C_{44} ..	25 + 25 pF, split stator ..	Eddystone Type 583
C_{10} ..	10 pF, ceramic ..	Dubilier Type CTD310
C_{11}, C_{15}, C_{32} ..	25 pF, silvered-mica ..	Dubilier Type 5811W
C_{12}, C_{26} ..	0.01 μ F, 500 V, tubular paper ..	Dubilier Minicap T.C.C. Type 543
$C_6, C_7, C_{16}, C_{17}, C_{18}, C_{21}, C_{22}, C_{23}, C_{27}, C_{34}, C_{35}, C_{36}, C_{40}, C_{41}, C_{42}, C_{46}, C_{47}, C_{48}, C_{52}$..	0.01 μ F, 500 V, tubular paper ..	Dubilier Minicap T.C.C. Type 543
C_{28} ..	300 pF ..	Dubilier Type 635
C_{30}, C_{51} ..	0.1 μ F, tubular paper ..	T.C.C. Type 343
C_{31} ..	8 μ F, electrolytic ..	T.C.C. Micropack, Type CE19P
C_{49} ..	20 pF, ceramic ..	Dubilier Type CTS310
C_{50} ..	16 μ F, electrolytic ..	Dubilier Type CT1650
C_{51} ..	500 pF, mica ..	Dubilier Type 635
C_{53} ..	8 μ F, electrolytic ..	Dubilier Drilitic BR850

VALVES

$V_1, V_2, V_4, V_5, V_8, V_9, V_{10}, V_{12}$ ..	..	Mullard EF50
V_3 ..	..	Mullard EC52
V_6, V_7 , Germanium crystal-valves ..	..	B.T.H. CG1
V_{11}, V_{13} ..	..	Mullard EA50

MISCELLANEOUS

Coaxial-cable plugs ..	..	Belling-Lee Type L604/P
Coaxial-cable sockets ..	..	Belling-Lee Type L604/S
Polystyrene tube, $\frac{3}{8}$ -in outside diameter ..	..	Denco
$\frac{1}{4}$ -in inside diameter ..	..	Denco
Polystyrene varnish ..	..	Denco
Coaxial cable (for aerial feeder and inter-unit connection) ..	..	T.M.C. Type P.T.I.M

NEW DOMESTIC RECEIVERS

TWO new versions of the Model 500 have been introduced by Ace Radio, Tower Road, London, N.W.10. Model 500T covers the so-called trawler band (70-200 m) in addition to 16-50 m, 200-550 m and 900-2,000 m and costs £22 18s 10d including tax. Model 500E, which is for export only, has short-wave ranges of 13-45 m and 35-100 m to meet the requirements of those countries with services on the 60 m and 80 m bands, but where long-wave reception is not required.

Denco (Clacton), Ltd., 355/9, Old Road, Clacton-on-Sea, Essex, have developed an inexpensive uni-



Denco Model DR23 broadcast receiver.

versal superhet (3 valves + rectifier) covering medium and long waves. It makes use of the Mullard B8A range of valves and has a UCH42 frequency changer, UAF41 pentode-diode, UL41 output and UY41 rectifier. The price is £12 19s 9d including tax.

A new console television receiver Model TSC91 is announced by E. K. Cole, Southend-on-Sea. It is based on the TS46 table model and makes use of a 9in tube. The price is £75 including tax.

WORLD OF WIRELESS

Television at Home and Abroad ♦ Ship's Radio ♦ Components Show

Faraday Lecture

THIS year's I.E.E. Faraday lecture is on television, and will be given by Sir Noel Ashbridge, Director of Technical Services of the B.B.C., and H. Bishop, Chief Engineer, B.B.C. By means of demonstrations the evolution of television will be traced and the latest B.B.C. outside broadcast equipment will be used to televise from the platform to receiving sets standing amongst the audience.

The lecture will be delivered at the Central Hall, Westminster, London, S.W.1, on February 16th at 6.30 and also at various centres throughout the country. Admission will be by ticket obtainable from the I.E.E., Savoy Place, London, W.C.2, in the case of the London meeting and from I.E.E. local secretaries for other centres.

Second Thoughts in France

THE French decision to adopt 819-line standards for the national television service (reported in our last issue) has not met with general and warm approval in the French technical press. Fears of long delay are commonly expressed, and one journal (*La Radio Française*) goes so far as to say "The premature choice . . . has been a mistake . . . We should have done what has been done in England,

which has acted logically, and can boast today of having 80,000 receivers in London. I defy anyone to prove that there are more than 3,000 in Paris."

On the other hand, the journal *Radio Technical Digest*, after quoting the *Wireless World* Editorial for October in support of the British decision says, "Certainly, the arguments of our English friends are very convincing—for them. But they are hardly valid for us . . ." The writer goes on to express the view that the problems of international programme exchanges will be overcome.

It is announced that four channels in the band 162-216 Mc/s will be used for the new system.

Marine Single Sideband

THE new Cunard White Star liner *Caronia*, which recently made her maiden voyage to America, is of some 34,000 tons and although a big ship, space does not permit such lavish radio accommodation as in her sister ships the two Queens. Transmitting and receiving equipment is, nevertheless, segregated but in adjacent rooms.

As the new vessel will undertake lengthy cruising voyages, the single sideband system of radiotelephony has been installed so that passengers may telephone to Europe and America from almost any part of the world. Some of the advantages expected from the single sideband

installation can be stated briefly as: improved signal-to-noise ratio for a given transmitter power, less distortion due to selective fading and multi-path propagation and narrower bandwidth compared with double sideband working.

The transmitter is rated at 300 watts R.F. output and will transmit on a single channel with a single sideband and an attenuated carrier. Its frequency range is 4 to 22 Mc/s. Either sideband can be selected by the receiver and although it will initially operate on a single channel, it is actually a double channel set.

The single sideband equipment is designed by Standard Telephones and Cables and the radio installation has been supplied and fitted by the International Marine Radio Company.

R.C.M.F. Show

AS already announced the annual exhibition of radio and electronic components, materials and test gear, organized by the Radio Component Manufacturers' Federation will be held at Grosvenor House, Park Lane, London, W.1, from March 1st to 3rd (10 a.m.-6 p.m.).

There will be 106 exhibitors—a slight increase on last year's total—and valve manufacturers are included for the first time this year. Admission is restricted to holders of tickets which are obtainable from the R.C.M.F., 22, Surrey Street, London, W.C.2.

R.N.V.(W.)R.

FURTHER to our announcement in the December issue of the reformation of the Royal Naval Volunteer (Wireless) Reserve, we recently had an opportunity to see over the London training centre in the Admiralty building in Whitehall.

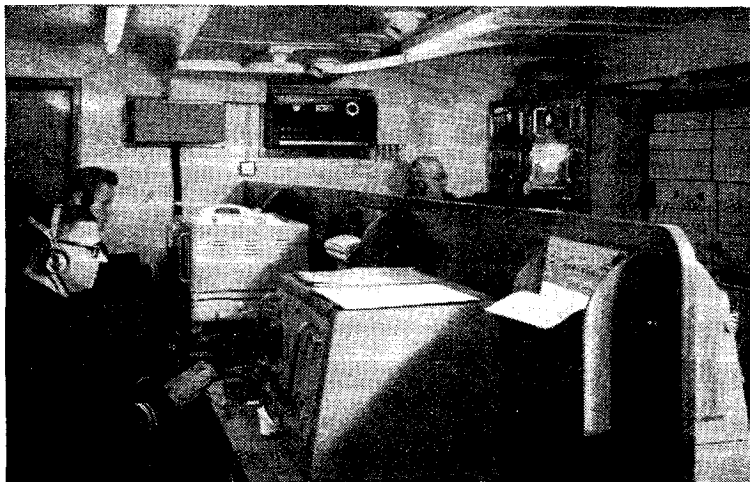
It has a well-equipped radio station consisting of a 300-watt C.W. and R/T transmitter, several CR100 and Hallicrafters receivers and the latest Naval V.H.F. telephony transmitter-receiver.

A part of the accommodation is laid out for instruction in morse, the wiring being arranged so that the exercises transmitted from an Admiralty station near Portsmouth especially for the R.N.V.(W.)R. on certain evenings of the week, can be relayed to all headphone points.

Reservists must attain a speed of 18 w.p.m. in sending and reading morse in order to qualify for a home station. This comprises a 30-watt C.W. transmitter, Hallicrafter receiver and power units.

E.M.I. Report

REFERRING to the manufacture of magnetic-tape recorders during his address at the seventeenth



RECEIVING ROOM in the S.S. *Caronia* showing the W/T receiver and, in the right background, the single sideband receiver.

annual general meeting of Electric and Musical Industries, Sir Ernest Fisk stated that instruments costing £550 have been shipped to 14 different countries including the U.S.A. Plant has been installed by the company for the manufacture of magnetic tape.

He also stressed, if it needed any emphasis, that, whilst British television had been standardized at 405 lines, manufacturers in this country are not limited to these standards, and are in a position to supply equipment to other specifications. In the case of E.M.I., equipment of 625 lines or even higher, if desired, can be supplied.

E.M.I. is standardizing two sizes of tubes for its receivers—roin and 15in.

PERSONALITIES

A. J. Gill, B.Sc.(Eng.), engineer-in-chief of the G.P.O., was created a Knight Bachelor in the New Year Honours. From 1944 until he succeeded Sir Stanley Angwin in 1947 he was deputy engineer-in-chief. Mr. Gill was recently appointed a vice-president of the I.E.E.



A. J. GILL, B.Sc. (Eng.), who is created a Knight Bachelor.

R. T. B. Wynn, M.A., assistant chief engineer, B.B.C., has been appointed a C.B.E. He joined the B.B.C. from Marconi's W.T. Co. in 1926. He is a vice-chairman of the I.E.E. Radio Section for this Session.

V. Dodd, who has been appointed an O.B.E., held various posts in the Air Ministry—which he joined as a wireless operator in 1920—until his transfer to the Ministry of Civil Aviation, where he is now an assistant director of telecommunications.

J. Arnold, production manager at Dubilier's Kirkby (Liverpool) factory, has been made an M.B.E. He has been with Dubilier over 27 years.

J. K. Bradley, M.B.E., has been appointed chief engineer of the new company, **Philco (Overseas), Ltd.** He joined the Philco organization in this country in 1937, and during the war served as a Major in the R.E.M.E. Prior to joining Philco he was with Cossor's.

