

May 25, 1926.

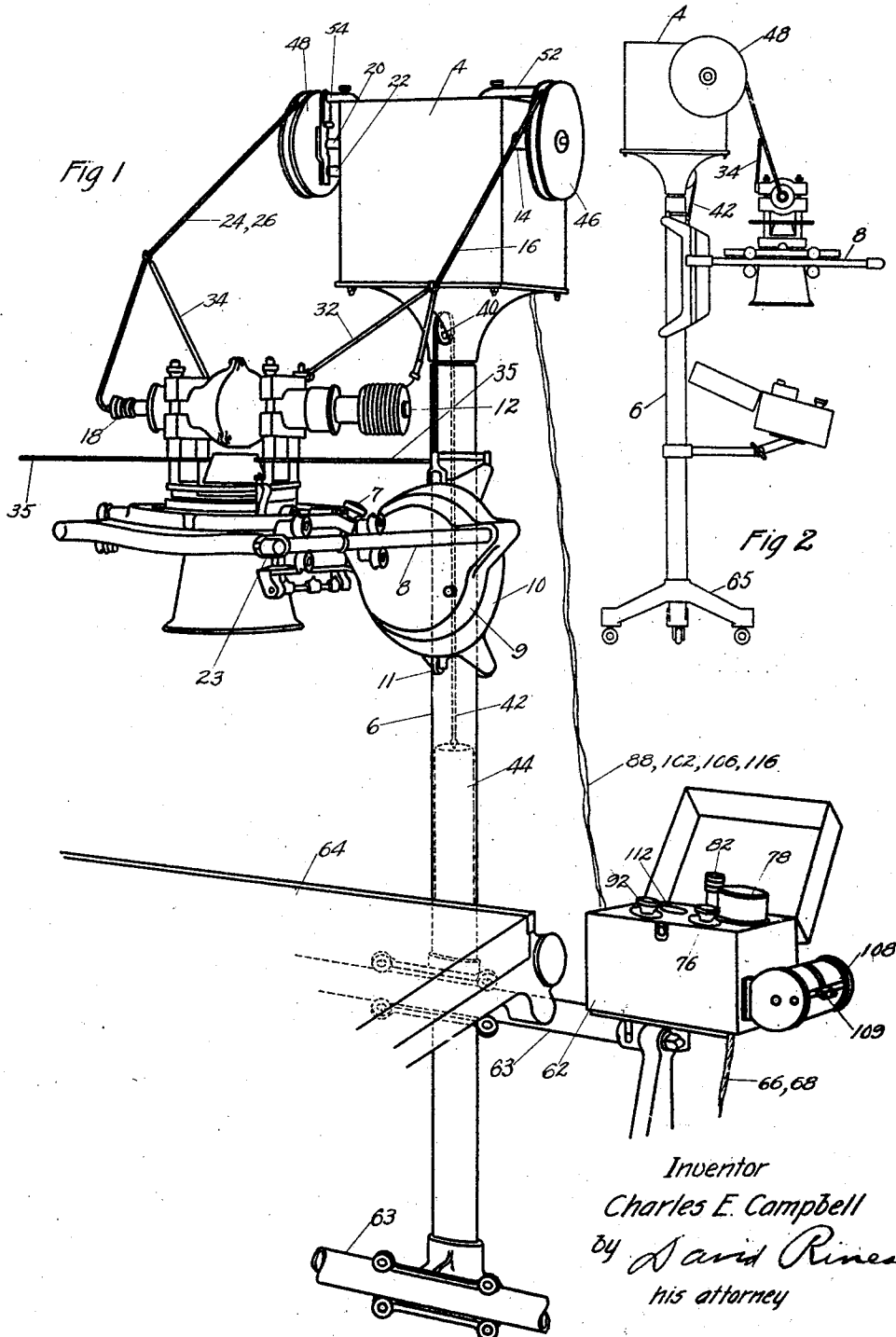
C. E. CAMPBELL

1,586,027

X-RAY APPARATUS

Filed August 12, 1921

6 Sheets-Sheet 1



May 25 , 1926.

