

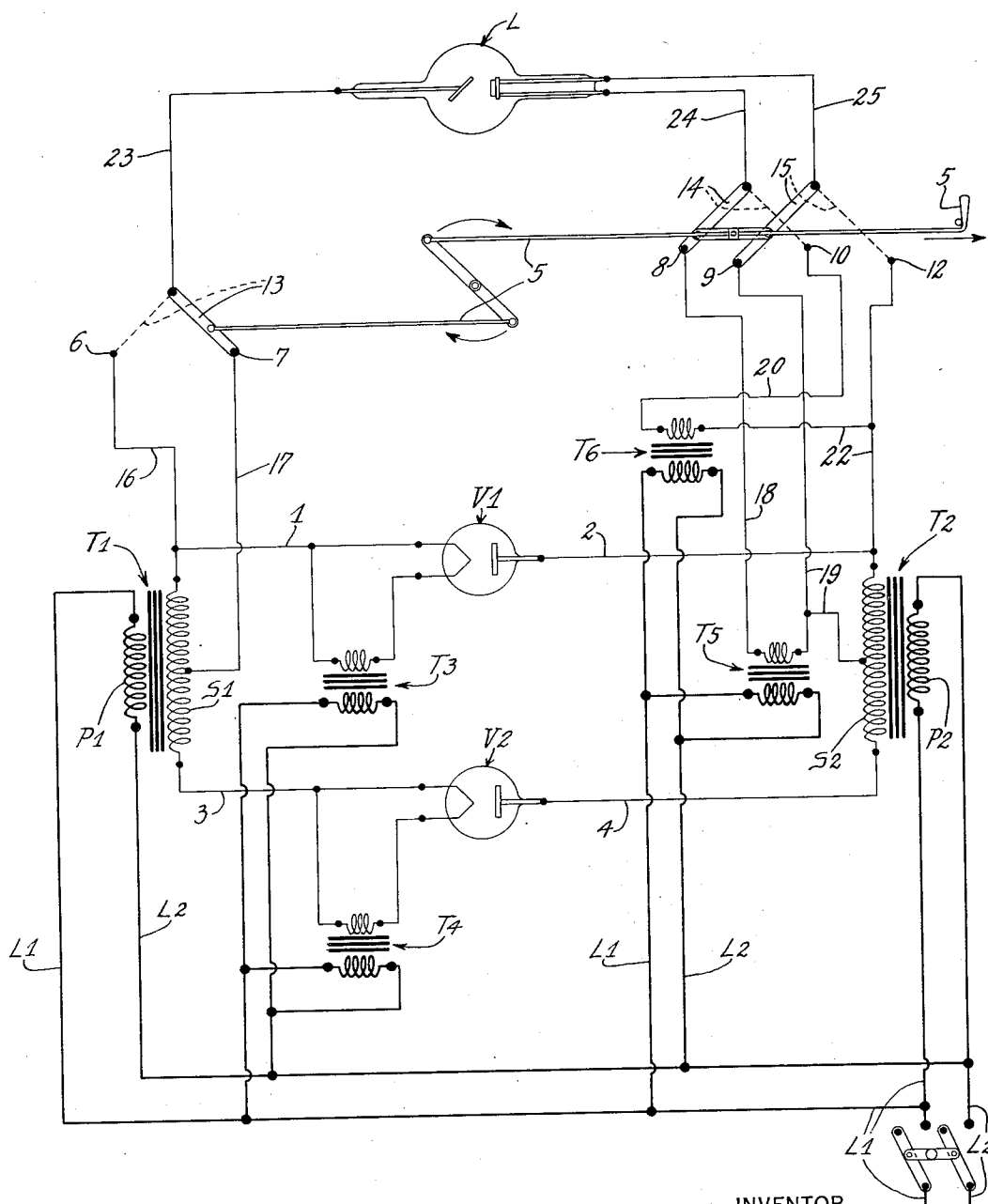
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X-RAY SYSTEM

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X-RAY SYSTEM

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My invention relates to X-ray apparatus and particularly to a system employed in an apparatus of the type shown and described in my Patent 1,754,799 issued April 15, 1930.

More particularly stated my invention resides in the construction and arrangement of the transformers and vacuum valve tubes in a circuit for energizing an X-ray tube in such a manner that the apparatus may be readily converted as desired, for either radiographic or therapeutic purposes.

