TECHNICAL DESCRIPTION

MARCONI-E.M.I. SYSTEM OF TELEVISION

PART 12. PROGRAMME FADING APPARATUS

CONTENTS

THE PROGRAMME FADING APPARATUS

Since there are a number of sources, such as the various studios and the O.B. units, from which the programme radiated from the Vision Transmitter may originate, it is necessary to provide means by which these various sources can be switched to the Vision Transmitter in succession. It will be evident that it is not sufficient to fade down the first programme by means of a simple potentiometer and subsequently fade up the second programme, because the fading process will operate upon the synchronising signals as well as the picture, and over a considerable part of the fading period synchronism will be lost at the receiver. It is preferable to provide some arrangement by which the picture of the first programme is faded down while the accompanying synchronising signals are maintained at full strength, a rapid change is made to the synchronising signals of the second programme, and the picture of the second programme is then faded up. Such considerations rule out simple potentiometer methods of fading, and require the provision of apparatus which will enable the fading process to act upon the picture components of the signals alone.

It will also be realised that where a number of programme sources, such as the studios of the London Television Station, are being fed with timing pulses from a central source, and arrangements are made that the synchronising signals associated with each programme source are themselves mutually in synchronism, it is possible to mix the outputs from two such sources by straightforward superimposition. The two sets of superimposed synchronising signals, being in synchronism as regards their timing and in parallel as regards their amplitude, will clearly behave as one.

Apparatus to carry out the functions of fading and mixing incoming programmes and delivering one programme to the Vision Transmitter has been provided, and is known collectively as the Programme Fading Apparatus.

The general principle of operation of this apparatus is illustrated in the schematic shown in Fig. 1. Let us suppose that a programme A is being radiated, and that it is desired to change over to a programme B. The programmes A and B are applied to the ends of a potentiometer P, whose centre point may be regarded for the moment as being earthed. The output from the slider of the potentiometer P is applied to a valve circuit, shown as V, this input being indicated as I_1. The programmes A and B are also applied to a change-over switch S, which enables either of them to be applied at full amplitude to the valve circuit V in the form of a second input, shown as I_2. The valve circuit V exercises no influence on the input I_1 other than to pass it through to the main output unchanged, but it behaves differently towards the input I_2, and extracts the synchronising signals only from this input by suppressing the picture components. The extracted synchronising signals from I_2 are then mixed with the unchanged input I_1 to form the main output. When the programme A is being normally radiated, the setting of the potentiometer P and of the switch S are as shown in Fig. 1, and the main output from the valve circuit V may be considered as being formed from three components :—

1. Programme A picture components from the input I_1
2. Programme A sync components from the input I_1
3. Programme A sync components from the input I_2

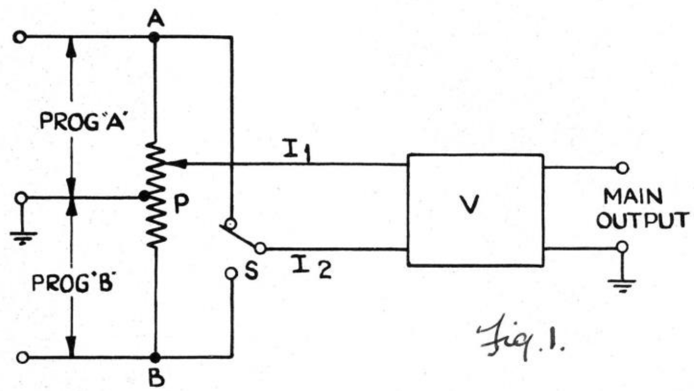

Fig. 1.

The two sets of synchronising signals under 2 and 3 above, being identical in all respects and superimposed, behave, therefore, as one set, and the apparatus in Fig. 1 has not so far effectively modified the input of Programme A.

When it is desired to fade down Programme A and fade up Programme B, the potentiometer P is rotated to its central position. This clearly suppresses the input I_1, but leaves unchanged the input I_2, so that the main output now consists of programme A sync signals only. A small further degree of rotation of the potentiometer remotely changes over the switch S. The position now is that the input I_1 is still suppressed, but the input I_2 now consists of programme B, and since the process of sync extraction from I_2 in the valve circuit V still continues, the main output consists of synchronising signals only from programme B. On completing the rotation of the potentiometer P to the position B in Fig. 1, the input I_1 reappears, but now consists

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of the programme B, so that the output now consists of the following three components :—

1. Programme B picture signals from the input I_1
2. Programme B sync signals from the input I_1
3. Programme B sync signals from the input I_2

As before, the two sets of synchronising signals, being identical and superimposed, behave as one, and the programme B is now passing through the apparatus substantially unchanged in form.

The facility of mixing is simply provided by removing the earth from the centre of the potentiometer P, when it will be evident that instead of programme A being completely faded down before programme B commences to be faded up, the fading up of programme B will proceed gradually and coincidently with the fading down of programme A, a full mixture being obtained with the potentiometer in its central position. Apart from the mixed synchronising signals which will now be entering the valve circuit via the input I_1, further synchronising signals from either programme A or B will be injected via the input I_2, depending upon the exact position of the potentiometer and the consequent position of the switch S, but since all these synchronising signals are coincident, this point is of no importance.

The fading potentiometer P is in the form of a separate rack mounted unit known as the Fading Potentiometer Panel. The valve circuit V is a rack mounted unit termed the Programme Fader Amplifier. It delivers its output to a Distribution Amplifier, which is similar but not identical to the type described in Item 5.7. The output levels from this amplifier are the standard transmission and monitor levels of the system. Thus, the apparatus as a whole effects no change in the levels of signals passing through it, and the outgoing black, white and sync levels to the transmitter or monitors are identical with those incoming from any programme source.

In order that any chosen pair of programme sources may be applied to the respective ends A and B in the fading potentiometer, a series of relays are provided, and are incorporated in the rack mounted panel known as the Programme Relay Panel. Certain other relays are provided on this panel, which give interlocking facilities to be described later.

It is desirable that the picture from a programme source which is about to be transmitted should be previewed before actually being radiated, just as the pictures from individual cameras in a programme source are previewed before being sent out as the programme from that source. To this end, each programme supplies a second input, having the standard monitor levels, to a further system of relays incorporated in a rack mounted panel known as the Monitor Relay Panel, and by means of which the monitor input from any programme source can be applied to a preview monitor adjacent to the apparatus.

The operation of the above Programme and Monitor Relay Panels, together with the fading or mixing operation, is carried out remotely from a position known as the Central Vision Mixing Desk.

The Programme Fading Apparatus as a whole, therefore, comprises the following sections of apparatus :—

(1) The Fading Potentiometer Panel
(2) Two Programme Fader Amplifiers (one spare)
(3) Three Distribution Amplifiers (this number being required in order that an adequate number of outputs may be available)
(4) The Programme Relay Panel
(5) The Monitor Relay Panel
(6) Jack strips (in order to enable the programme source, transmission and monitor inputs to be applied to the appropriate relays)
(7) Suitable H.T., L.T. and grid bias supplies
(8) Stabilisers

In the descriptions which follow, the Fading Potentiometer Panel, Programme Fader Amplifier and Distribution Amplifier will be treated in detail, and the Central Vision Mixing Desk and its associated Programme and Monitor Relay Panels will be covered in general terms, as the operation of this section of the apparatus follows established principles. The Stabilisers have already been described in Item 6.2. The remaining items are of straightforward design, and do not warrant inclusion in this description.

THE FADING POTENTIOMETER PANEL

In the interests of simplicity, we will first consider the problem of fading down a single programme, and proceed later to a consideration of the question of fading down one programme and fading up a second in one continuous operation.

It is not easy to employ a potentiometer at all for fading television signals unless it is possible to give its impedance a very low value. The reason may be seen by reference to Fig. 1, in which is shown a potentiometer whose slider is set at any intermediate position. The condenser C represents the stray capacity across the slider. It is evident that unless the resistance of the potentiometer and the capacity C are kept below certain limits, the impedance between the points B and C at the upper frequencies will be less than that at the lower frequencies, while the impedance between A and B will remain constant with frequency. The potentiometer will not, therefore, reduce the amplitude of all frequencies equally, but the upper frequencies will suffer a comparatively greater reduction. In order to keep C to a minimum, the length of lead between the slider and the subsequent apparatus should be as short as possible. This makes it desirable for any such vision frequency potentiometer to be rack mounted alongside its associated apparatus, and if control is desired from a remote desk, then some system of remote rotation of the rack mounted potentiometer should be provided. This feature is adopted in the case of the programme fading potentiometer, its spindle being driven by the rotor of a Selsyn motor which is energised by a corresponding Selsyn motor mounted in the Central Vision Mixing Desk.

