Wireless World

RADIO AND ELECTRONICS

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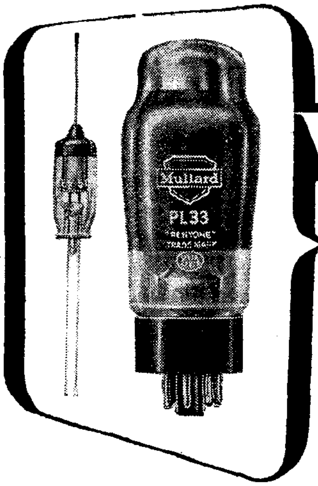

Valves and their applications

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

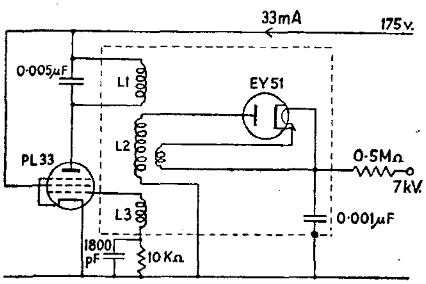

FIG.1

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.

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.

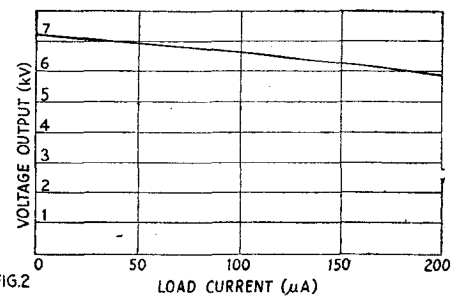

FIG.2

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 MΩ over the range of load current 0—100µA. 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.*

Mullard

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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Wireless World

RADIO AND ELECTRONICS

FEBRUARY 1949

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 stampeded 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 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 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.

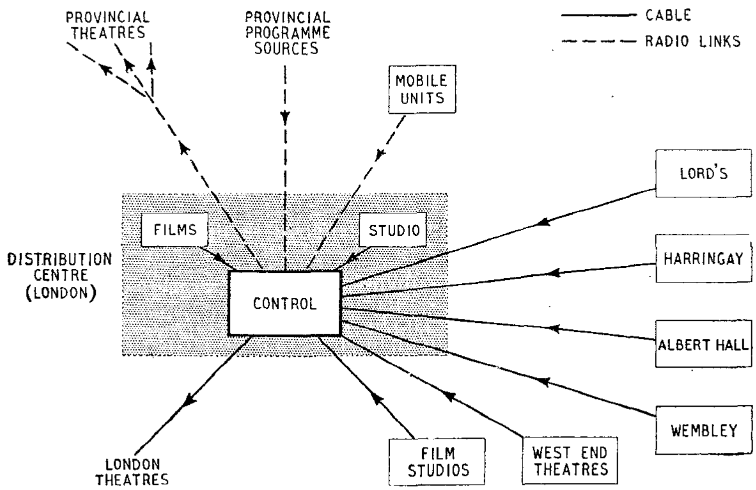


Fig. 1. Proposal for nation-wide theatre television network.

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

* 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.

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 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.

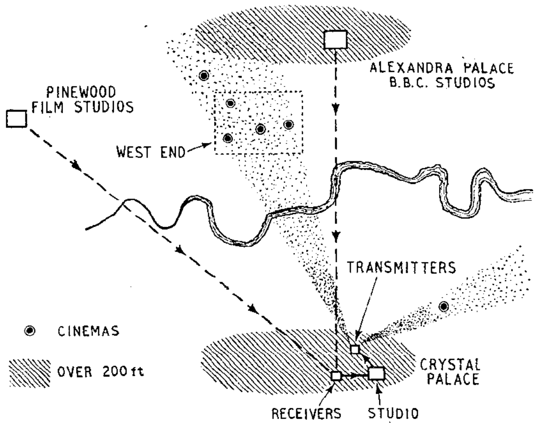


Fig. 2. Proposed experimental cinema television distribution plan in the London area.

