Aug. 9, 1960 L. PAROSELLI 2,948,822

X-RAY TUBES

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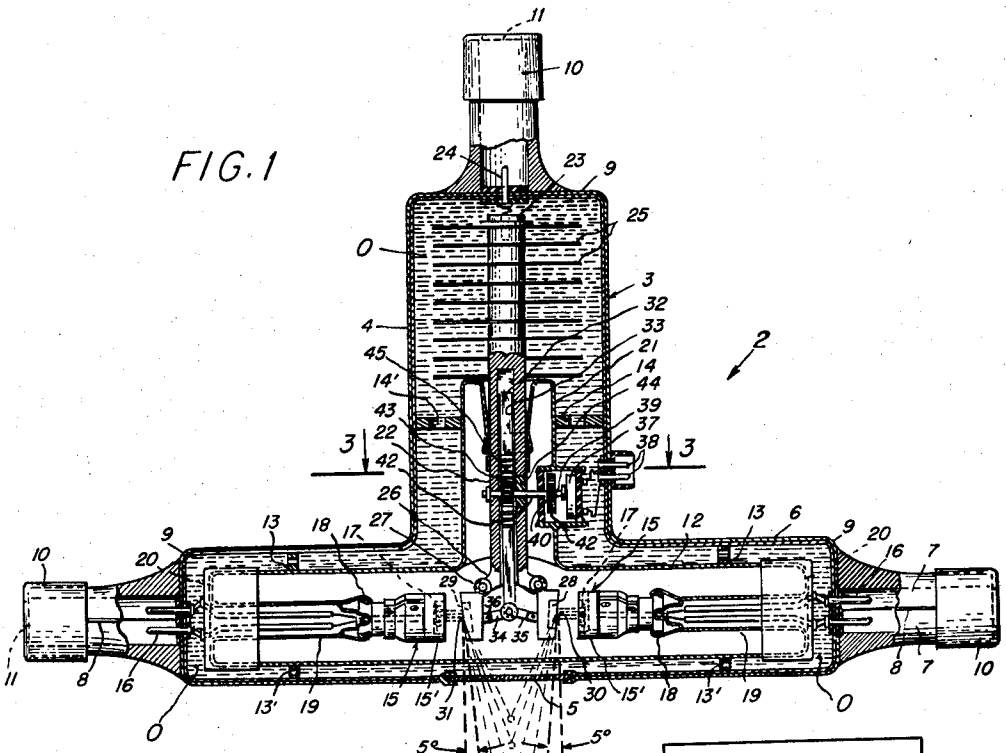
FIG. 1



