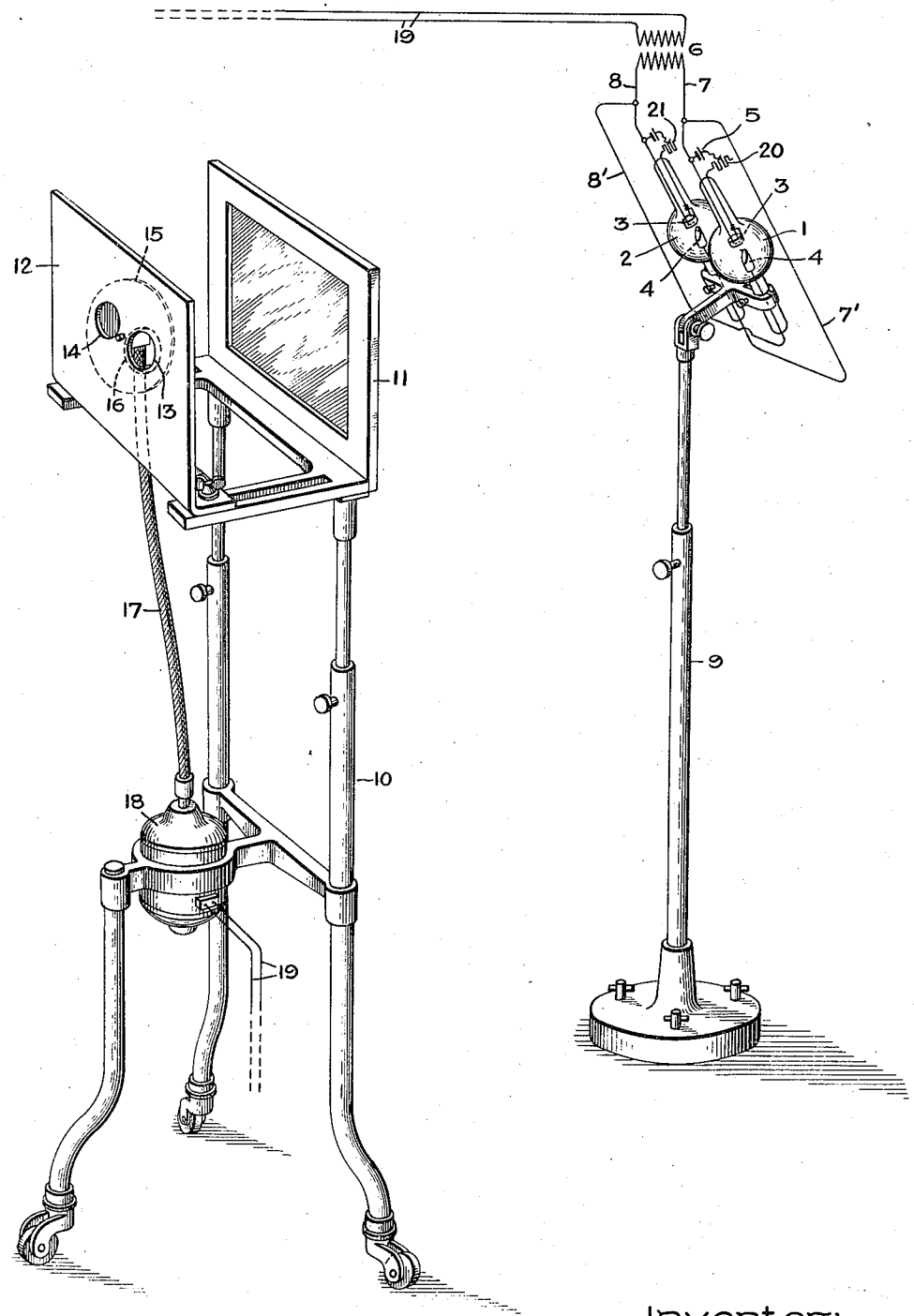
W. D. COOLIDGE.

STEREOSCOPIC X-RAY APPARATUS.

APPLICATION FILED MAR. 3, 1915.

1,250,093. Patented Dec. 11, 1917.



Witnesses:
Marcus L. Byng.
J. Ellis Glen.

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.

STEREOSCOPIC X-RAY APPARATUS.

1,250,093. Specification of Letters Patent. Patented Dec. 11, 1917.

Application filed March 3, 1915. Serial No. 11,896.

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 Stereoscopic X-Ray Apparatus, of which the following is a specification.

The present invention comprises an apparatus for viewing objects by means of X-rays, whereby shadow images in stereoscopic relief are produced.

In accordance with my invention two rectifying X-ray tubes are employed, these tubes being directly and oppositely connected to a source of alternating current without the provision of any auxiliary contact-making apparatus, so that each will receive alternately impulses of current. Successive images produced by these two X-ray tubes on a fluorescent screen are viewed in proper relation first by one eye of the observer and then by the other in synchronism with the current impulses to produce the effect of an image seen in stereoscopic relief.

My invention will be pointed out with particularity in the appended claims, but for a more detailed description of the same reference may be had to the following description taken in connection with the accompanying drawings illustrating in perspective one embodiment of my invention.

