April 3, 1934. A. MUTSCHELLER 1,953,889

THERMIONIC CATHODE X-RAY STABILIZER SYSTEM

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Fig. 1.

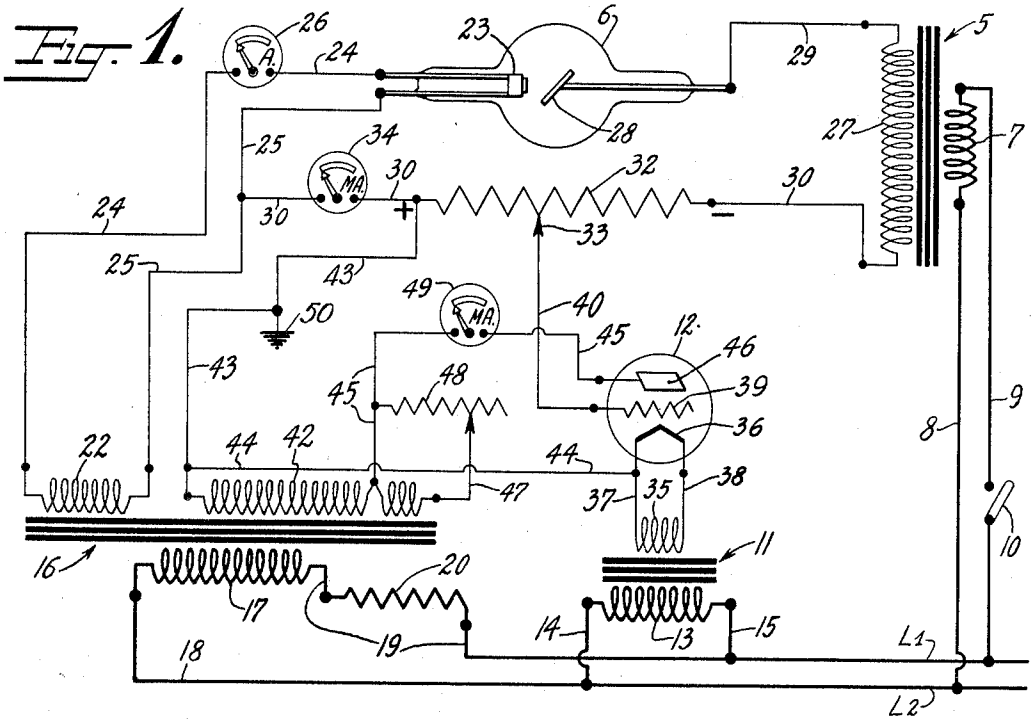
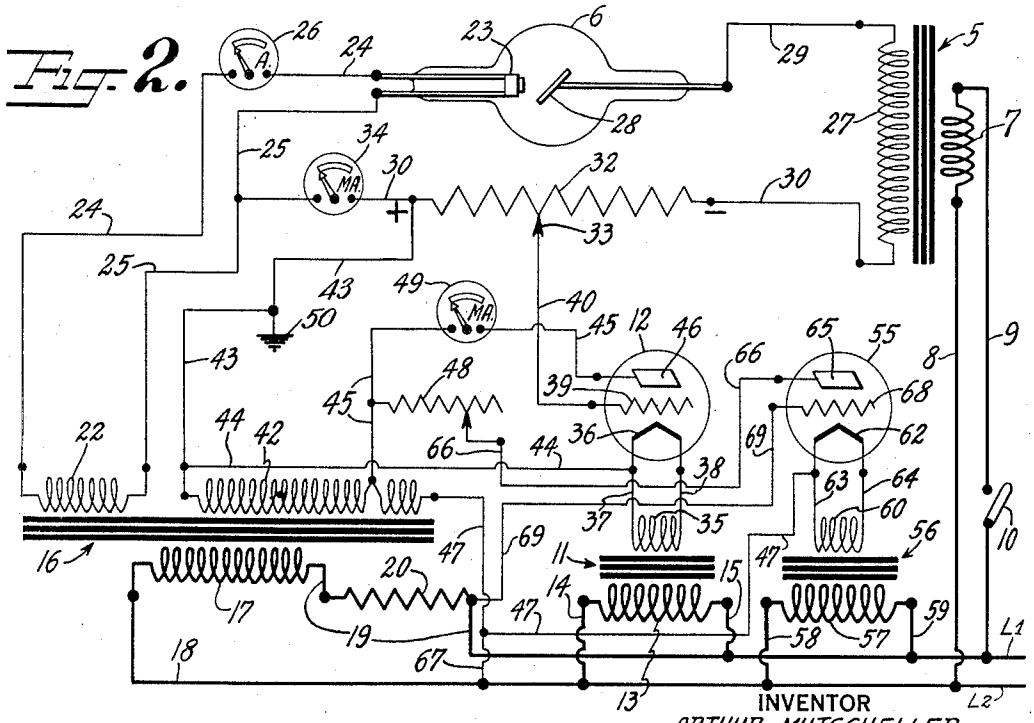