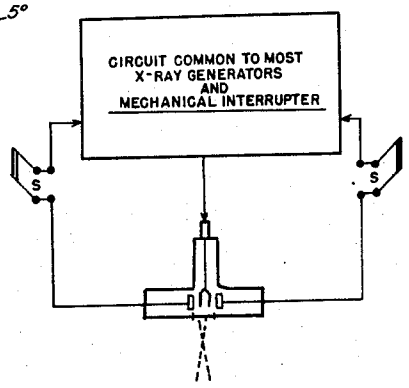


FIG. 2

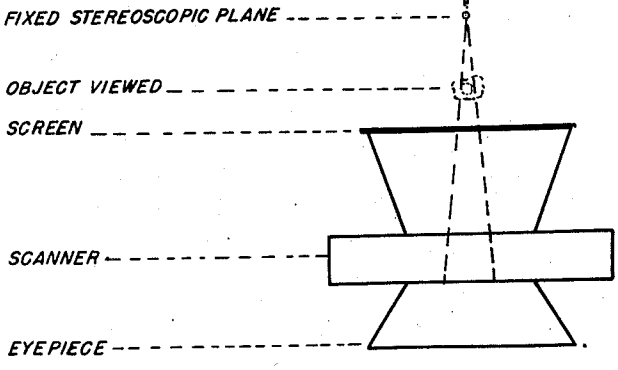


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FIG. 3

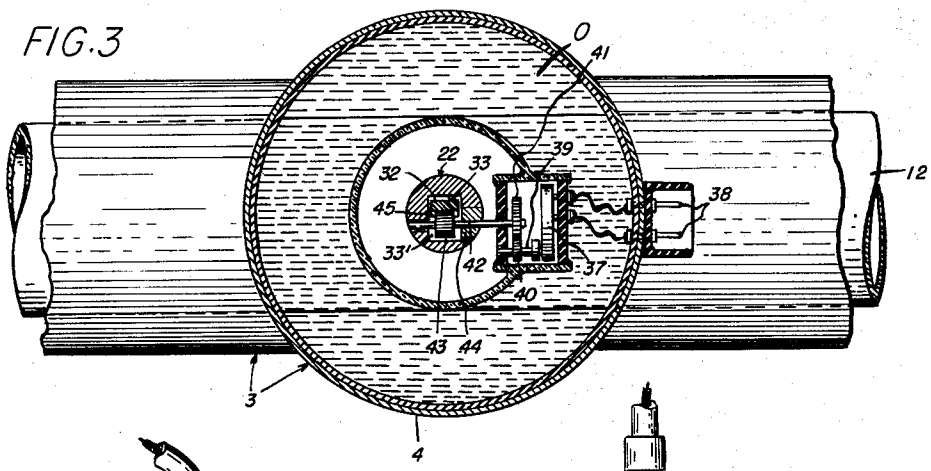


FIG. 4

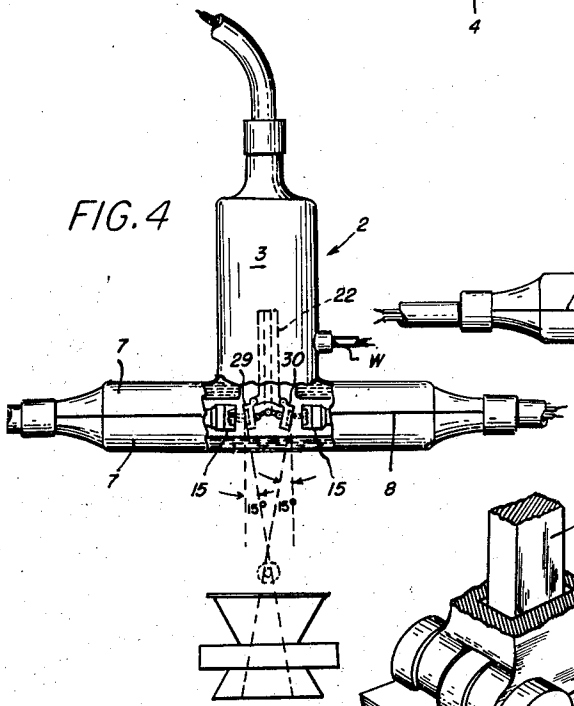


FIG. 5

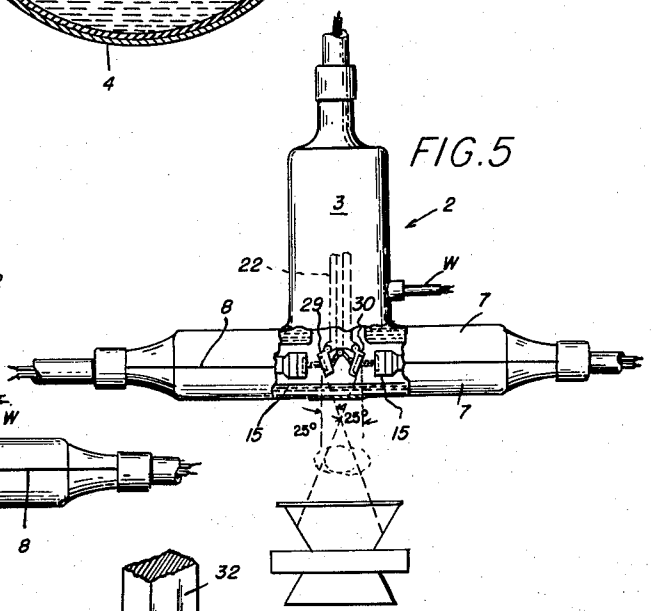
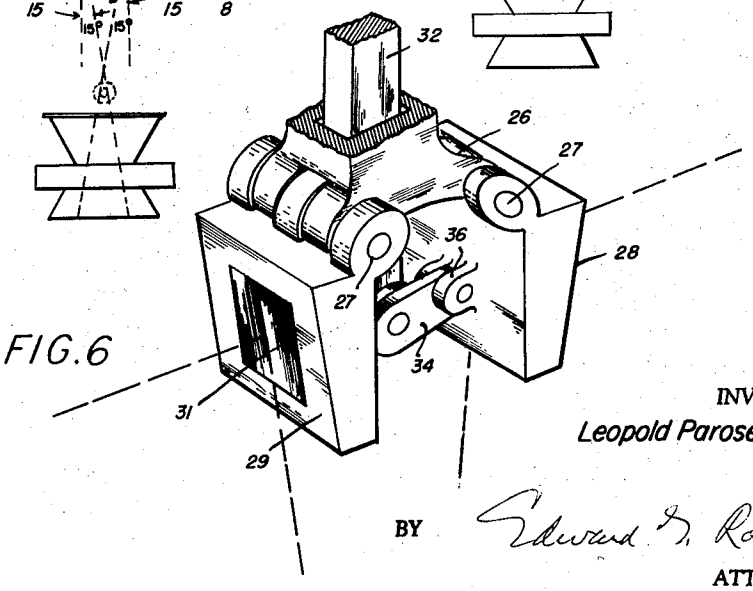


FIG. 6



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X-RAY TUBES

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7 Claims. (Cl. 313—56)

Generically, my invention relates to X-ray tubes. The principal object of my invention is an improved tube for use in roentography and fluoroscopy. My tube has two fixed cathodes and two adjustable anodes, which receive the electron bombardment whereby X-rays are produced.

In the present system of roentography, using a single or double focus tube at a selected distance, a radiographic exposure can be obtained.

In making stereoscopic films, the practice today is to set the tube and film at a selected distance with one exposure being made on one film. Then the tube is moved either mechanically or manually three inches or more, depending upon the distance of the film, and with the tube in the second position, another film is made. These films are viewed with the aid of a stereoscope and a stereoscopic image is produced. The moving of the tube by either mechanical or manual means is time-consuming and labor-costly.

My improved tube can be used just as are the X-ray tubes now in use for the present system of roentography, by employing one anode and related cathode, with the other anode and cathode disconnected from the X-ray circuit.