Hugh S. Pocock, our managing editor, has been appointed a director of our Publishers, Iliffe & Sons Ltd. He is also managing editor of our associated journals *Wireless Engineer* and *Electrical Review* and managing director of Electrical Review, Ltd.

Geoffrey Parr, who has been editor of *Electronic Engineering* since its inception in 1941, has resigned to join the Board of Chapman and Hall, Ltd., book publishers. **H. G. Foster, M.Sc.**, late of Birmingham University, has been appointed to succeed Mr. Parr.

R. G. Clark has resigned his directorship of the Ferguson Radio Corporation and is taking up an appointment in the U.S.A.

IN BRIEF

Licences.—With television licences totalling 82,400, the number of receiving licences in force in Great Britain and Northern Ireland at the end of November was 11,422,400. The month's increases in sound and television licences were 93,000 and 8,600, respectively.

Marine Radar.—Of the 430-odd British merchant ships fitted with radar gear at the end of the year, about 280 were equipped with the Admiralty Type 268 set. So far, only three civil sets—Cossor, Metrovick and Kelvin-Hughes—have received the Ministry of Transport's certificate of conformity with the agreed performance specification.

Physical Society's Exhibition.—The 33rd annual exhibition of scientific instruments and apparatus organized by the Physical Society will be held in the Physics Department of Imperial College, Kensington, London, S.W.7, from April 5th to 8th. Admission will be by ticket, valid for a specified session, available from Fellows of the Society, exhibitors and most of the learned societies.

Piped Television.—It is understood that the Westminster Council has approved the wiring of all its flats on the Pimlico and Cambridge Street housing estates for relaying television. Each block of flats will be equipped with a receiving aerial, from which the signal will be fed via an amplifier and distribution units to each flat. The weekly rental will be 4s 5½d for the first year and subsequently 3s 6d. The tenants will, of course, need their own standard television receivers.

Grad. Brit. I.R.E. Exam.—Candidates for the next graduateship examination for the British Institution of Radio Engineers must make application by April 1st. The examination will be held in London, Manchester, Birmingham, Glasgow, Edinburgh, Cardiff, Bristol, Blackburn, Newcastle-on-Tyne, Belfast and Dublin on May 19th and 20th.

Electrical Trades Union.—A radio and electronic engineers' branch of the E.T.U. has been formed in Liverpool. Details of the weekly meetings are obtainable from the secretary, E. A. Stevenson, 6, Woodhall Avenue, Wallasey, Cheshire.

Correction.—The reference at the end of "Electronic Circuitry" (page 24, Jan. issue) should read "Dome, R.B. *Electronics*, Dec., 1946, p. 112."

Consol.—A brief description of the use of Consol and complete details of the service and coverage provided by the existing four stations—Bushmills, Stavanger, Lugo and Seville—are given in the pamphlet "Consol—An Aid to Navigation" (M.C.A.P. 59) published by H.M.S.O., price 1s.



R. T. B. WYNN, M.A., who has been appointed a C.B.E.

Marconi V.H.F. gear was recently used to transmit photographs from a warship at sea to a shore station by Kemsley Newspapers as a further extension of their "Business Radio" licence. Ten-watt transmitter-receivers, Type H16, were installed in the destroyer *Finnistere* during fleet manoeuvres, and at the Lizard (Cornwall) lighthouse. The received pictures were transmitted by line from the Lizard to London.

G.E.C.—To facilitate the control of marine traffic in the port of Dundee, pilot cutters have been equipped with G.E.C. two-way radio-telephones. The 10-watt F.M. shore station and the small transmitter-receivers installed in each cutter operate on about 70 Mc/s. The Abertay lightship in the Firth of Tay has also been equipped with similar gear.

B.S.R. Recording.—Birmingham Sound Reproducers, in co-operation with A. C. Farnell, Ltd., recently undertook the recording of the whole day's civic functions arranged in connection with the opening of Hull's new City Hall. It entailed the use of some 20 miles of special line and over sixty 13in records were made. The arrangements included the use of a radio-equipped car in the procession which was granted a frequency for that occasion. Standard B.S.R. recording equipment was used throughout.

FROM ABROAD

Canada-U.S. Television.—Because of Canada's proximity to the United States and the possibility of exchanging television programmes between the two countries, the American standard of 525 lines is being adopted for the Canadian television service.

S.T.C.—Sweden's new 100-kW broadcast transmitter at Hörby, supplied by Standard Telephones and Cables, operates on 1,131 kc/s. It is believed to be the first medium-wave broadcast transmitter to have incorporated a

World of Wireless—

grounded-grid amplifier. It is claimed that the distortion products do not exceed 1 per cent up to 95 per cent modulation over the frequency range of 5 to 10,000 c/s with an average mains conversion efficiency of 38 per cent.

International Exhibition.—The French Radio Council advises us that an international exhibition of radio components, accessories and measuring instruments will be held from February 4th to 8th at the Exposition Park, Porte de Versailles, Paris (15^{eme}).

Amateurs in Germany.—With the introduction on January 1st of the various changes in the international allocation of call signs in accordance with the Atlantic City Convention, amateurs in Germany are now using a two-letter prefix. Only Allied amateurs are so far licensed in Germany and the prefixes used are: DL2, British zone; DL4, U.S. zone; and DL5, French zone. When Germans are licensed, which is expected very soon, they will be allocated DL1, 3, 6, 7, 8, 9, and 0.

Radio Seac.—The power of the Radio Seac transmitters at Colombo, which are to be taken over by the Ceylon Government, was given as 7.5 kW only in our last issue. A power of 100 kW is employed on some frequencies.

INDUSTRIAL NEWS

Test Gear Exhibition.—A two-week exhibition is being staged by Marconi Instruments at their London Showrooms, 109, Eaton Square, London, S.W.1. Admission to the show—open Monday to Friday from February 21st to March 4th—will be by ticket obtainable either from Marconi Instruments, Ltd., St. Albans, Herts, or the above address.

Ekco in India.—An agreement has been concluded between E. K. Cole and the National Radio and Engineering Co. of Bombay for the establishment and development of radio manufacture and distribution in India. Plans are provided for the production of receivers, components and electronic equipment.

Philco.—Reference was made last month to the formation of the new company, Philco (Overseas), Ltd., which is now responsible for the design and production of British-made Philco sets. Another company has now been formed, Philco (Great Britain), Ltd., which has been granted the franchise (sales, service and advertising) of Philco products in this country. These announcements have coincided with changes in the organization of the Radio and Television Trust which, through its subsidiary, Philco Radio and Television Corporation, has previously been responsible for marketing Philco products in this country. It has now discontinued the manufacture of radio and television receivers and has wound up the Philco Radio and Television Corporation.

S.T.C.—The Rectifier Division of Standard Telephones and Cables has now been established in new premises at Warwick Road, Boreham Wood, Herts. The premises were used as a

shadow factory for rectifier disc manufacture during the war. The sales, engineering and production sections are in adjacent buildings.

Changes of Address.—The Sheffield office of Wild-Barfield Electric Furnaces and G.W.B. Electric Furnaces is now at 4, Paradise Square, Sheffield, 1 (Tel.: Sheffield 22776). General Electrical Radio Co., manufacturers of the "Mighty Midget" receiver described on page 24 of the January issue, have moved to 21-24, Shenc Street, London, E.C.1.

L.R.S.—The price of the Goodman's Standard 12in speaker was misprinted in the advertisement of the London Radio Supply Co. in our last issue. The correct price is £6 15s.

Audix.—A London sales office has been opened by Audix, Ltd., at 116, Gloucester Place, W.1 (Tel.: Welbeck 9525).

Wolsey Television, Ltd.—This company's telephone number was incorrectly quoted in the last issue. It is Brixton 6651/2.

EXPORT

B.o.T.—Organizational changes in the Board of Trade are announced. The Commercial Relations and Treaties Dept. and the Export Promotion Dept. have been amalgamated and are now known as the Commercial Relations and Exports Department.

Uruguay.—Tenders are called for by the Uruguayan Director-General of Communications for the supply of two "diversity" receivers for C.W. and R.T. The specification and further particulars are obtainable from the Board of Trade (Commercial Relations and Exports), Room 1076, Thames House North, Millbank, London, S.W.1, quoting reference EPD.55447/48.

South Africa.—Tenders are called for by the Department of Posts and Telegraphs, Pretoria, for E.H.F. frequency-modulated equipment to be used in conjunction with a carrier telephone-telegraph system. The specification is available from the above address, quoting reference EPD.42953/48.

Argentina.—Agencies for radio components are required by Compania Comercial "Meryland," of 1301, San Juan Stret, Buenos Aires. Particulars of the company, whose activities cover Uruguay as well as the Argentine, are obtainable from the above address, quoting reference EPD.42664/48.

MEETINGS**Institution of Electrical Engineers**

Faraday Lecture.—"Television" by Sir Noel Ashbridge, B.Sc. (Eng.) and H. Bishop, C.B.E., B.Sc. (Eng.), at 6.30 on February 16th at the Central Hall, Westminster, London, S.W.1.

Radio Section.—"The Development of Magnetic-Tape Recorders," by E. M. Payne at 5.30 on January 26th. (Joint meeting with the Acoustics Group of the Physical Society.)

"Direction-Finding Site Errors at V.H.F.," by H. G. Hopkins, B.Sc., Ph.D., and F. Horner, M.Sc., and "Scattering of Radio Waves by Metal Wires and Sheets," by F. Horner, at 5.30 on February 2nd.

Discussion on "Water-Cooling versus

Air-cooling for High-Power Valves," opened by J. Bell at 5.30 on February 15th.

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

Cambridge Radio Group.—"Noise and Bandwidth," by L. A. Moxon, B.Sc., at 8.15 on January 31st, at the Cavendish Laboratory, Cambridge. (Joint meeting with the Cambridge University Wireless Society.)

"Television," by D. Jackson, at 6.0 on February 22nd, at the Cambridge-shire Technical College.

Mersey and North Wales Centre.—Faraday lecture on "Television" at 6.45 on February 2nd, at the Philharmonic Hall, Hope Street, Liverpool.

"The Application of F.M. to V.H.F. Multi-channel Radio-telephony," by J. H. H. Merryman, M.Sc., and R. W. White, B.Sc., at 6.30, on February 7th at the Liverpool Royal Institution, Colquitt Street, Liverpool.

North-Eastern Radio Group.—A discussion on "Energy Conversion Devices for Electrical and Electronic Measurement of Non-Electrical Quantities," opened by J. C. Findlay at 6.15 on February 21st, at King's College, Newcastle-on-Tyne.