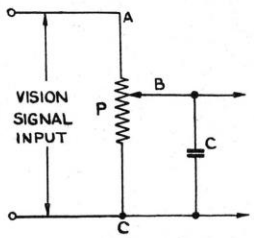

Figure 1

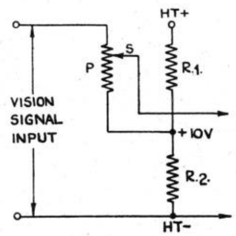

Figure 2

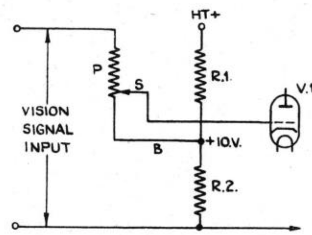

Figure 3

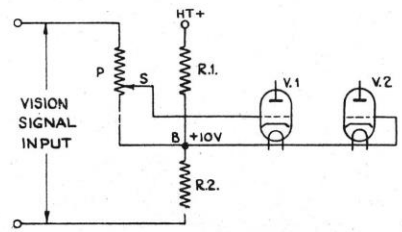

Figure 4

The incoming signals which are applied to the fading potentiometer have the standard transmission levels (White Level +16.5V ; Black Level, +10V ; Sync Level, +3.5V). Since we wish to fade the picture and
297 synchronising signals to zero about a datum corresponding to black level, it is clear that the lower end of the potentiometer must be returned, not to earth, but to a point artificially maintained at black level, i.e. at +10V with respect to earth. (This point has been more fully explained in relation to a corresponding circuit in the Picture Monitor, see Item 10.1, page 3.) As batteries are inadmissible, this artificial black level must be derived from a voltage divider across some appropriate H.T. line, the circuit now being as in Fig. 2, where the voltage divider is shown as R_1 R_2. It will be seen that the resistance R_2 is included between the lower end of the potentiometer P and earth, so that vision frequency potentials will exist across R_2, being supplied to this resistance from the input through the potentiometer P. If, therefore, the slider S of the potentiometer is intended to feed the grid of a valve whose cathode circuits are earthed, as they must be if a common H.T. supply is to be used, then this valve will be energised by vision frequency potentials even when the slider of the potentiometer P is in its minimum position, because the input to the valve is now effectively connected across R_2. This state of affairs is illustrated in Fig. 3. It follows, therefore, that it is impossible to fade this programme completely out. The potentials across R_2 could be eliminated, except for the D.C. component, by shunting it with a large condenser, but although the fraction of this component existing across R_2 will be small if the resistance of the potentiometer is large compared with R_2, it is considered preferable to secure complete cancellation of all potentials across R_2. This is done by introducing a further valve, V_2, with its grid connected to the point B, and forming a push-pull amplifier with V_1. This arrangement is shown in Fig. 4. Now, when the potentiometer P is faded completely down, the grids of both V_1 and V_2 are connected to the junction B of the potential divider, and the unwanted voltage across R_2 energises the two grids in phase. Since, however, the valves are in push-pull there will be no output from their anode circuits.

We have now to modify the circuit so that not only can programme A be faded down, but programme B can be faded up, the two fades being executed as one smooth operation. It follows that the potentiometer P must be rearranged so that its centre point is connected to the junction B of the potential divider, and the two programmes are applied to its two ends. This arrangement is shown in Fig. 5.

A difficulty now arises in that when, for example, programme A is being radiated, it will be accompanied by a small proportion of programme B,

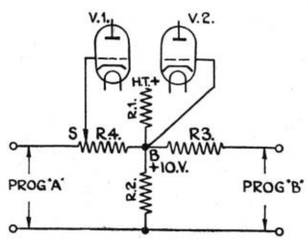

Figure 5

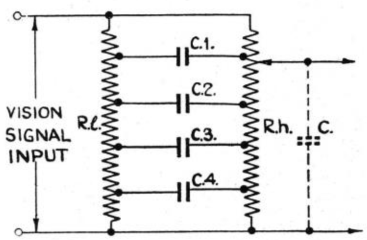

Figure 6

and vice versa. Referring to Fig. 5, if R_3 is the resistance of the right-hand half of the potentiometer P, and if V_B is the voltage corresponding to programme B, then a fraction of this programme, approximately given by $\frac{R_2\ V_B}{R_2 + R_3}$, will appear across R_2. This programme B voltage across R_2 will send a current through the other half of the potentiometer R_4 and the programme A output, in series, and thus voltages corresponding to programme B will be developed between the slider S and the point B, and will therefore appear at the grid of V_1. To reduce this to a minimum, R_3 must be made much greater than R_2. Unless the watts consumed in the potentiometer R_1 R_2 are to be excessive, R_2 cannot be of too low a value, and in practice it is made 625 ohms. R_3 must be considerably greater than R_2, and has been given a value of 140,000 ohms. Similarly, in order that programme A may not interfere with programme B when the latter is being radiated, R_4 must be given a high resistance, and is made equal to R_3 at 140,000 ohms. It has, however, already been stated that the use of such a high resistance potentiometer will result in considerable attenuation of the upper frequencies and is therefore inadmissible. It is possible, to overcome this difficulty by employing a form of double potentiometer, the principle of which is illustrated in Fig. 6. In this diagram, R_h represents a simple potentiometer for controlling the amplitude of vision signals, and which is obliged by other considerations to be of high resistance. The upper frequencies are therefore attenuated by virtue of the presence of the stray output capacity C. In parallel with R_h, however, is connected a further resistance R_l, of comparatively low resistance, and joined at intervals to R_h by a system of condensers C_1 to C_4. Owing to the low resistance of R_l, the potential gradient along it will be the same for all frequencies over the working range. The condensers C_1 to C_4 will feed A.C. potentials to the high resistance potentiometer R_h, the amplitude at each condenser being proportional to its position along the potential gradient. Applying this principle to the double sided potentiometer of Fig. 5, we have the circuit of Fig. 7.

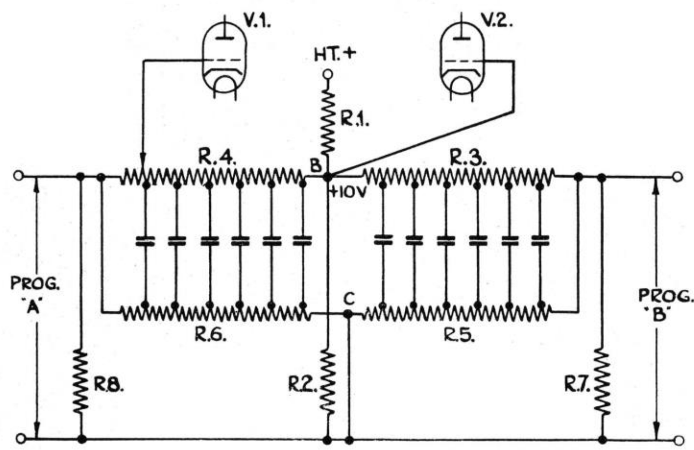

Figure 7

The high resistance potentiometer R_h of Fig. 6 is represented by $R_3 + R_4$ in Fig. 7, and R_l of Fig. 6 by $R_5 + R_6$ of Fig. 7. The centre point B of $R_3 R_4$ in Fig. 7 is still maintained at a black level of +10V by the H.T. potential divider $R_1 R_2$, but since the lower potentiometer $R_5 R_6$ is concerned with A.C. potentials only, it may have its centre point C earthed. The upper potentiometer R_3 R_4 may conveniently be termed the D.C. potentiometer, and the lower potentiometer R_5 R_6 the A.C. potentiometer. To make the schematic more complete the resistances R_7 and R_8, which must be provided to terminate the incoming programme lines in their characteristic impedances, have also been added. The value of these resistances will clearly be somewhat greater than the characteristic impedance of the lines since the potentiometers are effectively in parallel with them.

Referring now to the actual circuit diagram of the apparatus, Fig. 10, the practical interpretation of the schematic Fig. 7 can be seen. 298

In Fig. 10, R_3 of Fig. 7 is represented by the resistances	$R105$—$R114$ inclusive	
,, ,, ,, R_4 ,, ,, ,, ,, ,, ,, ,, ,,	R 95—$R104$	,,
,, ,, ,, R_5 ,, ,, ,, ,, ,, ,, ,, ,,	$R126$—$R135$	,,
,, ,, ,, R_6 ,, ,, ,, ,, ,, ,, ,, ,,	$R116$—$R125$	,,
,, ,, ,, R_7 ,, ,, ,, ,, ,, ,, ,, ,,	$R137$	
,, ,, ,, R_8 ,, ,, ,, ,, ,, ,, ,, ,,	$R136$	
,, ,, ,, R_1 ,, ,, ,, ,, ,, ,, ,, ,,	$R38$, $R45$, $R46$, $R44$ and $R43$	
,, ,, ,, R_2 ,, ,, ,, ,, ,, ,, ,, ,,	$R40$ and $R41$	

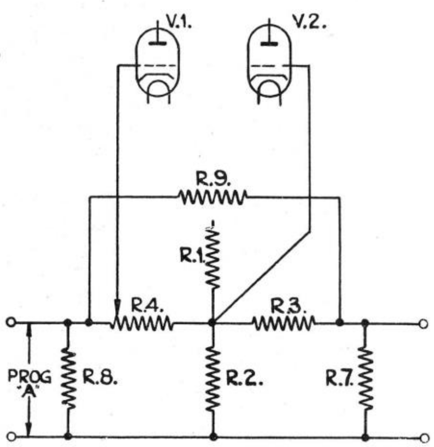

Figure 8

The system of condensers in Fig. 7 is represented by its equivalent in Fig. 10, composed of C_{68} to C_{86} inclusive.