And my tube can be utilized to capital advantage in making stereoscopic films without moving the tube, as is necessary at present—at considerable saving in time and expense. The stereoscopic plane is achieved by moving the anodes the desired degree by outside electrical control. One exposure is made from one anode and related cathode, then a new film is put in place beneath the object to be radiographed—and another exposure is made from the second anode and related cathode, with the first anode and cathode disconnected. These two films can then be stereoscoped.

In fluoroscopy as presently practiced, the object to be fluoroscoped is placed between the X-ray tube and a fluorescent screen and the object viewed through the screen. This can also be accomplished with my improved X-ray tube by employment of one anode and related cathode, with the other anode and cathode disconnected.

I have invented a stereoscopic X-ray tube embodying two fixed cathodes and two movable anodes wherein the anodes are angularly adjustable with respect to the cathodes to produce a plurality of fixed planes of the emitted X-rays in relation to the fluoroscope or a scanning device without shifting the position of the tube. Stated otherwise, to produce a stereoscopic effect when X-raying an object a fixed plane to focus the rays must be established. When fluoroscoping a large object one fixed plane must be utilized, for example, and for a smaller object a different fixed plane must be used. I accomplish this change of fixed planes by adjusting the angle of the anodes, without the necessity for moving the position of the tube, a manifest advantage.

