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X-RAY APPARATUS

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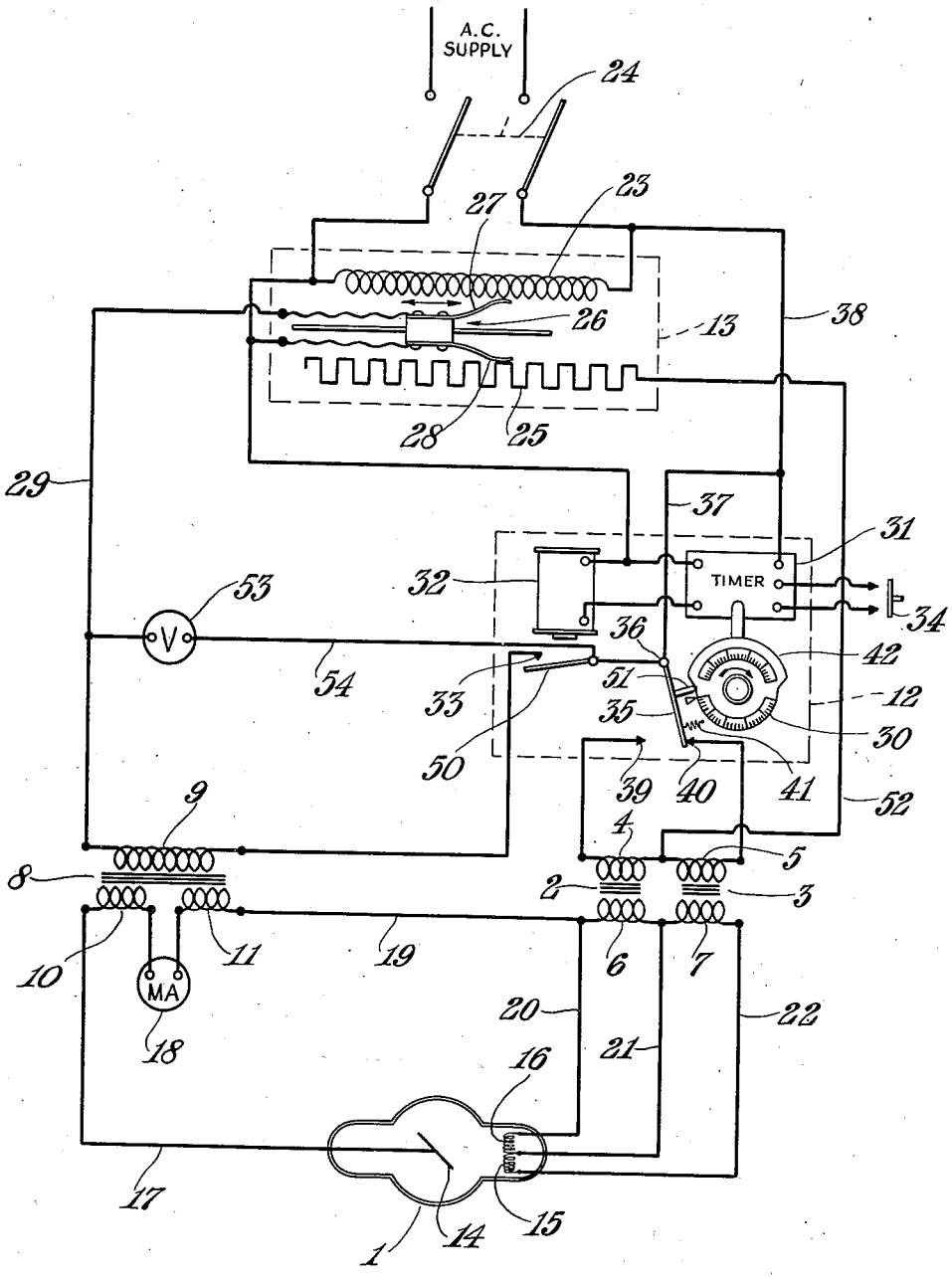

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X-RAY APPARATUS

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4 Claims. (Cl. 250—93)

My invention relates to X-ray apparatus using a multi-focus X-ray tube.