North-Western Centre.—Faraday lecture on "Television" at 7.30 on February 9th at the Houldsworth Hall, 90, Deansgate, Manchester.

North-Western Radio Group.—"Aids to Training—The Design of Radar Synthetic Training Devices for the R.A.F.," by G. W. A. Dummer, M.B.E., at 6.30 on February 23rd at the Engineers' Club, Albert Square, Manchester.

Television Society

"Television Transmission and Reception at 480 Mc/s," by M. Morgan, M.Sc., at 7.0 on January 26th, at the C.E.A., 164, Shaftesbury Avenue, London, W.C.2.

Radio Society of Great Britain

Annual general meeting at 6.30 on January 28th at the I.E.E., Savoy Place, London, W.C.2. The discussion on 420-Mc/s work announced last month will not be included.

London Meeting.—"Impedance Matching" by H. A. M. Clark, B.Sc. (Eng.), at 6.30 on February 25th, at the I.E.E.

British Sound Recording Association

"Disc Recording and Reproducing Styli," by S. R. Lance, at 7.0 on February 25th at the Royal Society of Arts, John Adam Street, London, W.C.2.

Institute of Navigation

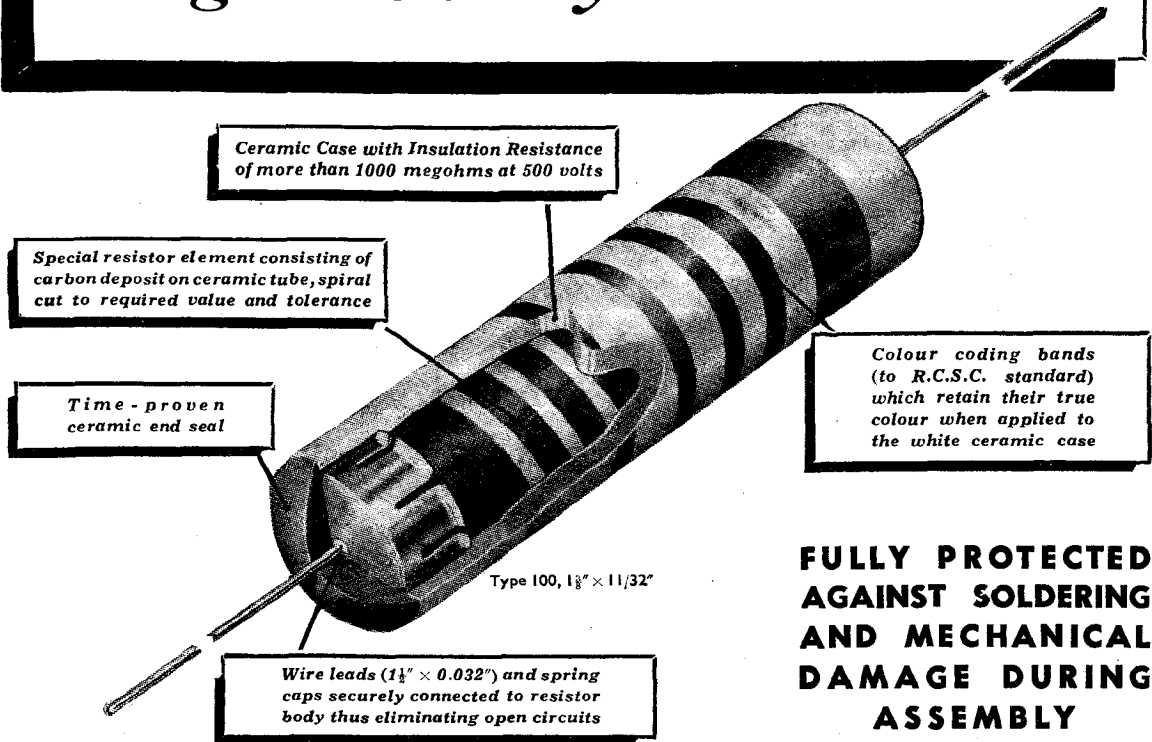
A symposium of papers on operational aspects of marine radar at 2.30 on February 18th at the Royal Geographical Society, 1, Kensington Gore, London, S.W.7.

British Institution of Radio Engineers

London Section.—A discussion on "Electronic Equipment for the Engineer," at 6.0 on February 17th at the Royal Empire Society, Northumberland Avenue, London, W.C.2. (Joint meeting with the Institution of Production Engineers.)

South Midland Section.—"Ceramic Capacitors," by W. G. Roberts, B.Sc., at 7.0 on February 24th at the Technical College, The Butts, Coventry.

Take a look inside the
ERIE Insulated
 High Stability RESISTOR



**FULLY PROTECTED
 AGAINST SOLDERING
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 DAMAGE DURING
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QUALITY IS BUILT INTO EVERY DETAIL

ERIE High Stability Resistors, besides displaying characteristics well within the limits laid down in the current R.C.S.C. Specification, are fully insulated, fully tropical and extremely robust; and are, therefore, eminently suitable for operation in restricted spaces and under the severest of conditions. Type

100, $\frac{1}{2}$ watt, illustrated above, is the first to be released and will be followed in due course by Type 108, $\frac{1}{4}$ watt; and Type 109, $\frac{1}{8}$ watt. All standard tolerances down to $\pm 1\%$. Manufacturers and Research Establishments are invited to write for full details.

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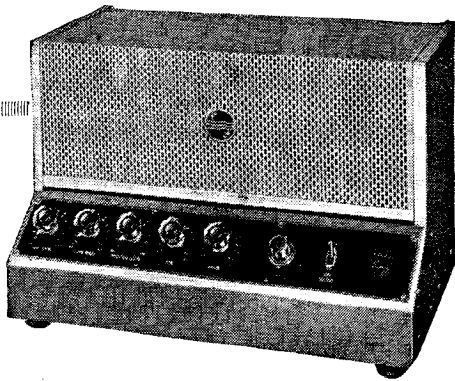
Cables: Resistor, London

Factories: London and Gt. Yarmouth; Toronto, Canada; Erie, Pa., U.S.A.

2756

25 WATT & 50 WATT AMPLIFIERS

New high standard of stability and reproduction. Very high degree of amplification. Simplicity of operation.



EXTREME SENSITIVITY. Perhaps the most noteworthy feature of these amplifiers is their high sensitivity, which allows wide-range pick-up with low-level high fidelity microphones.

For example, the 25-watt has an overall power amplification of 133 d.b. or twenty-million-million-times. This is mainly achieved by the inclusion of a high-gain input stage completely enclosed in a rubber-mounted magnetic screening case.

OUTPUT. The output transformer of each amplifier is of generous size, and has an eight-sectioned primary in order that it can be included in the inverse feed-back loop. The following outputs are provided:—

- Max. undistorted voltage (R.M.S.) 100, 50, 25 volts.
- Load impedance (25-watt) - - 400, 100, 25 ohms.
- Load impedance (50-watt) - - 200, 50, 12.5 ohms.

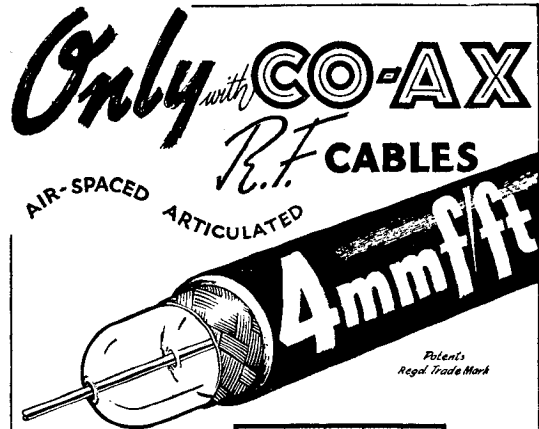
These amplifiers are normally intended to use with the 100-volt-line system in which each loudspeaker has its own transformer. This allows simple parallel connection of the loudspeaker load, the use of long lines, and the rating of loudspeakers in terms of their actual power consumption in watts.

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A34	73	0.6	1.5	0.88

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C 1	7.3	150	2.5	0.36
PC1	10.2	132	3.1	0.36
C11	6.3	173	3.2	0.36
C 2	6.3	171	2.15	0.44
C22	5.5	184	2.8	0.44
C 3	5.4	197	1.9	0.64
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MAGNETIC AMPLIFIERS

Principles, Operation and Functions

By "CATHODE RAY"

SOMETIMES magnetic amplifiers are called d.c. transformers. In appearance at least they might easily be mistaken for transformers, even when examined closely, because they consist mainly of iron cores wound with two or more coils. The name is further justified to the extent that if you put d.c. through one of the windings you can get a higher voltage or current from the other. But they differ fundamentally from a.c. transformers in that it is possible—in fact quite usual—for both voltage and current to be higher at the same time. The idea of perpetual motion having been long ago abandoned, it is hardly necessary to say that the extra power thus obtained must be put into the device somewhere, in some form. In principle, therefore, it is more like the valve amplifier, in which the output power is *controlled* by the grid input but is actually provided by the anode supply.

That is almost as far as the resemblance to a valve amplifier goes. There are plenty of differences, besides the appearance and construction. In spite of working at zero-frequency, the control input demands appreciable current. Its action is far from instantaneous, the time lag being of the order of hundredths or even tenths of a second. The source of power is a.c.; 50c/s is possible but 400-1,000 c/s generally much more effective. The output is also a.c., of the same frequency (plus harmonics), which of course can be rectified if d.c. is preferred.

Although the basic principles of the magnetic amplifier are not new, they are probably unfamiliar to most *Wireless World* readers. And they are a little more difficult to follow than the principles of the valve amplifier. Whereas one can represent the characteristics of a valve in the form of a family of curves con-

necting control-grid voltage directly with anode current, and from such a diagram deduce the performance with fair accuracy, a magnetic amplifier's characteristics have an awkward middle-man—the magnetic flux in the core. His relationship with current can be expressed quite directly by a curve, but his relationship with voltage is of the rate-of-change sort. Although this is familiar enough in connection with ordinary iron-core chokes and transformers, the portions of magnetization characteristics worked over in magnetic amplifiers are by comparison unorthodox, to say the least. I am reminded of the shock the distortion-hunting quality-enthusiasts received when at the outbreak of war they were obliged to study how valves were used in radar.

