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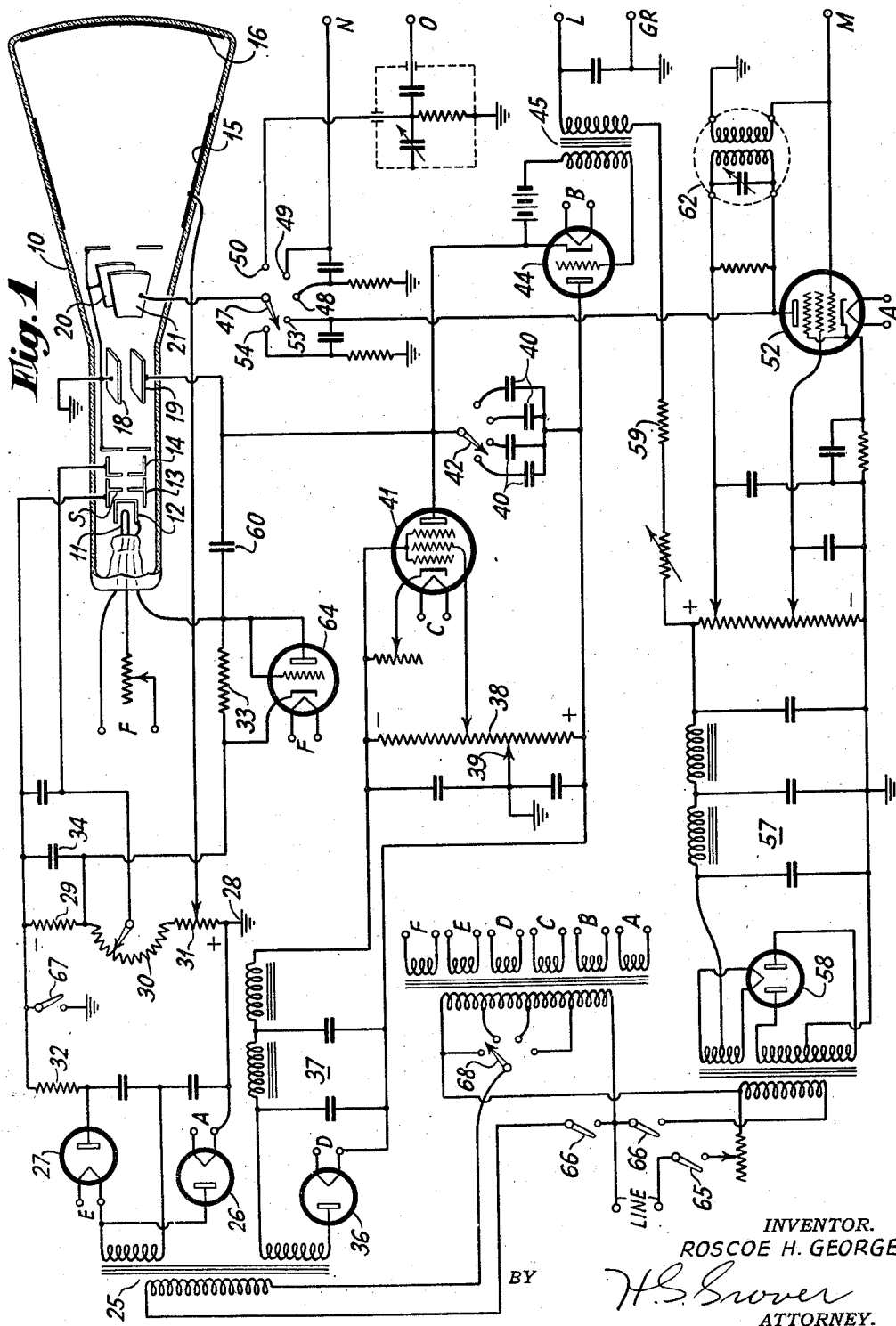
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2,222,943