1,586,027

C. E. CAMPBELL

X-RAY APPARATUS

Filed August 12, 1921

6 Sheets-Sheet 2

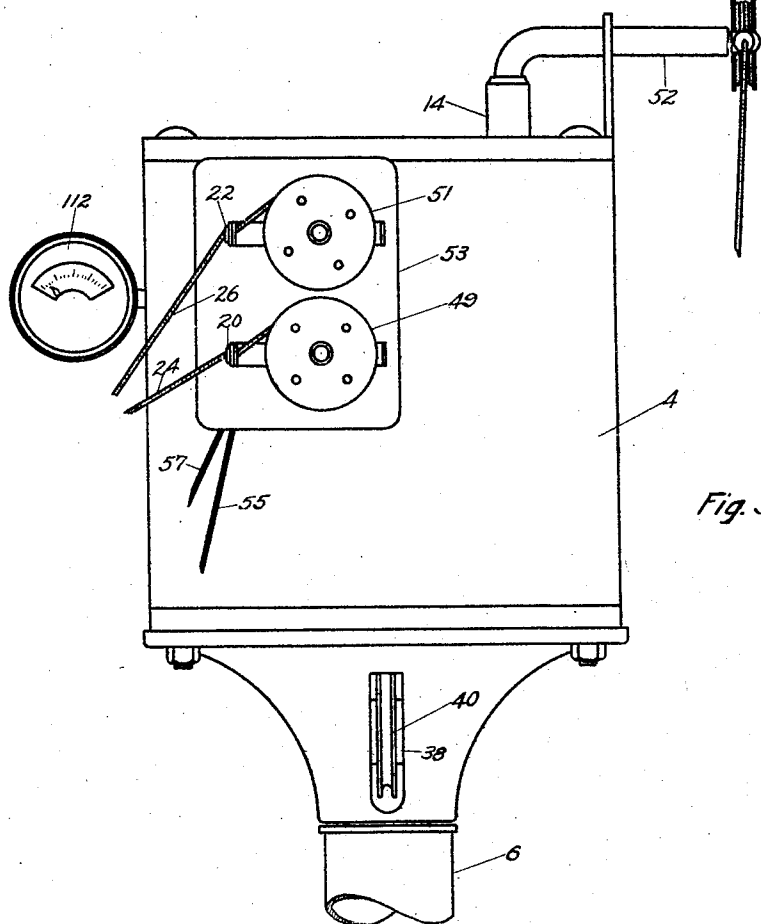


Fig. 3

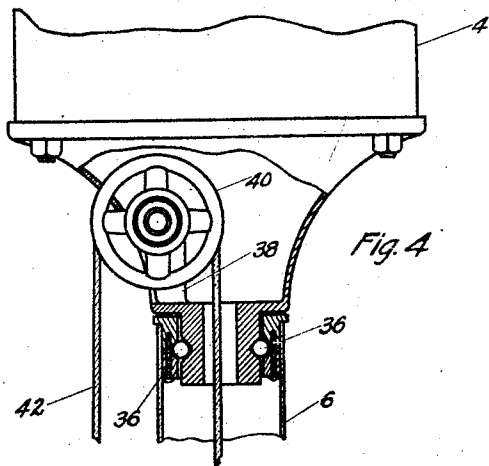


Fig. 4

Inventor
Charles E. Campbell
by *Sand Rinea*
his attorney

May 25, 1926.