Fig. 1 is a typical characteristic curve for iron. By "iron" I mean any metal or alloy suitable

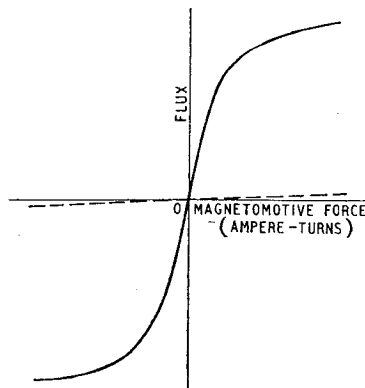
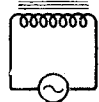


Fig. 1. Typical magnetization characteristic for iron (full line) compared with air (dotted).

for magnetic cores. Actually, owing to the effect called hysteresis, the upgoing and downcoming curves separate to form a loop; but that is one complication we can happily ignore for the purpose of this elementary treatise.

Consider now a simple iron-cored coil connected to an a.c. supply (Fig. 2). Assuming that the resistance is negligible, the current is limited only by the back-e.m.f. generated by the magnetic flux linking the turns of the coil, and that back-e.m.f. has to be practically equal to the applied voltage. As we know, the e.m.f. is proportional to the rate at which the flux changes, and to the number of turns. The rate at which the flux changes is proportional to the peak flux during each cycle, and to the number of cycles per second. (And to a minor extent on the waveform).

Fig. 2. The current in this circuit can be made extremely small if the slope of the magnetization curve is nearly vertical, as in Fig. 3.



So the current that flows is the amount which is necessary to set up the right amount of flux to generate the back-e.m.f. The greater the flux per ampere-turn, the smaller the current. Air and most other substances have a very low flux per ampere-turn (i.e. low permeability), as indicated by the small slope of the dotted line in Fig. 1. The advantage of "iron" is that it has a much higher—sometimes enormously higher—permeability, and so the magnetizing current is comparatively very small and the impedance of the coil very large.

This advantage is complicated by the fact that the permeability is not constant. As shown by the slope of the curve in Fig. 1, it decreases at first gradually and then very rapidly as the flux increases to saturation. The designer of chokes and transformers generally makes sure that his core section and number of turns are sufficient to generate the required back e.m.f. without departing from the steep and comparatively straight part of the curve at any point in the cycle of current.

The other familiar fact to recall is that the lower the frequency the greater the peak flux must be to maintain the same rate of change and generated e.m.f.

Magnetic Amplifiers—

Suppose now that a type of "iron" is selected which gives an almost vertical initial slope followed by rapid and complete saturation (Fig. 3). Provided that the coil has been designed so that the flux needed to generate the back-e.m.f. is less than saturation value, the ampere-turns required, and hence the current drawn, will be almost negligible. In other words, the impedance of the coil is nearly infinite. The working point can be pictured as moving up and down the precipitous slope in Fig. 3 at supply frequency.

Next, suppose that another coil is wound over the same core, and a small d.c. is passed through it. Except for the first few moments, when this current is growing, there is no rate of change of current and therefore no back-e.m.f. The current is limited only by the resistance of the circuit. With the Fig. 3 characteristic, anything more than a minute current must bring the working point over the upper or lower bend and into the saturation region; say to the point A.

Before we consider the obviously very upsetting effects of this on the a.c., let us dispose of the fact that, with a single core as imagined, the d.c. circuit acts as a secondary winding of a transformer and loads the a.c. supply. This effect can be avoided by

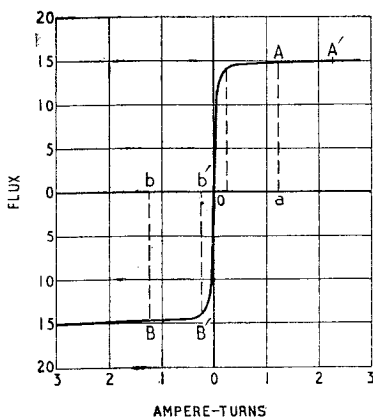


Fig. 3. Type of core characteristic suitable for magnetic amplifiers.

splitting the system into two halves, as in Fig. 4, with one d.c. winding reversed. The alternating voltages generated in the

two d.c. coils will therefore cancel one another out; and if one core works at point A (Fig. 3) the other will, from the a.c. point of view, work at B.

Now consider what happens during each cycle of the a.c. Remember that the current is still bound to make the flux vary in such a way as to generate an alternating back-e.m.f. of sine waveform (assuming a sine-wave supply). Let us start with the half-cycle in which the a.c. in coil A adds to the d.c. magnetization. This is represented by point A in Fig. 3 moving to the right. It is clear that the current can rise indefinitely without causing the flux to change very much, and no appreciable e.m.f. can be generated in this coil. But in

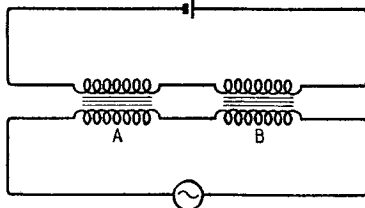


Fig. 4. Two-core system for balancing out alternating voltage in d-c circuit.

coil B the a.c. is opposing the d.c. and no sooner has it reached a value that brings the working point from B to B' than the flux begins to change at a very rapid rate indeed. A very small further rise in current is therefore sufficient to generate the whole of the required back-e.m.f. for this half-cycle in coil B alone. The current in coil A is, of course, the same, so actually goes only as far as A'.

The flux and current waveforms during this half-cycle will evidently be something like those shown in Fig. 5. The current waveform is nearly square, the uprights corresponding to the almost instantaneous shifts from A to A' and B to B' in Fig. 3, during which the flux-change and back-e.m.f. are negligible; and the nearly flat top corresponds to the steep slope up from B'. To generate a sinusoidal e.m.f. the flux must vary sinusoidally. It does so in phase with the current, of course; and since one core is saturated all the time the varia-

tion of flux occurs almost entirely in the other.

Continuing the argument on the same lines for the second half-

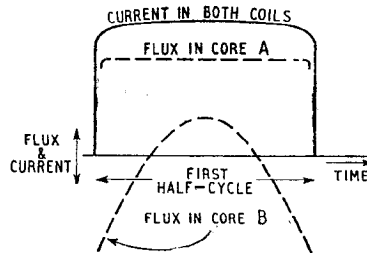


Fig. 5. Theoretical waveforms during one half-cycle in Fig. 4, with no a.c. in d-c circuit.

cycle we get the same shapes upside-down; so a sequence of waves would look like Fig. 6.

What we are most interested in, however, is not the waveform but the magnitude of the a.c. Instead of being negligible, as it was when no d.c. flowed, its value is now represented by AA' or BB' in Fig. 3, divided, of course, by the number of turns. Suppose the a.c. and d.c. coils have equal numbers of turns. The strength of the d.c. is then proportional to oa , and the a.c. to bb' , which is almost equal. But whereas quite a small voltage is likely to be sufficient to cause that d.c. to flow against only the resistance of the coil, a very much larger alternating voltage can be used without saturating the core in the no-d.c. condition. That voltage is, of course, proportional to the flux bB and to the frequency of the a.c. So to get a large step-up in voltage the iron should have a large saturation flux and the frequency should not be low. (For other reasons it should not be too high either; 400-1,000 c/s is usually recommended.)

As with a valve, the amplified voltage is not very interesting unless it is available outside the amplifier, in some sort of load. A load can be connected in series with the a.c. supply, and the a.c. will flow through it. Assuming that the supply voltage is constant, the voltage developed across the load (and hence the power in the load) must be at the expense of that across the coils. A little thought leads us to the conclusion that, with such remarkably suitable core material as

Fig. 3 indicates, the output current is only very slightly affected by a reduction in alternating voltage; so remains nearly equal to the d.c. even when the output voltage is substantially greater. In other words, the device is a power amplifier.

It is also its own output transformer, because there is no need to stick to a one-to-one a.c./d.c. turns ratio. If desired, the input current can be stepped up (hence the term "d.c. transformer").

Reversing the direction of the d.c. makes no difference to the external results. So a graph of a.c. ampere-turns against d.c. ampere-turns looks like Fig. 7. With perfect core material, having a characteristic made up of truly vertical and horizontal portions instead of the nearly perfect Fig. 3, the lines in Fig. 7 would slope at 45° from zero, and would be independent of the voltage of the a.c. supply; but in practice some a.c. flows even with zero d.c., and the slope is less than 45° and varies with supply voltage.

The foregoing explanation is all rather idealistic, because we have neglected a very awkward complication. We have been assuming all along that the balanced coil device of Fig. 4 would succeed in preventing a.c. from flowing in the d.c. circuit. To do so the alternating voltages induced in the two d.c. coils must be exactly opposite at every moment. That means that they must be identical

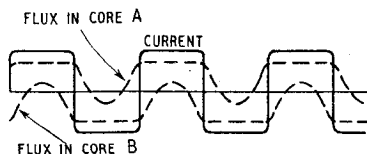


Fig. 6. Continuation of Fig. 5 for several cycles.

in waveform. When no d.c. flows, the fluxes in the two cores (if they and the windings are identical) are both sinusoidal, and the supply voltage is at all times divided equally between coils A and B. But look at Fig. 6, showing the two flux waves when d.c. flows. If you invert one of them, to represent the d.c. point of view, it is very far from being equal and opposite to the other. During any half-cycle, the flux

change is confined almost entirely to one of the two cores, so the alternating voltage generated by it in the d.c. winding is hardly opposed at all by the other, and, unless it were prevented by high-impedance chokes, would cause an a.c. to flow in the d.c. circuit and through the d.c. coils, upsetting our simple theory rather badly by making its own contribution to the magnetizing (or demagnetizing) of the cores.

In practice it is not usually convenient to prevent this a.c. from flowing. As a result, the wave-

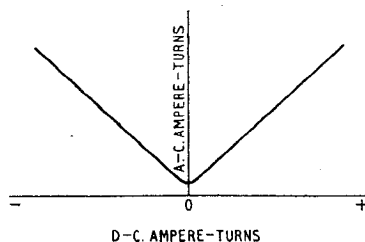


Fig. 7. Input/output characteristic of simple magnetic amplifier.

forms actually obtained are quite different from those in Figs. 5 and 6. The results as an amplifier, which are the important thing, are not so very different, however; and this is my excuse for having led you up a rather lengthy theoretical garden. Fig. 7, modified as necessary by the imperfections of the iron used, holds more or less good.

In case any readers are tiresome enough to insist on knowing what goes on inside the amplifier when the d.c. coils provide an a.c. path, I offer the following argument.