In the prior art various machines of this type have been constructed but, due to the fact that relatively low voltages are utilized for radiographic purposes in comparison with the voltages utilized for therapeutic purposes, these machines have been relatively large and subject to numerous limitations. The transformer and other electrical apparatus, such as condensers, reactances and resistances have, heretofore, been employed to accomplish the requisite increase in voltage for the two-fold purpose of this type of apparatus.

The utilization of these numerous transformers, etc., renders the machine as a whole rather cumbersome and increases the possibility of a break-down occurring during the operation of the apparatus, thus limiting the useful life of the apparatus and the X-ray tube.

It is therefore an object of my invention to provide, in an apparatus of this character, a simplified circuit wherein the various electrical parts are few and the apparatus as a whole constitutes a compact unit.

Another object of my invention is to so arrange and connect the various parts in the circuit that the electrical stresses are equalized throughout the entire circuit and the load on the supply lines is thus reduced to a minimum.

Still further objects of my invention will become apparent to those skilled in the art by reference to the accompanying drawing wherein the single figure is a diagrammatic view of the circuit utilized in my X-ray apparatus.

Referring now to the drawing in detail I have shown two high tension transformers T1 and T2 each of which is provided with the usual magnetic cores. The primary windings P1 and P2 of these transformers are arranged to receive electrical energy, from supply conductors L1 and L2 connected to any source of alternating commercial potential.

The secondary winding S1, of the high tension transformer T1, is connected at one end to the filament of a vacuum valve tube V1, by means

of a conductor 1. The anode of this valve tube is connected by means of a conductor 2 to one end of the secondary winding S2 of high tension transformer T2. A heating transformer T3 has its secondary winding connected to the filament of the valve tube V1 for the purpose of heating the latter and the primary winding of this heating transformer likewise receives energy from the supply conductors L1 and L2.

The other end of the secondary winding S1 is connected, by means of a conductor 3, to the filament of a second vacuum valve tube V2 and a conductor 4 connects the anode of this latter tube to the other end of the secondary winding S2. A second heating transformer T4 is also provided for heating the filament of this latter tube and its primary winding is connected to the supply conductors L1 and L2.

An X-ray tube L is arranged to be energized by the high voltage transformers T1 and T2 and a high tension switch 5 is provided for the purpose of connecting the X-ray tube to these transformers. This high tension switch is adapted to assume two positions each of which causes the transformers to supply two distinct potentials in a manner to be hereinafter described. This switch is provided with a series of contact terminals 6, 7, 8, 9, 10 and 12 and three contact members or switch arms 13, 14 and 15.

A conductor 16 is arranged to connect one end of the secondary winding S1 to the contact terminal 6 while a similar conductor 17 connects the contact terminal 7 to an intermediate point of the secondary winding S1. A conductor 18 connects the contact terminal 8 with one end of the secondary winding of a heating transformer T5 while a conductor 19 connects an intermediate point of the secondary winding S2 and the other end of the secondary winding of the heating transformer T5 to contact terminal 9.

A similar heating transformer T6 has one end of its secondary winding connected, by means of a conductor 20, to contact terminal 10. A conductor 22 connects one end of the secondary winding S2 and the other end of the secondary winding of heating transformer T6 to the contact terminal 12. The switch arm 13 is connected, by means of a conductor 23, to the anode of the X-ray tube L while conductors 24 and 25 connect the switch arms 14 and 15 of the high tension switch 5 to the filament of the X-ray tube L. The primary windings of the heating transformers T5 and T6 are also energized from the supply conductors L1 and L2.

The operation of my system may be described

as follows: Assume it is desired to operate the apparatus for radiographic purposes. The high tension switch is moved to the position shown in the drawing and the primaries of the various transformers are then energized from the supply conductors L1 and L2 by the closing of a suitable switch. Transformer T3 will heat the filament of valve tube V1, transformer T4 the filament of valve tube V2, and transformer T5 the filament of the X-ray tube L. The primary windings P1 and P2 of the high tension transformers will thereupon energize the secondary windings S1 and S2. The transformers T1 and T2 are equal in every respect and it will be assumed that they each produce 90 KV peak, although they may be constructed to generate higher or lower potential as desired.