C. E. CAMPBELL

1,586,027

X-RAY APPARATUS

Filed August 12, 1921

6 Sheets-Sheet 3.

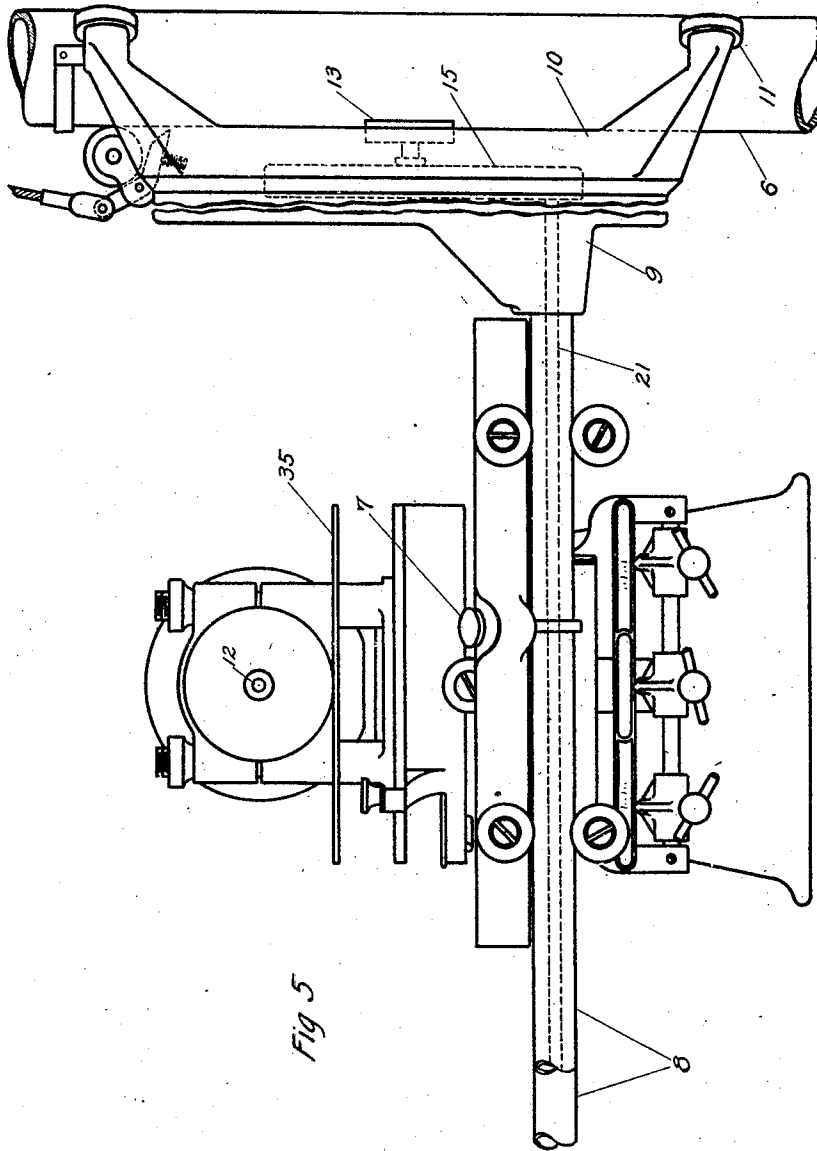


Fig 5

Inventor
Charles E. Campbell
by *David Rines*
his attorney

May 25, 1926.