If we are not to be allowed to assume that the a.c. impedance of the d.c. circuit is infinitely large, the next simplest assumption is that it is zero. That being so, any a.c. which flows cannot set up an alternating voltage between the d.c. terminals. But we know that there are alternating voltages across the separate d.c. coils, because they are close-coupled to the a.c. coils. Assuming for simplicity that the turns ratio is 1:1, and that all the flux links all of both coils (i.e., no magnetic leakage from the core), the alternating voltages across the a.c. and d.c. coils are equal. On the a.c. side they add up (assuming zero load resistance) to be equal and oppo-



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site to the sinusoidal supply voltage; on the d.c. side they exactly cancel out. The only waveform

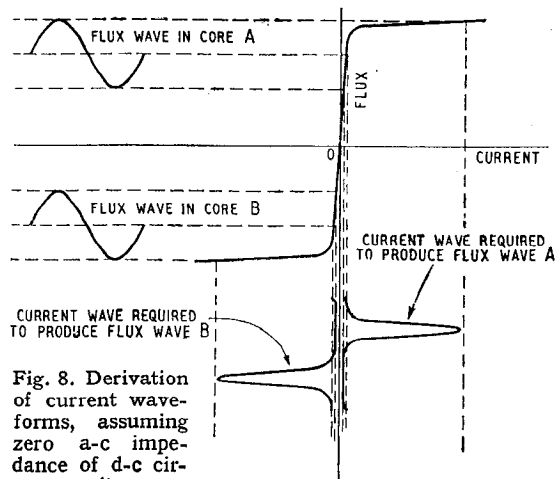


Fig. 8. Derivation of current waveforms, assuming zero a-c impedance of d-c circuit.

that can satisfy both these requirements at once is sinusoidal. To generate sinusoidal voltages in both coils, the flux waves in both cores must be sinusoidal. These flux waves are the result of the net current waves in a.c. and d.c. coils.

To generate sinusoidal flux waves from points A and B in Fig. 3 would seem to be impossible without fantastically high current peaks during the half-cycles working in the saturation region; but as you will see in a minute or two, the distortion of the current wave causes the mean flux for a given value of d.c. to be pushed round the saturation bends towards the origin.

This knowledge has been anticipated in Fig. 8, which reminds one of the diagrams used to show rectification of a signal by non-linear valve characteristics. The two current waves which this graph shows to be necessary to produce the sinusoidal flux waves are, as I have said, the net current waves acting on the two cores; that is to say, the combined effects of the currents in the a.c. and d.c. coils. But since the two a.c. coils are in series, the currents flowing through them must be identical; and similarly for the d.c. coils. The problem is to analyse these two current waves into the parts flowing in the a.c. and d.c. coils respectively.

That may sound difficult, but

actually is not. Let x stand for the current in each a.c. coil, and y for the current in each d.c. coil. Because one d.c. coil is reversed, we know that current wave $A = x + y$ and $B = x - y$. Adding A and B together gives $2x$, and subtracting them gives $2y$. So we only have to add waves A and B and halve the result to get the current in the a.c. coils, and subtract A from B and have the result to get the current in the d.c. coils. This operation is performed graphically in Fig. 9.

Even this triumph of reasoning does not get us very near real practical waveforms, because we have made so many simplifying assumptions. When the impedances of control and load circuits and various other things are taken into account, the problem becomes very stiff. The amplitude of the a.c. still approximates to that of the d.c., however (for equal turns), and it can be seen that the fundamental frequency of the a.c. in the d.c. circuit is twice that of the supply.

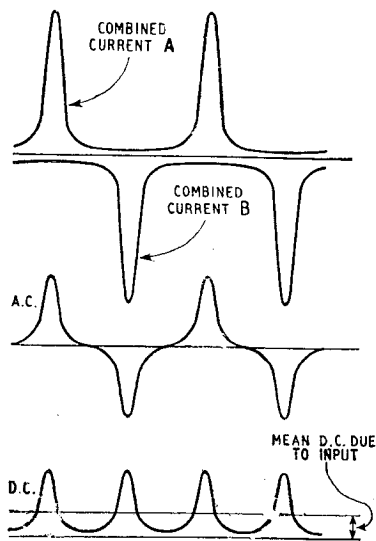


Fig. 9. Analysis of combined current waveforms from Fig. 8 into currents in a-c and d-c circuits.

There are many different kinds of "irons" from which to choose for making cores; some have only very gradual bends instead of the sharp saturation knee of Fig. 3; some have their knees higher up; and some climb to saturation less steeply. How do these features affect the performance of the amplifier?

If the steep slope is not so steep (that is to say, if the permeability is low or only moderate), then a correspondingly large control d.c. is necessary before saturation sets in and causes the a.c. to begin to rise at its full rate. In other

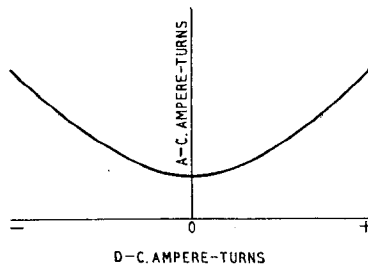


Fig. 10. Characteristic of amplifier using core material of lower permeability.

words, the amplifier is insensitive to small signals, and instead of Fig. 7 one gets a curve more like Fig. 10. The output also depends more on the supply voltage. We have already seen that the magnitude of flux at the knee determines the maximum alternating voltage (of a given frequency) that can be used. So if the core saturates at a low flux density it limits the output power.

Mumetal has a quite phenomenally steep slope, but a low saturation density; so it is particularly suitable for a low-power sensitive amplifier, but not so suitable when the power output is to be of the order of several watts, especially as it is expensive. For the higher powers it is much more economical to use Radiometal or even Stalloy, in spite of the lower gain. One can make up for the lower gain by using more than one stage of amplification.

An alloy recently developed for magnetic amplifiers and similar purposes is H.C.R. metal. Its maximum permeability is not quite so high as Mumetal's (about two-thirds) but is far ahead of most others; and in suddenness

of saturation it beats even Mumetal. Fig. 3 is, in fact, an H.C.R. metal characteristic, adapted from data supplied by the makers (Telegraph Construction and Maintenance Co., Ltd.). It has been simplified by taking a mean between the up and down tracks of the hysteresis loop. The flux scale refers to a core section of 1 sq cm, so is also a flux density scale in kilogauss, when the ampere-turn scale refers to 1 cm core length.

As I said earlier, if a d.c. output is wanted it can be obtained by rectifying the a.c. Selenium rectifiers are commonly used. If the whole or part of this d.c. is passed through coils wound on the cores, the amplifier characteristics are considerably modified. It is quite easy to find out how. Suppose PQR in Fig. 11 is the original amplifier characteristic. Now draw a curve, OS, showing rectified amp-turns (on the d.c. scale) against a.c. output. If the rectifier were perfect it would, of course, be a straight line. Now

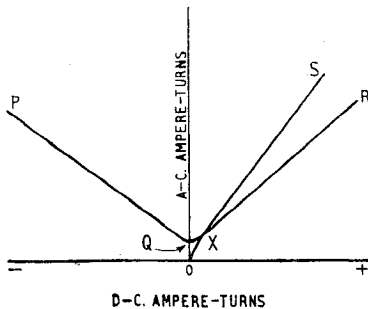


Fig. 11. Combination of amplifier characteristic (PQR) with "feedback" characteristic (OS) to give modified amplifier characteristic (Fig. 12).

the total d.c. magnetization is equal to the input (measured along the horizontal scale) plus the rectified output (indicated by the horizontal distance of the line OS from the vertical scale).

In Fig. 11 the "feedback" characteristic starts from O on the d.c. scale, so its intersection, X, with PQR marks the working point with no input. It can be transferred to a new diagram (Fig. 12), where it appears as Q'. To find working points corresponding to positive or negative inputs, move the curve OS bodily along so that its foot marks the

input, and transfer the intersections with PQR to Fig. 12. When joined up they give the new amplifier characteristic, P'Q'R'.

Its two outstanding features are its lack of symmetry, meaning that the polarity of the input now matters; and the increased steepness on one side, meaning that d.c. of that polarity is more highly amplified.

If the amount of rectified "feedback" is increased until its line OS in Fig. 11 runs nearly parallel to the simple amplifier characteristic QR, the amplification approaches infinity. But it may be inadvisable to work too close to this condition, because if the "feedback" slope cuts the other line at more than one place the amplifier becomes unstable and the working point flies suddenly to one end or the other—a condition which, however, has its uses, such as working relays. If the zero-input working point occurs in the middle of the steep part, the resulting characteristic (dotted in Fig. 12) indicates an output that corresponds to the input in polarity as well as in magnitude.

Another means of controlling the amplifier characteristics is familiar to valve users—"bias." The only difference, of course, is that it is current instead of voltage. Bias current can be conveniently obtained by rectifying the supply a.c.

I have persistently put "feedback" in inverted commas because although this scheme bears an obvious similarity to feedback in valve amplifiers, and is often so named in connection with magnetic amplifiers, it is not on all fours with it. For one thing, there is not the same distinction between positive and negative

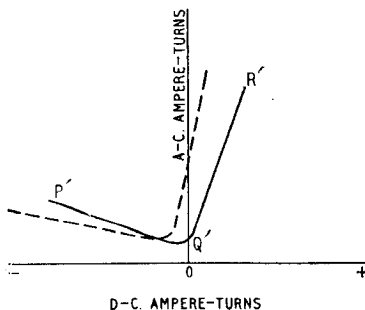
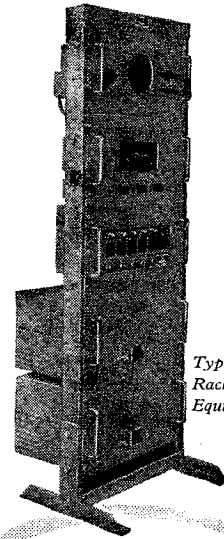


Fig. 12. Amplifier characteristic with self-excitation.



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feedback. The polarity of the current fed back depends only on the connections; not on the polarity of the input, as in valve amplifiers. If the connections are reversed, the only difference is to reverse the + and - in Fig. 12.

