

L. E. DEMPSTER.
X-RAY DEVICE.
APPLICATION FILED APR. 19, 1915.

1,246,066.

Patented Nov. 13, 1917.

Fig. 1.

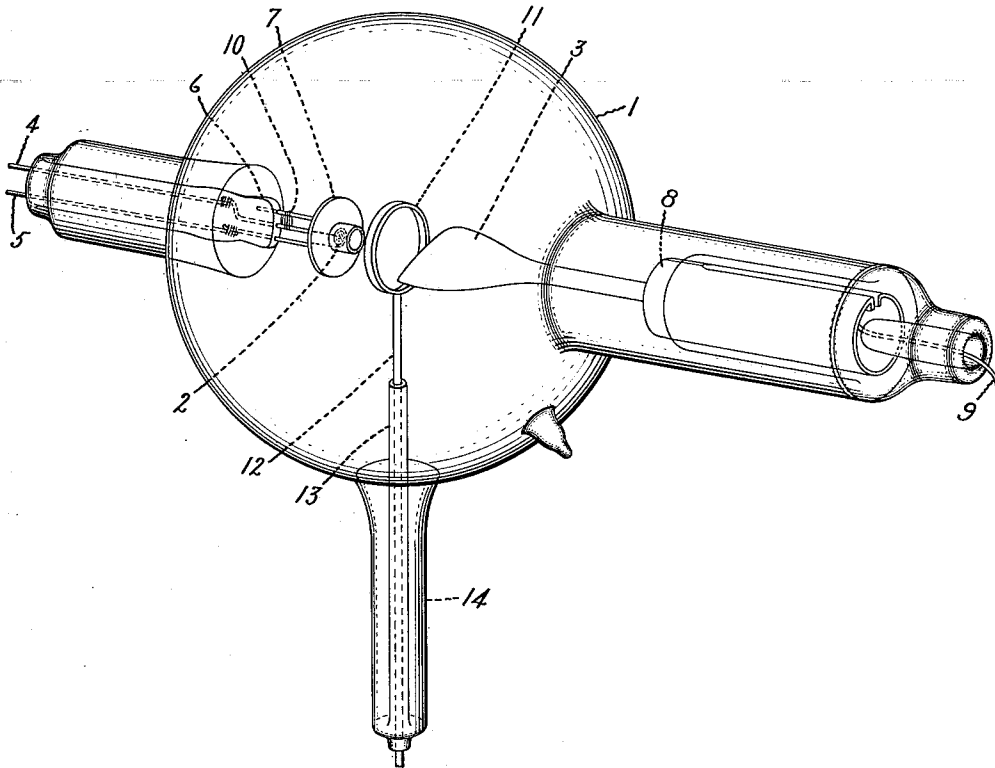


Fig. 2.

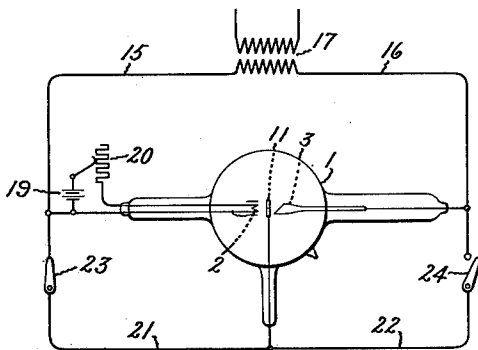
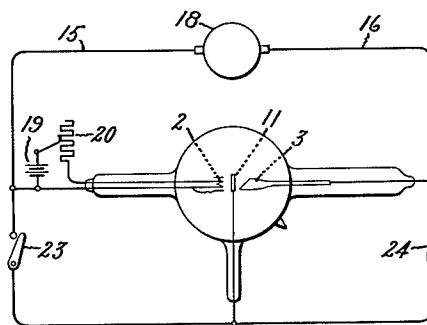


Fig. 3.



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UNITED STATES PATENT OFFICE.

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X-RAY DEVICE.

1,246,066.

Specification of Letters Patent.

Patented Nov. 13, 1917.

Application filed April 19, 1915. Serial No. 22,360.

To all whom it may concern:

Be it known that I, LEONARD E. DEMPSTER, a subject of the King of Great Britain, residing at Schenectady, county of Schenectady, State of New York, have invented certain new and useful Improvements in X-Ray Devices, of which the following is a specification.

The present invention relates to electron discharge devices, particularly X-ray tubes operating with a substantially pure electron discharge and its object is to provide a tube which may be operated with focal spots of different sizes interchangeable at will.

In Patent No. 1,203,495, issued October 31, 1916, to Dr. W. D. Coolidge is described and claimed a pure electron discharge X-ray tube provided at the cathode with an electrostatic or electromagnetic focusing device whereby the cathode rays are concentrated upon a spot of small area on the anode.

In accordance with my invention, I have provided an electron discharge device of the character described with an additional focusing device whereby a field may be established intermediate the cathode and anode acting to increase or decrease the convergence of the beam of cathode rays thereby correspondingly varying the area of the focal spot.