When a 'fade' between the two programmes is desired, the contacts K_1 and K_2 are held closed by the relay RY_{21}, so that the circuit is substantially as already described. When a 'mix' is required, however, the relay RY_{21} opens the contacts K_1 K_2, which removes the centre point connections to the D.C. and A.C. potentiometers, and thus allows the voltages from the two programmes to be smoothly developed along the potentiometers from one end to the other. In this connection, however, a further precaution is required. In both the 'fade' and 'mix' positions, that is to say, with the contact K_1 either closed or open, the standing potential along the D.C. potentiometer is $+10$V. As regards the A.C. potentiometer, however, in the 'fade' position with K_2 closed, the standing potential is 10V at each end, but falls off to zero at the centre, since this point is earthed. A very slight
299 difference of potential will therefore exist across the extreme end condensers C_{68} and C_{86}, and a somewhat greater difference across the next two condensers C_{69} and C_{85}, this difference increasing until the centre condenser C_{77} carries across it the full difference of 10V. When, in preparation for a 'mix,' the relay RY_{21} opens the contact K_2, earth is removed from the centre point of the A.C. potentiometer and, since the ends of the slider are connected to the ends of the D.C. potentiometer, the A.C. potentiometer is free to take up a uniform standing potential of 10V along the whole of its length. All the condensers C_{68} to C_{86} therefore discharge, the potentials on each side being equalised at 10V. This would cause a surge in the radiated picture, which is

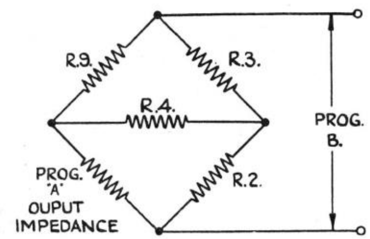

Figure 9

undesirable. This is obviated by returning the centre point C of the A.C. potentiometer, not specifically to earth, but to the junction of R_{42} and R_{47} on the negative H.T. potentiometer $R_{39}R_{50}R_{49}R_{48}R_{47}R_{42}$, when, by suitable choice of component values, the point C can be maintained at zero potential whether K_2 is open or closed. In order that the centre points of the D.C. and A.C. potentiometers may be adjusted exactly to $+10$V and 0V respectively, the elements R_{38} and R_{39} of the positive and negative potential dividers are brought out to manual controls designated **D.C. Potr. Centre Voltage** and **A.C. Potr. Centre Voltage,** respectively. The values of these potentials may be examined by means of the monitoring jacks J_1 and J_2.

It has already been observed that in order to minimise the interference with one programme which must occur owing to the presence of a small voltage due to the other programme across the lower section of the potential divider R_2 in Fig. 5, the resistances R_3 and R_4, also of Fig. 5, must be made much greater than R_2, but it will be appreciated that this measure merely

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[*Figure 10 attached*]

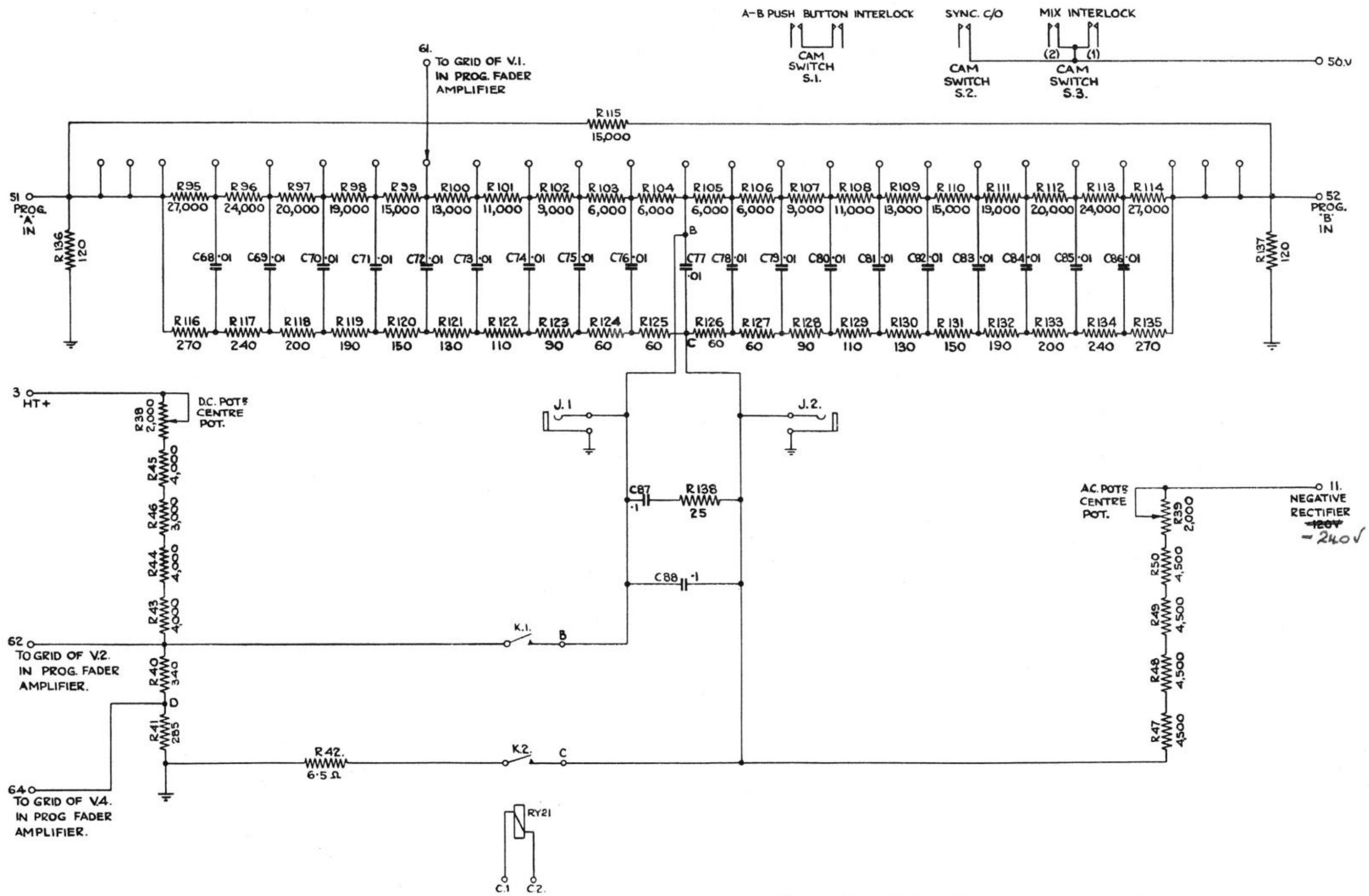


Figure 10. Fading Potentiometer Panel

secures a considerable reduction, and not complete extinction of the interference. Complete cancellation, however, is effected by adopting the modification shown in Fig. 8. In this diagram the circuit is that shown in Fig. 5 with the addition of a resistance R_9 across the whole of the potentiometer $R_3 + R_4$. Supposing programme A is faded up, then a voltage corresponding to programme B is developed across R_2, and this voltage drives a current through R_4, thus giving rise to interference. Referring to Fig. 8, the interference from programme B clearly tends to place a positive potential on the grid of V_2. However, by adding R_9 a small voltage, also from programme B, is applied to the grid of V_1, and by choosing a value of R_9 correctly the voltage imposed on the grid of V_1 can be made equal to that on the grid of V_2. In that case, since V_1 and V_2 are in push-pull, there will be no resultant output corresponding to programme B. The circuit comprising R_2 R_3 R_4 R_9 and the output impedance of programme A, in fact form a bridge, as shown in Fig. 9. From this it can easily be seen that if the component values are mutually correct there can be no current from programme B in R_4. A similar argument, of course, applies when programme B is faded up and programme A constitutes the interfering source.

Upon the shaft of the double potentiometer are mounted three cam switches, S_1, S_2, and S_3, the function of which will be described in greater detail when the Mixing Desk itself is considered.

THE PROGRAMME FADER AMPLIFIER—TYPE 1A

It has been explained (see Item 12.0) that the function of this unit is fundamentally to permit of the fading down of the picture components of vision signals, and that actually the picture and synchronising components, are both faded down together but provision is made for by-passing a supply of synchronising signals only, continuously injected into the amplifier.

The circuit comprises three pairs of push-pull amplifiers, V_1 V_2, V_3 V_4 and V_5 V_6, and an output cathode follower V_7. The push-pull amplifier V_1 V_2 contributes the picture and synchronising signals, the amplitude of which is under control by means of the Fading Potentiometer Panel already described, and the amplifier V_3 V_4 contributes the supply of synchronising signals only. The outputs of the amplifiers V_1 V_2 and V_3 V_4 must therefore be mixed, and it will be seen that the anode circuits of the corresponding valves in these amplifiers are common, that is to say, the outputs of the anodes of V_1 and V_3 are mixed, and also the outputs of the anodes of V_2 and V_4. The common push-pull output from these two push-pull amplifiers now contains vision and synchronising signals in which, in effect, the picture components only have been controlled in amplitude by the fading potentiometer, but owing to the continuous injection of synchronising signals by V_3 V_4, the absolute amplitude of the synchronising components has been doubled and the picture/sync ratio therefore halved. The function of the further push-pull amplifier V_5 V_6 is to correct the picture/sync ratio to the desired figure of 1 / 1. Finally, the single output valve V_7 delivers the signal to the next piece of apparatus, which is the Distribution Amplifier.