Briefly, the X-ray tube comprises a ray proof, win-

dowed envelope supporting therein a highly evacuated X-ray tube mounting a pair of cathodes in its opposite ends and a single anode shaft in the neck of the tube terminating in two target anodes, and mechanism to shift the angle of the targets to direct the crossing streams of X-rays at different angles from the targets, capable of producing a plurality of fixed planes with respect to the fluoroscope.

One preferred embodiment is illustrated in the drawings and described below:

In the drawings—

Fig. 1 is a top plan view of the tube

Fig. 2, a fragmentary sketch indicating that a mechanical interrupter and two switches are in the accessory power supply apparatus

Fig. 3, an enlarged cross-section taken along line 3—3 of Fig. 1

Fig. 4, a top plan view of the tube, with the top partially broken away to illustrate one fixed plane of the emitted X-rays

Fig. 5, a view showing a different fixed plane

Fig. 6, an enlarged perspective view of the lower end of the anode rod depicting the two adjustable anodes.

For purpose of explication, I have marshalled below the number parts, and in some cases like numbers denote like parts:

2—tube assembly
3—ray proof envelope
4—lead lining
5—glass windows
6—longitudinal section of envelope
7—two halves of section 6
8—weld
9—ends of envelope
10—caps on envelope ends
11—openings in caps
12—X-ray tube
13—braces in arms of envelope
14—medially disposed brace
13_1—openings in braces 13
14_1—openings in brace 14
15—cathodes
15_1—focusing cups
16—terminals
17—filaments
18—glass collars
19—inner extremities of tube
20—opposite ends of tube 12
21—neck of tube
22—anode shaft
23—upper end of anode shaft
24—terminal
25—fins
26—shoulders
27—hinge point
28, 29—anodes
30, 31—target portions of anodes
32—shaft
33—rectilinear bore in anode shaft
33_1—enlarged portion of bore
34, 35—links
36—lugs on anodes
37—sealed motor
38—terminals
39—motor shaft
40—pinion gear
41—gear
42—shaft
43—pinion gear
44—bushing
45—ratchet

Referring to the drawings, the tube assembly is generally indicated by the numeral 2, with ray proof envelope 3, which may be fabricated of aluminum having lead lining 4 and glass window 5, through which the X-rays are directed. The longitudinal section 6 of the envelope is formed in two halves 7 welded as at 8 after the X-ray tube is inserted.

Envelope 3 is provided with ends 9 suitably capped as at 10 with openings 11 through which the cable connections to the high voltage power supply are inserted, and the circuit, common to most X-ray generators, includes two switches S and a mechanical interrupter as indicated in Fig. 2.

The X-ray tube itself which may be a high vacuum "Pyrex" glass hot cathode tube type is designated by numeral 12 and is braced within envelope 6 as by a pair of braces 13 in the arms of the envelope and medially disposed brace 14 with openings 13, and 14, respectively in the braces for free circulation of the oil O.

Within tube 12 I have mounted a pair of cathodes 15 having terminals 16 for connection with the power supply, the cathodes being fabricated of tungsten with a fused tungsten filament 17, said cathodes supported within the tube by collars 18 fused thereto at the inner extremities of tube 19 inverted from the opposite longitudinal ends 20 of tube 12. The cylindrical focusing cup 15, surrounds the filament 17 in each anode, as is well-known, and the cathodes are supported by known methods.

The focal spot of an X-ray tube can be changed in shape, size and uniformity of energy distribution by changing the size and shape of the filament and/or shape and its relative location. The shape, size and location of filament 17 as depicted herein as well as of the other components of my tube may be varied, and the methods of mounting the cathodes and anodes within the tube, and materials may be changed, to equivalent materials.

Between the terminals 16 and the cathodes are lead-in wires.