C. E. CAMPBELL

1,586,027

X-RAY APPARATUS

Filed August 12, 1921

6 Sheets-Sheet 4

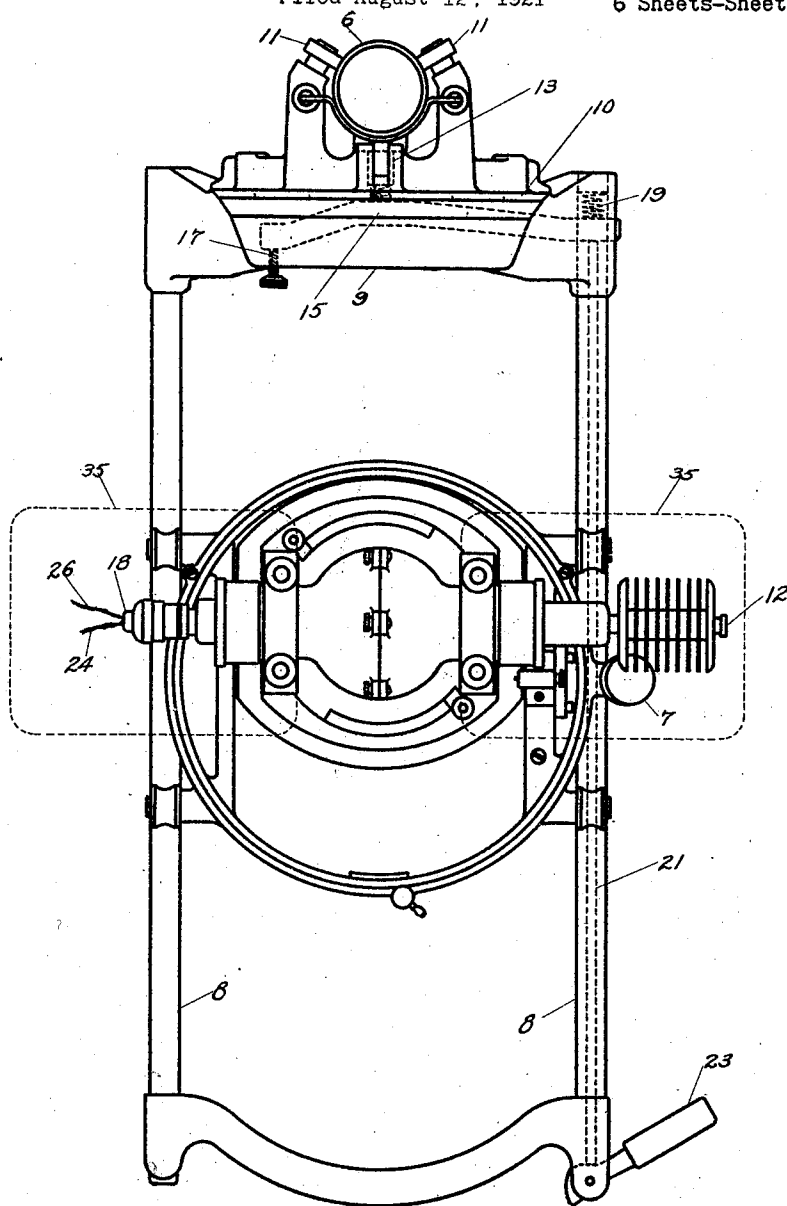


Fig. 6

Inventor
Charles E. Campbell
by David Rines
his attorney

May 25, 1926.