ELECTRON SWITCHING CIRCUIT

Filed April 21, 1938

2 Sheets-Sheet 1



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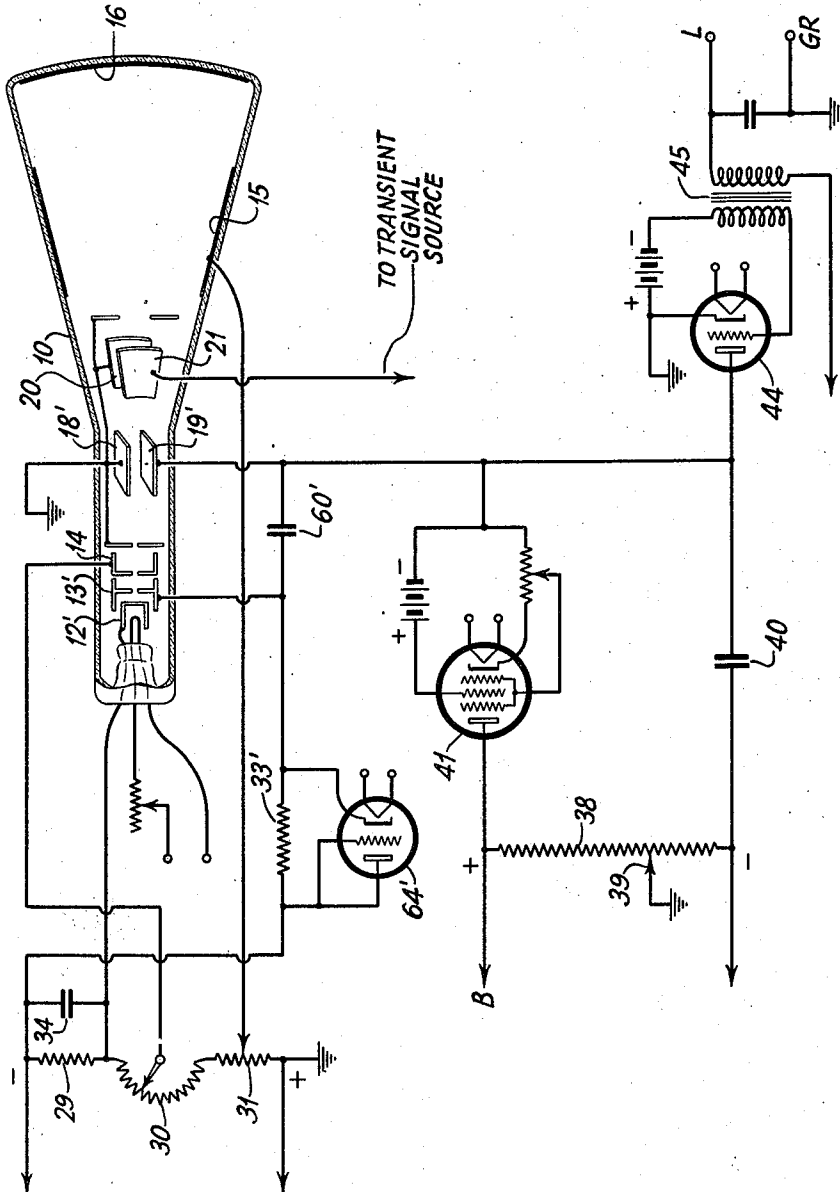
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Fig. 2



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ELECTRON SWITCHING CIRCUIT

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12 Claims. (Cl. 250—27)

This invention relates to improvements in electron switching circuits for use particularly with cathode ray oscilloscopes wherein it is desired to control the horizontal deflection of the cathode ray beam in cathode ray tubes in accordance with the occurrences of certain transient conditions which are to be observed in the fluorescent or luminescent screen of the tube.

In known cathode ray oscilloscopes, means have been used whereby the cathode ray beam may be deflected horizontally by the application of appropriate deflecting voltages to electrostatic deflecting plates or electromagnetic deflecting coils, the voltages being controllable in frequency and impressed upon the particular deflecting unit used in a regular recurring manner. Such systems where the frequency of the deflecting potential is independent of any other frequency conditions are known as external synchronizing systems.

In cathode ray oscilloscopes it is also common to synchronize the horizontal deflection of the cathode ray beam with the frequency of occurrence of the transient conditions in such a manner that the recurrent transient conditions and the horizontal deflections of the cathode ray beam occur in synchronism. Such a system is known as an internal synchronizing system.

Internal synchronization is ordinarily employed in connection with transient conditions which are relatively closely spaced with respect to each other so that the time of delay between the termination of one transient condition and the beginning of the succeeding transient condition is not material when compared to the length of the transient condition in question. Where this is the situation such internal synchronizing system may be used but there are instances when the length of the transient condition is short as compared to the duration between the successive transient phenomena. When internal synchronization is used under these conditions and a separate horizontal deflection of the cathode ray beam is utilized for each transient condition, the portion of the cycle occupied by the transient condition is relatively small and the transient phenomena is reproduced only during a relatively small proportion of the horizontal sweep of the cathode ray beam. The remaining portion of the sweep which corresponds to the interval between recurring transient conditions occupies a substantial portion of the sweep of the cathode ray beam and a corresponding proportion of the screen of the tube and, in view of the fact that information regarding this portion of the cycle

is unimportant, considerable time is lost and a horizontal magnification of the transient condition is not made possible.

It is possible, however, that by using known sweep circuits to increase the frequency of the sweep to some multiple of the frequency of the transient condition to such an amount that the transient condition will occupy substantially the entire horizontal portion of the screen but when this is done the cathode ray beam will be deflected horizontally several times during the interim between successive occurrences of the transient phenomena. These successive deflections of the cathode ray beam are particularly objectionable since it is desirable to represent on the screen nothing more than the transient condition to be observed.