I shall describe my invention with reference to X-ray tubes having two incandescible cathodes adapted to produce two focal spots, to be referred to as a small focal spot and a large focal spot. However, the invention is not limited thereto but can be used with multi-focus tubes in general.

When using a double-focus X-ray tube, it is the usual practice to use the small focus when taking longer exposures at low currents and to use the larger focus when taking shorter exposures at higher currents. In practice the changeover of the focus is usually effected by a manual switch and if the operator does not select the proper focus the tube and particularly the target may be damaged.

The main object of my invention is to provide an apparatus in which the proper focus, depending upon the exposure time selected, is automatically made operative.

Another object of my invention is to provide means for keeping the current of the X-ray tube substantially constant, or at least within predetermined limits, when different operating voltages are used.

In accordance with the invention I provide timing-switching means which are so connected with the cathodes that the cathode adapted to produce the small focal spot will be operative only when the selected exposure time is above a certain predetermined value and that the cathode adopted to produce the large focal spot will be operative only when the selected exposure time is below a predetermined value.

To insure that the tube current will remain substantially constant when the operating voltage of the tube is given different values, I provide regulating means which is so associated with the means for adjusting the X-ray tube voltage, that the voltage across the operative cathode will be varied with changes in the operating voltage of the X-ray tube.

In order that my invention may be clearly understood and readily carried into effect I shall describe the same in more detail with reference to the accompanying drawing in which the single figure is a schematic view of an X-ray apparatus embodying the invention.

The apparatus shown in the drawing comprises an X-ray tube 1, two cathode-heating transformers 2 and 3 having primary windings 4 and 5 respectively and secondary windings 6 and 7 respectively, a high-tension transformer 8 having a low-tension primary winding 9 and two high-tension secondary windings 10 and 11, a timing-switching device 12 and a voltage-adjusting device 13.

The X-ray tube 1 comprises an anode 14, an incandescible cathode 15 adapted to produce a large focal spot on the target of anode 14 and an incandescible cathode 16 adapted to produce a small focal spot on the target of anode 14.

Anode 14 is connected through a conductor 17 to one end of secondary winding 10 whose other end is connected to one end of winding 11, through a milliammeter 18 which serves to measure the X-ray tube current. The other end of winding 11 is connected through conductors 19 and 20 to one end of cathode 16 to complete the operating circuit of the X-ray tube.

The connecting point of cathodes 15 and 16 is connected through a conductor 21 to the connecting point of windings 6 and 7 and the free ends of cathodes 15 and 16 are connected through conductors 20 and 22 respectively to the free ends of windings 6 and 7 respectively.

The voltage-adjusting device 13 comprises an auto-transformer 23 adapted to be connected through a main switch 24 across an A. C. supply, for instance a 220 volts 60 cycle supply, an impedance 25, shown as a resistance, and a sliding contact member 26. Member 26 comprises a block of insulating material adapted to slide on a suitable guide and carrying a finger 27 engaging the turns of transformer 23 and a finger 28 engaging the resistance 25. Finger 27 is connected through a flexible lead and conductor 29 to one end of winding 9 whereas finger 28 is connected through a flexible lead to one end of transformer 23.

The timing-switching device 12 comprises a dial 30 which is calibrated in seconds, an electrical timer 31 and a relay 32 having a normally-open armature 50 adapted to engage a contact 33 connected to one end of winding 9. The dial 30 is provided with a cam 42 for a purpose later to be described.

The time setting of the timer 31 is controlled by the position of dial 30 and a push button 34 serves to initiate the operation of the timer which energizes relay 32 for the desired time period. As electrically-operated timers of the above type are well-known in the art, further illustration or description of the same is believed unnecessary.