C. E. CAMPBELL

1,586,027

X-RAY APPARATUS

Filed August 12, 1921

6 Sheets-Sheet 5

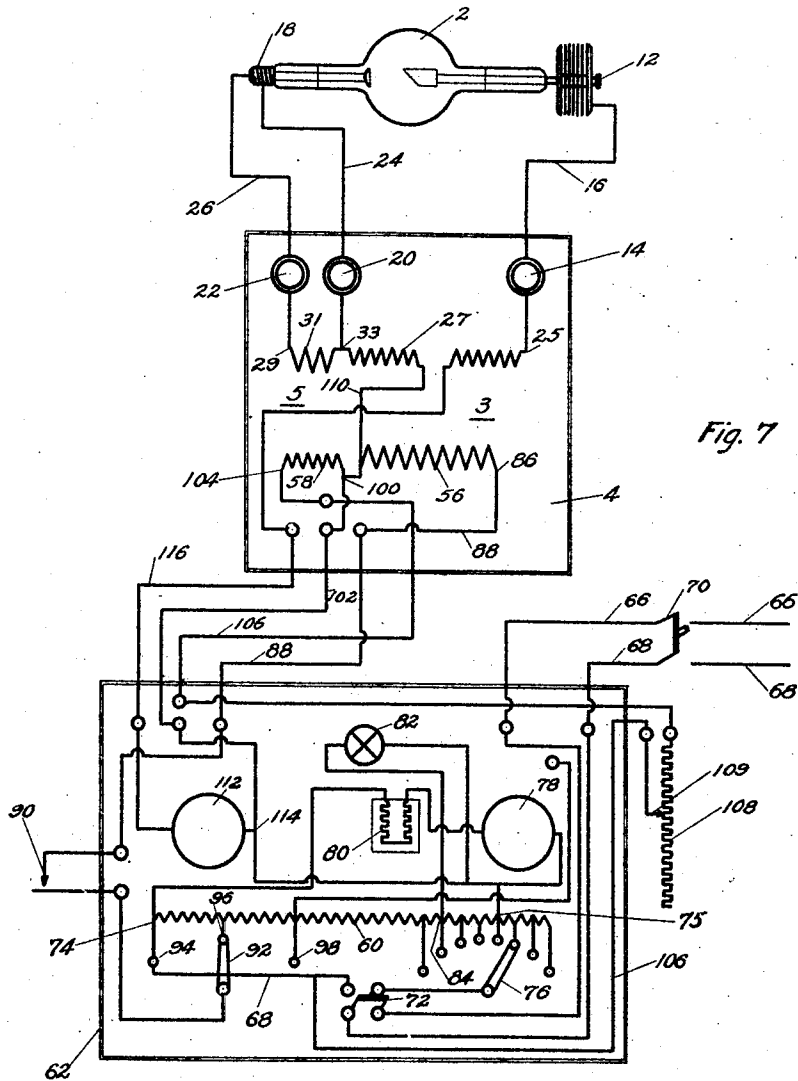


Fig. 7

Inventor
Charles E. Campbell
by David Rines
his attorney

May 25, 1926.