According to the present invention means are provided whereby the cathode ray beam is produced only during the time a trace of the transient condition is being made, the cathode ray tube being biased to beam cut-off during the remaining position of its cycle of operation. By providing such means the beam is present only where actually needed and its production is prevented at all other times regardless of the potentials applied to the beam deflecting means.

Furthermore, means are provided whereby the electron beam may be deflected horizontally at the beginning of each transient condition and after such deflection the beam is cut-off and a maximum deflecting potential is maintained on the deflecting unit until the next succeeding transient occurs at which time the deflecting voltage is changed so that a beam, if present, would be quickly returned to an initial starting point. Then a beam is permitted to be produced and is deflected horizontally across the screen of the tube. By regulating the time of the horizontal sweep, the space occupied by the particular transient condition may be controlled and the regulation may be such that the transient condition will occupy the entire horizontal portion of the screen on the cathode ray tube. In view of the fact that the cathode ray beam is not present during the time interval between transient conditions and during the reversal or removal of the deflecting voltage, no back trace or series of traces of the beam is present and the only image occurring on the fluorescent screen is that of the transient condition per se. Through the use of such a system it is, therefore, possible to observe transient conditions which are relatively short in duration but which are separated one from another by a relatively

long space of time by deflecting the cathode ray beam once for each transient condition. Between successive traces the beam is discontinued as well as the further application of deflecting potentials. The system also incorporates provisions whereby the intensity of the transient signals may be controlled so that the vertical deflection of the cathode ray beam may be so adjusted as to occupy a substantial portion of the screen of the cathode ray tube.

It is, therefore, one purpose of the present invention to provide means whereby a cathode ray beam is developed in a cathode ray oscilloscope only during the interval when a trace of a transient condition is being presented on the screen of the tube.

A further purpose of the present invention resides in the provision of means whereby the cathode ray tube is normally biased to beam cut-off, the bias being removed or reduced so that a cathode ray beam may be produced only during the interval when a constant rate of change voltage is being applied to the horizontal deflecting plates with means whereby the constant rate of change interval may be sufficient to include the transient condition or a portion thereof.

A still further purpose of the present invention resides in the provision of means whereby a deflecting voltage is applied to the deflecting means only during the period when a transient condition exists.

A still further purpose of the present invention resides in the provision of means whereby the potentials applied to the deflecting unit of the cathode ray tube may be such as to maintain a beam, if one were present, in its position of maximum deflection during time periods between successive transient conditions.

Still another purpose of the present invention resides in the provision of means whereby the potentials applied to the deflecting unit of the cathode ray tube are such as would return the beam, if present, to its initial position when a synchronizing impulse or an impulse derived from the initial impulse of a transient condition is applied to the system.

A still further purpose of the present invention resides in the provision of means whereby the cathode ray beam is extinguished and the tube is biased to cut-off, during static conditions which occur at the end of each transient condition and during the reversal of the deflecting potentials just prior to the beginning of the next transient condition.

Another purpose of the present invention resides in the provision of means whereby the speed of deflection of the cathode ray beam may be controlled independently of the time of delay between successive productions and deflections of the beam.

Another purpose of the present invention resides in the provision of means whereby a substantially instantaneous reversal or removal of the deflecting potential and change of the cathode ray tube bias to develop a beam may be assured.

Still another purpose of the present invention resides in the provision of means whereby relatively short transient conditions may be observed even though the transient conditions are separated one from another by a relatively long space of time as compared to the length of time consumed during the transient phenomena.

Other purposes and advantages of the present

invention may become more apparent to those skilled in the art from a reading of the following specification and claims particularly when read in connection with the drawings wherein like reference characters represent like parts and wherein:

Figure 1 represents a circuit arranged in accordance with the present invention; and

Figure 2 shows a modification of a portion of Figure 1.

Referring to Figure 1 a cathode ray tube 10 is shown inside of which are positioned various electrodes for producing a cathode ray beam. These electrodes include a heater 11, a cathode or emitter 12, a control electrode 13 and an accelerating electrode or anode 14. The inside wall of the tube is coated with a conducting layer 15 which may operate as a further accelerating electrode and because of the electrostatic field which is produced as a result of the different potentials applied to the first accelerating electrode 14 and the conducting coating 15, the electron beam is brought to a focus on a fluorescent or luminescent coating 16 on the end of the tube. Two pairs of deflecting plates are provided, the plates 18 and 19 being for the purpose of deflecting the cathode ray beam in a horizontal direction, while the plates 20 and 21 are for the purpose of deflecting the cathode ray beam in a vertical direction.