Fig. 2.



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THERMIONIC CATHODE X-RAY STABILIZER SYSTEM

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15 Claims. (Cl. 250—34)

My invention relates to X-ray systems and has particular relation to such a system wherein the current flowing through the X-ray tube, which is conventionally termed the discharge current, is maintained constant under all conditions of operation of the X-ray tube regardless of the time period of energization of the latter.

In X-ray systems when it is desired to energize the X-ray tube with relatively high milliamperage current the current utilized to heat the thermionic cathode of the X-ray tube or valve tubes employed for rectification purposes is comparatively high and must be maintained constant in order to maintain the discharge current constant. As the low-tension transformer for heating the cathode and the high tension transformer for supplying the discharge current are usually connected to a common source of alternating current of commercial potential, the drawing of a heavy current by the primary winding of the high tension transformer causes a voltage drop in the source which likewise causes a drop in the cathode heating current. It naturally follows that a drop in the cathode heating current affects the discharge current, due to a decrease in electron emissivity of the thermionic cathode, which results in a lesser X-ray output from the X-ray tube.

Various systems and methods for counteracting this variation of current are known to the prior art, such for example, as a phase changing stabilizer or a synchronously operated short circuiting device in which the time of short circuiting is controlled by the tube current.

The first mentioned system, namely, the phase changing stabilizer operates on the principle of the counter-action of the current supplied from a closely coupled transformer against the current supplied from a loosely coupled transformer which results in the stabilization of the resulting current. These devices, however, operate with a very low power factor and depend upon over saturation of a magnetic core for the loosely coupled transformer and are, therefore, subject to the deleterious effects of overheating or are lacking in a high degree of permanency.

In the systems wherein a synchronously operated short circuiting device is employed a portion of the heating current impulses are short circuited inversely in proportion to the desired cathode temperature. This enables the cathode to be heated to its maximum temperature and greatest electron emission before the X-ray tube is energized. A coil is usually utilized which is connected in the high tension discharge circuit for operating the short circuiting contactor and the time period of short circuiting is increased to bring the cathode emissivity to that necessary to give the desired milliamperage value. The variations of the current in the discharge circuit are thus compensated for by variations in the time periods of short circuiting the cathode heating circuit which reduces the temperature and electron emissivity of the cathode.

In this manner a stabilization of the cathode heating current is obtained but in such systems an appreciable time must elapse after short circuiting the cathode heating current before the cathode cools sufficiently to reduce the electron emissivity from maximum to the emissivity required to give the desired milliamperage of discharge current.

Under normal operating conditions this cooling of the cathode to the usual operating value requires approximately one-tenth of a second which is lost to the actual exposure period. It, therefore, follows that with exposures of less than one-tenth of a second duration devices of this general type are not feasible.

It is accordingly an object of my invention to provide a system for energizing an X-ray tube wherein the discharge current flowing through the tube is maintained constant.

Another object of my invention is the provision of a system for energizing an X-ray tube wherein the discharge current flowing through the tube is maintained constant under all conditions regardless of the time period of energization of said tube.

Another object of my invention is the provision of a system for energizing an X-ray tube wherein the desired amount of energization currents may be preset and this current maintained constant during the entire period of energization regardless of the length of the time period during which the tube remains energized.