Considering the circuit in detail, the grid of V_1 receives an input of picture and synchronising signals in the positive sense from the slider of the Fading Potentiometer Panel, via terminal 61 of that unit. The necessity for push-pull amplification, and therefore of the valve V_2, has already been described in the preceding section, and its grid receives, as also indicated in that section, an input of pure black level, i.e. a steady positive potential of +10V derived from the point B on the potential divider of the Fading Potentiometer Panel and leaving that unit via terminal 62. It will be remembered that there is also superimposed upon this black level a residue of vision frequency potentials arising from the operation of the Fading Potentiometer Panel. This, being also present upon the grid of V_1, will not appear in the anode output of this amplifier. The cathode circuit of the amplifier V_1 V_2 contains the common resistances R_{121}, R_{122} and R_{123}, which confer on it the property of automatic push-pull operation, a feature which need not be dealt with again here, as it has been described elsewhere (for example, Item 7.8, page 6, The Monitoring D.C. Amplifier). The gain
301 of the amplifier may be preset to two determined levels by means of the resistances R_{108} and R_{107}. The inductance L_7 corrects for the capacity in shunt to the common cathode resistances, which, if uncorrected, would upset the push-pull operation by increasing the output at the anode of V_1, while decreasing that at the anode of V_2. This can easily be seen if the shunt capacity is assumed to be sufficiently large that beyond a certain upper limit of frequency it completely short-circuits the common cathode resistance. In such a case V_1 clearly behaves as an ordinary amplifier without cathode feed-back and its output is much greater than normal, while V_2 is a passenger because owing to the absence of cathode potentials the grid-cathode circuit of V_2 is not energised.

At the anode circuits of V_1 and V_2, therefore, we have picture and synchronising signals in push-pull, the PICTURE signals being negative at the anode of V_1 and positive at the anode of V_2.

Turning now to the amplifier V_3 V_4, this must extract only synchronising signals from the complete vision input. A supply of the latter derived from one or other of the two incoming programmes (selection being carried out by the Programme Relay Panel) is therefore applied to the grid of V_3. To the grid of V_4 is applied a fixed potential of +4.5V derived from the point D on the potential divider in the Fading Potentiometer Panel, and leaving that unit via terminal 64. The amplifier V_3 V_4 operates automatically in push-pull by virtue of the presence of the common cathode resistances R_{127}, R_{128} and R_{129}. The presence of these resistances has the effect of rendering both cathodes strongly positive, the value being +13.5V at black level. Since the standing potential of the grid of V_4 has been fixed at +4.5V, it follows that the grid-cathode potential of this valve has the value of −9V at black level. The sense of the vision signals on the grid of V_3 is positive, and therefore by virtue of the push-pull action is negative at the grid of V_4. It follows that picture signals drive the grid-cathode potential of V_4 more negative than −9V, the value at black level. However, the circuit is so arranged that a grid-cathode potential of −9V is on the cut-off point of the operating characteristic, and a negative potential greater than this figure cuts off the valve. As far as picture signals are concerned, therefore, V_4 is cut off and inoperative. Now when V_4 is operative, it may be considered by itself as a cathode follower, since it is a valve in whose cathode there is a large unshunted resistance. Its cathode-earth impedance therefore has a low value (which is the normal property of cathode followers) and shunts the actual cathode impedance of 15,000 ohms provided by R_{127}, R_{128} and R_{129} in series. (Similarly, it follows that from the point of view of V_4, V_3 is a cathode follower whose impedance is in shunt with the 15,000 ohm cathode resistance.) When V_4 is inoperative, however, it is no longer a cathode follower, and in fact may be considered as having been removed from circuit, therefore the cathode-earth impedance of V_3 rises to the full value of $R_{127}\,R_{128}\,R_{129}$, i.e. 15,000 ohms. V_3 then acts as an anode-coupled amplifier with very heavy anti-phase cathode feed-back, and only a very small output will appear in its anode. We have already seen that in these circumstances there can be no output in the anode of V_4 because it is cut off, and it therefore follows that during picture excursions the complete push-pull amplifier formed by V_3 and V_4 provides an almost negligible anode output. On synchronising signals, however, the grid-cathode potential of V_4 is making excursions in the positive sense from the black level at -9V, and the valve is normally operative. The common cathode impedance of the two valves is now low, and V_3 is normally operative, as the heavy feed-back present when V_4 was inoperative has now been eliminated. The pair of valves, therefore, function normally as a push-pull amplifier on synchronising signals, and it is clear that by their action they suppress the picture components. The synchronising signals appear in the anode circuit of V_3 as positive excursions, and in V_4 as negative excursions. The sense of the signals in the anode circuit of V_3 is the same as the sense in that of V_1. These two anodes are therefore coupled together by means of the common anode resistance R_{90} and the common anode inductance L_1, which forms the usual termination for the subsequent intervalve coupling filter. The anode circuits of V_2 and V_4 are similarly coupled.

It was pointed out above that the extinction of picture signals by the amplifier $V_3\,V_4$ is not complete, there being a small residue of picture signals negative in sense at the anode of V_3, and positive at the anode of V_4. The cancellation would only be complete if the feed-back was infinite, that is to say if the collective value of R_{127}, R_{128} and R_{129} also was infinite. It is, however, made complete by the following additional precautions. The full input of picture and synchronising signals, as well as being applied to the grid of V_3, is applied to the potentiometer $R_{110}\,R_{109}$, the junction of which is connected to the grid of V_2. The lower end of R_{109} is returned, as has already been described, to the potential divider junction in the Fading Potentiometer Panel, so that V_2 can be supplied with its desired standing D.C. potential of $+10$V. Superimposed on this standing potential, however, there will clearly be a small proportion of picture and synchronising signals in the normal, or positive, sense, derived from the junction of R_{110} and R_{109}. These will energise the grid of V_2 in the positive sense, and by virtue of the push-pull operation of this valve and V_1, the grid of the latter will be energised in the negative sense. V_1 and V_2 now amplify these small inputs, which appear in the anode circuit of V_1 in the positive sense, and at the anode of V_2 in the negative sense. But the normal sense of the picture signals in the common anode circuit of V_1 and V_3 is negative, so that by suitably proportioning the elements R_{110} and R_{109}, the residue of negative picture signals emanating from the anode of V_3 can be exactly cancelled out. The same argument applies to the common anode circuit of V_2 and V_4, where the sense of the picture signals is normally positive, and the residue from the anode of V_4 is again positive, but where the amplified input from the potentiometer R_{110} and R_{109} is, of course, negative.

Even now the cancellation of the picture residue from $V_3\,V_4$ is not complete. We have seen that this residue is due to the incomplete feed-back provided by $R_{127}\,R_{128}\,R_{129}$ when unshunted by the cathode impedance of V_4. At the upper frequencies, however, these resistances are shunted by the natural stray capacities of the circuit and the feed-back is reduced, so that the residue in the anode circuits of V_3 and V_4 is greater. Means must therefore be provided to increase the cancellation at the upper frequencies. This is done by shunting the resistance R_{110} with the small condenser C_{56}, which increases the amount of anti-phase upper frequencies injected into the output by V_1 and V_2.

At the common anode circuits of $V_1\,V_3$ and $V_2\,V_4$, we have, when the fading potentiometer is faded up, picture and synchronising signals, and when it is faded down, synchronising signals only. These outputs are applied to the grids of the further push-pull amplifier $V_5\,V_6$ via the usual prototype low-pass filter coupling elements L_2 and L_4.

D.C. couplings are employed, the D.C. components being reduced in amplitude, in the one case by the elements R_{95} and R_{113}, and in the other case by R_{94} and R_{111}, and the A.C. components are by-passed by the condensers C_{58} and C_{57} in accordance with the usual technique.

At the grids of V_5 and V_6 the following grid-earth levels apply :—

	V_5	V_6
White level	-6.5	$+9.5$
Black level	0	$+3.0$
Sync level	$+16$	-13

These levels are obtained by returning the grid leaks to the junction of the resistances R_{117} and R_{118}, which form a potentiometer across the negative H.T. supply from the Negative Rectifier, and at their junction there exists a potential of -80V. The sense of the signals is negative at V_5 and positive at V_6, but in addition it will be noted that the continuous injection of additional synchronising signals by the amplifier $V_3\,V_4$ has resulted in an increase of their amplitude relative to the picture signals, and the picture/sync ratio has now fallen to 1/2.46. It is the function of the amplifier $V_5\,V_6$ to correct this ratio to its original figure of 1/1. This is done as follows.

The amplifier cathodes are provided in this case with separate cathode resistances formed by R_{136}, R_{137}, R_{138} and R_{139} for V_5, and R_{130}, R_{131} and R_{132} for V_6. The two cathodes are, however, linked by the further resistance R_{112}, which enables potentials from one cathode to be communicated to the other, so that push-pull operation automatically follows. As has been described elsewhere, the effect of the resistance R_{112} is to reduce the stage gain of the amplifier below the maximum which it could give if R_{112} were absent 302 and if instead a single common cathode resistance were provided for the two valves.

The provision of a separate cathode impedance for V_6 enables the standing potential of the cathode to be chosen, and it is so adjusted that the cathode-earth potential corresponding to black level is $+8.5$V. We have seen above that the grid-earth potential of this valve at black level is $+3$V. The grid-cathode potential at black level is therefore -5.5V. Under conditions of white level the grid-earth potential becomes $+9.5$V, and the cathode-earth potential $+12$V, so that the grid-cathode potential is now -2.5V. Over this range of grid cathode potentials linear amplification of the picture component obtains. A synchronising signal develops a grid-earth potential of -13V, but the circuit components of this amplifier have been chosen in a similar manner to the arrangement of the previous amplifier V_3 V_4, so that grid-earth potentials of greater than -8.5V completely cut off the anode current. With no anode current the cathode-earth potential is zero, and the grid-cathode potential is -8.5V. The following table summarises these results.