For supplying operating potentials to the cathode ray tube a power transformer 25 is provided, the secondary of which is connected to a pair of rectifier tubes 26 and 27. These tubes are connected in the form of a voltage doubler so that the filament or heater of tube 26 supplies a positive potential, whereas the anode of tube 27 supplies a negative potential. The cathode or heater of tube 26 is connected to ground at 28 and across the source of direct current potential is connected a potentiometer consisting of resistances 29, 30 and 31. Connected between the resistances 29 and the anode of tube 27 is another resistance 32 the purpose of which will be explained later. The conducting coating 15 of the cathode ray tube is connected to a desirable point along the resistance 31, whereas the cathode 12 of the tube is connected to a point between resistances 29 and 30 and in this connection is included the resistance 33. In order that the control electrode 13 may be maintained negative with respect to the cathode 12, the control electrode is connected to the negative end of resistance 29 and this resistance is parallel by a condenser 34. The first anode or accelerating electrode 14 is connected to an adjustable point along the resistance 30. By means of such a circuit a cathode ray beam may be developed within the tube 10 but for a purpose later to be explained the potential of the control electrode with respect to the cathode (which corresponds to the potential drop across the resistance 29) is maintained sufficiently negative to prevent the production of a cathode ray beam.

In order to supply a horizontal deflecting voltage to the plates 18 and 19 a source of current is provided comprising a rectifier 36 and a filter circuit 37. The output of this source of direct current is applied to a potentiometer or potential divider 38. Cooperating with this potentiometer 38 is an adjustable contact 39 which is connected to ground, the adjustment being for the purpose of applying a bias to the deflecting plates 18 and 19 in order to horizontally position and center the trace of the electron beam.

A plurality of condensers 40 are provided and these condensers are charged by the current from the rectifier tube 36. Included in the charging circuit is an electron discharge tube 41 which has the characteristic of passing a constant amount of anode current. The anode of this tube is connected to a selector switch 42 which may be brought into contact with one plate of any of the condensers 40. The other plates of these condensers are connected together and are in turn connected to the positive end of the potentiometer 38. Because of the potentials applied to the elements of the discharge tube 41 the particular condenser 40 to which the selector switch 42 is connected is charged linearly. For the purpose of rapidly discharging the particular condenser 40 that is used, a discharge tube 44 is provided, the discharge tube including a cathode, a control electrode and anode. The cathode of the discharge tube 44 is connected to the selector switch 42 whereas the anode of the discharge tube is connected to the common plates of the condensers 40. Normally, the discharge tube 44 is non-conducting but is rendered conducting by the application of an impulse to the control electrode of the tube. This impulse is derived from a secondary of transformer 45, the primary of which is connected to terminals L and Gr.

When impulses are applied to the terminals L and Gr the discharge tube 44 is rendered intermittently conducting for the purpose of intermittently discharging the particular condenser 40 that is connected in the circuit and between intermittent dischargers the condenser is charged linearly by the current from rectifier tube 36 through the constant current tube 41. The horizontal deflecting plates 18 and 19 are connected to respond to the charged or discharged condition of the condenser 40 since the plate 19 is connected to the selector switch 42 and the plate 18 is connected to ground.

In order to produce a vertical deflection of the cathode ray beam in response to a signal or transient condition the signal is applied to the ground terminal Gr and any one of the three terminals M, N or O. If the signal is particularly weak it is then applied to the terminals Gr and M in order that it may be amplified by the electron discharge tube 52. The control electrode of this tube is connected to the terminal M and the other electrodes of the tube are maintained at operating potentials by reason of their connection to the potential divider 56 the ends of which are connected to the output of a rectifier 58 and filter circuit 57. The anode of the discharge tube 52 is connected to the vertical deflecting plate 21 through the selector switch 47 which may be placed in either of the positions 53 or 54. The different terminals 53 and 54 are provided in order that if only the alternating current component of the transient is to effect deflection the terminal 54 may be used whereas if both the alternating and direct current components are to be observed the terminal 53 is used. If the signal is stronger it may be connected to the terminals Gr and N and applied to the vertical deflecting plate 21 by means of the selector switch 47 which may be placed in either of the positions 48 or 49 depending upon whether or not the direct current component is desired. For high voltage signals the terminals Gr and O are used and the signal is impressed upon the vertical deflecting plate 21 by placing the selector switch

47 on the contact 50. The other vertical deflecting plate 20 is connected to ground in order to complete the vertical deflecting circuit.

With the system as so far described deflecting impulses may be derived from the condensers 40 when synchronizing impulses are applied to the discharge tube 44. If only this portion of the system is used the electron beam will be deflected during the charging period of the condenser 40 and will be maintained in a position of maximum deflection until the condenser is discharged by the discharge tube 44 and assuming that the bias of the cathode ray tube is such as to permit the production of a cathode ray beam, then the beam will be continuously present in the cathode ray tube.

In accordance with the present invention it is, however, desired that the beam be extinguished during such periods when its presence is not necessary and also during periods of return of the beam to its initial starting point. In order to accomplish this function a condenser 60 is provided and is connected between the horizontal deflecting plate 19 and the cathode or emitter 12. As previously stated a high resistance 33 is included in the cathode circuit.

