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PROTECTING DEVICE FOR X-RAY APPARATUS

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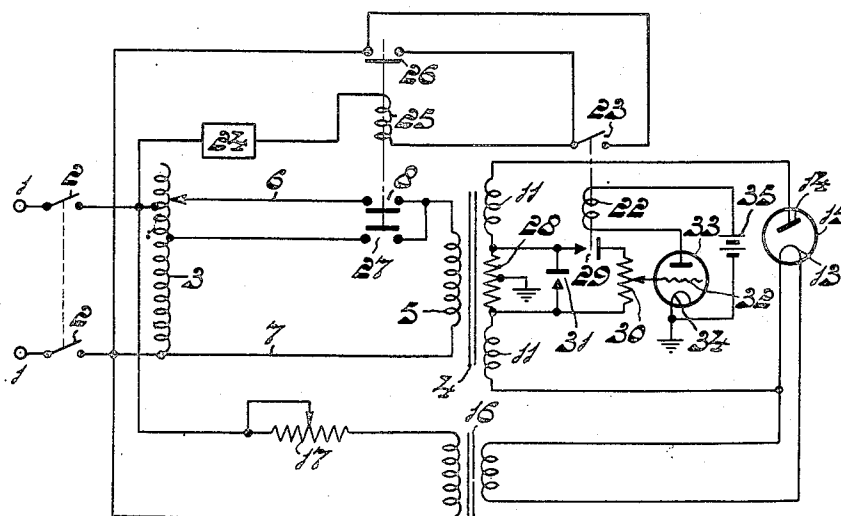
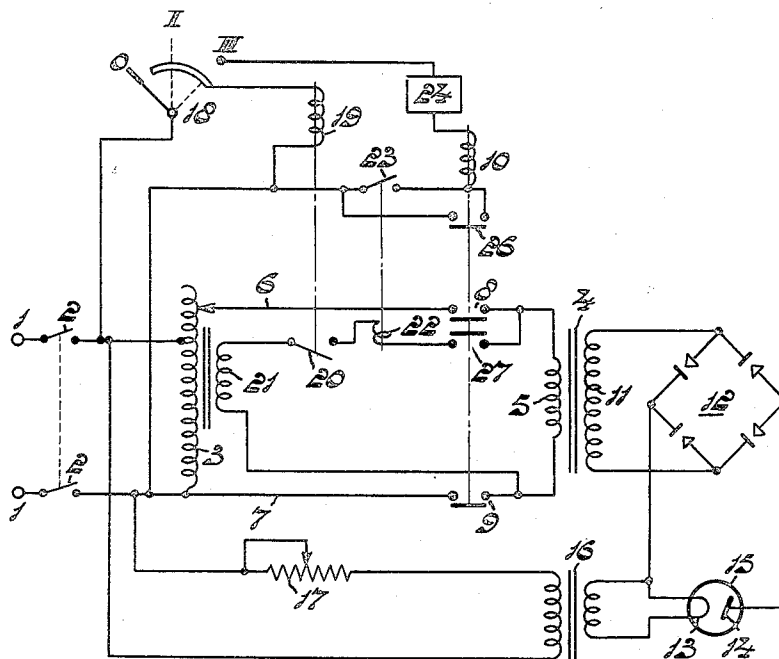


Fig. 2

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PROTECTING DEVICE FOR X-RAY APPARATUS

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4 Claims. (Cl. 250—95)

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*Improvements in or relating to X-ray apparatus
for diagnosis*

In X-ray apparatus the operating voltage i. e. the potential difference between anode and cathode of the X-ray-tube during normal operation is much lower than the no-load voltage, since voltage losses occur in the apparatus and supply mains upon loading it. On putting an X-ray-apparatus into operation first the current for heating the incandescent cathode is switched on, the high-voltage being applied after the cathode has been heated. The loading current directly rising to its full value prevents the voltage of the tube from becoming too high.