Another object of my invention is the provision of a system for energizing an X-ray tube wherein a compensating load is connected to the source of energy for the X-ray tube, corresponding to the load of the tube, and which is automatically removed from the source upon connection of the X-ray tube thereto.

Another object of my invention is the provision of a system for energizing an X-ray tube wherein a compensating load is normally imposed upon the source of energy for the tube, equivalent to the load of the X-ray tube which is automatically removed therefrom upon connection of the tube thereto to prevent current fluctuations in the

source normally attendant the connection of the tube to the source.

A further object of my invention is the provision of a system for energizing an X-ray tube wherein the discharge current is maintained constant by presetting the amount of cathode heating current and maintaining this amount constant under all operating conditions by varying the same inversely to fluctuations in the source of supply.

Still further objects of my invention will become apparent to those skilled in the art by reference to the accompanying drawing wherein:

Figure 1 is a diagrammatical representation of an X-ray circuit for energizing an X-ray tube showing the system employing the features of my present invention, and

Figure 2 is a diagrammatical representation of the same system disclosed in Figure 1 with an additional feature for maintaining the discharge current constant irrespective of supply source fluctuations.

Referring now to the drawing in detail I have shown in Fig. 1 a suitable source of alternating current of commercial potential, such as the conductors L1 and L2. A high tension transformer 5, which is utilized for supplying currents of high potential to an X-ray tube 6, has its primary winding 7 connected to the source of supply L1, L2 by means of a pair of conductors 8 and 9, and a switch 10 is provided for opening and closing this circuit. A low tension transformer 11 is provided for supplying heating currents to an audion tube 12, the latter being employed for a purpose to be hereinafter more fully stated, and the primary winding 13 of this transformer is also connected to the supply source L1, L2 by means of a pair of conductors 14 and 15.

A second low tension transformer 16 has its primary winding 17 likewise connected to the source of supply L1, L2 by means of a pair of conductors 18 and 19. A ballast resistance 20 is interposed in the conductor 19 and is in series with the primary winding 17 and the source of supply for limiting the current supplied to the former. This transformer 16 is provided with a secondary winding 22 which is connected to the cathode 23 of X-ray tube 6 for supplying heating currents to the latter, by means of a pair of conductors 24 and 25.

An ammeter 26 is connected in series with the conductor 24 for recording the current supplied to the cathode 23 and may be graduated in terms of milliamperes.

The high tension transformer 5 has one end of its secondary winding 27 connected to the anode 28, of the X-ray tube 6, by means of a conductor 29 and the other end of this secondary winding is connected, by means of a conductor 30, to the conductor 25 for completing the high tension circuit. A resistance 32, having a sliding contactor 33, is interposed in the conductor 30 for a purpose hereinafter set forth, and a milliampere meter 34 is likewise in series with the high tension circuit for recording the current flowing through the circuit.

The low-tension transformer 11 has its secondary winding 35 connected to the cathode 36 of the audion tube 12 by means of a pair of conductors 37 and 38. The grid 39 of this audion is connected to the sliding contactor 33 of the resistance 32, by means of a conductor 40, for the purpose of applying a negative potential thereto during operation of the system.

The low-tension transformer 16 is provided with a compensating winding 42 the greater portion of which constitutes an auxiliary load upon this transformer and one end of this winding is connected, by means of a conductor 43, to the conductor 30 at the positive end of the resistance 32. This same end of the auxiliary winding 42 is connected through a conductor 44 to the conductor 37 and thus to the cathode 36 of the audion 12.

This winding 42 has a total output potential of approximately 1000 volts and a conductor 45 connects the greater portion of this winding with the plate 46 of the audion 12. The remaining portion of the secondary winding 42, which is arranged for an output potential of approximately 100 volts, is short circuited by means of a conductor 47 across a variable rheostat 48.

A milliampere meter 49 may be interposed, if desired, in the conductor 45 for recording the plate current supplied to the audion 12 although this meter is not essential and the high tension discharge circuit may be suitably grounded, as at 50, for safety purposes. The rheostat 48 is utilized to regulate the current flowing through the entire auxiliary winding 42 and consequently the audion 12. The ballast resistance 20 cooperates with this rheostat 48 in limiting the current flowing through the winding 42. The primary purpose of the inclusion of the ballast resistance 20 is to limit the size of the rheostat 48. By increasing the size of the rheostat 48 to that required to give the proper regulation over a predetermined range of current the ballast resistance 20 may be dispensed with, if desired.