For the purpose of explaining the operation of the device it will be assumed that the condenser 40 is charged and that the cathode ray beam is in its full deflection position. Because of the value of the resistance 29 and the bias of the cathode ray tube, no cathode ray beam is produced since the control electrode 13 is negative with respect to the cathode in an amount sufficient to produce biasing of the tube to cut-off. When a synchronizing impulse is applied to the discharge tube 44 the tube is rendered conducting and the particular condenser 40 that is in use is rapidly discharged through the discharge tube 44. At the same time, the potential is removed from the horizontal deflecting plate 19 and the potential of one plate of the condenser 60 is brought to substantially the potential of the lower end of the resistance 33. This change in potential of this plate of the condenser 60 causes a flow of electrons to the other plate of the condenser or a flow of current through the resistance 33 in such a direction that the cathode end of the resistance 33 is driven in a positive direction to further bias the tube to cut-off, i. e., to increase the negative potential of the control electrode with respect to the cathode. During this period the deflecting plate 19 is made positive with respect to the plate 18 so that if a beam were present it would impinge the fluorescent screen on the side where the trace begins. After the condenser 40 has been discharged and the flow of current through discharge tube 44 ceases then the particular condenser 40 that is placed in the circuit is again charged linearly by reason of the discharge tube 41 and the horizontal deflecting plate 19, as well as one plate of the condenser 60, are made negative with respect to the deflecting plate 18 for the purpose of deflecting the cathode ray beam horizontally. During the time when the one plate of condenser 60, (that is, the plate of the condenser which is connected to deflecting plate 19) is being changed from a positive to a negative charge in accordance with the charging of condenser 40, the other plate of condenser 60 assumes a positive charge which permits a flow of current through the resistance 33 in such a direction that the cathode 12 is driven in a negative direction with the result that the negative bias of the

control electrode with respect to the cathode is reduced and a cathode ray beam is then produced. The beam continues to be produced during the time required for the condensers 40 and 60 to assume their charge at which time a trace of the transient condition is produced on the screen of the cathode ray tube. As soon as the condensers 40 and 60 are fully charged the cathode ray beam is fully deflected and the flow of current through the resistance 33 ceases. When this condition arises the bias of the cathode ray tube is then increased to the amount determined by the value of resistance 29 which, as stated above, is sufficient to bias the tube to cut-off. This condition is maintained until the next succeeding impulse is applied to the discharge tube 44 at which time another complete cycle of operation begins. In order to assure rapid discharge of the condenser 60 a discharge tube 64 is provided which comprises at least a cathode and an anode, the cathode is connected to the left end of the resistance 33 where the anode is connected to the right end of the resistance as shown in the drawing. During discharge of the condenser 40 the current flow through the resistance 33 by reason of the variation of the charge on condenser 60 is such that the anode of the tube 64 is made positive with respect to its cathode and the tube becomes conductive to provide a shunt path around the resistance 33. During the time that the condenser 40 is being charged the current flow through the resistance 33 as a result of changing the potential applied to the plates of condenser 60 is in the opposite direction and all of the charging current for the condenser 60 with the exception of the cathode ray beam current, which is relatively small, must pass through the resistance 33. The resistance 33 is, of course, made sufficiently large that the potential drop occasioned by the flow of current is sufficient to remove the bias from the cathode ray tube and permit the production of a beam of electrons.

Such a system as stated above is particularly useful in observing transient conditions of short duration which are spaced one from another by a relatively long period of time. An example of such a condition might be a transient condition in the ignition of an internal combustion engine where the length of time consumed by the ignition impulse is very short as compared to the time between successive impulses. If the apparatus were used to observe transient conditions associated with the ignition of an internal combustion engine then an impulsing device operated in synchronism with the rotation of the engine can be used to supply the synchronizing impulses, the instant of occurrence of the synchronizing impulse being so chosen that the deflecting voltage is removed from the horizontal deflecting plates just prior to the beginning of the transient condition in question so that when the condenser 40 is again charged the transient condition will be presented upon the screen of the cathode ray tube.

In order to preclude the necessity of using an external source of current for supplying the synchronizing impulse, the primary of transformer 45 is connected to the rectifier and filter circuit 57 through a resistance 59 so that the only external elements necessary between terminals L and Gr is a pair of contacts which might be operated by a cam or some other convenient circuit closing apparatus in synchronism with the

rotation of the internal combustion engine under test.

In order to properly adjust the potentials of the electrodes of the cathode ray tube and to focus the beam on the screen of the tube, some means must be provided whereby the tube may be caused to operate to produce a trace on the screen of the tube in order that the effect of such adjustments may be observed. For this purpose the element 62 is provided and is connected in the anode circuit of the tube 52. The element comprising a pair of mutually inductive members one of which is paralleled by a variable condenser. When this element is placed in the circuit the tube 52 is changed from an amplifier tube to an oscillator so that an oscillating frequency may be applied to the vertical deflecting plates of the cathode ray tube. In addition means may also be used to cause continued impulses to be applied to the discharge tube 44 so that continued horizontal deflection will result. When the element 62 is placed in the circuit and some means for successively rendering the discharge tube 44 conducting is provided a continued operation of the cathode ray tube results permitting adjustment of the various parameters of the circuit. As a matter of convenience the element 62 is so constructed that it may be inserted in an ordinary 4 prong tube socket when calibration and adjustment of the system is necessary. When the system is properly adjusted so that transient conditions may be observed the element 62 may then be conveniently removed from the circuit.