A switch arm 35 pivoted at 36 has its heel point connected through conductors 37 and 38 to one end of the transformer 23 and is adapted to engage either of two fixed contacts 39 and 40 connected to the free ends of windings 4 and 5 respectively. Arm 35 is provided with a pin

51 which is pressed against the edge of cam 42 by a spring 41. Thus, when dial 30 is set for a time less than a predetermined value, for instance less than one second, the arm 35 will engage contact 40 and when dial 30 is set for a longer exposure time arm 35 will engage contact 39. It should be noted that dial 30 is moved manually and is not moved by the timer 31.

In operating the device, the main switch 24 is closed which energizes transformer 23 and also energizes either cathode 15 and 16, depending upon the position of dial 30. The cathode energizing circuit for the position shown can be traced from one side of switch 24 through conductors 38 and 37, switch arm 35, contact 40, winding 5, conductor 52, a portion of resistance 25, and finger 28 to the other pole of switch 24.

The desired operating voltage for the exposure is obtained by moving the slider member 26 which controls the voltage to be applied across winding 9 through a circuit which may be traced from one side of transformer 23 through conductor 38, armature 50, contact 33, winding 9, conductor 29, finger 27, a portion of winding 23 to the other end of winding 23. The operating voltage applied across the X-ray tube can be measured by a voltmeter 53 having one terminal connected to conductor 29 and its other terminal connected through a conductor 54 to the heel of arm 50.

Movement of slider member 26 also adjusts the voltage to be applied across either cathode 15 or cathode 16 by changing the amount of the resistance 25 which is included in the cathode energizing circuit.

The exposure time is then set by means of dial 30, whereby either winding 4 or 5 and thus either cathode 16 or 15 are energized. Push button 34 is then pressed with the result that armature 50 engages contact 33 to energize winding 9 and apply the operating voltage to the X-ray tube. At the end of the exposure time armature 50 is opened and additional exposures of the same or different durations may be made.

Although I have described my invention with reference to specific examples and constructions I do not desire to be limited thereto because obvious modifications will appear to one skilled in the art.

What I claim is:

1. An X-ray apparatus comprising an X-ray tube having an anode and a plurality of incandescible cathodes including a cathode adapted to produce a small focal spot and a cathode adapted to produce a large cathode spot, means for applying operating voltage to said X-ray tube, means for applying energizing voltage to said cathodes, timing means for controlling the exposure time, and means controlled by said timing means and controlling said cathode energizing means to automatically and selectively energize the large focal spot cathode for only short exposure times and the small focal-spot cathode for long exposure times.

2. An X-ray apparatus comprising an X-ray tube having an anode, a cathode adapted to produce a small focal spot, and a cathode adapted to produce a large focal spot, means for applying operating voltage across the tube, means for applying energizing voltage to the cathodes, means for timing the exposure including a manually-operated dial for setting the exposure, and means controlled by said dial and controlling said cathode energizing means to make the large focal spot cathode operative only when the dial is set for an exposure time below a predetermined value and to make the small focal spot cathode operative only when the dial is set for a higher exposure time.

3. An X-ray apparatus comprising an X-ray tube having an anode and a plurality of incandescible cathodes, means for applying operating voltage to said X-ray tube including a voltage-regulating device, means for timing the exposure including a timing device, means for energizing said cathodes including a voltage-regulating device having a dial for setting the exposure time, means associated with said latter means and said dial to make said cathodes selectively operative in accordance with the setting of the dial, and a common control member for said voltage-regulating devices to decrease the cathode energizing voltage with increases in the X-ray tube operating voltage.

4. An X-ray apparatus comprising an X-ray tube having an anode, a cathode adapted to produce a large focal spot, and a cathode adapted to produce a small focal spot, means for applying an operating voltage to said X-ray tube including a voltage-regulating device, means for energizing said cathodes including a voltage regulating device, means for controlling the exposure time including a timing device having a dial for setting the exposure time, means controlling the cathode energizing means to make the large focal spot cathode operative only when the dial is set for an exposure time below a predetermined value and to make the small focal spot cathode operative only when the dial is set for a longer exposure time, and a common control member for said voltage-regulating devices to decrease the cathode energizing voltage with increases in the X-ray tube operating voltage.

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