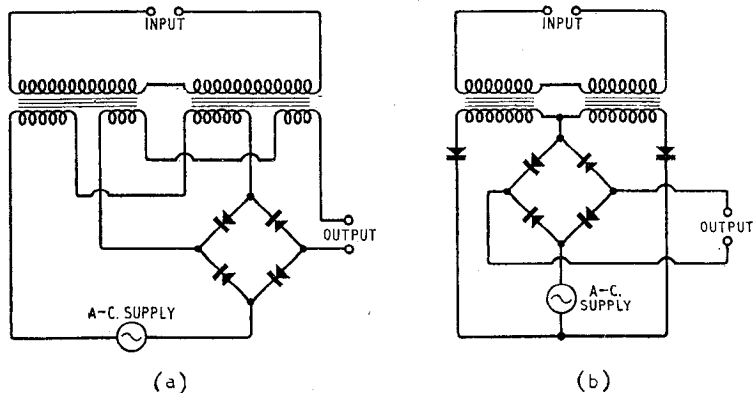


Fig. 13. (a) Example of self-excitation circuit. (b) Example of auto-excitation circuit.

With either connection, the effects of both positive and negative feedback can be obtained according to whether the working point is to left or right of the lowest point on the curve. So the description "self-excitation," which will be familiar to dynamo experts, is generally preferred. One obvious way of applying it is by passing the rectified output through a third pair of coils (Fig. 13a). An advantage of this method is that the amount of self-excitation can be adjusted very precisely. But, of course, the extra windings make the whole thing larger. An alternative, shown in Fig. 13(b), and described as "auto-excitation," is to rectify the current through the a.c. coils.

A difficulty about using "feedback" to get a very high stage gain is that the amplifier is made much more sensitive to the alternating supply voltage. One way of obviating this is to connect amplifiers in push-pull.

But there is no need to go into all the possible arrangements. What is likely to be of more concern to readers new to magnetic amplifiers is whether they are likely to supersede valve amplifiers. The answer should by this time be a fairly clear negative. Owing to its sluggish response

(which, incidentally, worsens as the gain is increased), the magnetic amplifier is restricted to d.c. applications. Being current-controlled rules it out even from d.c. applications if the signal source resistance is very high.

The applications of magnetic

best with high-impedance circuits, magnetic amplifiers are easier to design and make for low impedances. They are more robust and long-lived than valves, more reliable and have no socket contacts or microphony. They incorporate their own impedance-matching transformers, are more stable than valve d.c. amplifiers, generally need no power smoothing systems, and enable several separate control inputs to be combined without conductive connection.

One typical use is for enabling a robust meter movement or a relay to be operated by a light- or heat-sensitive device such as a barrier layer cell or a thermocouple. Lights can be automatically turned on when daylight fades. Servo-mechanisms and power-control systems of many kinds find magnetic amplifiers a help. The V2 rocket was a rather unhappy example of this.

Working input can be as low as 0.001 microwatt, and power gains per stage are limited mainly by the necessary stability—anything up to 10,000 is within reason. For higher gain or stability more than one stage is preferred.

B.B.C. TELEVISION MAP

(See Page 55)

THE map reproduced on p. 55 shows the results of a survey recently carried out by the B.B.C. Research Department. The survey was extended well beyond the boundary of the nominal service area.

The field-strength measurements, from which the contours plotted on the map have been derived, were made at several places along eight routes radiating from Alexandra Palace, up to distances of about sixty miles. Whenever possible, places in open country were chosen, where there were no nearby hills or buildings that might produce reflected components of field strength, which could give misleading results. In order to take account of the substantial variations in field strength that occur at these frequencies between points which are almost contiguous, a continuous record of the field strength at each place was made as the vehicle in which the measuring equipment was installed moved slowly along. The average value of field strength at each place was then determined from these records. The aerial on the vehicle was twenty feet above

the ground, and as the average height of television receiving aerials is nearer thirty than twenty feet, the measured values were subsequently corrected to get the field strength at thirty feet above ground, these corrections being made on the assumption that the gain of the aerial increased linearly with height. All the measurements were made while the transmitter was radiating either normal programme or the "artificial-bars" signal, and the results were then multiplied by a factor to obtain the peak field strength, which corresponds to the white elements in the picture.

Some additional measurements were made at each of the principal towns within the area. The field strength there was usually less than in the surrounding country by between three and six decibels, and this reduction should be remembered when using the contour map, since, to avoid undue complication, closed contour loops have not been drawn around the towns.

The stippling on the map indicates the area within which considerable fading may be experienced.

LETTERS TO THE EDITOR

Higher Definition Television? ♦ Inverted Omega for Inverted Ohm ♦ Clearing Up Scale Distortion ♦ Uses of Signal-strength Meters

Television Standards

MAY I make an emphatic plea in favour of an experimental high-definition television system, which I hold to be economically feasible. The gist of usual objections can be summarized as follows:—

1. Higher writing speed would be necessary.
2. Present sets do not do full justice even to existing standards.
3. The cost of a very wide band amplifier would be prohibitive.
4. Scanning power for the line time base would be much increased.
5. American sets working to higher standards show disappointing performance.
6. Land lines and cables would be unable to deal with higher definition transmissions.

I shall try to show that none of the above objections are as serious as they may appear at first glance;

1. *Spot size.*—Modern transmitting and receiving tubes are capable of resolving a raster corresponding to 800 lines; the plastic lens projection system, developed by I.C.I., is capable of dealing with even more lines.

2. *Present receivers.*—In the laboratories of our leading set and valve manufacturers receivers are demonstrated which make full use of the wide band transmission from Alexandra Palace, and some manufacturers maintain their high standard in actual production. It is now up to the transmitter to establish a new lead.

3. *Wide band amplifier.*—The new B.B.C. transmitters will operate in single-sideband mode, thus resulting in substantial frequency band economy. It can be stated generally, that due to selectivity demands (avoiding sound on vision and vision on sound) the number of tuned circuits of a vision amplifier cannot be reduced safely below 7 to 8 (including wavetraps), while it is possible to obtain satisfactory gain with three valves only of the modern miniature type. With a higher definition system and hence wider carrier spacing, the selectivity problem, if anything, might be eased, which means that the number of valves only, and not of tuned

circuits, would have to be increased and thus lead to a more balanced distribution of both. A single-sideband receiver for a 700-line system will perform adequately with five valves tuned by single staggered circuits, so that the additional complication and expense are less frightening than expected. Perhaps secondary emission valves of the EE50 type will return with a more reliable performance and simplify the problems of a very wide band amplifier.

4. *Scanning power requirements.* We witnessed in recent years remarkable improvements in the design of scanning systems. By efficient use of energy recovering diodes and optimal design of scanning coils the increased demands on line timebase power can be met easily, thus an experimental R.C.A. system requires 66 watts power input for a line frequency of 31.5 kc/s and an e.h.t. of about 10 kV.

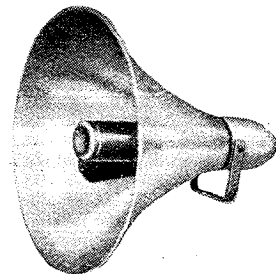
5. *American picture quality.*—The big discrepancy between the American laboratory and production performances can be explained by indifferent transmitter quality, mass production methods, etc. If we in this country can obtain good pictures with 405 lines, they will be better still with 700 lines.

6. *Losses in coaxial cables and lines;* these are serious, and the obvious answer is: do not use them, but microwave links only.

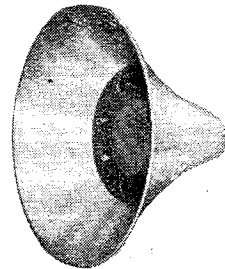
A different matter has also to be considered, the problem of the transmitting system; the high-definition transmitters of the future might use the Videosonic method. Its advantages are obvious; saving in frequency band, omission of a separate high power sound transmitter, omission of a separate sound amplifier in the receiver and sound interference suppression due to properties of pulse modulation. The audio band, rather restricted at present, will be widened considerably with an increased number of lines, and the main objection to the Videosonic system would thus disappear.

Summing up, it seems to me, that a high definition receiver is feasible both technically and economically, and that the establishment of an experimental transmitter of about 650-700 lines in the near future is desir-

NEW ECONOMICAL A Two-Purpose Loudspeaker which Saves Capital Expenditure



Pat. Applied For



Always there has been the difficulty in many applications, whether the Horn type loudspeaker with its high power possibilities, or the Cone type with its greater frequency range for the same size, is to be used for any particular installation. Both types have their advantages and limits. This new design by F.I. enables the major components of two types to be interchangeable. Main flare, fixing device and assembling nut are common to either of two assemblies. Add centre section and L.S.7. unit for a complete re-entrant horn type 42 REH, or add PAC 6 and special mounting to have a cone and directional baffle system: 42 RC. Whichever type suits you most, you have the opportunity of acquiring the components for the alternative assembly when you are in need of them.

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Letters to the Editor—

able. Some countries are preparing television systems with 625 and 819 lines already. In 1936 the present B.B.C. 405-line system was considered by many to set too high a standard; let us set a new one once more to be replaced later by a colour or a stereoscopic system or both.

A. LANDMAN.

The Plessey Company,
Ilford, Essex.

"Cathode Ray" Articles

"Admittance."—Since I proposed, under this heading, that the symbol " Ω " would be a suitable one to fill the gap which exists alongside the term "Mho," my attention has been drawn to the fact that it has already been used for this purpose by the Dubilier Condenser Company in a technical booklet published some years ago. I am very glad to acknowledge this prior use, because it might suggest to the appropriate B.S.I. committee that it is about time they filled this gap in their book of standard Engineering Terms and Abbreviations. We have been writing "mA/V" too long and are tired of it.

"Scale Distortion."—While making acknowledgments I must also admit that perhaps my comments on Mr. Casey's article were rather harsh. I still hold, however, that his references to my pre-war dicta on Scale Distortion were misleading, and that the quotations he makes from them in his letter in the January, 1949, issue are, without their context, also misleading. To avoid perpetuation of misunderstanding may I briefly sketch in that context?

In the first article on Scale Distortion (24.9.37) I nowhere suggested that an enormous power was necessary to reproduce loud programmes at their original intensity; in fact, I gave at least equal prominence to scale distortion caused by reproducing speech at *above* its natural intensity, and the "weighting network" I advocated for listeners who were not technically intelligent was Music/Speech switch giving a bass *cut*, to correct this frequently heard condition, if they would not adjust the volume correctly.

But since some readers imagined the contrary, I wrote later (10.3.38): "there are some who thought that my idea of 'original' sound intensity meant the result that would be obtained if the whole B.B.C. Symphony Orchestra or other source of sound were performing in the listener's back parlour; in other words, if the orchestra is capable of putting out 100 watts of sound, so must the loud speaker. I hope the subsequent correspondence

succeeded in making clear that such a dreadful thought was far from me. At the same time, I did feel that as my examples were based on assumed figures it would be much more satisfactory to work on actual measured sound intensities."

