

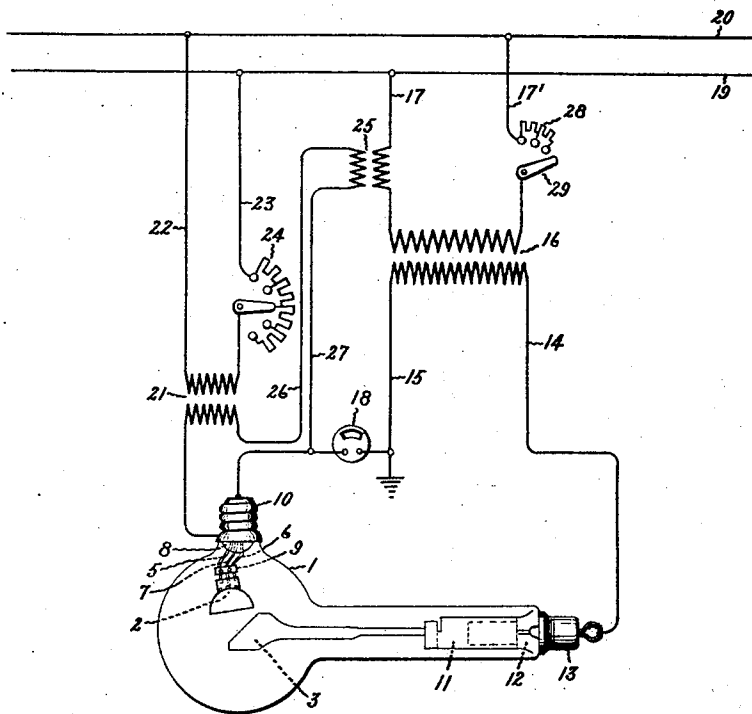
March 10, 1925.

1,529,344

W. D. COOLIDGE

X-RAY APPARATUS

Original Filed July 15, 1918



Inventor:
William D Coolidge,
by *Albert G. Davis*
His Attorney.

UNITED STATES PATENT OFFICE.

WILLIAM D. COOLIDGE, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

X-RAY APPARATUS.

Original application filed July 15, 1918, Serial No. 245,055. Patent No. 1,365,633, the latter being a division of application Serial No. 161,892, filed April 13, 1917, Patent No. 1,310,061. Divided and this application filed October 13, 1920. Serial No. 416,716.

To all whom it may concern:

Be it known that I, WILLIAM D. COOLIDGE, a citizen of the United States, residing at Schenectady, in the county of Schenectady, State of New York, have invented certain new and useful Improvements in X-Ray Apparatus (division of my prior application Serial No. 245,055, filed July 15, 1918, which in turn is a division of Serial No. 161,892, filed April 13, 1917, patented July 15, 1919, No. 1,310,061), of which the following is a specification.

The present invention comprises an X-ray device having a number of novel features rendering it particularly suitable for operation by people who have little special training in the operation of X-ray apparatus.

The X-ray tube is connected directly to the secondary winding of a transformer which is designed to furnish current at voltages high enough for X-ray purposes, when the primary winding is supplied with alternating current of ordinary commercial voltage and frequency.

A terminal common to the X-ray tube, the main supply transformer and the cathode lighting transformer is connected to ground to reduce the danger of electric shock.

The novel features of my invention will be pointed out with greater particularity in the appended claims and more fully described in the following description taken in connection with the accompanying drawing, which is a diagram illustrating a system of connections embodying my invention.

Referring to the drawing, the X-ray tube comprises an envelope 1 consisting, for example, of glass, into which are sealed a cathode 2 and an anode 3. The cathode comprises a coiled filament consisting of highly refractory metals, such, for example, as tungsten, and a surrounding focusing device having a hemispherical member and a cylinder member, preferably also consisting of refractory metal, for example, molybdenum or tungsten. The cathode and the focusing member are electrically connected by attaching the end of the cathode to the focusing member. Two wires 5 and 6 which are connected to the focusing member, together with a wire 7, which is connected to one end of

the cathode spiral, are sealed into a stem 8 of the X-ray tube. An insulating bridge piece 9 maintains the wires 5, 6 and 7, spaced apart and serves to preserve rigidity. A heating current is conducted to the cathode spiral through the wires 6 and 7, which are connected to an external threaded terminal 10 constructed similar to an incandescent lamp base. The cathode is positioned, as by bending the wires 5, 6 and 7, or in any other way, to intercept on the focusing member, any inverse discharge taking place from a heated focal spot on the electrode 3 when negative with respect to the electrode 2. In this manner an inverse thermionic discharge is prevented from impinging on the opposite glass wall and injuring the tube.

The anode 3 of the X-ray tube consists preferably of wrought tungsten and is connected to an iron tube 11 carried by a glass stem of the tubular extension 12 of the X-ray tube. Connection is made to an external metal cap 13 provided with a ring so the electrical connection may be easily made.

As more fully described in my Patent No. 1,203,495, issued October 31, 1916, the X-ray tube is thoroughly freed from gases and exhausted to a pressure so low that conduction of energy may take place therethrough by thermionic current substantially independent of gaseous ionization. The tube is solidly connected by the conductors 14, 15, to the secondary terminals of a transformer 16. The primary of the transformer is connected by conductors 17 and 17' to a source of alternating current, as represented by conductors 19 and 20. The current through the tube may be indicated by a suitable milliammeter 18.

A current for maintaining the cathode filament at incandescence is furnished by a small low voltage transformer 21, the primary of which may be connected conveniently by conductors 22, 23, to the same source of alternating current which supplies the main high potential transformer 16. In series with the conductor 23 is an adjustable resistance 24 for regulating the cathode heating current. The conductor 15 preferably is solidly grounded as indicated in the drawing.

The current through the X-ray tube de-

pendes mainly on three factors, namely, the electron emissivity of the cathode; the tube design; and the impressed voltage.

As a very substantial drop in voltage occurs in the mains 19, 20, when the tube is taking current from the main transformer 16, means is provided for maintaining the voltage of the filament heating current substantially constant under these conditions to prevent any material change in the temperature of the cathode. One way for compensating for this drop in voltage comprises a boosting transformer 25, the primary of which is in series with the primary of the main transformer 16 and the secondary of which is connected by conductors 26, 27, in series with the secondary of the transformer 21. In some cases this boosting transformer may be omitted.

A resistance 28 is provided which is first included in circuit by the closure of the switch 29. This resistance may be removed from circuit immediately and the tube operated directly from the alternating current source.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. An X-ray apparatus comprising the combination of an X-ray tube having a cathode adapted to be heated, and an anode,

a source of alternating current, a main step-up transformer having a primary winding connected to said source and a secondary winding connected to the electrodes of said tube, a separate auxiliary transformer having a primary winding connected to said source, and a secondary winding connected to the cathode of said tube, and a common solid ground connection for the cathode of said tube and the secondary windings of said transformers.

2. An X-ray apparatus comprising the combination of an electron tube having a cathode adapted to be heated by passage of current, a main transformer having a secondary winding connected to the electrodes of said tube, an auxiliary transformer having a secondary winding connected to the cathode of said tube, a third transformer having a primary winding in series with the primary winding of said main transformer and a secondary winding connected in series with the secondary of the auxiliary transformer, and a connection to ground common to the secondaries of said three transformers.

In witness whereof, I have hereunto set my hand this 6th day of October, 1920.

WILLIAM D. COOLIDGE.