The circuit shown in Fig. 2 differs from that shown in the figure just described in that a second audion tube 55 is included in the system. The purpose of the audion 12 is to allow a current to flow through the auxiliary winding 42, that is equivalent to the drop in current in the source of supply attendant the energization of the high tension transformer 5, thus constituting a compensating load which is automatically shut off from the source when current flows in the discharge circuit. On the other hand the provision of the audion 55 compensates for variations from other causes normally found in the usual commercial source of supply.

A low tension transformer 56 has its primary winding 57 connected to the source L1 and L2, by means of a pair of conductors 58 and 59. The secondary winding 60 of this transformer is connected to the cathode 62 of this audion 55, by means of a pair of conductors 63 and 64, for the purpose of supplying heating current thereto.

In this modification the conductor 47, which extends from one end of the auxiliary winding 42, is connected to the cathode 62 and the plate 65 is connected, by means of a conductor 66, to the adjustable arm of rheostat 48. The filament or cathode 62 and plate 65 are thus in series with a portion of the secondary winding 42. A conductor 67 connects the conductor 47 with the supply conductor L2 and the grid 68 is connected, by means of a conductor 69, to the other supply conductor L1, at one end of the ballast resistance 20.

In this manner a slight potential is applied between the grid 68 and the cathode 62 with the grid, due to the characteristics of the audion 55, being normally supplied with a predetermined potential. A current will flow under normal conditions between the cathode 62 and plate 65 without any choking effect by the grid 68. When, however, the current rises in the source of supply due to any cause the grid 68 allows the flow of current between the cathode and plate to likewise increase in the well known manner of opera-

tion of audion tubes, and has the same effect as that of decreasing the resistance within the circuit by means of the rheostat 48. In all other respects the system shown in Figure 2 is identical with the system shown in Figure 1.

In the operation of my system a suitable switch (not shown) in the supply source L1, L2 is first closed thereby energizing the primary windings 17 and 13 of the transformers 16 and 11. The secondary winding 22 thus becomes energized to heat the cathode 23 of X-ray tube 6 and the secondary winding 35 of transformer 11 becomes energized to heat the cathode 36 of audion 12. Upon energization of transformer 16 the auxiliary winding 42 is likewise energized and permits a current to flow through this winding and between the cathode or filament 36 and plate 46 of audion 12. This circuit may be traced from one end of winding 42, through conductor 44 to the cathode 36, then to the plate 46, through milliammeter 49, conductor 45, rheostat 48 and conductor 47 back to the winding 42. A portion of the current flowing in this circuit will flow through conductor 45 to the intermediate point of the secondary winding 42 but the majority of the current will flow through the rheostat 48 and the entire winding 42.

The greater portion of winding 42 between the points of connection of the conductors 43, 45 is of a capacity within the range of drop in voltage or in other words causes a potential drop in the source L1, L2 equivalent to that resulting in the source of supply attendant the energization of the high tension transformer 5, and the current is regulated by means of the rheostat 48 to give the desired amount of filament heating current for the cathode 23 of X-ray tube 6. The ballast resistance 20 is selected to give a current within a short range of the desired cathode heating current or between approximately 3½ and 5 amperes and further adjustment of the cathode is made by rheostat 48.

As the winding 42 is wound upon the same core of transformer 16 as the winding 22, which supplies heating current to the cathode 23, increasing the current in the winding 42 by means of the rheostat 48 causes a decrease in the current in the winding 22 and consequently in the cathode heating current. Conversely a decrease in current in the winding 42 by regulation of the rheostat 48 causes a simultaneous increase of current in the winding 22 and cathode 23.