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

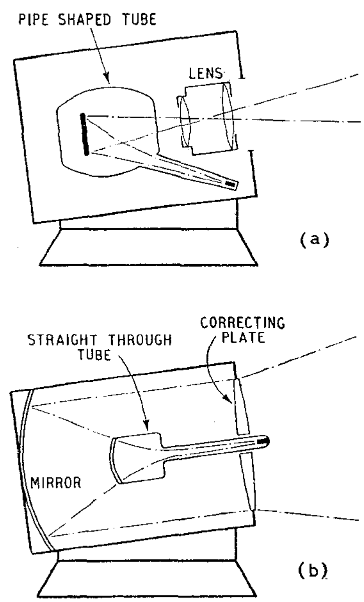


Fig. 3. Lens and mirror electronic projectors.

*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 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 × solid angle) which equals (power consumption × luminous efficiency × 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 $= 50{,}000 \times 5 \times 10^{-3} \times 5 \times (\pi/4) \times (1/1)^2 = 900$ lumens 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 in reasonable agreement with the computed value, particularly as no account has been taken of the losses in the optical system.

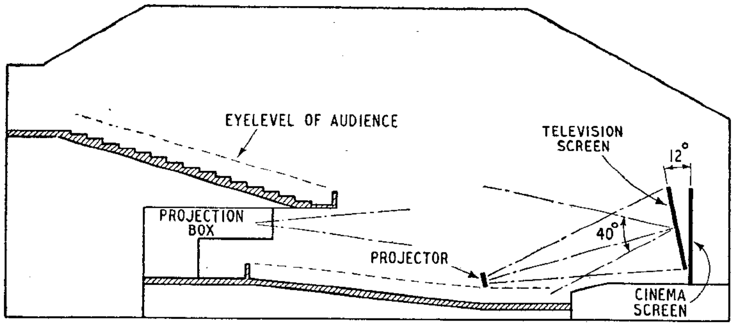


Fig. 4. Elevation of average theatre showing the angle required for screen reflection in the vertical plane.

Turning to other factors, further brightness measurements indicate a contrast range from black to white of 50:1 with a constant gamma up to ⅔ 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.

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.

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 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.

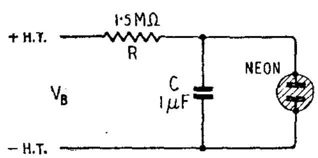


Fig. 1. The simple circuit of the warning device. C must be a high-grade capacitor with negligible leakage at 100–150V or the circuit will not work.

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 μA. 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 receiver. 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 ½-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 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.

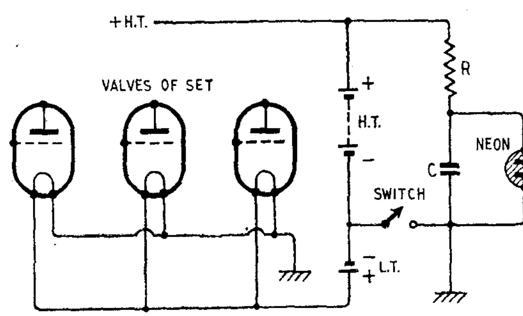


Fig. 2. In some sets minor alterations in the wiring of the on-off switch SW may be necessary. The arrangement illustrated is in every way satisfactory.

* 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 μA. 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 μA. 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 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 μA. 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.

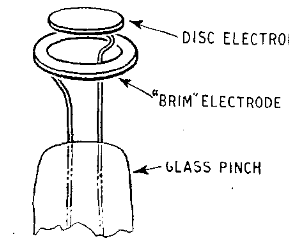


Fig. 4. Electrode assembly of low-voltage neon used. To obtain the lowest striking and extinguishing voltage the disc electrode should be negative.