C. E. CAMPBELL

1,586,027

X-RAY APPARATUS

Filed August 12, 1921

6 Sheets-Sheet 6

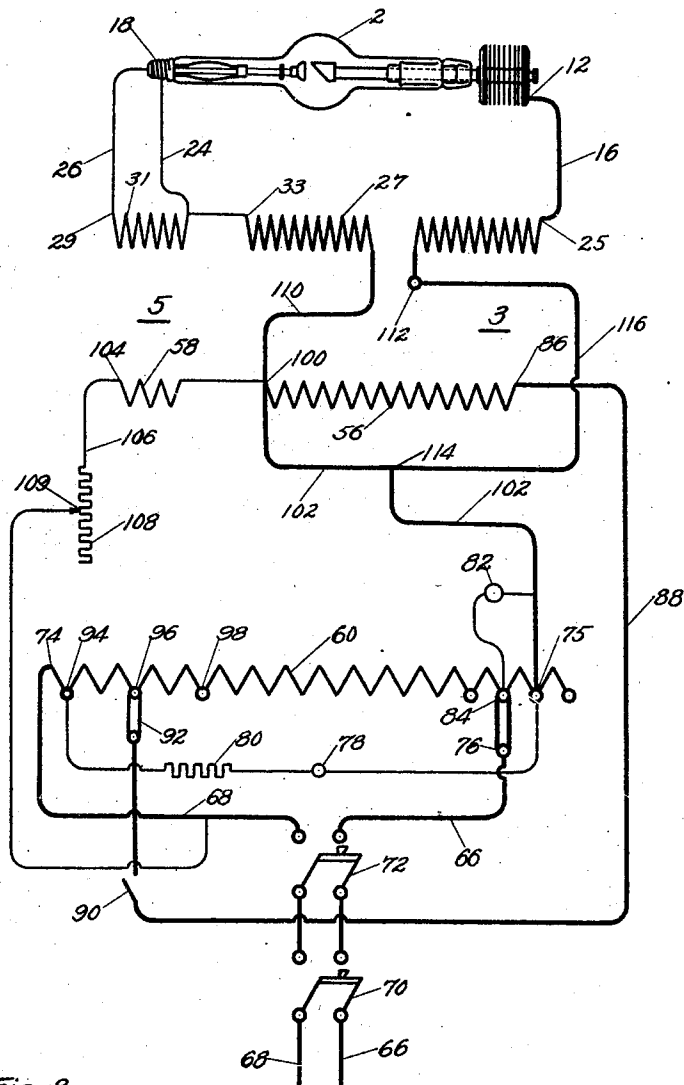


Fig. 8

Inventor
Charles E. Campbell
by David Rinea
his attorney

UNITED STATES PATENT OFFICE.

CHARLES E. CAMPBELL, OF LYNN, MASSACHUSETTS.

X-RAY APPARATUS.

Application filed August 12, 1921. Serial No. 491,692.

The present invention relates to X-ray apparatus, and more particularly to apparatus of a type commonly employed by physicians, surgeons and other practitioners for viewing or taking radiographs of parts of the human body, and for other purposes.

The X-ray tube of present-day apparatus is mounted upon an upright or other support and its terminals are connected by conductors to a transformer situated, usually at a distance from the tube, upon a separate support. Owing to the comparatively large size of the transformer, the desirability, in the interest of safety, of enclosing its high-tension parts in a casing that shall be out of harm's way, the necessity for providing against accidental crossing of the said conductors, and for other reasons, the use of a separate support for the transformer has heretofore been always regarded as essential.

The chief object of the present invention is to simplify and improve upon present-day apparatus, and to this end, one of the most important features of the invention contemplates providing self-contained apparatus in which the transformer casing and the tube are carried upon a single support.

X-ray tubes are usually adjustable along and about their uprights, so as to permit of their ready presentation to a variably positioned object that it is desired to operate upon. Adjustability of this character carries with it the possibility of accidental crossing of the conductors that connect the tube to the transformer, and such crossing may sooner or later cause a short-circuit.

It is another object of the present invention, therefore, to provide a mounting for the transformer upon the tube support such that the danger of the conductors crossing will be eliminated. This end may be attained in many ways, but according to the preferred embodiment of the invention, the transformer and the tube are caused to occupy always the same relative position around the support. As the transformer and the tube thus rotate or swivel together around the support, the conductors connecting their respective terminals rotate with them, so that their relative position remains unchanged. The moving parts being heavy, their weight and that of a counterweight are supported in a novel manner. These and other features will be understood by

a consideration of the invention as embodied, in its preferred form, in the X-ray apparatus hereinafter described, illustrated in the accompanying drawings and defined in the appended claims.

In the drawings,

Figure 1 is a perspective view of a preferred embodiment of the present invention;

Figure 2 is a diagrammatic elevation of a modification;

Figure 3 is a fragmentary view in elevation of another modification;

Figure 4 is a vertical section through the upright, showing the ball-bearing mounting of the casing;

Figure 5 is a side elevation of the X-ray generator, shown mounted upon its tracks and showing the tracks mounted upon their upright;

Figure 6 is a plan view of the same, the insulating plates being shown in dotted lines;

Figure 7 is a diagrammatic view of circuits and apparatus employed in connection with the present invention; and

Figure 8 is a simplified diagram of the circuits shown in Fig. 7.

According to the present invention, an X-ray generator shown as a tube 2 (Figs. 1 and 8) of the electronic type, and a source of energy for the generator, shown as a transformer 3, contained within a casing 4, are mounted upon a single support, shown as a hollow, movable upright 6. The casing 4 contains also a source of heating current for the electronic tube 2, shown as a transformer 5. Self-contained apparatus is thereby provided that may be moved from place to place as a unit, where and when desired. The tube and the transformer may both be mounted upon tracks 8, and conveniently within the same casing 4, if so desired. The tube and the transformer are preferably, however, mounted independently of each other; the tube upon the tracks 8, and the casing 4, containing the transformer or other source of energy, higher up, above the tube, as upon the top of the upright 6. By mounting the high-potential source of energy above the heads and arms of persons in the room, the danger of accidents from contact with the high-potential parts will be avoided.