The rheostat 48 is therefore adjusted until the ammeter 26 records the amount of cathode heating current desired and the milliampere meter 49 will record the milliamperage of plate current of the audion 12. If desired, the milliammeter 49 may be proportioned to record the milliamperage of the X-ray tube. As an increase of current in the winding 42 follows an increase of plate current, which is recorded by the milliammeter 49 and a decrease in cathode heating current occurs, there would likewise follow, upon energization of the high tension transformer 5, a decrease in the milliamperage of discharge current. In a like manner a decrease in plate current through audion 12, by regulation of the rheostat with an attendant increase in cathode heating current would result in an increase in the milliamperage in the discharge circuit of the X-ray tube. The reading of milliammeter 49 is, therefore, inversely proportional to the milliamperage of the discharge circuit and may be calibrated to record the amount of current desired in this circuit when the high tension transformer is energized.

The sliding contactor 33 of rheostat 32 is adjusted and the switch 10 is closed to energize the primary winding 7 of high tension transformer 5. This will in turn cause the secondary winding 27 to energize the X-ray tube 6 with high potential electrical energy during positive half waves of the alternating current cycle with the X-ray tube acting as a rectifier thus suppressing the flow of current through the high potential or discharge circuit during the remaining or negative half waves of the cycle. This high potential or discharge circuit may be traced from one end of the secondary winding 27, through conductor 30 and rheostat 32, milliammeter 34, conductor 25 to cathode 23 of X-ray tube 6, and from anode 28 thereof through conductor 29 to the other end of secondary winding 27.

If the setting up of the sliding contactor 33 is such that an increase or drop in cathode heating current, as recorded by the ammeter 26, occurs upon energization of the high tension transformer this rheostat is adjusted until no variation of the meter 26 occurs upon energization of the transformer. This rheostat 32 is initially set once for existing line and wiring conditions and need not be further disturbed. Immediately upon energization of the high tension transformer and the flow of current in the high tension or discharge circuit a negative potential is applied to the grid 39 of audion 12 by means of the conductor 40.

As this latter conductor is connected to the adjustable arm 33 of rheostat 32, which is naturally negative with reference to the positive end of this rheostat the grid is consequently impressed with a negative potential. The cathode 36 of audion 12, being connected to the positive end of rheostat 32 through conductors 43 and 44, is impressed with a positive potential relative to the grid 39 with the result that the passage of electrons from the cathode 36 to the plate 46 is prevented.

In applying a negative potential to the grid the current which was flowing through the auxiliary winding 42 in the manner previously described is automatically shut off by the action of the audion in stopping the flow of electrons between the cathode 36 and plate 46. The load or current consumed by the greater portion of secondary winding 42 is thus simultaneously removed from the source of supply L1, L2 with the energization of the high tension transformer, and the drawing of current from the source, which causes the milliammeter 49 to drop to zero.

As the system has been properly adjusted by the regulation of the rheostats 48 and 32 the discharge current remains uniform and there is no variation in the filament heating current when the load of the high tension transformer is connected to the source.

When the switch 10 is again opened to deenergize the high tension transformer 5 the current flowing in the discharge circuit immediately ceases. This removes the negative potential from the grid 39 which again enables a current to flow between the cathode 36 and plate 46 of audion 12 and the load of the auxiliary winding 42 is again applied to the transformer 16. The system is again in condition for energizing of the X-ray tube without a drop in the source normally attendant the energization of the high tension transformer.

In the modification of my system shown in Figure 2 the operation of the system is identical with that just described with the additional feature of compensating for supply source variations

resulting from other causes. The audion tube 55 has its grid 68 connected to the supply conductor L1 by means of conductor 69 and the filamentary cathode 62 is connected to the supply conductor L2 by means of conductors 67 and 47. A potential is, therefore, applied between the grid and cathode which corresponds to the potential of the source L1, L2. This potential, however, due to the characteristics of the audion 55 is insufficient to prevent the flow of electrons between the plate 65 and cathode 62 during the normal operation of the system. As the cathode 62 is connected to one end of the auxiliary winding 42, by means of the conductor 47, and the plate 65 is connected to the arm of rheostat 48 these electrodes are in series with the rheostat 48 and a portion of the winding 42.

The potential impressed upon the grid 68 from the source L1, through conductor 69, is such that an increase in the potential of the source causes an increased flow of energy through the audion 55, between the cathode 62 and plate 65, and a decrease of the potential of the source L1, L2 causes a diminution of the energy flowing between the cathode 62 and plate 65. This action of audion 55 causes an identical action in the rheostat 48, i. e., upon a decrease flow of energy through the former a decrease follows in the series connected rheostat 48 and vice versa.