	White Level	*Black Level*	*Sync Level*
Grid-earth potential of V_6 ..	$+$ 9.5	$+$ 3	-13
Cathode-earth potential of V_6	$+12$	$+$ 8.5	0
Grid-cathode potential of V_6	$-$ 2.5	$-$ 5.5	$-$ 8.5

This table shows that whereas the picture/sync ratio of the input to this amplifier (the grid-earth potential) is 1/2.46, the picture/sync ratio of the effective grid swing to which the anode output will correspond, is 1/1. The amplifier, therefore, by cutting off the excessive sync amplitude, has restored the picture/sync ratio to its original value. As before, when V_6 cuts off, its low cathode-earth impedance, which by virtue of its behaving as a cathode follower was in shunt to the collective system of resistances in the common cathode circuit, is removed. V_5 then suffers very heavy feed-back, so that it delivers a negligible output for those excessive amplitudes of input synchronising signal during which V_6 is cut off. In order that the adjustment of picture/sync ratio may be under manual control, the cut-off point of V_6 should be variable over a small range, and accordingly the cathode resistance R_{32} is brought out for a manual control designated **Sync Amplitude.**

At the anode circuit of V_5 and V_6 there appears a push-pull output of picture and sync signals having a picture/sync ratio of 1/1, the sense being positive at the anode of V_5 and negative at V_6. As a simple asymmetrical output in the positive sense is all that is required, the output from V_6 is ignored. That from the anode of V_5 is applied to the grid of the output cathode follower V_7 via the usual type of coupling, involving the prototype filter inductance L_6, the terminating elements R_{93} and L_5, and the usual elements R_{96}, R_{114} and C_{59} to reduce the standing D.C. potential. The cathode output of V_7 feeds the subsequent unit, which is a Distribution Amplifier of somewhat different type from that described in Item 5.7, and requiring an input black level of 1.2V. The actual cathode potential of V_7 must be $+1.2$V, and the grid potential must be somewhat lower. Clearly, such a potential cannot be obtained by returning the grid resistance of this valve to earth, and to obtain the requisite negative potential it is returned to the potentiometer R_{67}, which, with the further resistance R_{119}, forms a further potential divider across the -120V supply. The black level should be capable of manual adjustment, and R_{67} is therefore brought out as a manual control designated **Black Level.**

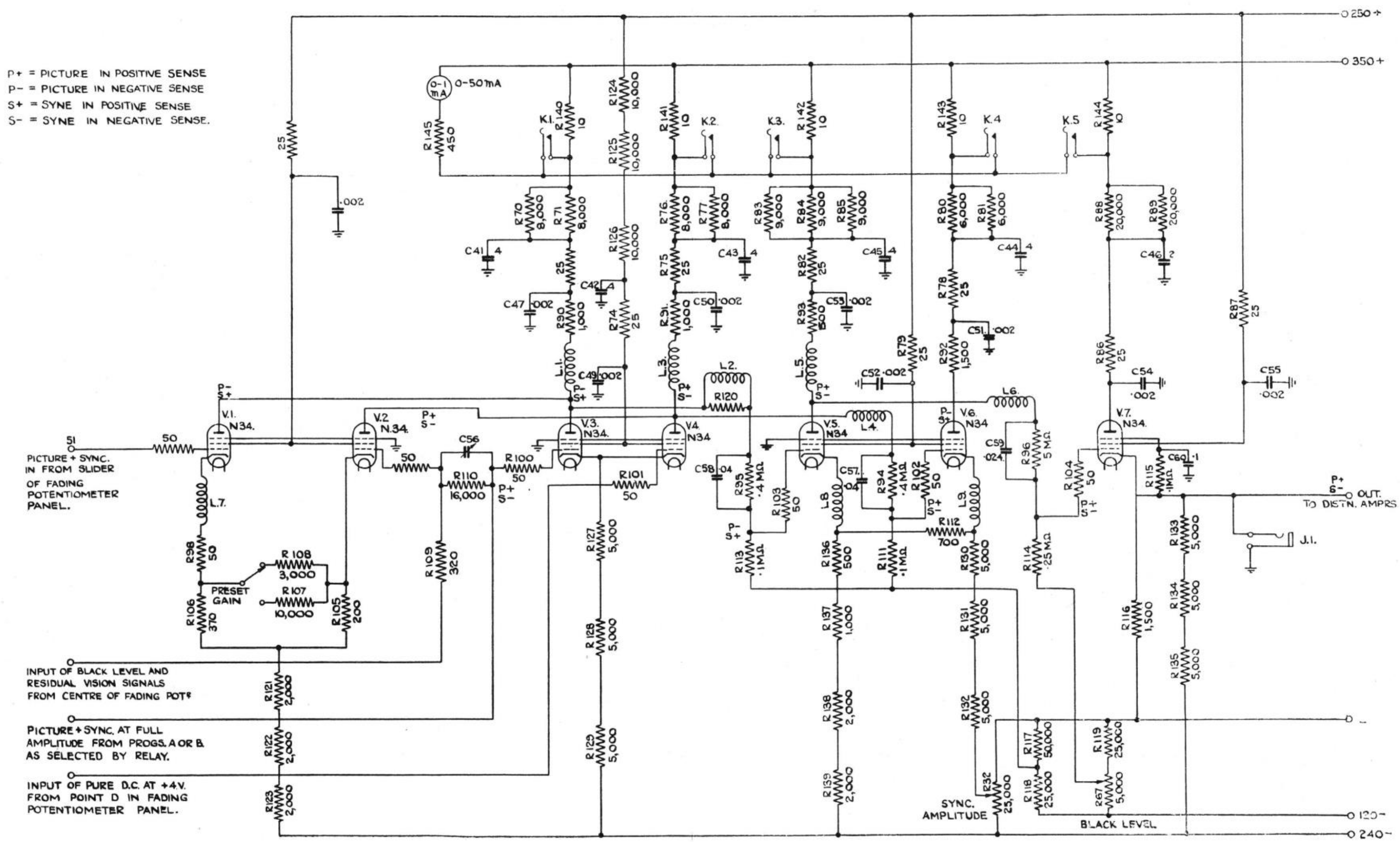


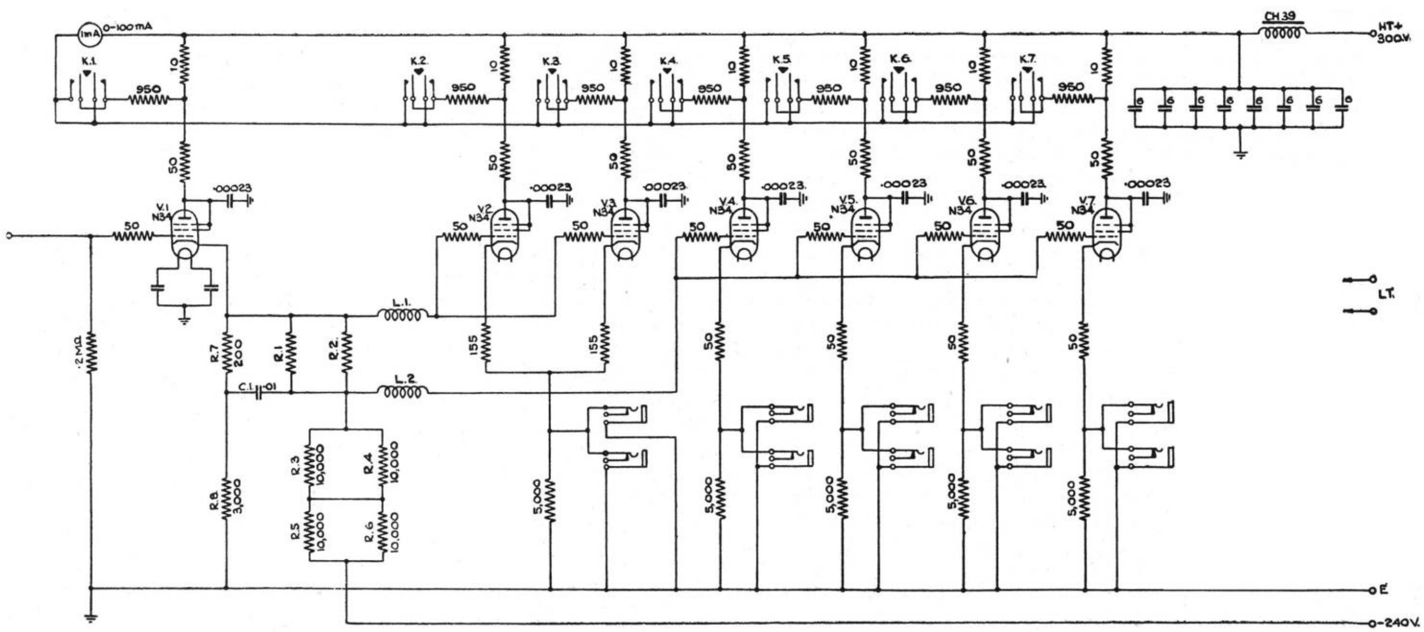
Figure 1. Programme Fader Amplifier (Type 1A)

THE DISTRIBUTION AMPLIFIER—TYPE 2C

The function of this unit is to receive an input of picture and synchronising signals from the Programme Fading Amplifier, and to provide a number of outputs having the standard transmission or monitor levels. The circuit will be recognised as being substantially similar to the Distribution Amplifier already described in Item 5.7 (Distribution Amplifier, Type 2a), except that it is simpler. This difference, which consists in the absence of a negative hold-off voltage between V_1 and the subsequent valves, arises owing to the fact that the black level of +1.2V emerging from the Programme Fading Amplifier is comparatively low, and also that the Distribution Amplifier can be designed with the knowledge that a negative H.T. supply is available, as it has been already provided for the Programme Fader Amplifier.