The X-ray tube L is thereupon energized by the transformer secondaries S1 and S2 through a circuit which extends, during one half the wave, from a portion of the secondary winding S1, through conductor 3, valve tube V2, conductor 4, a portion of secondary winding S2 to the intermediate tap, then by means of conductor 19, contact terminal 9, switch arm 15, conductor 25 X-ray tube L, thence by means of conductor 23, switch arm 13, contact terminal 7 and conductor 17 to the intermediate point of secondary winding S1. During the remaining half of the wave the circuit may be traced from a portion of secondary winding S1, through conductor 1, valve tube V1, conductor 2, a portion of secondary winding S2 to the intermediate point, then by means of conductor 19 and switch arm 15 to the X-ray tube L and back to the intermediate point of secondary winding S1 in the same manner as previously traced.

The switch arm 14 being in engagement with the contact terminal 8, at the same time that arm 15 is in engagement with contact terminal 9, permits the transformer T5 to supply the energy for heating the filament of the X-ray tube L. The heating transformer T6 remains idle during the operation of the apparatus for radiographic work. The X-ray tube L, in the radiographic position of high tension switch 5, is supplied with a potential of 90 KV due to the series connection of a portion of each of the secondary windings and rectification is full wave through the valve tubes V1 and V2.

Assuming now it is desired to utilize the apparatus for therapeutic purposes the operator will move the high tension switch to the position shown in dotted lines. The X-ray tube L will now be energized by the secondary windings S1 and S2 through a circuit which, during one half the wave, may be traced as follows: from one end of the secondary winding S1, conductor 3, valve tube V2 conductor 4, secondary winding S2, conductor 22, contact terminal 12, switch arm 15, conductor 25, X-ray tube L, thence by means of conductor 23, switch arm 13, contact terminal 6 and then by means of conductor 16 to the other end of secondary winding S1.

The X-ray tube L is supplied with a potential of 180 KV, with the high tension switch 5 in this position, due to the series connection of the entire secondary windings S1 and S2 while the rectification is half wave, through the valve tube V2. The switch arm 14 being in engagement with contact terminal 10 causes the filament of the X-ray tube to be energized by the heating transformer T6 through conductors 20 and 24 while the transformer T5 is idle.

It thus becomes readily apparent to those

skilled in the art that I have provided a complete system for X-ray apparatus that is adaptable for both radiographic and therapeutic purposes, readily convertible from one type of apparatus to the other, and which constitutes a very compact and efficient unit.

Although I have shown and described one specific embodiment 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 an X-ray device the combination with an X-ray tube of a pair of high tension transformers and a source of electrical energy therefor, said transformers being provided with secondary windings, one of said secondary windings having each of its ends connected to the filament of separate thermionic valve tubes, the other secondary winding having each of its ends connected to the anode of each of said thermionic valve tubes, a high tension switch provided with a plurality of terminals and adapted to assume two positions, means for connecting an intermediate point of each of said secondary windings to said switch, said switch in one position arranged to connect one end of each secondary winding to the anode and cathode respectively of said X-ray tube, said switch in its other position arranged to connect the intermediate point of each of said secondary windings with the anode and cathode respectively of said X-ray tube, and means for heating the filaments of said thermionic valve tubes and said X-ray tube.

2. In an X-ray machine the combination with an X-ray tube of a pair of high tension transformers and a source of energy therefor, a pair of thermionic valve tubes, a high tension switch provided with a plurality of terminals and adapted to assume two positions, one of the secondary windings of said high tension transformer having one of its ends connected to one terminal of said switch and to the filament of one of said thermionic valve tubes, the other end of said secondary winding being connected to the filament of the other of said thermionic valve tubes, an intermediate point of said secondary winding connected to a terminal of said switch, the secondary winding of the other of said high tension transformers having one of its ends connected to the anode of one of said thermionic valve tubes and to a terminal of said high tension switch and the other end connected to the anode of the other of said valve tubes, an intermediate point of said last mentioned secondary winding connected to a terminal of said switch, said switch in one of its positions causing the energy generated by the entire windings of both of said secondary windings to flow through said X-ray tube and in its other position causing the energy generated by a portion of both of said secondary windings to flow through said X-ray tube, and means for heating the filaments of said thermionic valve tubes and said X-ray tube.