Under working conditions I_C falls, as Fig. 3 shows, from about 34.25 μA to approximately 18 μA whilst the neon is quiescent. The average current drawn from the h.t.b. by the warning device is some 25 μA—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	20μA
100V	25μA
110V	30μA
130V	40μA
150V	50μA
175V	70μA

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 MΩ or C of precisely 1.0 μF.

(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 ¼-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 ½ 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

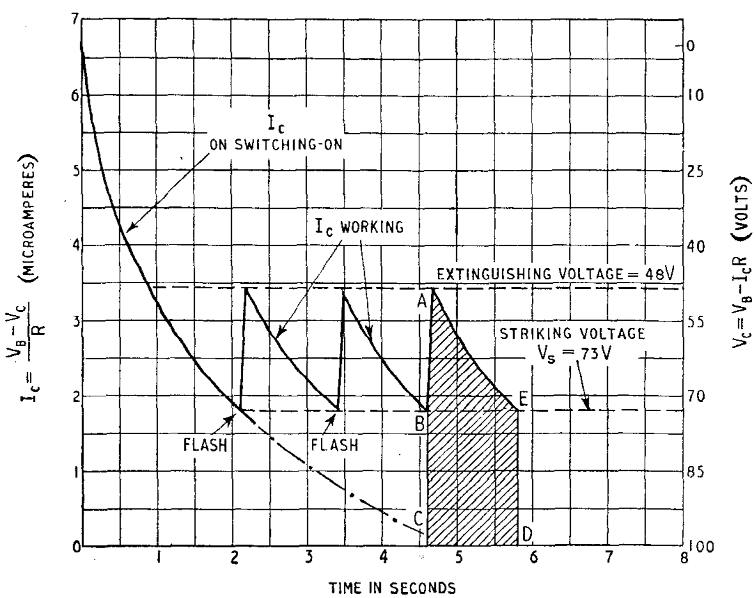


Fig. 3. Showing I_C and V_C on first switching on and under working conditions, where V_B = 100V; R = 1·5MΩ; C = 1·0μF; V_S = 73V; V_E = 48V. Current drain from the battery can be determined from the shaded area.

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

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

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 night-time 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 F_2 layer ionisation, usually comes to an end by February. Consequently the daytime m.u.fs may increase considerably. Owing to a seasonal trend there should also be an appreciable increase in the night-time m.u.fs 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

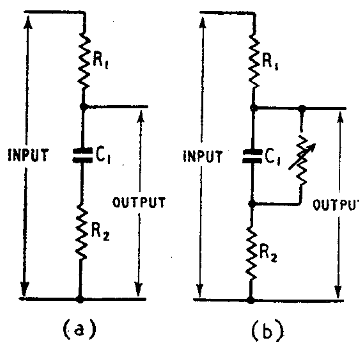


Fig. 1. The basic bass lift circuit is shown at (a). The lift is controllable by a variable resistor (b).

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 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

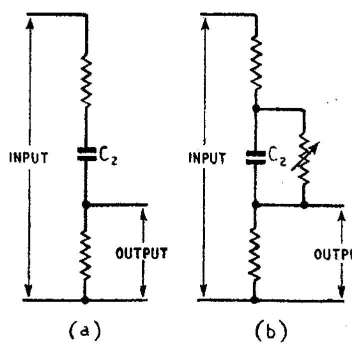


Fig. 2. Bass cut can be obtained with this circuit (a) and is controllable by a variable resistor (b).

and cut are controlled by the potentiometer R_3.

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

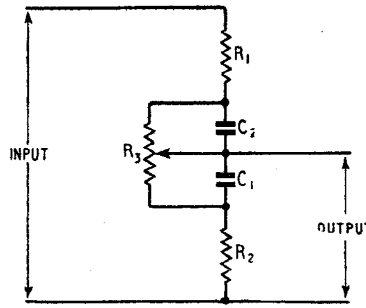


Fig. 3. This diagram shows the bass cut and lift circuits combined and controlled by the potentiometer R_3.