The valves V_2 to V_7 are cathode followers whose output circuits may be connected, in the manner described in Item 5.7, to form transmission outputs of 110 ohms impedance or monitor outputs of 140 ohms impedance. The valves V_2 and V_3 are parallel connected to form a 110 ohm output, and each of the valves V_4 to V_7 operate singly to form four 140 ohm outputs. The transmission levels at the output jacks of V_2 and V_3 must be W.L. +16.5V, B.L. +10V, and S.L. +3.5V, with a picture/sync ratio of 1/1, while the monitor levels at the output jacks of V_4 to V_7 must be W.L. +10V, B.L. +3.5V, and S.L. 0V, with a picture/sync ratio of 70/30. To achieve these levels, the black level at the grids of V_2 and V_3 must be +10.0V, while that at the grids of V_4 to V_7 must be −5.5V. The Programme Fading Amplifier, however, only provides a single output having black level at +1.2V. To derive from this the two necessary inputs for V_2, V_3 and for V_4, V_5, V_6, V_7, the additional valve V_1 is interposed. It is a cathode follower, whose cathode circuit is especially designed to provide two separate outputs having the above characteristics. In the first place, the cathode circuit is returned to the −240V negative H.T. supply via the resistances R_1 to R_6 inclusive, and the circuit components are so chosen that with a black level of +1.2V on the grid of V_1, the cathode potential of this valve takes up a black level of +10V and may be therefore directly connected to the grids of V_2 and V_3. The grids of V_4 to V_7, however, require a black level which is more negative than this, and such a potential is found at the junction of the resistances R_1 R_2 and R_3 R_4 R_5 R_6, since the elements R_1 R_2 and the further elements R_3 R_4 R_5 R_6 form two sections of a simple resistance potentiometer connected between points having potentials of +10V and −240V respectively. It will be seen, however, that this potentiometer action, which results in a reduction of the black level at the grids of V_4 to V_7 as compared with that at V_2 and V_3, will also reduce the amplitude of all vision frequency potentials, and it is necessary to ensure that the amplitude of all frequencies is equally reduced. Consideration of the necessary values of the resistances R_1 to R_6 and the shunt capacity from the junction to earth reveals that there will be relative attenuation of the upper frequencies, the result of which will be that the reproduction of detail in monitors fed from the valves V_4 to V_7 will be less satisfactory than the standard of the transmission. To obviate this difficulty, the further potentiometer R_7 R_8 is provided, and is connected between the cathode of V_1 and earth. Vision frequency potentials are, of course, developed across this also, but only a very small proportion of the standing anode current flows through this path, the main part flowing, as has already been described, in the other potentiometer R_1 to R_6. The ratio of the sections R_7 and R_8 is made the same as that of the sections of the other potentiometer R_1 R_2 R_3 R_4 R_5 R_6, so that at the junction of R_7 and R_8 the amplitude of the vision frequencies has been reduced in the same proportion as they should have been reduced in the potentiometer R_1 to R_6, were this of ideal design for such a purpose. Since the absolute values of the resistances R_7 and R_8 are comparatively low, the effect of the shunt capacity across R_8 is not important and there is no discrimination as between the upper and lower vision frequencies. Their relative amplitudes at the junction of R_7 and R_8 are therefore the same as they were at the cathode, although their absolute values have been reduced. The coupling condenser C_1 now passes these frequencies to the junction of the other potentiometer, and the frequency discrimination of the potentiometer R_1 to R_6 is therefore eliminated.

It is desirable to stress the difference between this circuit and the D.C. coupling circuit frequently employed in vision frequency units, such, for example, as the Suppression Mixer, since at first sight there seem to be some points of similarity between the two. In a circuit such as that employed between two stages of the Suppression Mixer, the object is to couple the anode of one valve to the grid of a second without any amplitude discrimination between any of the vision frequency components and the D.C. component, but to reduce the standing potential of the anode of the first valve since this cannot be directly applied to the grid of the second. To that end the standing D.C. potential is reduced by a resistance potentiometer, the vision frequency components are by-passed by a condenser across the upper elements of this potentiometer, and the loss of gain of the D.C. component is compensated in the decoupling circuit associated with the anode of the first valve. In the case of this type of Distribution Amplifier, however, whereas we still wish to reduce the standing potential of the cathode of V_1, which although correct for direct application to the grids of V_2 and V_3 is too high for the grids of V_4 to V_7, we cannot employ the same method, since there would then be a relative loss in the D.C. component applied to the valves V_4 to V_7. Such a loss could not be compensated for by the decoupling circuit technique, since V_1 is a cathode follower, and the circuit is therefore quite different. In the circumstances, therefore, we must reduce the A.C. components applied to the grids of V_4 to V_7 by the same amount as the inevitable loss in the D.C. component by means of the additional potentiometer R_7 and R_8. Actually included, and forms such a filter with the cathode capacity of V_1 on the one side and the grid capacity of V_2 V_3 on the other. A similar inductance L_2 corrects the coupling between V_1 and the grids of V_4 to V_7 for frequency and form a further low-pass filter with the stray capacity at the junction of the two resistance potentiometers on the one hand and with the grid



the operation of the two potentiometers formed by the resistances R_1 to R_8 and the coupling condenser C_1 is a similar technique to that employed in the Fading Potentiometer Panel already described.

In accordance with the usual technique, the coupling between V_1 and $V_2 V_3$ must be arranged to take the form of a prototype low-pass filter, if attenuation of the upper frequencies is to be avoided. The inductance L_1 is therefore capacity of V_4 to V_7 on the other. It will be seen, therefore, that these two inductances fulfil a different function from the inductances provided at approximately the same point in the circuit of the Distribution Amplifier, Type 2a (Item 5.7).

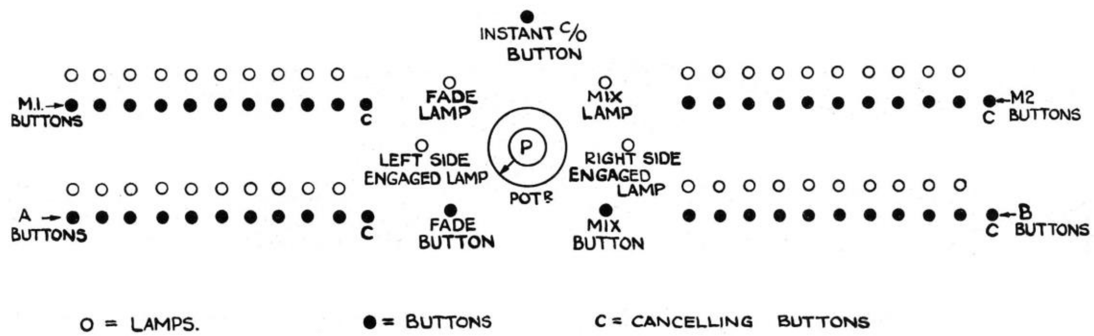
The remainder of the circuit, however, conforms entirely to the design of Type 2a, and will be already understood.

THE CENTRAL VISION MIXING DESK

The control, for programme purposes, of the Programme Fading Apparatus is carried out from a remote position known as the Central Vision Mixing Desk, the layout of which is illustrated.

Behind the Desk Panel and in the centre is a Selsyn motor, the spindle of which is brought out to the manual control knob shown at P, the windings of which are connected to the windings of the similar Selsyn motor in the Fading Potentiometer Panel. Any degree of rotation of the knob P, therefore, is reproduced by the Selsyn motors as a similar rotation of the rack mounted potentiometer, and the knob P is in effect the vision fading or mixing control.

and SM_2 relays in the Monitor Relay Panel. The depression of an M_1 or M_2 button operates the corresponding SM_1 or SM_2 relay, and applies the monitor input of the programme with which it is associated to one or other of the two preview monitors. The automatic cancelling of any button when another in the same group is operated, prevents two programmes being superimposed on the same monitor. In addition, the SM_1 and SM_2 relays are interlocked so as to prevent the application of any preview line to both preview monitors at the same time. For instance, if Studio A is being previewed upon Preview Monitor 1, by the operation of the **Studio A** button in the **SM1** group, then operation of the **Studio A** button in the **SM2** group will not apply this



The apparatus is designed to fade or mix between a maximum of 10 different incoming programmes, and in addition to provide simultaneous previewing of two programmes at the same time on two separate preview monitors. To this end, the desk is equipped with four sets of ten push buttons, shown as A, B, M_1 and M_2. These buttons are of the mechanical self-holding type, and any button, when operated, remains depressed until released by the operation of another button in the same group. In addition, each group of buttons is provided with a cancelling button. The four push-button units, A, B, M_1 and M_2, are associated with four corresponding banks of relays, designated PA, PB, SM_1 and SM_2, and of these, the PA and PB relays are mounted in the Programme Relay Panel, and the SM_1

programme to the second preview monitor. This is done because the paralleling of the two preview monitors on to one incoming preview line will clearly terminate it in 70 ohms instead of in the desired value of 140, and distortion of the signals would result.