I thus entered on the Queens Hall tests with an open mind rather than "to prove that there was such a difference between the actual and reproduced levels of sound that a weighting network was necessary."

In the earliest article, and ever since, I have emphasized the fallaciousness of the more or less automatic "bass compensation" schemes. I suggested "a fairly comprehensive system of tone control" for intelligent listeners, so that they could get the balance of tone they liked best during each programme condition, since the setting of the volume control does not in general correspond in magnitude or even in sign with scale distortion, still less with the overall correction desirable.

"CATHODE RAY"

"Antiference"

WE should like to draw attention to the fact that the use of the word "Antiference" in connection with anti-static devices (which sufficiently resembles our trade name and registered trade mark "Antiference" to lead intending purchasers to believe that we are the manufacturers) is in our view a clear infringement. Legal steps will in future be taken to deal with all such infringements.

NORMAN S. BEEBE,
Director, Antiference, Ltd.

London, W.1.

Value of an S Meter

YOUR correspondent G2MC, I think, puts the case a little strongly when he questions the need for the provision of an "S" meter in a communications receiver on the grounds of discrepancies in reports.

These discrepancies are all too familiar, of course, and for reports to be of the value they ought to be, some standard of meter calibration is required. Until such an ideal is attained we will continue to be afflicted with telephony reports of "50 db over S₉" from DX stations or "100% readable and S₁."

However, the only alternative to an "S" meter is reliance on the human ear, which is far from being an accurate measuring device. All the anomalies and snags pointed out by 2MC apply equally to reports given by ear.

Surely the two obvious advantages of an "S" meter are (1) The ability to give accurate *comparative* reports on small changes of received

carrier level to a station conducting tests, and (2) the giving of reports when the a.v.c. is operating—for when it is operating properly the only marked difference to the ear between two signals of different level should be a change in background noise.

A third useful feature is in the checking of the receiver's performance. A known signal such as that from the station's own crystal calibrator can be used as a reference and if there is some doubt whether poor signals are due to loss of receiver performance or to "conditions" the "S" meter reading from this known source can be used as a check.

2MC is right when he says that the "S" meter depends on the design of the preselector. In fact, this is the commonest cause of discrepancies. The usual case is that the *gain*, though not necessarily the sensitivity, of the "front" end of the receiver varies widely from the h.f. to the l.f. end of a range and from one range to another, and thus the voltage passed to the i.f. amplifier and therefrom *via* the a.v.c. to the "S" meter will vary widely for a constant input at the aerial terminals.

In a receiver without constant gain the manufacturer should state what correction should be applied to the meter readings on various bands.

Questions of aerial efficiency and site conditions apply equally to aural reports; all the operator can do is to quote the aerial gain (or loss) compared to a simple dipole in its favoured direction.

For calibration, if we assume S₀ to be the receiver noise level, without site noise due to the aerial, and S₁ to be a signal just strong enough to be audible but not to move the meter, S₂ will be the absolute sensitivity of the receiver—the input voltage required to produce an audio output 10db above the receiver noise. In a good receiver this would be 1 μ V. If "S" points are graded every 6db thereafter S₉ would be 125 μ V. Someone can work out what 50db over this figure would be and then decide whether any amateur installation is likely to lay down such a signal at a great distance, whatever the conditions.

At most sites and with most aerals an S₁ signal would not be audible in the practical case, and even with 100% modulation and a phenomenally low noise level only scraps of words would occasionally be heard though no intelligence could be conveyed. This lines up with the verbal description of S₁ as a "barely perceptible signal."

Denco, Ltd., C. H. RANFT.
Clacton-on-Sea, G5RF.
Essex.

Unbiased

By
FREE GRID

Aurascope Radar

MOST of you will know what a halo looks like, but for those of you who stuck grimly to the modern note at school, perhaps I had better say that it is a sort of celestial coronet somewhat resembling the lines of force surrounding an electrostatic charge. This apparently is exactly what it is according to the latest scientific discoveries, but with the difference



Feeling very uneasy.

that it surrounds our entire bodies and, moreover, we do not have to wait until we have shuffled off this mortal coil and become static, for we have it here and now.

The American savants whose writings on the subject I have just been reading do not use the term halo, but speak of the human aura. Apparently it changes in configuration according to the state of our health and would appear, therefore, to be a handy diagnostic tool for the doctor, but unfortunately its presence is only perceptible to those who are "psychogenic," whatever that may mean.

But radio science has once more come to the rescue and it is no longer necessary to be "psychogenic" or even just plain "psychic" to perceive this human aura. Some genius has found that it is more or less opaque to radio waves of the order of one millimetre. I say "more or less opaque" advisedly, for it is this feature which raises its status immediately from that of a mere laboratory phenomenon to a valuable "effect" which can be put to instant use by the medical specialist. The writers state that the ratio between the percentage of one-millimetre waves absorbed and those returned to the sender varies with the health of the individual. Furthermore, these *ultrissima* short waves can be focused to such a fine point that the medico can pick out particular portions of our aura for

diagnostic examination. He can, according to what I have been reading, not only pick out and analyse the contents of a man's stomach but determine also the degree to which the process of digestion has advanced by plotting the local auric configuration.

Now doctors in America must have their fun just as much as the Bevan boys over here, but I must confess to feeling very uneasy when I read further on that it is not necessary for the apparatus to be virtually "juxtadermatous" (what philological fun these Americans have) as in the case of X-rays. It is suggested that by arrangement with a restaurant manager records of patrons' digestive processes analogous to the candid snapshots of a miniature camera may be taken from behind a screen.

This method of what I can only describe as "medical market research" has patient-getting potentialities undreamt of by the resourceful Mr. Bob Allen. Who could remain unmoved when the postman delivered a radar-graph (or should it be radar-gram) of his duodenum in action, with the simple footnote "Get it fixed before it fixes you"?

Heresy in High Places

SELDOM have I been so shocked and shaken as when confronted by the banner headline in *W.W.* last month "Distortion: Does It Matter?". I can only say that it had much the same effect on me as if one of the ecclesiastical journals came out with the headline, "Sin: does it matter?" or, to turn to the secular field, as if *Pravda* headed its leading article "Does Stalin Count?" or "Molotov no dobera."

It is true that *Wireless World* was merely reporting a discussion on this matter at one of the meetings of the I.E.E., but is not this the "Lambeth Conference" of the technical episcopacy. One might have expected it, therefore, to produce a radio Sancroft of equal stature to his ecclesiastical original who, with his six supporters, chose the Tower and the danger of corporal schism rather than have any truck with the legal heresy which was largely responsible for costing "Dismal Jimmy" his throne in 1688.

Truth, which is science's other name, always thrives on persecution, and suppression is its life-blood.

THE COMBINED TELEVISION AND "EXSTAT" AERIAL

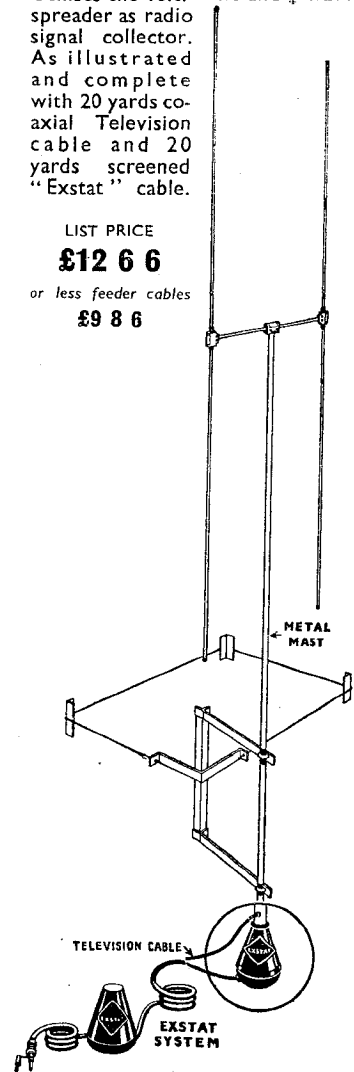
An aerial which provides for both television and interference-free radio reception and obviates the necessity for two separate installations. Available for the London or Birmingham transmissions. Utilises the 10ft. mast and $\frac{1}{4}$ wave spreader as radio signal collector. As illustrated and complete with 20 yards coaxial Television cable and 20 yards screened "Exstat" cable.

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RANDOM RADIATIONS

By "DIALLIST"

Portable Television

THAT, ANVHOW, is the name given to it by the American company which makes a new type of midget televisor; but it isn't quite the counterpart of the portable wireless set, for its power supply is not built in and you can't therefore do a spot of viewing whenever or wherever you feel like it. In point of fact the "portable" here means just what its name implies: it can be carried easily from here to there. The set is about the size of a week-end suitcase; it has the same sort of carrying handle and it weighs only 15 lb. There is a built-in telescopic dipole (horizontal, of course), and all you need for reception is a 110-volt, 60-c/s socket—and a television station within range. A 3-inch c.r.t. is used, but magnifying lenses are available which give three times the picture area obtainable with the unaided tube. The price of the complete outfit (with magnifying lens) is 153.95 dollars, or a little less than £38 10s. Would something similar catch on here? I really don't know. I have a feeling, though, that the $7\frac{1}{2} \times 6$ in image is about the smallest that is genuinely acceptable to most potential televiewers. Again, we have only one transmitter in being and another coming along in the near future, whereas there are few big towns in the eastern states of America which have not at least one service available. Over these, then, there's some point in including a lightweight televisor in your luggage if you are travelling over quite large areas. There's no similar advantages yet with us, unless your movements are limited to a 10-15 mile radius (remember that built-in dipole) of A.P.

A New Menace

Writing of travelling and television brings to mind the latest short cut to eternity for members of the Suicide Club, which is described (but *not* recommended) in a recent issue of the New York *Radio-Electronics*. As a motorist of many years' experience—I wouldn't like to tell you when my first car was

built—the very last thing I should want is a television receiver installed alongside the steering column at an angle which gives the driver comfortable (!) viewing as he speeds over the open road or crawls through the traffic. I sincerely hope that car television won't be permitted in this country, or that if it is it will be limited to the passenger seats behind the driver.