Referring to the drawing, the Roentgen tubes 1, 2, are of the rectifying type described in the *Physical Review*, December, 1913, and my Patent No. 1,203,495, issued October 31, 1916. These tubes each have a cathode 3 comprising a refractory material, such as tungsten, adapted to be heated to incandescence. The cathode is preferably of filamentary form and as indicated, is surrounded by a conductive ring connected to the cathode whereby the static field near the cathode is caused to radially direct or focus the electron discharge emanating from the cathode upon an anode 4, also preferably consisting of tungsten. The space within the tube is evacuated to such a low pressure and the electrodes are so completely freed from gas that electrical conduction through the tube occurs as a substantially pure electron discharge and evidences of positive ionization are substantially absent during the operation of the tube. When the cathode is heated to incandescence, for example, by means of a battery 5, and a sufficiently high potential is impressed between the cathode and anode, and with the anode at a temperature not above dull redness, passage of current can occur only when the heated electrode is negative. Because of this asymmetric characteristic the tubes 1 and 2, therefore, may be connected in such a manner to an alternating source of current, for example, the secondary of a transformer 6, that one-half wave will pass through tube 1 and the other half wave pass through the tube 2. In the connections illustrated the cathode of tube 1 and anode of tube 2 are connected by conductors 7 and 7′ to one terminal of the transformer secondary and the cathode of tube 2 and the anode of tube 1 are connected by conductors 8 and 8′ to the opposite terminal of the transformer secondary.

For stereoscopic X-ray examinations the two tubes may be supported by an adjustable stand 9. Opposite the tubes is located an adjustable tripod 10, carrying a fluorescent screen 11 and a shield 12 in which are located two sight holes 13, 14, spaced apart a suitable distance so that one eye of the observer can be placed to one sight hole and the other eye to the other sight hole to observe images on the screen 11. A shutter 15 (shown in dotted lines) is located to revolve between the two sight holes in synchronism with the alternations of the electrical current supplying the X-ray tubes. A hole 16 in the shutter 15 is positioned to uncover the sight hole 13 when tube 2 is receiving current and to uncover the sight hole 14 when the tube 1 is receiving current. The desired synchronous operation of the shutter can be conveniently secured by a flexible shaft 17 driven by a synchronous motor 18. This motor preferably is connected by the conductor 19 to the source of current whereby the transformer 6 is supplied.

When an object to be observed by means of the X-rays is placed between the screen 11 and the two X-ray tubes and the shutter is rotated in synchronism with the current impulses in the tubes, as above described, a succession of images upon the screen 11 may be observed. The alternations of the current are so chosen that the succession of images will blend by persistence of vision to produce upon the observer the effect of a continuous shadow image in stereoscopic relief. The current taken by the tubes 1 and

2 may be regulated by adjusting the filament temperatures by means of the variable resistances 20, 21, to be substantially the same and this adjustment of current will remain invariable. The tubes 1 when taking the same current and operating from a common source will give rays of substantially equal intensity. The hardness may be varied at will by changing the transformer voltage.

It will be observed that this arrangement possesses the advantage of extreme simplicity as no complicated circuit closing apparatus is required to energize the X-ray tubes during the desired time intervals. The synchronism between the revolution of the shutter and the successive illumination of each of the tubes is necessarily rigidly maintained as the shutter may be operated by the same source of alternating current that is impressed upon the X-ray tubes.

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

1. The combination of a source of alternating current, two Roentgen-ray tubes conductive to current in one direction only having their terminals respectively oppositely connected directly to the terminals of said source, a diaphragm having two sight holes, a fluorescent screen located between the diaphragm and said tubes, and means for opening and closing said sight holes alternately in synchronism with the alternations of current from said source to view shadows on the fluorescent screen in stereoscopic relation.

2. The combination of a source of alternating current, two X-ray tubes each having a cathode operating at incandescence, direct electrical connections between said tubes and the source of current to supply the tubes alternately with impulses of current of opposite polarity, a fluorescent screen, a diaphragm having two sight holes for viewing images on said screen, and means operating in synchronism with the alternating current supplied to the X-ray tubes for opening and closing said sight holes alternately to view in stereoscopic relation images of an object between the X-ray tubes and said screen.

3. The combination of a source of alternating current, a step-up transformer, two X-ray tubes each having a cathode operating at incandescence, a coöperating anode, and an inclosing envelop evacuated to a gaseous pressure so low that operation of the tube is independent of positive gas ionization, a direct wire connection between the cathode of one tube and the anode of the second tube to one terminal of the transformer secondary, a direct wire connection between the anode of the first tube and the cathode of the second tube to the opposite terminal of the transformer secondary, a fluorescent screen, a diaphragm having two sight holes, a shutter for said sight holes and a synchronous motor energized by current from said source of alternating current for operating said shutter to open and close said sight holes alternately to view X-ray shadows of an object on the screen in stereoscopic relation.

In witness whereof, I have hereunto set my hand this first day of March, 1915.

WILLIAM D. COOLIDGE.

Witnesses:
H. C. BUTCH,
HELEN ORFORD.