The depression of any A button operates its associated PA relay, which applies the programme with which it is associated to the left-hand side of the Fading Potentiometer, while the operation of a B button similarly applies a programme to the right-hand side of the Fading Potentiometer Panel.

Since the A and B buttons control the actual transmission inputs of the incoming programmes, it is desirable to guard against a number of operational errors, and a rather more complex interlock system is associated with the A

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and B buttons and the corresponding PA and PB relays than is the case with the M_1 and M_2 buttons and SM_1 and SM_2 relays. These interlocks provide for protection against the following errors :—

(1) The application of more than one programme to one side of the Fading Potentiometer at the same time.

(2) The application of the same programme to both sides of the Fading Potentiometer at the same time.

(3) The removal of a programme connected to one side of the Fading Potentiometer during the period when the potentiometer is faded on to that side, the programme being then, of course, on transmission. This might occur owing to the accidental release of the appropriate A or B button.

(4) The establishment of the *Mix* condition as opposed to the *Fade* condition well in advance of the proposed mixing operation, a condition which might result in a small degree of interference from the programme to which the mix is to be made.

(5) The omission by the operator to cancel the *Mix* condition after it has been used, in which case he might later, when desiring to fade down his programme, mix in unwanted matter at present on the other side of the potentiometer.

(6) The withdrawal of one of the two programmes which are being mixed by placing the Fading Potentiometer in its central position, during the period over which this mix is maintained.

(7) The establishment of the *Mix* condition between two programmes whose synchronising signals are not themselves in synchronism.

These various possibilities of error are dealt with in the following manner.

(1) This is simply prevented by the automatic cancelling action which exists between the individual buttons in one group.

(2) This is prevented by electrical inter-connection of the corresponding PA and PB relays applying to the same programme, so that if one has been closed, the other cannot be operated.

(3) If a programme has been connected by an A button to the A side of the Fading Potentiometer, and the latter has been faded over to the A side so that the programme is on transmission, the A button can now be released without releasing the corresponding PA relay which would cause a break in the transmission. A similar arrangement applies in respect of the other side of the potentiometer and the PB relays. To effect this, the spindle of the actual fading potentiometer in the Fading Potentiometer Panel is provided with a cam switch, shown in Fig. 10, Item 12.1 as S_1, and which operates two relays designated IL_1 and IL_2 in the Programme Relay Panel. The D.C. supply to the push button units passes to the PA relays via IL_1, and to the PB relays via IL_2. When the fading potentiometer is over to the A side, the cam switch S_1 breaks the circuit of IL_1, the release of which breaks the supply to the A push-button unit, and prevents any further operation being effective. The operation of the cam switch simultaneously completes the circuit of IL_2, which applies the operating voltage to the B buttons, which can now be operated so as to preselect a programme of the B side. Similarly, when the potentiometer is over to the B side, the relay IL_2 is broken and the B push-buttons rendered dead, while relay IL_1 is made and the A buttons therefore energised. It is evident that the protective measures so far described will, by removing the supply bodily from the A or B buttons, release the button controlling the programme on transmission. To avoid this, the PA relays are provided with self-locking circuits, which are placed in operation by the release of IL_1, and similarly the PB buttons are provided with locking arrangements actuated by the release of IL_2. It is obviously necessary to have the locking action controlled effectively by IL_1 and IL_2, since when the supply is restored to one set of buttons by fading the potentiometer from one side to the other, it must be possible to abolish the self-locking action in order to restore the normal facility of preselecting a new programme.

(4) & (5) When it is desired to effect a mix, the centre point earth is, as we have seen, removed from both sections of the fading potentiometer. If this is done when the potentiometer is at its fully faded-up position, some interference from the other programme may be experienced owing to a small voltage due to the latter appearing across the terminating resistance of the incoming transmission line of the initial programme. This state of affairs may be confirmed by reference to Fig. 10, Item 12.1, the terminating resistance on the one side being R_{136}, and on the other R_{137}. In order to avoid the operator having to remember not to establish the *Mix* condition until the moment before he desires to effect the mix, it is arranged that the *Mix* condition can only be prepared, but not actually brought into effect, until the potentiometer has been faded down on the existing programme to the extent of 3 studs. In addition, it is explained under (5) above that it is desirable to provide automatic cancellation of the *Mix* condition on completing mixing. The centre point earth is removed from the fading potentiometer by the opening of the contacts K_1 K_2 belonging to the relay RY_{21}. This relay is operated by a further relay designated IL_3 in the Programme Relay Panel. IL_3 is itself operated by the button designated **Mix** via another cam switch on the fading potentiometer shaft, (and shown in Fig. 2 as $S_{3\,(2)}$), which is only closed when the fading potentiometer is on the last 3 studs in either of its extreme positions. The contacts of IL_3, which operate the fading potentiometer relay RY_{21}, can also be held short-circuited by a further cam switch mounted on the fading potentiometer spindle, and shown as $S_{3(1)}$ in Fig. 10, Item 12.1, which is closed at all times except 308

when the fading potentiometer is on the last two studs in either of the extreme postions.

The following is the sequence of operations which occurs when a mix from a programme A to a programme B is to be effected, this demanding complete rotation of the potentiometer from one extreme to the other. With the potentiometer initially in the extreme position for programme A, the **Mix** button is pressed. This supplies D.C. via $S_{3(2)}$ to IL_3, which operates and applies D.C. to $S_{3(1)}$. However, since this switch is open nothing further happens. All that has so far occurred is that the apparatus has taken note of the fact that the operator desires to effect a mix. The potentiometer is now rotated, and at stud 3 $S_{3(1)}$ supplies D.C. from IL_3 to RY_{21}, which sets up the *Mix* condition. The above operations are the equivalent of holding down the **Mix** button during rotation over the first three studs of the potentiometer. On further rotation of the potentiometer to stud 4, $S_{3(2)}$ opens and releases IL_3, but RY_{21} is held by $S_{3(1)}$. Rotation of the potentiometer continues, and in the central position the two programmes are fully mixed in equal proportions. When stud 3 on the B side is reached $S_{3(1)}$ opens and, IL_3 having already released, RY_{21} now releases, and the *Mix* condition is cancelled. It should be noted, however, that the *Mix* condition can be re-established if desired by operating the **Mix** button, as the potentiometer, on arriving at stud 4 on the B side, will have closed $S_{3(2)}$ and so enabled IL_3 to operate if the **Mix** button is depressed.

It follows therefore, that the desired results of not bringing into effect the *Mix* condition, and of cancelling it after use, are both achieved by means of this system. It will be seen from Fig. 10, Item 12.1 that the last three studs of the fading potentiometer at each of its extreme ends are in parallel, so that fading does not commence until the slider has been moved as far as the fourth stud. This arrangement enables the above cam switch operations to take place before the amplitudes of the incoming vision signals have been modified by the action of the potentiometer

(6) Although protection is provided, under (3) above, against removal of a programme which is on transmission by the accidental release of an A or B button, this protection is insufficient in the case where an A and B programme are being simultaneously transmitted by means of the *Mix* facility. It will be seen from (3) above that the two relays IL_1 and IL_2 which provide the protection, respectively break the supply to the A and B push-buttons, but that when the supply to the A buttons is broken, as is the case when a programme on the A side is on transmission, the supply to the B push-buttons is maintained, in order to allow the operator to preselect a new programme on the B side. In the *Mix* condition,
309 however, what is required is that the operator should be prevented from effectively altering the set-up of both the A and the B buttons. To effect this in the *Mix* condition, the supply to both the relays IL_1 and IL_2 must be simultaneously broken, thus removing the D.C. operating voltage from the A and the B buttons. A further relay designated IL_4 is therefore included in the Programme Relay Panel, whose coil is in parallel with the relay RY_{21} mentioned above, so that whenever RY_{21} is operated, as described under (4) and (5) above, either by IL_3 or by the cam switch $S_{3(1)}$, IL_4 is also operated. Thus, all the A and B push-buttons are effectively dead, except that the circuits energised by the two buttons whose programmes are being mixed on transmission remain energised as before, by self-hold arrangements.

The establishment of the *Mix* condition is indicated on the desk by a red lamp designated **Mix,** and the *Fade* condition by a green lamp designated **Fade.** The **Mix** lamp must be on, and the **Fade** lamp must be off from the beginning of the rotation of the potentiometer. Relay IL_3 operates at the beginning of the rotation but releases when stud 4 is reached. However, relay IL_4 is operated during the period when IL_3 is released. The lamps are therefore controlled from parallel contacts, one each of relays IL_3 and IL_4.