Moreover, as the rheostat 48 effects the flow of energy through the remainder of the winding 42 and audion 12, an increase or decrease of energy through rheostat 48 has the same effect as increasing or decreasing the energy through this latter circuit in the same manner as though the rheostat 48 was manually adjusted as previously described. This naturally causes an increase or decrease in the energy supplied by the winding 22 to the cathode 23 of the X-ray tube 6 inversely to the change of energy flowing through winding 42 in the manner stated relative to Fig. 1. It, therefore, becomes obvious that audion 55 functions with supply source fluctuations to increase or decrease the loading on the winding 42 of transformer 16 and cause inverse fluctuations in the secondary winding 22 of this transformer.

When the high tension transformer 5 is energized a negative potential is impressed upon the grid 39 of audion 12 to prevent the flow of energy through the greater portion of the winding 42 in the same manner as described relative to Fig. 1 and in all other respects the operation of this latter modification is identical with the former.

It can thus be readily appreciated by those skilled in the art that I have provided a system for energizing an X-ray tube wherein a compensating load is normally applied to the source of supply for the X-ray tube that corresponds to the drop in the source of supply attendant the energization of the X-ray tube. This compensating load is simultaneously disconnected from the source upon energization of the tube from the latter to thereby prevent a drop in potential of the source and to maintain the cathode heating temperature constant. Furthermore my system compensates for supply source variations resulting from extrinsic causes and maintains the temperature of the cathode and discharge current constant under all conditions.

Although I have shown and described several embodiments of my invention I do not desire to be limited thereto as various other modifications of the same may be made without departing from the spirit and scope of the appended claims.

What is claimed is:

1. In a system for energizing a thermionic cathode discharge device, means for supplying heating current to the cathode of said device, high tension means for supplying electrical energy to said device, a source of electrical energy for energizing both of said means and subject to a drop in potential upon connection of said high tension means thereto, and compensating means connected to said first mentioned means and causing a drop of potential in said source equivalent to the drop of potential therein attendant the connection of said high tension means thereto, said compensating means including a device associated with said high tension means to cause said compensating means to become non-conductive upon energization of said discharge device.

2. In a system for energizing a thermionic cathode discharge device, means for supplying heating current to the cathode of said device, high tension means for supplying electrical energy to said device, a source of electrical energy for energizing both of said means and subject to a drop in potential upon connection of said high tension means thereto, and compensating means connected to said first mentioned means and causing a drop of potential in said source equivalent to the drop of potential therein attendant the connection of said high tension means thereto, said compensating means including a device associated with said high tension means to cause said compensating means to become non-conductive and remove the potential drop in said source attendant energization of said compensating means, upon connection of said high tension means to said source with attendant drop of potential therein.

3. In an X-ray system, an X-ray tube having a cathode to be heated, a low tension transformer for supplying heating current to the cathode of said X-ray tube, a high tension transformer for energizing said X-ray tube, a source of electrical energy for energizing both of said transformers and subject to a drop in potential upon connection of said high tension transformer thereto, a compensating load connected to said low tension transformer and causing a drop of potential in said source equivalent to the drop of potential in said source attendant the connection of said high tension transformer thereto, said compensating means including a device operably connected to said high tension transformer to cause said compensating load to become non-conductive and remove the potential drop from said source attendant energization thereof, simultaneously with the connection of said high tension transformer to said source with an attendant drop of potential in the latter.

4. In an X-ray system, an X-ray tube having a cathode to be heated, a low tension transformer for supplying heating current to the cathode of said X-ray tube, a high tension transformer for energizing said X-ray tube, a source of electrical energy for energizing both of said transformers subject to a drop in potential upon connection of said high tension transformer thereto, and means constituting a compensating load energizable by said source and causing a potential drop in the latter to compensate for the drop of potential in said source attendant the connection of said high tension transformer thereto, said compensating load including means operably connected to said high tension transformer to cause said compensating load to become non-conductive and the effect thereof removed from said source upon connection of said high tension transformer to

said source to prevent a drop in potential from occurring in the latter and thereby maintaining the current supplied to the cathode of said X-ray tube constant.