In the neck 21 of tube 12 I mount anode shaft 22 formed of copper or equivalent material such as molybdenum having its upper end 23 connected to terminal 24 for connection with the high voltage power supply. Rod 22 is centrally sealed in neck 21 of the tube by suitable methods and upon its upper end portion 23 I mount fins 25 to dissipate the heat conducted away from the anode or target members hereinafter described, and as copper is a good conductor, rod 22 may be manufactured thereof.

Rod 22 at its lower end portion is formed with diverging, integral sloping shoulders 26 and to the outer ends thereof are hinged, as at 27—a pair of anodes 28, 29 in which are set a pair of tungsten targets 30, 31,

For adjusting anodes 28, 29 I have provided shaft 32, received and guided in longitudinal, rectilinear bore 33 in anode rod 22 having an enlarged cut-out portion 33_1. Pivoted to the lower end of bar 22 are a pair of links 34, 35 also pivoted at their outer ends to lugs 36 on the inner, confronting faces of anodes 28, 29.

Mounted on one side of tube 12 is a sealed electric motor unit 37 connected to terminals 38 on the outside of envelope 3, which are for coupling as by cable W with a suitable remote control (not shown) for controlling motor 37 to adjust anodes 28, 29 to any desired angle, as will be understood.

Shaft 39 of the motor carries pinion gear 40 engaging gear 41 carried on shaft 42 journalled through anode rod 22 and the motor. Upon shaft 42 is a pinion gear 43 (see Fig. 3) in enlarged section 33_1, of bore 33. To insert shaft 42 transversely of rod 22 I have provided bushing 44. Pinion gear 43 engages ratchet 45 on shaft 32.

The foregoing linkage connections and gearing permit angular adjustment of targets 30, 31 in a direction toward or away from each other which accomplishes the production of any desired fixed plane at which to produce a stereoscopic image of an object which is placed in the intersecting beams of X-rays emitted by the targets 30, 31 when the cathode filaments 17 are heated and the targets bombarded with the electrons from the cathodes. When both anodes and cathodes are connected to the circuit including interrupter the two targets emit X-rays alternately in accordance with the interrupted current being supplied to each side of the tube. Or one or the other of switches S may be opened in order to utilize one set of anodes-cathodes or the other. The control for the motor 37 may have indicia for indicating the exact degree of angular disposition of the target portions 30, 31 so that the anodes may be adjusted instantaneously to any degree, as for example, from 15°, as shown in Fig. 4 to 25° in Fig. 5. Or the angle may be adjusted to less than 15°, down to 5°, or even less. At any selected angle, the angle of one anode with respect to its related cathode is identical in degree to that of the opposite anode and its related cathode. And in this connection, I can accomplish a broader or narrower focus of the X-rays by adjustment of the angle of the anodes, when utilizing one set of anodes and selected cathode—or the other.

In its broader aspects, my invention comprehends the employment not only of the various means described, but of equivalent means for performing the recited functions. It is desired to effect such changes and modifications as may come fairly within the scope of the appended claims.

I claim:

1. An X-ray tube housed in a ray proof, windowed envelope having a longitudinal portion of substantially uniform diameter and a centrally disposed and integral neck portion extending therefrom of uniform and greater diameter, the tube having a longitudinal tubular section and an integral transversely extending section extending from the medial part of the first named section, the improvements consisting of two fixedly mounted cathodes in opposite sides of the longitudinal section, an anode rod mounted in the transverse section terminating in two depending shoulders, two anodes having target sections pivotally mounted on said shoulders and in the same plane as the cathodes, an internal shaft in the rod and extending through and beneath the shoulders, links on the lower end of the shaft pivotally connected to the anodes, an electric motor controlled from outside the envelope mounted on the transverse section of the tube, gearing connecting the motor and shaft for longitudinal movement of the shaft in the rod whereby the angle of the target sections of the anodes with respect to the cathodes may be changed and a plurality of converging angles, of the emitted X-rays are produced.

2. An X-ray tube as in claim 1 for use in stereoscopic fluoroscopy, means to angularly adjust the anodes with respect to the cathodes to change the fixed planes at which stereoscopic images are produced when an object is positioned between the window of the envelope and a scanning device and the tube is energized.