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

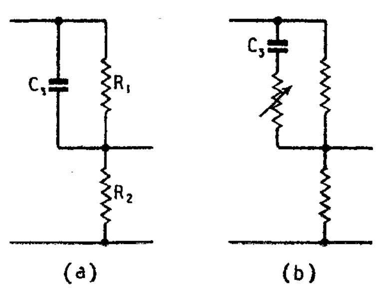


Fig. 4. Top lift is given by this basic arrangement (a) and can be varied by a series resistor (b).

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

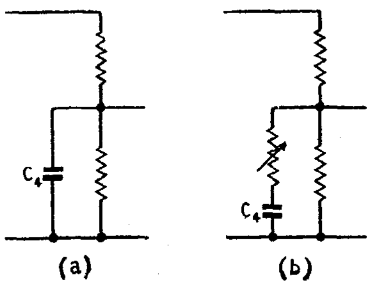


Fig. 5. Top cut is obtained from circuit (a) and controlled by a variable resistor as in (b).

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-

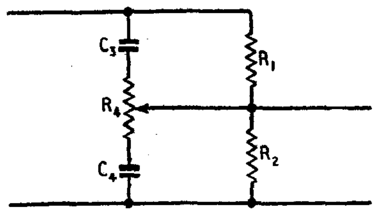


Fig. 6. Here the top cut and lift circuits are combined and controlled by R_4.

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 0.02μF to 0.01μF. 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-

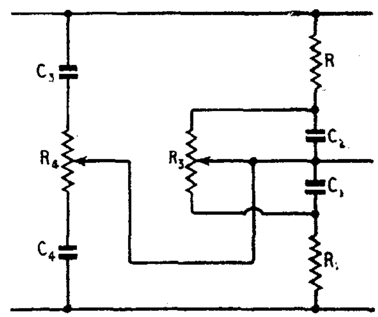
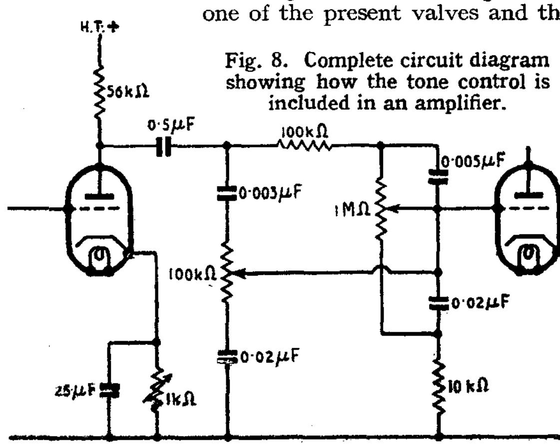


Fig. 7. The combination of the bass and top circuits is shown here.

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 paper[1] 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.

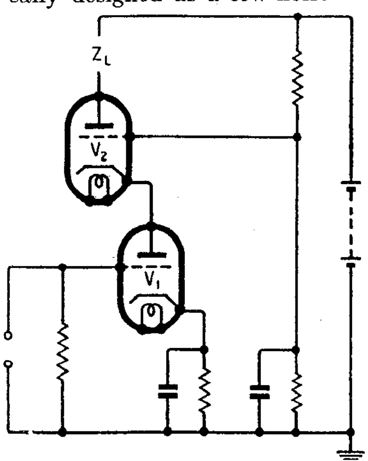


Fig. 1. Low-noise cascode circuit.