In order to control the entire system by a single element a switch 65 is provided which, when operated, interrupts the power from all of the transformers. In order to protect the operator against shock hazard the system in actual practice is placed inside of a cabinet, the door of which is provided with a cut-out switch for interrupting the power from all high voltage conductors. Associated with the operation of the door are switches 66 each of which are opened when the door of the cabinet is opened and cause the interruption of potential from all high voltage conductors. A switch 67 is also provided and this switch is closed when the cabinet door is opened, to ground the negative potential supply conductor. The resistance 32 is included in this circuit in order to protect the tubes 26 and 27. The filament power is, however, not interrupted so that the various tubes may remain at proper operating temperature to be in condition for operation when the cabinet door is again closed.

From the above it may be seen that a means has been provided whereby a cathode ray tube may be used to show traces of transient conditions which are relatively short in duration but which are separated one from another by a relatively long space of time, the cathode ray beam being produced only during the time when a trace is to be made on the screen of the tube. When full deflecting potential has been developed across the horizontal deflecting plates and during the time interval between transient conditions as well as the reversal of deflecting potentials on the horizontal deflecting plates, no cathode ray beam is produced.

In the operation of Figure 1 it will be observed that the flow of electrons from the left plate of condenser 60 during its charging divides, the major portion of the electrons flowing through the resistance 33, to provide a drop in potential such that the right end of resistance 33 is made

negative with respect to the left end. Because of this potential drop, as explained above, the cathode of the cathode ray tube is made more negative in potential so that the grid bias of the tube is reduced to permit the production of an electron beam. The remaining portion of the electrons flow directly to the cathode and constitute the cathode ray beam. This system, although entirely operative, is slightly objectionable in view of the fact that the current flow through resistance 33 is reduced by the amount of the beam current. If it is desirable to cause the entire charging current of condenser 60 to flow through the resistance 33 an arrangement such as shown in Figure 2 may then be used. This figure differs from the disclosure shown in Figure 1 in that the resistance 33' is connected between the control electrode 13' and the negative end of resistance 29. The resistance 29, as in Figure 1, is paralleled by condenser 34.

The source of horizontal deflecting voltage in Figure 2 comprises a source of direct current which may be derived from any appropriate rectifier or filter circuit and a potentiometer 38, a point 39 along which is connected to ground. A discharge tube 41 is provided for charging the condenser 40, the discharge tube operating as a constant current device in order that the condenser 40 may be charged linearly. For discharging the condenser 40 a discharge tube 44 is provided which corresponds to the tube bearing the same reference character in Figure 1. Horizontal deflecting plate 18' is connected to ground, whereas plate 19' is connected to one plate of the condenser 40. A small condenser 60' corresponding to condenser 60 in Figure 1 is connected between horizontal deflecting plate 19' and the control electrode 13'.

The operation of Figure 2 is broadly the same as that of the system shown in Figure 1, except that the positive plate of the condenser 40 is connected to the one of the horizontal deflecting plates which is not grounded. Assuming that the condenser 40 is charged, then the plate of condenser 60' which is connected to the deflecting plate 19' will be positively charged. Under these conditions no cathode ray beam will be present in the tube because of the potential of the control electrode 13' with respect to the cathode 12' as a result of the potential drop along resistance 29.

When the discharge tube 44 is made conducting to discharge condenser 40 then the charge is removed from one plate of condenser 60' and in so doing electrons flow from the other plate of the condenser 60' to the junction of the resistance 33' and the control electrode 13'. In order to quickly discharge the condenser 60' a discharge device 64' is provided which corresponds to the discharge device 64 in Figure 1. The electrons from this plate of condenser 60' therefore flow from cathode to anode through the discharge device 64' and the control electrode 13' is still maintained sufficiently negative with respect to the cathode 12' that no cathode ray beam results.

During the charging period of condenser 40 the plate of condenser 60' which is connected to horizontal deflecting plate 19' assumes a positive charge and electrons accordingly flow toward the other plate of condenser 60. This flow of electrons from the negative end of resistance 29 through the resistance 33' causes a potential drop in resistance 33' such that the potential of the control electrode 13' is driven in a posi-

tive direction to place such a bias on the tube that an electron beam may be produced. By using such a system it may therefore be seen that the electron beam current which flows in the cathode ray tube does not oppose the condenser charging current that flows in resistance 33' as is the case in Figure 1. This arrangement results in a slightly more positive action of the system than could be attained through the use of the system shown in Figure 1.