3. An X-ray tube as in claim 1 for use in the production of radiographic films and fluoroscopy, switch means in the circuit connected to each set of anodes and related cathodes whereby the sets can be employed separately or together for the production of films or object images.

4. An X-ray tube housed in a ray-proof, windowed envelope, said envelope having a longitudinal portion with a substantially uniform diameter in the body portion thereof and a centrally disposed neck portion of uniform and greater diameter than the longitudinal portion, the tube including a longitudinal portion and a centrally disposed neck portion, two cathodes fixedly mounted in opposite ends of said longitudinal portion and having focusing cups opposite each other, an anode rod mounted in the neck portion having two oppositely disposed shoulders at its lower end and means for dissipating heat mounted on the other end, a bore in the lower portion of the rod, a shaft received and guided by said bore, two anodes pivotally mounted on said shoulders having their target sections opposing the focusing cups of the cathodes, linkage between the lower end of the shaft and the anodes,

and motor operated gearing operatively connected with the shaft and controllable from outside the tube for longitudinal movement of the shaft to vary the angle of the target sections of the anode to produce a plurality of converging angles of the emitted X-rays.

5. An X-ray tube housed in a ray-proof, windowed envelope said envelope having a longitudinal portion with a substantially uniform diameter in the body portion thereof and a centrally disposed neck portion of uniform and greater diameter than the longitudinal portion, the tube including longitudinal portion and a centrally disposed neck portion, two cathodes mounted in opposite ends of said longitudinal portion and having focusing cups opposing each other, an anode rod mounted in the neck portion having two oppositely disposed shoulders at its lower end, fins mounted on the other end for dissipating heat, a bore in the lower portion of the rod, a shaft received and guided by the said bore, two anodes hinged on said shoulders having their target sections opposing the cathodes, links between the lower end of the shaft and the anodes and motor operated gearing operable from outside the tube and connected with the shaft for longitudinal movement of the shaft to vary the converging angles of the emitted X-rays.

6. An X-ray tube housed in an envelope having a longitudinal portion with a substantially uniform diameter extending oppositely from the central portion, the central portion extending at right angles and having a uniform and greater diameter than the first mentioned portion, the tube including a longitudinal portion and a centrally disposed neck portion, a pair of cathodes fixedly mounted in opposite ends of said longitudinal portion and having focusing cups opposing each other, an anode rod mounted in the neck portion having two oppositely disposed shoulders at its lower end and a plurality of fins mounted on the other end, a bore formed in the lower portion of the rod, a shaft received and guided by said bore, two anodes hinged to said shoulders having their target sections in the same plane and opposing the focusing cups of the cathodes, linkage between the lower end of the shaft and the

anodes, motor operated gearing connected with the shaft for longitudinal movement thereof, said motor positioned within the envelope and operable from outside the envelope to vary the angle of the converging X-rays emitted from the tube by changing the angle of the target sections of the anodes.

7. In an X-ray tube, the combination including a ray-proof, windowed envelope, said envelope having a longitudinal portion and a central portion extending at right angles from and integral with the longitudinal portion, the tube mounted within the envelope and including a longitudinal portion and a centrally disposed neck portion, a pair of cathodes fixedly mounted in opposite ends of said longitudinal portion and having focusing cups opposing each other, an anode rod mounted in the neck portion having two oppositely disposed shoulders at its lower end and a plurality of fins on the other end, a bore formed in the lower portion of the rod, a shaft received and guided by the said bore, two anodes hinged to said shoulders having their target sections opposed to the focusing cups of the cathodes, links between the lower end of the shaft and the anodes, motor operated gearing connected to the shaft for longitudinal movement thereof, and housed within the envelope, a power supply connected with the tube and means to connect either or both sets of opposing anodes and cathodes for fluoroscopy and roentgenography and to vary the angle of the emitted X-rays from either or both of the target sections of the anodes.

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