In the accompanying drawings Figure 1 is a perspective view of an X-ray tube made in accordance with my invention, and Figs. 2 and 3 are diagrams of connections.

The X-ray tube shown in Fig. 1 comprises an inclosing envelop 1 consisting of glass, and provided with a cathode 2 and an anode 3. The cathode as indicated by dotted lines consists of a short coiled filament of refractory metal, such as tungsten and is connected to current-conveying terminals 4, 5 sealed into a stem 6. Surrounding the cathode is a cylindrical conductive member 7 consisting conveniently of molybdenum. The anode is supported by a tube 8 consisting of iron or molybdenum, electrical connection being made by a sealed-in conductor 9. The space within the envelop is exhausted to a pressure so low that conduction of current can occur by electron discharge substantially without gas ionization, for example, to a pressure of a few hundredths of a micron or less. The electrodes are freed from ionizable gas by methods described in an article by W. D. Coolidge in the *Physical Review*

for December, 1913, and in Coolidge Patent No. 1,203,495, issued October 31, 1916. When the cathode in a device thus prepared is heated to incandescence and a suitable potential impressed between the cathode and the anode a discharge occurs which with a sufficiently high voltage produces X-rays by impact with the anode surface.

The cylinder or ring 7 is used to establish an electrostatic field radially about the cathode and with this in view is preferably connected to the cathode as by the conductor 10. When the ring 7 is thus negatively charged the field surrounding the cathode has the effect of focusing or concentrating the cathode rays upon a spot of small area on the anode. The size of this spot depends largely on the geometric relations of the various parts of the tube but for any given tube, the focusing is fixed unless special provision is made to vary the focusing.

As already indicated I have provided for this purpose an additional focusing means located intermediate the cathode and the anode. In the particular embodiment of my invention illustrated in Fig. 1 this additional focusing device assumes the form of a ring 11 surrounding the path of the beam of cathode rays. This ring may consist of iron or molybdenum and may be supported by a metal rod 12 sealed into a glass stem 13 secured by fusion to a side tube 14 of the envelop.

When the ring 11 is charged negatively the concentrating effect of the main focusing device is increased, thus sharpening the focusing. When the ring 11 is charged positively, the effect of the main focusing device is counteracted, thus broadening the focus.

A simple means for carrying out my invention is illustrated in Figs. 2 and 3. In Fig. 2 the X-ray tube 1 has its electrodes connected by conductors 15 and 16, to the secondary of a transformer 17, and in Fig. 3 conductors 15 and 16 are connected to the terminals of a direct current source 18 which may be a rectifier, high potential battery or electrostatic plate machine. The cathode 2 is heated by means of a battery 19 connected thereto in series with the resistance 20. A conductor 21 is provided for connecting the ring 11 to the cathode terminals and the conductor 22 for connecting the ring 11 to the anode terminal. When both switches 23, and 24 are open the ring 11 has sub-

stantially no effect upon the operation of the tube. By closing the switch as indicated the intermediate focusing device is connected to the cathode thus charging it negatively and sharpening the focus. In Fig. 3 the switch 24 is shown as being closed and the switch 23 as being open. With this electrical connection the area of the focal spot is increased. Although my invention has been illustrated in connection with an electrostatic main focusing device it is equally applicable to a tube equipped with an electromagnetic main focusing device.

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

1. An X-ray device comprising the combination of a sealed evacuated envelop, a cathode adapted to be independently heated, an anode, means surrounding the cathode for focusing the cathode rays, a device located intermediate the cathode and anode for varying the ray-concentrating action of said focusing means and connections for independently varying the electrostatic charge of said device.

2. An X-ray device comprising the combination of a sealed envelop, an electron-emitting cathode, an anode, means for focusing the cathode discharge upon the anode, and means intermediate said focusing device and the anode for interchangeably broadening and sharpening at will the focal spot on said anode.

3. An X-ray tube comprising the combi-

nation of a sealed envelop, an electron-emitting cathode, an anode, a conductive member surrounding the cathode and electrically connected thereto, a conductive ring, located intermediate said cathode and anode and surrounding an axis passing through said electrodes and independent external electrical connections to said ring respectively from said cathode and said anode.

4. An X-ray device comprising the combination of a sealed envelop, an electron-emitting cathode, an anode, means for establishing an electrostatic field radially about the cathode to focus the cathode rays, a conductive member at least in part surrounding an axis passing through said electrodes, and means for electrically connecting said member to either of said electrodes at will.

5. An electric discharge device comprising the combination of a sealed envelop evacuated to a pressure so low that a substantially pure electron discharge may be passed therein, a cathode adapted to be independently heated, an anode deprived of ionizable gas, a charge-receiving member located adjacent said cathode, an electrical conductor surrounding at least in part the space between said electrodes, and an electrical connection between said conductor and one of said electrodes.

In witness whereof, I have hereunto set my hand this 17th day of April, 1915.

LEONARD E. DEMPSTER.