In view of the fact that the operation of the system shown in Figure 2 is substantially the same as that shown in Figure 1, only a portion of the entire system is shown for simplicity. The application of the signal or transient condition to the vertical deflecting plates, together with the means for supplying appropriate potentials to the various electrodes of the tubes used in the circuit, are not shown.

It is to be understood that although discharge devices 64 and 64' are shown connected in parallel with the resistance 33 and 33' these discharge tubes are not absolutely necessary but aid materially in producing a rapid discharge of the condensers 60 and 60'. Furthermore, it is to be understood that although a diode is shown and described as this discharge means, any other asymmetric unit, such as a dry disc rectifier, might as well be used.

In the operation of the systems the value of condenser 60 or the resistance 33 may be changed slightly when the time of horizontal sweep, that is, the size of the charging condenser 40, is altered. Accordingly, a variable condenser 60 or a variable resistance 33, or both, may be used. As a matter of simplicity only one condenser 40 is shown in Figure 2, although it is to be understood that several condensers may be used, together with a selector switch for placing one or another of the different condensers in the circuit.

Although no specific means are shown for supplying the impulses which place the discharge tube 44 in a conducting condition, it is to be understood that various sources of impulses might be used and it is only necessary that the impulses occur in synchronism with the frequency of occurrence of the transient signal impulses. In view of the fact that the system is very rapid in operation, it is possible to derive the impulse for controlling the grid of the discharge tube 44 from the initial portion of the transient signal itself. Furthermore, if the transient signal is in any way associated with a light condition, a light responsive device, such as a photoelectric cell, may be connected to the terminals L and Gr so that at each occurrence of the light condition the discharge tube 44 is rendered conducting.

In order that the first and second anode potentials of the cathode ray tube may be changed, yet their ratio be maintained the same, a switch 68 is provided for connecting portions of the primary of the filament transformer in series with the primary of the anode voltage transformer 25.

Various modifications and alterations in the present invention may be made and it is desired that any and all such modifications be considered within the purview of the present invention except as limited by the herein appended claims:

I claim:

1. A system for controlling a cathode ray tube comprising means for producing a beam of elec-

trons, said means including a cathode, a control electrode and an accelerating electrode, means for normally maintaining said control electrode negative with respect to said cathode by an amount sufficient to bias the beam to cut-off, a beam deflecting unit, means for impressing a source of deflection voltage upon said deflecting unit, a cathode circuit including a resistance in series therewith, an asymmetric unit connected in parallel with said resistance, and a condenser connected between said deflecting unit and said cathode whereby the bias on the tube may be sufficiently reduced to permit the production of a cathode ray beam during the application of the deflecting voltage.

2. A system for controlling a cathode ray tube comprising means adapted to develop a beam of electrons, said means including a cathode, a control electrode and an accelerating electrode, a cathode circuit including a resistance and means for normally maintaining said control electrode negative with respect to said cathode in an amount sufficient to bias the tube to beam cut-off, means for deflecting the developed beam comprising a deflecting unit and a source of deflection voltage, an asymmetric unit connected in parallel with said cathode resistor and a condenser connected between said deflecting unit and said cathode whereby the bias may be sufficiently reduced to permit the production of a cathode ray beam during the deflection of the beam.

3. A system for controlling a cathode ray tube comprising means adapted to develop a beam of electrons, said means including a cathode, a control electrode and an accelerating electrode, a cathode circuit including a resistance and means for normally maintaining said control electrode negative with respect to said cathode in an amount sufficient to bias the tube to beam cut-off, means for deflecting the developed beam comprising a deflecting unit and a source of deflection voltage, a condenser connected between said deflecting unit and said cathode adapted to assume a predetermined charge from the deflection voltage, and electron discharge means connected in parallel with said cathode resistance adapted to permit a rapid change in the charge on said condenser when the deflection voltage is removed whereby the negative bias on the cathode ray tube is reduced to permit a cathode ray beam to be developed when the deflection voltage is again applied.

4. A system for controlling a cathode ray tube comprising means adapted to develop a beam of electrons, said means including a cathode, a control electrode and an accelerating electrode, a cathode circuit including a resistance and means for normally maintaining said control electrode negative with respect to said cathode in an amount sufficient to bias the tube to beam cut-off, means for deflecting the developed beam comprising a pair of deflecting plates and a source of deflection voltage, a condenser connected between one of said deflecting plates and said cathode adapted to assume different degrees of charge in accordance with different deflection voltages applied to said plates, and means for rapidly altering the charge on said condenser when the deflection voltage is removed from said plates whereby the potential of said control electrode with respect to said cathode is made less negative by the potential drop along the resistor from the change in the charge of the condenser when the deflection voltage is applied to the deflection plates.