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 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-mu valve (to permit the application of a.v.c.) and then such a stage could be

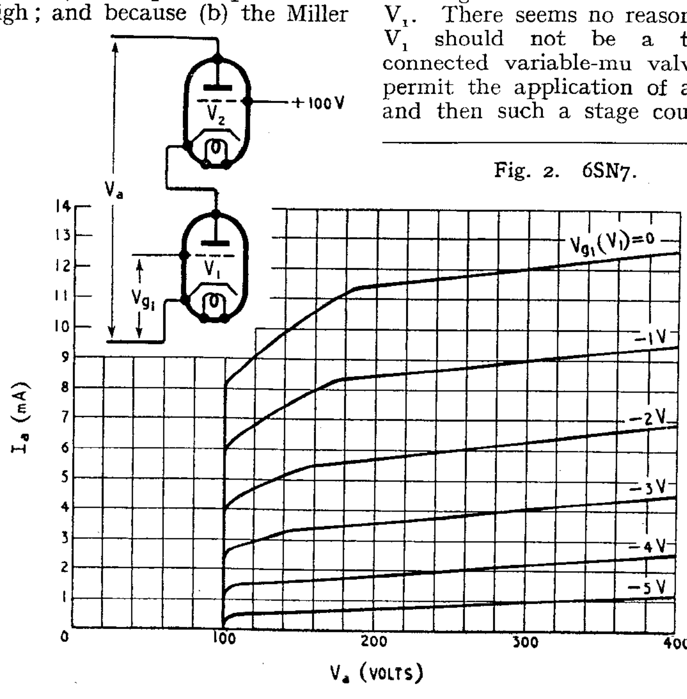


Fig. 2. 6SN7.

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

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

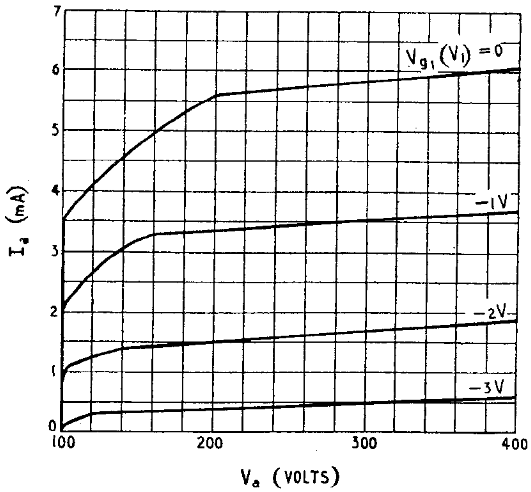


Fig. 3. ECC 32.

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 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.

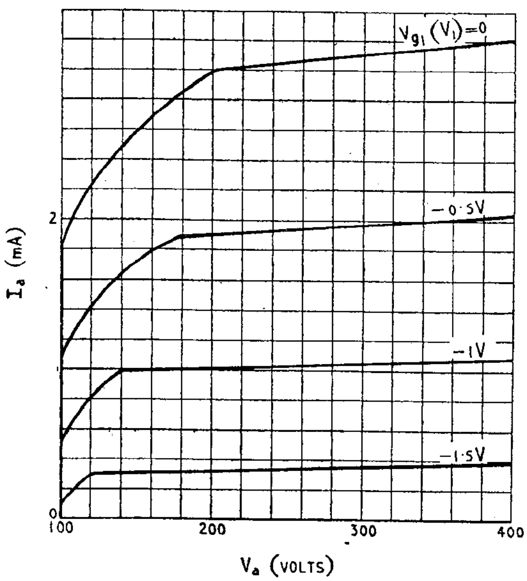


Fig. 4. ECC 35.

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

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

Long-delay Relay Circuit

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 thyratron, 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 thyratron heater is switched on—for example the circuit might obtain its power from the same transformer as that which supplies the thyratron 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 thyratron.

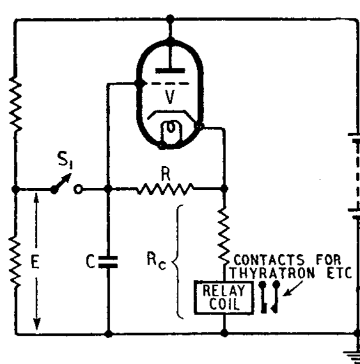


Fig. 5. Relay time-delay circuit.

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