5. In an X-ray system, an X-ray tube having a cathode to be heated, a low tension transformer for supplying heating current to the cathode of said X-ray tube, a high tension transformer for energizing said X-ray tube, a source of electrical energy for energizing both of said transformers and subject to a drop in potential upon connection of said high tension transformer thereto, and means comprising a compensating load connected to said low tension transformer and causing a potential drop in said source equivalent to the drop of potential therein attendant the connection of said high tension transformer to said source, said compensating load including means connected with said high tension transformer to cause said compensating load to become non-conductive and the effect thereof to be removed from said low tension transformer and said source upon energization of said high tension transformer.

6. In an X-ray system, an X-ray tube provided with a cathode to be heated, an electrical circuit for supplying heating current to the cathode of said X-ray tube, a high tension circuit for supplying energy to said X-ray tube, a source of electrical energy common to both of said circuits and subject to a drop in potential upon energization of said high tension circuit, and means constituting a compensating load circuit operably connected with said source of energy for causing a potential drop therein equivalent to the drop of potential in said source attendant energization of said high tension circuit, said compensating load circuit including means connected to said high tension circuit to simultaneously cause said compensating load circuit to become non-conductive and remove the effect thereof from said source upon application of the load of said high tension circuit thereto.

7. In an X-ray system, an X-ray tube provided with a cathode to be heated, a transformer connected with said cathode in order to heat the same by supplying current thereto, a high tension transformer for energizing said X-ray tube, a source of electrical energy common to both of said transformers for supplying exciting currents thereto, and a compensating load circuit connected to said first mentioned transformer and energized thereby constituting a load which causes a potential drop in said source equivalent to the drop of potential in said source attendant the energization of said last mentioned transformer, said compensating load circuit including a discharge device associated with said last mentioned transformer and X-ray tube, to simultaneously render said compensating load circuit non-conductive and remove the effect thereof from said first mentioned transformer and said source, upon energization of said high tension transformer.

8. In an X-ray system, an X-ray tube having a cathode to be heated, a transformer provided with a plurality of secondary windings one of which is connected to the cathode of said X-ray tube for supplying heating current thereto and the other being connected to a discharge device and constituting a compensating load circuit, a high tension transformer for supplying high potential energy to said X-ray tube, a source of electrical energy common to both of said transformers and subject to a drop in potential upon energization of said high tension transformer, and regulating means in said compensating load circuit to adjust the latter and cause a potential drop in said source equivalent to the drop of potential therein following energization of said high tension transformer, said discharge device in the compensating load circuit being operably connected to said high tension transformer and X-ray tube to open said compensating load circuit and remove the load thereof from said source simultaneously with the energization of said high tension transformer from said source.

9. In an X-ray system, an X-ray tube having a cathode to be heated, a low tension transformer for supplying heating current to the cathode of said X-ray tube, a high tension transformer for energizing said X-ray tube, a source of electrical energy for energizing both of said transformers subject to a drop in potential upon energization of said high tension transformer from said source, a compensating load associated with said low tension transformer and causing a potential drop in said source equivalent to the drop of potential in said source attendant the connection of said high tension transformer thereto, and adjustable means connected with said compensating load to vary the energy supplied by said low tension transformer thereto, and to vary the energy supplied to said cathode inversely to the variations of energy supplied to said compensating load, said compensating load including a three electrode tube connected to said high tension transformer to cause said compensating load to become non-conductive and remove the effect thereof from said low tension transformer and consequently from said source, upon the connection of said high tension transformer to said source.

10. In an X-ray system, an X-ray tube having a cathode to be heated, a low tension transformer for supplying heating current to the cathode of said X-ray tube, a high tension transformer for energizing said X-ray tube, a source of electrical energy for energizing both of said transformers and subject to a drop in potential upon connection of said high tension transformer thereto, and a compensating load connected to said low tension transformer and causing a potential drop in said source equivalent to the drop of potential therein attendant the connection of said high tension transformer to said source, said compensating load including a three electrode tube having two of its electrodes connected to said compensating load and the third electrode connected with said high tension transformer to cause said compensating load to become non-conductive and remove the effect thereof from said low tension transformer and consequently from said source, upon the energization of said high tension transformer from said source.