Application of the high voltage when the cathode is cold or insufficiently heated may cause break-down of a supply conductor, sparking in the envelope of the tube or damage to the X-ray tube. Consequently, care must be exercised, particularly according as the voltage used is higher and if, since the size is preferably minimized, the apparatus is incapable of withstanding the no-load voltage corresponding to the maximum permissible operating voltage.

Overvoltages may also be produced by mains voltage variations and transient phenomena, but particular switching means generally permit of avoiding them, without avoiding however the production of overvoltages in taking X-ray exposures due to the absence of the expected and previously adjusted tube current. This may be caused by interruption of the heating circuit or by short-circuits. It might be attempted to infer from the primary heating current the data required for detecting a fault in the heating circuit, but this is not very reliable owing to the slight difference between the no-load current strength and the strength of the loading current of the heating transformer.

The present invention has for its object to prevent the X-ray apparatus from being connected into circuit in the absence of emission of the incandescent cathode in X-ray tubes. It concerns X-ray diagnosis apparatus comprising a circuit supplying a voltage which is lower than the normal supply voltage and, with the heating circuit cut in, is supplied to the primary of the high-voltage transformer, the discharge current resulting from emission of the incandescent cathode operating a device and the apparatus being adapted to be connected into circuit for taking an exposure after said device has been made operative.

The low voltage preferably has a value at which the X-ray tube works in the space charge range

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at the high voltage end of the transformer. Frequently, different current intensities and sometimes different X-ray tubes must be used, it being advantageous that the current strength produced on applying the voltage is substantially independent of the adjusted heating current.

The resistance of an X-ray tube, which is practically infinite in the absence of cathode-emission, is of the order of 1 to 2 megohm in the space charge range. The impedance difference is sufficient to change over a relay of a relay tube at the earthed centre of the secondary winding of the high-voltage transformer.

If the transformer ratio of the high-voltage transformer is chosen to be approximately 150 to 200, the resistance variation of the X-ray tube reduces the impedance at the primary side from about 10^6 ohms to about 200 ohms. This impedance variation is sufficient to provide for the desired protection at the primary side by means of an alternating current relay. The low voltage circuit may include the exciter winding of such a relay and this winding may, by the action of the supply current, close a relay contact closing an interruption in a circuit including the exciter winding of an electromagnetic switch for connecting the high voltage-transformer to the normal supply voltage.

In order that the invention may be readily carried into effect it will now be described in detail with reference to the accompanying drawing illustrating two examples of circuit-arrangements for apparatus according to the invention, and in which

Fig. 1 shows the use of protective means at the primary side of the transformer.

Fig. 2 shows them at the secondary side.

An autotransformer 3 is connected by way of main switch 2 to terminals 1 of the A. C. mains. This transformer supplies the normal voltage through a regulating contact for the high-voltage transformer 4 and is connected through supply conductors 6, 7 to the primary winding 5. Supply conductor 6 includes a switch arm 8 and supply conductor 7 may also comprise such an arm 9. These switch arms form part of an electromagnetic switch 10 and are open if the apparatus is inoperative. A secondary winding 11 is connected to an X-ray tube 15 comprising an anode 14 and an incandescent cathode 13, according to Fig. 1 with the interposition of rectifiers 12.

The cathode 13 of X-ray tube 15 is supplied from a heating transformer 16, whose primary comprises the regulating resistor 17 for adjusting the heating current.

In Fig. 1 an electric circuit connected to the mains-voltage includes a switch 18 adapted to occupy three positions 0, I, II. In position 0 there is no flow of current. In position I, current is supplied to an exciter winding 19 of the relay so that the movable contact 20 completes the circuit connecting the auxiliary winding 21 of autotransformer 3 to the primary 5 of the high-voltage transformer 4. The voltage supplied by this winding has a value lower than that supplied by autotransformer 3. After switch 2 has been closed and no deviation occurs in the heating current, the X-ray tube passes current by which the low voltage winding 21 is loaded. The loading current passes through an exciter winding 22 of an electromagnetic relay and closes contact 23 of a circuit including a time switch 24 and the winding of switch 18. In position II of switch 18 this circuit is closed. Besides switch arms 8 and 9 the winding 10 operates a switch arm 27 interrupting the low-voltage circuit and a switch arm 26 shunting the contact 23. The transformer 4 is connected to the normal supply voltage by connecting the arms 8 and 9 into circuit. The duration of the load is adjusted by means of the time switch 24, the latter subsequently interrupting the current so that switch 18 is released.