5. A system for controlling a cathode ray tube comprising means adapted to develop a beam of electrons, said means including a cathode, a control electrode and an accelerating electrode, a cathode circuit including a resistance and means for normally maintaining said control electrode negative with respect to said cathode in an amount sufficient to bias the tube to beam cut-off, means for deflecting the developed beam comprising a deflecting unit and a source of deflection voltage, a condenser connected between said deflecting unit and said cathode, an electron discharge device comprising an electron emitter and an anode, and means for connecting said anode to said cathode and said emitter to one end of said cathode resistor whereby the bias may be sufficiently reduced to permit the production of a cathode ray beam during the deflection of the beam.

6. A system for controlling a cathode ray tube comprising means adapted to develop a beam of electrons, said means including a cathode, a control grid, and an accelerating electrode, a grid-cathode circuit, means for normally maintaining a negative bias on said control grid with respect to said cathode by an amount sufficient to prevent the production of a beam of electrons, a resistance in said grid-cathode circuit, an asymmetric unit connected in parallel with said resistance, a beam deflecting unit, a condenser connected between said deflecting unit and said grid-cathode circuit, and means including a source of deflection voltage for energizing said deflecting unit whereby the charging current for said condenser may sufficiently remove the bias on said tube during the application of the deflection voltage to permit the production of a cathode ray beam.

7. A system for controlling a cathode ray tube comprising means adapted to develop a beam of electrons, said means including a cathode, a control grid, and an accelerating electrode, a grid-cathode circuit, means for normally maintaining a negative bias on said control grid with respect to said cathode by an amount sufficient to prevent the production of a beam of electrons, a resistance in said grid-cathode circuit, an asymmetric unit connected in parallel with said resistance, a pair of beam deflecting plates, means adapted to apply a deflecting voltage to said deflecting plates, and a condenser connected between one of said deflecting plates and said grid-cathode circuit whereby the bias of the tube may be reduced during the application of the deflecting voltage because of the voltage drop across the resistor as a result of the charging of the condenser.

8. A system for controlling a cathode ray tube comprising means adapted to develop a beam of electrons, said means including a cathode, a control electrode and an accelerating electrode, a control electrode circuit including a resistance and means for normally maintaining said control electrode sufficiently negative with respect to said cathode to prevent the development of a beam of electrons, a beam deflecting unit, means for applying deflection voltages to said deflecting unit, an electron storage device connected between said deflecting unit and said control electrode, and an asymmetric unit connected in parallel with said resistance whereby the voltage drop along said resistance due to the charging current of said electron discharge device when deflecting voltages are applied to the deflecting unit will permit the production of a cathode ray beam.

9. A system for controlling a cathode ray tube

comprising means adapted to develop a beam of electrons, said means including a cathode, a control electrode and an accelerating electrode, a control electrode circuit including a resistance and means for normally maintaining a bias on said control electrode sufficiently negative with respect to said cathode to prevent the development of a beam of electrons, a pair of beam deflecting plates, means including a source of deflection voltage connected to said deflecting plates, an electron storage device connected between said deflection plates and said control electrode, and a current rectifier connected in parallel with resistance whereby the bias on the tube is reduced when a deflection voltage is applied to said plates due to the potential drop across said resistor as occasioned by a change in the energy content of said electron storage device to permit the production of a cathode ray beam.

10. A system for controlling a cathode ray tube comprising means adapted to develop a beam of electrons, said means including a cathode, a control grid and an accelerating electrode, a grid cathode circuit, means for normally maintaining a negative bias on said control grid with respect to said cathode by an amount sufficient to prevent the production of a beam of electrons, an impedance in the grid cathode circuit, a beam deflecting unit, means adapted to apply a deflecting voltage to said deflecting unit, and an electron storage device connected between said deflecting unit and said grid cathode circuit whereby the bias of the tube may be reduced during the application of the deflecting voltage to the deflecting unit because of the voltage drop across the impedance as a result of the presence of the storage device.

11. A system for controlling a cathode ray tube comprising means adapted to develop a beam of electrons, said means including a cathode, a control grid, and an accelerating electrode, a grid cathode circuit, means for normally maintaining said control grid negative with respect to said cathode by an amount sufficient to bias the tube to beam cut-off, a resistance connected in the grid cathode circuit, a pair of deflecting plates, means adapted to apply a deflecting voltage to the deflecting plates, and a condenser connected between one of said deflecting plates and said grid cathode circuit whereby the bias on the tube may be sufficiently reduced during the application of the deflecting voltage to permit the production of a beam of electrons because of the voltage drop across the resistance as a result of a change in the charged condition of the condenser.

12. A system for controlling a cathode ray tube comprising means adapted to develop a beam of electrons, said means including a cathode, a control electrode and an accelerating electrode, a control electrode circuit including a resistance and means for normally maintaining said control electrode sufficiently negative with respect to said cathode to prevent the development of a beam of electrons, a beam deflecting unit, means for applying deflecting voltages to said deflecting unit, and a condenser connected between said deflecting unit and said control electrode, whereby the voltage drop along said resistance due to the change in the charge on said condenser when deflecting voltages are applied to the deflecting unit will permit the production of a cathode ray beam.

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