3. In an X-ray machine the combination with an X-ray tube, of a pair of high tension secondary windings and a source of electrical energy therefor, a high tension switch adapted to assume two positions, a vacuum valve tube connected to one end of each of said secondary windings, and a second valve tube connected to the remaining end of each of said secondary windings and to said high tension switch, said switch

in one position being adapted to connect both of said secondary windings and one of said valve tubes to said X-ray tube for the purpose of rectifying the energy generated by all of the windings of each of said secondary windings and energizing said X-ray tube therewith, and said switch in its other position being adapted to connect a portion of both of said secondary windings and both of said valve tubes to said X-ray tube for the purpose of rectifying the energy generated by a portion of each secondary winding and energizing said X-ray tube therewith.

4. In an X-ray machine the combination with an X-ray tube, of a pair of high tension transformers and a source of electrical energy therefor, secondary windings for said transformers, a high tension switch adapted to assume two positions, a vacuum valve tube connected to one end of each of said secondary windings, and a second valve tube connected to the remaining end of each of said secondary windings and to said high tension switch, said high tension switch in one of its positions being adapted to connect the entire secondary windings of both of said transformers and one of said valve tubes in series with each other and said X-ray tube, and said switch in its other position being adapted to connect a portion of both of said secondary windings and one of said valve tubes in series with each other and said X-ray tube.

5. In an X-ray machine the combination with an X-ray tube of a pair of high tension transformers and a source of electrical energy therefor, secondary windings for said transformers, a high tension switch adapted to assume two positions, a vacuum valve tube connected to one end of each of said secondary windings, and a second valve tube connected to the remaining end of each of said secondary windings and to said high tension switch, said high tension switch in one of its positions being adapted to connect the entire secondary windings of both of said transformers and one of said valve tubes in series with each other and said X-ray tube, and said switch in its other position being adapted to connect a portion of each of said secondary windings and one of said valve tubes in series with each other and said X-ray tube during a fraction of a predetermined period, and the remaining portion of each of said secondary windings and the other of said valve tubes in series with each other and with said X-ray tube during the remainder of said predetermined period.

6. In an X-ray machine the combination with an X-ray tube of a pair of high tension secondary windings and a source of electrical energy for energizing said windings, a pair of valve tubes connected to said secondary windings for rectifying the current generated thereby, a partially completed input circuit for said X-ray tube including each of the entire secondary windings and one of said valve tubes, a partially completed input circuit for said X-ray tube including a portion only of each of said secondary windings

and one of said valve tubes, and a two position high tension switch, said switch in one position connecting said X-ray tube to said first mentioned circuit to complete the same and in its other position connecting said X-ray tube to said second mentioned circuit to complete the same.

7. In an X-ray machine the combination with an X-ray tube of a pair of high tension secondary windings and a source of electrical energy for energizing said windings, a pair of vacuum valve tubes connected to said secondary windings for rectifying the energy generated thereby, a partially completed input circuit for said X-ray tube including each of the entire secondary windings and one of said valve tubes, a partially completed input circuit for said X-ray tube including a portion only of each of said secondary windings and one of said valve tubes, and a two position high tension switch, said switch in one position connecting said X-ray tube to said first mentioned circuit to cause said X-ray tube to be energized by current from both of the entire secondary windings and rectified by one of said valve tubes, and in its other position connecting said X-ray tube to said second mentioned circuit to cause said X-ray tube to be energized by the current generated by a portion of each of said secondary windings and rectified by one of said valve tubes.

8. In an X-ray machine the combination with an X-ray tube, of a pair of high tension secondary windings and a source of alternating electrical energy for energizing said windings, a pair of valve tubes connected to said secondary windings for rectifying the energy generated thereby, a partially completed input circuit for said X-ray tube including each of the entire secondary windings and one of said valve tubes, a partially completed input circuit for said X-ray tube including a portion only of each of said secondary windings and one of said valve tubes, a third partially completed input circuit for said X-ray tube including the remaining portions of each of said secondary windings and the other of said valve tubes, and a two position high tension switch, said switch in one position connecting said X-ray tube to said first mentioned circuit to cause said X-ray tube to be energized by current from both of the entire secondary windings and rectified by one of said valve tubes, and in its other position connecting said X-ray tube to the remaining partially completed circuits to cause said X-ray tube to be energized during one half wave of the alternating current cycle by current generated by a portion of each of said secondary windings and rectified by one of said valve tubes, and during the remaining half wave of the alternating current cycle to be energized by current generated by the remaining portions of both of said secondary windings and rectified by the other of said valve tubes.

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