(7) Since it is impossible to mix two programmes whose synchronising signals are not themselves synchronous, i.e. programmes derived from two separate sources, the operator should be prevented from accidentally establishing the *Mix* condition in this case. To effect this, the relays IL_3, IL_4 and RY_{21} have their coils returned to earth by way of break contacts on all the PA and PB relays wired in series. A given relay is permanently associated with a given programme source, and break contacts associated with programme sources which are mutually in synchronism are permanently short-circuited. If, by depressing the appropriate A and B buttons, the operator chooses on the A and B sides a pair of programmes whose synchronising signals are in synchronism, the **mix** button and the potentiometer cam switches can energise the coils of IL_3, IL_4 and RY_{21}, the necessary current passing through the short-circuiting pieces of the PA and PB relays, and consequently the *Mix* condition can be established. If, however, the operator sets up a pair of sources whose synchronising signals are not in synchronism, then in the case of one, or both, of these sources the preselective operation of the appropriate PA and PB relays will prevent the establishment of the *Mix* condition, by virtue of the opening of the un-short-circuited break contacts. It also follows from this that the *Mix* condition cannot be established until the preselection on the A and B push-buttons of a pair of synchronous sources has been carried out. In other words, the operator must choose his programmes and, if desired, then establish the *Mix* condition.

Should the operator, having established the *Mix* condition, desire to restore the *Fade* condition without rotating the potentiometer, he can do so by operating a further button designated **Fade.** This is wired in series, with the above series circuit formed by the relays IL_3, IL_4 and RY_{21} and all the PA and PB break contacts. The depression of this button releases the above three relays.

It is convenient to have available the facility of instantaneously changing over from one programme to another, rather than to effect the change by means of a gradual fade on the fading potentiometer. A particular case of this is where, for the sake of reliability, one programme is arriving via two separate channels. Should the quality of the programme on the channel being taken for transmission become less good than the alternative channel, it would be desirable to change over to the alternative as quickly as possible without drawing attention to the change by making an obvious fade on the potentiometer. This could, of course, be done by employing the *Mix* facility if the channels were mutually synchronous, or were being taken on circuits in the Programme Relay Panel set up for mutually synchronous channels. (See short-circuiting of PA and PB break contacts above.) It does not always happen, however, that circumstances are such as to permit of the use in this way of the *Mix* facility, and to meet this case, a further button is provided on the desk designated **Instant Change-over.** This button, when pressed, parallels the coils of the IL_1 and IL_2 relays, so removing the interlock described under (3) above. Supposing, for instance, that a programme under the control of button A_1 is on transmission, and the same programme is available by another route under the control of button A_4, then an instantaneous changeover may be made without touching the potentiometer, by holding down the **Instant Change-over** button and depressing the button A_4. The latter remains depressed, and its operation releases A_1. Therefore, since the **Instant Change-over** button removes the interlock, the new programme is established. Alternatively, the button A_4 could be depressed well in advance, when the A_1 button will be released, but the circuit controlled by A_1 will, by virtue of the interlock, still remain on transmission. An immediate change-over may now be made at any desired moment by simply operating the **Instant Change-over** button.

There is provided on the spindle of the fading potentiometer a further cam switch S_2, the object of which is to perform the function of the switch S shown in Fig. 1, Item 12.0, and to change over the synchronising signals from one source to another at the centre point of a fade. The cam switch S_2 operates a further relay IL_5. This relay contains contacts connected to each end of the fading potentiometer, and therefore both the programmes which have been applied to the latter by the operated PA and PB relays are available at IL_5. The changeover contact of this relay is connected to the grid of V_3 of the Programme Fader Amplifier, as shown in Fig. 12, and operation of this relay clearly changes over the programme from which sync signals are to be extracted by the amplifier V_3 V_4. The contacts are arranged to provide a *make before break,* so that at no period is there any complete absence of synchronising signals.

THE PROGRAMME FADING APPARATUS
OPERATION AND MAINTENANCE

Operation

(1) Make sure that the desk potentiometer and the rack mounted potentiometer are both in the extreme A or B position.

(2) Close the main switches designated **Vision** and **Monitor.**

(3) Close the cubicle mains switch designated **Programme Fader Equipment.** This applies A.C. to all the H.T. Rectifier filaments, which now warm up. A.C. is also available for the Negative Rectifiers and L.T. Units, but no A.C. is immediately available for the H.T. Transformers of the H.T. Rectifier, as the application of this is delayed for two minutes by a thermal delay switch mounted on the mains cubicle.

(4) Switch on the single L.T. Unit, which supplies both sets of programme fading equipment.

(5) Switch on the Negative Rectifier.

(6) Assuming that the thermal delay switch in the mains cubicle has operated, switch on the Programme Fader H.T. Rectifier.

(7) Switch on the H.T. to Distribution Amplifiers Nos. 1 and 2 by means of the mains switch on H.T. Rectifier No. 2. If Distribution Amplifier No. 3 is also required in order to provide the necessary number of outputs, its H.T., which is separately fed from H.T. Rectifier No. 3, should be similarly applied.

(8) Switch on the Waveform Monitor.

(9) Allow apparatus 15 minutes to warm up.

(10) The next operation is the plugging up of the programme source input jacks for both transmission and monitor inputs. The transmission (110 ohm) inputs from each of the programme sources should be plugged into the *corresponding* programme fader input jacks on the adjacent jackstrip, which delivers them to the corresponding PA and PB relays. It will be appreciated that it is important not to plug a programme into any other jack but that in the corresponding position, since such an action will nullify the interlock protection against the mixing of asynchronous sources, described in the previous section.

311 The monitor (140 ohm) inputs from each of the programme sources should similarly be plugged into the corresponding input jacks on the adjacent jackstrip, which delivers these inputs to the SM_1 and SM_2 relays.

(11) The first programme source transmission input should now be terminated by the following series of operations :—
 (a) Turn the control potentiometer to the A position
 (b) Depress the appropriate PA button
 (c) Operate the **Instant Change-over** button

The incoming 110 ohm programme line from programme source No. 1 has now been applied to the A end of the fading potentiometer, and is therefore properly terminated in 110 ohms. The Waveform Monitor DC_1 jack should now be plugged to the parallel jack associated with the incoming 110 ohm line of programme No. 1, and the white, black and sync levels checked. The second incoming programme should now be similarly terminated by depressing its PA button, and then operating the **Instant Change-over** button, and its incoming level should be examined in the same way. This procedure should be repeated for all incoming programme sources.

(12) Each incoming programme source monitor input should be examined for white, black and sync levels, after having in each case terminated the line in 140 ohms. This is done by simply depressing the appropriate M_1 button.

(13) With the Waveform Monitor check the output from J_1 on the Fading Potentiometer Panel, which should be pure D.C. at +10V. If necessary adjust to this value by means of the associated control designated **D.C. Potr. Centre Voltage.**

(14) With the Waveform Monitor check that the output from J_2 in the Fading Potentiometer Panel is zero. If instead a small positive or negative D.C. voltage is present, adjust to zero by means of the associated control designated **A.C. Potr. Centre Voltage.**

(15) It is now necessary to adjust the absolute black level delivered from the Distribution Amplifiers. Plug DC_1 on the Waveform Monitor into the transmission output of a Distribution Amplifier, having terminated the latter in 110 ohms by means of a dummy resistance or the transmitter line. Adjust the black level control on the Programme Fader Amplifier until the black level is 10V. Adjust the sync amplitude control on the Programme Fader until the troughs of the sync pulses are at +3.5V.

Operation (*Contd.*)

(16) The following confirmatory test is useful. If the above operations have been properly carried out, there should be no change of black level along the D.C. section of the fading potentiometer, and in addition, when the *Mix* condition is established there should still be zero potential at the centre of the A.C. potentiometer. This state of affairs may be confirmed by the following method.

Connect the transmission output of one of the Distribution Amplifiers to the dummy load resistance of 110 ohms, and examine this output via DC_1 of the Waveform Monitor. Set up a programme on one side of the main potentiometer, and set the latter at its centre position. Adjust the monitor until black level coincides with the cursor. Now fade up the chosen programme, when there should be no change in black level. If there is such a change, check that the black level of the incoming programme is correct, and if so, make a further small adjustment of the **D.C. Potr. Centre Voltage.** This test clearly establishes that the black level along the D.C. section of the potentiometer is constant. Next set up a pair of different but mutually synchronous programmes on the *A* and *B* sides of the potentiometer; fade the latter up to one end; establish the *Mix* condition by pressing the **Mix** button, and rotate the fading potentiometer to the centre. Examine via DC_1 on the Waveform Monitor the output from J_2 on the Fading Potentiometer Panel, which should show a black level of 0V. If this is not so, check, as before, the black levels of the two incoming programmes, and if no fault is to be found with them, some slight further adjustment of the **A.C. Potr. Centre Voltage** will be necessary.

It should be noted that should the third Distribution Amplifier not be required, and its H.T. be therefore switched off, its input should be removed from the output of the Programme Fading Amplifier by means of the concentric plug provided, since without its H.T. on its input will draw grid current of an excessive amount from the output of the Programme Fading Amplifier.

Maintenance

The following voltage and current readings should apply when the apparatus has been set up in the manner described above, and when it is passing black level and synchronising signals from a programme source.

Programme Fader Amplifier

	Anode Volts	*Screen Volts*	*Anode Current*
V_1	245	250	24mA
V_2	270	250	24mA
V_3	245	160	—
V_4	270	160	—
V_5	265	250	30mA
V_6	305	250	10mA
V_7	220	250	13mA

Distribution Amplifier

	Anode Volts	*Anode Current*	*Black Level at Cathode* Volts	*Black Level at grid* Volts
V_1	297	30mA	+10	+1.2
V_2	297	41mA	+17	+10
V_3	297	41mA	+17	+10
V_4	297	22.5mA	+4.75	−5.5
V_5	297	22.5mA	+4.75	−5.5
V_6	297	22.5mA	+4.75	−5.5
V_7	297	22 5mA	+4.75	−5.5