If, however, the incandescent cathode 13 of X-ray tube 15 does not emit, for example, due to a short-circuit or a defective cathode, the impedance transformed on to the primary circuit is such that no sufficiently strong current passes in the low-voltage circuit to excite relay winding 22. Contact 23 remains open and switch 18 remains inoperative.

This also holds in Fig. 2, wherein the exciter winding 22 for contact 23 is included in the anode circuit of a relay tube 33 comprising a source of anode voltage 35. Relay tube 33 comprises an earthed cathode 34 at the grid 32 which is connected to a point of resistor 30. This point may be displaceable to permit adjustment of the instant at which the anode current is sufficiently strong to energise winding 22 in accordance with the emission of the cathode 13 of the X-ray tube.

The resistance 30 is connected through rectifier 29 to the ends of resistor 28 at the centre of the secondary 11 of the high-voltage transformer. In parallel with this resistor is connected another rectifier 31 so that a rectified current passes through resistor 30. The center of resistor 28 is connected to earth.

The operation of the device corresponds to that shown in Fig. 1.

What we claim is:

1. An X-ray diagnostic apparatus comprising an X-ray tube including an anode and incandescent cathode, a high-voltage transformer coupled to said tube and including a primary winding, first means for applying a heating current to said cathode, second means for applying a given operating potential to the primary winding of said transformer, third means for applying a potential which is lower than said given potential to the primary winding of said transformer, first current-responsive means coupled to said tube and responsive to the current flow there-through when said lower potential is applied to said primary winding, second current-responsive means responsive to actuation of said first current-responsive means when emission from said cathode reaches a given value for connecting said second means to said primary winding, and timing means operatively associated with said second current-responsive means for determining the duration of the application of said given operating potential to said primary winding.

2. An X-ray diagnostic apparatus comprising an X-ray tube including an anode and incandescent cathode, a high-voltage transformer coupled to said tube and including a primary winding, first means for applying a heating current to said cathode, second means for applying a given operating potential to the primary winding of said transformer, third means for applying a potential which is lower than said given potential and at which the X-ray tube will operate in the space charge region to the primary winding of said transformer, first current-responsive means coupled to said tube and responsive to the current flow therethrough when said lower potential is applied to said primary winding, second current-responsive means responsive to actuation of said first current-responsive means when emission from said cathode reaches a given value for connecting said second means to said primary winding, and timing means operatively associated with said second current-responsive means for determining the duration of the application of said given operating potential to said primary winding.

3. An X-ray diagnostic apparatus comprising an X-ray tube including an anode and incandescent cathode, a high-voltage transformer coupled to said tube and including a primary winding and a center-tapped secondary winding, first means for applying a heating current to said cathode, second means for applying a given operating potential to the primary winding of said transformer, third means for applying a potential which is lower than said given potential and at which the X-ray tube will operate in the space charge region to the primary winding of said transformer, first current-responsive means coupled to said tube and the center tap of said secondary winding and responsive to the current flow through said tube when said lower potential is applied to said primary winding, second current-responsive means responsive to actuation of said first current-responsive means when emission from said cathode reaches a given value for connecting said second means to said primary winding, and timing means operatively associated with said second current-responsive means for determining the duration of the application of said given operating potential to said primary winding.

4. An X-ray diagnostic apparatus as claimed in claim 3 in which said first current-responsive means is an electric discharge tube.

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