Puzzling

THIS MONTH I SEEM to be writing a lot about "TV" doings in the U.S.A. That's because things are developing pretty fast over there and there have been quite a few interesting innovations of late. One of these, I confess, has me completely beaten. A big American radio and television manufacturing company (Zenith) announces the appearance at an early date of a receiver with a "giant circle screen." An illustration shows a console set with a circular viewing screen which is completely occupied by the picture—there are no black borders. I'm frankly puzzled for two reasons: (1) How can you obtain a circular picture from a 5:4 aspect ratio rectangular transmission in any other way than by first cutting the received image to a 1:1 aspect ratio and then still further jettisoning part of what the transmitter sends out by limiting the picture on the receiver screen to the circle contained by the resulting square? The only other way I can think of would be deliberately to distort a 5:4 aspect ratio image into a 1:1 and then to round off the corners—but I can't think that that would give acceptable results. (2) Why should the circular image be described in the announcement as "what you have been waiting for"?

Rectangle versus Square and Circle

Think it over for a moment and I believe you'll agree that the picture-shape least acceptable to the human eye is the circular. Next in order of unpopularity comes the square.

Visit a picture gallery and whether it contains the works of old masters or of outstanding recent and modern artists you'll find that the overwhelming majority of the paintings are rectangular in shape, with one dimension (normally the horizontal) greater than the other. Amongst the few great paintings with curved borders, the elliptical far outnumber the circular. The same is true of the drawing, the photograph, the newspaper or magazine illustration and the cine image. For some reason that I can't attempt to explain the eye seems always to have preferred an oblong or elliptical image and to have been best pleased by one of either kind in which the major axis is horizontal. The camera lens projects an approximately circular image, but from the very early days of photography prints have been rectangular. The square might have seemed the most likely kind of rectangle to be chosen; but it wasn't. Well, the round-picture televisor is being launched by a firm with a pretty good experience of the radio and television market. It will be interesting to see whether it catches on despite the apparent preference of the human eye for oblong images.

In Defence of Siting

AT THE RISK of receiving a poke in the eye from "Free Grid's" gamp, I must join I. B. R. Cater (correspondence, *W.W.*, January, 1949) in defence of the verb "to site." Actually it is a military technical word dating back to the spacious days before the first world war, when home-brewed beer was tuppence a pint and half a pound of good tobacco cost less than does a packet of gaspers to-day. It has always been used with one meaning only: to place something in a position deliberately and carefully chosen for it. I don't know of any word of unquestionable lineage which has the same signification; and when the language doesn't contain a word expressing an action or an idea that he wants to describe, the technical man has always been allowed to coin one. Unfortunately his coinage is not always very beautiful or very happy; but I don't find "siting" or "sited" particularly offensive. They are at any rate better than "positioning" and "positioned." Siting is surely the only word which describes what

is (or ought to be!) done whenever ground radar equipment is brought into action. If you just place or install or locate it here or there, you are liable to find standing breaks all over the screens and to be bothered by queer errors. But if you *site* it by choosing its position with the greatest possible care, perhaps after trying it in two or three likely looking spots before finally deciding, you are sure that you are getting the best out of it. "Siting" was in use in Army manuals long before radar was thought of.

Four-dimensional Investigation!

A MOST INTERESTING paper was read just before Christmas at the Institution of Mechanical Engineers by H. A. V. Bulleid. His subject was "Cinematography in Engineering." The author certainly has engineering in the blood, for his father, O.V.B. is chief mechanical engineer of the Southern Section of British Railways, his uncle H. G. Ivatt, C.M.E., of the Midland Section, and his grandfather H. A. Ivatt was C.M.E. of the old Great Northern Railway. We don't make anything like enough use of the cine either in the electrical research lab or in the lecture room. As Mr. Bulleid showed, it is capable of giving the research worker answers to puzzling problems which cannot be found in any other way. It enables him, for instance, to make four-dimensional investigations, for the high-speed camera and projector, with 8,000 frames a second, provide a magnification in time of 500 to 1. In one big American laboratory a speed of 40,000 frames per second has been claimed, with a corresponding time magnification of 2,500 to 1. One doesn't need to do much thinking to realize how useful the high-speed cine could be in the investigation of such things as the action of rotary switches and other moving contacts; of the filament vibrations which cause microphony in valves; of the movements of loudspeaker cones. . . . One great advantage of the cine is that it makes a permanent record, which may be referred to as often as required. It thus becomes the natural ally of the oscilloscope. From the instructional point of view the cine is invaluable. We certainly found it so during the war for teaching not only the practice, but also the theory of radar.

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RECENT INVENTIONS

A Selection of the More Interesting Radio Developments

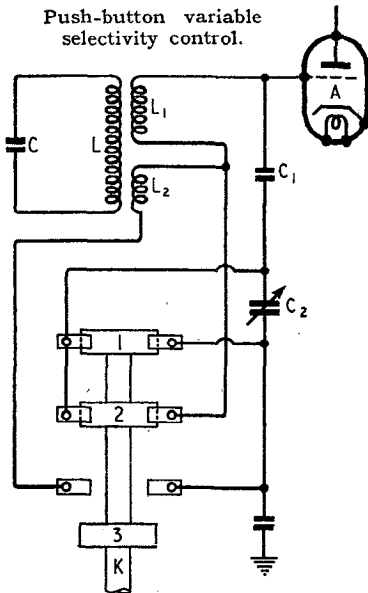
Press-button Tuning

A SWITCH-TUNED superhet is provided with an extra push-button control which is used to broaden the bandpass response of the I.F. amplifier, in order to take advantage of the high musical standard of local transmissions when circumstances permit.

The drawing shows the input circuit to the I.F. stage A with the press-

button control shaft K in its normal position. With this setting, the primary circuit LC is coupled directly to the secondary L_1C_1 , the auxiliary coil L_2 and condenser C_2 being out of action. This arrangement gives a narrow bandpass characteristic for receiving ordinary or long-distance programmes.

Push-button variable selectivity control.



button control shaft K in its normal position. With this setting, the primary circuit LC is coupled directly to the secondary L_1C_1 , the auxiliary coil L_2 and condenser C_2 being out of action. This arrangement gives a narrow bandpass characteristic for receiving ordinary or long-distance programmes.

By pushing in the shaft K, the contacts 1 and 2 are broken and the contact 3 connects the auxiliary coil L_2 in series with the coil L_1 , to broaden the bandpass coupling. At the same time, the trimming condenser C_2 is brought into action, to keep the new response curve symmetrical in shape.

E. K. Cole, Ltd., and H. Hunt. Application date, September 22nd, 1945. No. 599647.

Large-scale Television

RELATES to television receivers of the kind in which the scanning stream of a cathode-ray tube is used to vary the point-to-point transparency of a sensitive screen, so that the picture can be projected through the screen on to a viewing surface mounted outside the tube. A suitable sensitive screen consists of a thin film of oil deposited on a glass disc, which is made of larger size than the actual scanning

raster, and is slowly rotated in order to present fresh areas to the stream. The effect of the scanning is to set free small static charges, which cause local surface deformations on the film of oil. These act as small lenses to vary the initial focusing of the projection beam against a cut-off grating, and so allow modulated light to reach the viewing-screen.

According to the invention, a second stream of electrons (unmodulated) is arranged to scan the area immediately surrounding the actual raster, in order to offset certain marginal distortions observed in the projected picture, and caused by abrupt changes in the static field strength produced on the film, near the edges of the raster.

W. Ehrenberg. Application date, September 11th, 1945. No. 598802.

Aerial Switching

IN radar equipment it is necessary to decouple the receiving circuits from the high voltages fed to the aerial during transmission, and to restore the connection in time to accept the resulting echo signals. One form of high-speed switch used for this purpose consists of a toroidal resonator having a gas-filled discharge tube bridged across its poles. The device is located at a suitable point along the waveguide feeder, and is automatically operated as each outgoing signal produces a short circuiting flash through the discharge tube. The duration of the flash is important, since it determines the time during which the receiver is out of action, and, in practice, this tends to be unduly prolonged, owing to the slow de-ionization and recovery rate of the gases contained in the tube.

According to the invention, the discharge tube is filled with small particles of glass "shot," averaging one millimeter in diameter. By sub-dividing the discharge path into units of comparatively small volume and large surface area, the particles accelerate the "cleaning up" of the ions and electrons produced by each discharge, and increase the switching speed.

The M-O Valve Co., Ltd., and N. L. Harris. Application date November 30th, 1945. No. 600889.

Frame Aerials

THE wire turns of a frame aerial are closely wound, and then cemented together with insulating material into the form of a flat pliable tape. This is laid, sandwich-fashion, in a shallow channel left between the two moulded halves of a frame, which is made from

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.

a synthetic resin previously impregnated with finely divided iron dust.

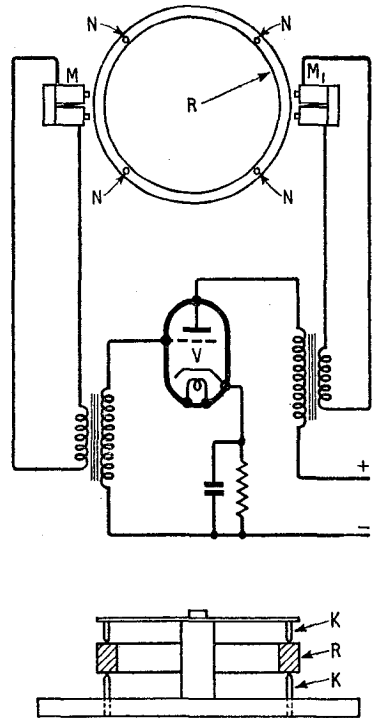
The high dielectric constant and magnetic permeability of the material surrounding the wire conductors is stated to increase the pick-up of an aerial of given size, the arrangement being intended for small portable sets.

Masteradio, Ltd., and R. Pollock. Application date, Oct. 17th, 1945. No. 598165.

Electro-Mechanical Oscillators

AN electro-mechanical resonator, suitable for developing frequencies between 3 and 10 kc/s, consists of a magnetic ring which is supported at nodal points of vibration and is coupled at anti-nodes to a valve oscillator.

As shown in the diagram, the resonator R is excited through electromagnets M, M_1 coupled to the input and output circuits, respectively, of a valve V, for which the resonator provides a feedback path. It is supported, at the nodes N, between upper and lower contacts K, of which two pairs only are shown. Alternatively, the



Magnetic ring resonator.

ring is fitted with a thin internal web to form a shallow cup-shaped resonator, which can then be supported at its centre.

For use within the specified range of frequencies, a resonator of this type can be made of more convenient size than an equivalent reed or magnetostrictive vibrator.

Marconi's Wireless Telegraph Co., Ltd., and P. J. Neilson. Application date, June 15th, 1945. No. 599274.