11. In an X-ray system, an X-ray tube having a cathode to be heated, a low tension transformer for supplying heating current to the cathode of said X-ray tube, a high tension transformer for energizing said X-ray tube, a source of electrical energy for energizing both of said transformers and subject to a drop in potential upon the connection thereto of the load of said high tension transformer, and a compensating load associated with said source and normally energized thereby and causing a potential drop in said source equivalent to the drop of potential therein attendant the connection of the load of said high tension transformer thereto, said compensating load including a three electrode tube connected to said high tension transformer to cause the instantaneous removal of one of said

loads from said source upon the application of the other of said loads thereto, to prevent a drop of potential in said source and to thereby maintain the cathode heating current constant.

12. In an X-ray system, an X-ray tube having a cathode to be heated, a low tension transformer for supplying heating current to the cathode of said X-ray tube, a high tension transformer for energizing said X-ray tube, a source of electrical energy for energizing both of said transformers subject to a drop in potential upon connection thereto of the load of said high tension transformer, and a compensating load associated with said source and causing a drop of potential therein equivalent to the drop of potential in said source attendant connection of said high tension transformer thereto, said compensating load including a three electrode tube having two of its electrodes connected to said compensating load and the remaining electrode connected to said high tension transformer to cause said compensating load to become non-conductive and remove the effect thereof from said source upon connection of the load of said high tension transformer thereto, and said three electrode tube being operable to cause said compensating load to become conductive and cause a drop of potential in said source upon disconnection of the load of said high tension transformer therefrom to prevent a variation of potential in said source whereby the supply of current to the cathode of said X-ray tube is maintained constant.

13. In an X-ray system, an X-ray tube provided with a cathode to be heated, a low tension transformer for supplying heating current to the cathode of said X-ray tube, a high tension transformer for energizing said X-ray tube, a source of commercial electrical energy subject to normal potential fluctuations for energizing both of said transformers and subject to a drop in potential upon connection of said high tension transformer thereto, a compensating load connected to said source and causing a potential drop therein equivalent to the drop of potential in said source attendant the energization of said high tension transformer, and means connected to said compensating load and to said source for varying the energy supplied to said compensating load upon the occurrence of normal fluctuations in said source, said compensating load being connected to said high tension transformer to cause said compensating load to become non-conductive and remove the effect thereof from said source upon the connection of said high tension transformer thereto.

14. In an X-ray system, an X-ray tube provided with a cathode to be heated, a low tension transformer for supplying heating current to said cathode, a high tension transformer for energizing said X-ray tube, a source of electrical energy for energizing both of said transformers and subject to variations caused by extrinsic forces and also subject to a drop in potential upon connection of said high tension transformer thereto, a compensating load connected to said source and causing a potential drop therein equivalent to the drop of potential in said source attendant the energization of said high tension transformer, means connected to said compensating load and to said source for varying the energy supplied to said compensating load upon the occurrence of normal fluctuations in said source to maintain the heating current supplied to said cathode constant, said compensating load including means connected to said high tension transformer to instantaneously cause said compensating load to become non-conductive and remove the effect thereof from said source upon the connection of said high tension transformer thereto to prevent a variation in said source and to maintain said cathode heating current constant.

15. In an X-ray system, an X-ray tube provided with a cathode to be heated, a low tension transformer for supplying heating current to said cathode, a high tension transformer for energizing said X-ray tube, a source of electrical energy for energizing both of said transformers and subject to variations caused by extrinsic forces and also subject to a drop in potential upon connection of said high tension transformer thereto, a compensating load connected to said source and causing a potential drop therein equivalent to the drop of potential in said source attendant the energization of said high tension transformer, and a three electrode tube connected to said compensating load and to said source for varying the energy supplied to said compensating load upon the occurrence of normal fluctuations in said source to maintain the heating current supplied to said cathode constant, said compensating load including a second three electrode tube connected to said high tension transformer to instantaneously cause said compensating load to become non-conductive and remove the effect thereof from said source upon the connection of said high tension transformer thereto to prevent a variation in said source and to maintain said cathode heating current constant.

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