In order to adapt the apparatus for use

upon objects variably positioned within wide limits, the X-ray tube is adjustable in a plurality of directions. It may be adjusted horizontally towards and from the upright along the tracks 8, and it may be clamped in adjusted position along the tracks by a set screw or other clamping device 7. It may be adjusted angularly or rotatably about an axis at right angles to the upright by turning a disk-like casting 9, to which the tracks 8 are secured, within an annular casting 10. Accidental turning of this character is prevented by the disk-casting 9 frictionally binding against the inner annular walls of the casting 10. The tube may be adjusted vertically by running the casting 10 up and down along the upright 6, antifriction rollers 11 mounted upon the casting 10 engaging the exterior of the upright to reduce frictional contact. The tube may be angularly adjusted about the upright by swiveling the tracks thereabout as a unit. The tracks 8 may be locked in vertically and angularly or rotatably adjusted position along and about the upright by a fibre clamp 13, Figs. 5 and 6. The clamp 13 may be actuated into clamping engagement against the upright by a lever 15 pivotally movable about an adjustable pivotal point 17, in opposition to the force of a spring 19, by a rod 21. The rod 21 is manually controlled by a hand lever 23 that is positioned at the front of the apparatus, where it may readily be manipulated by the operator. Other tube adjustments are also provided, such as a shifting, tilting and rotating adjustment, useful for stereoscopic purposes. This is illustrated more particularly in Figures 5 and 6, but not described herein, because not necessary to an understanding of the present invention.

The terminal 12 at the anode end of the X-ray tube 2 is connected to a point 14 of the casing 4 by a conductor 16. The terminal 18 at the cathode end of the tube is similarly connected to points 20 and 22 by conductors 24 and 26. Insulating plates 35 prevent sparking from the terminals 12 and 18 to other parts located on and near the tracks 8. The point 14 is connected to a terminal 25, Figures 7 and 8, of the secondary winding 27 of the transformer 3. The point 22 is connected to a terminal 29 of the secondary winding 31 of the filament-heating transformer 5. The other terminals of the secondary windings 27 and 31 are connected together at 33 and the connecting point 33 is connected to the point 20.

The conductor 16 may be held separated from the conductors 24 and 26 by spreaders 32 and 34, carried either by the tracks 8 or connected parts, or more directly by the tube casing. The spreaders 32 and 34 may be adjusted to hold the conductors nearer together or farther apart than shown in Fig-

ure 1, as desired, but the use of the spreaders alone will not suffice to prevent crossing of the conductors when the X-ray tube is adjusted rotatably about and vertically along the upright, rotatably about an axis at right angles to the upright, and horizontally to and from the upright. As two of the conductors are of very high potential, such crossing may result in rupturing the insulation covering the conductors, and the causing of a short circuit, with possibly serious damage.

According to the present invention, when the X-ray tube is angularly or rotatably adjusted about the upright, the casing 4 is automatically similarly adjusted. The relative angular positions of the generator and the casing and, therefore, of the conductors also, are thus maintained practically unchanged. The preferred mechanism for bringing this about will now be described.

The casing 4 is rotatably mounted upon the top of the upright 6, ball bearings 36 being interposed, as shown in Figure 4. The casing is provided with a bracket 38 upon which is mounted a pulley 40. One end of a flexible cable or chain 42 that is mounted over the pulley is fastened to the casting 10, and the other end is secured to a counterweight 44 within the hollow upright 6. The counterweight approximately balances the weight of the casting 10 and the tracks 8 and the parts carried thereby, in any position of vertical adjustment along the upright. As above indicated, it is within the scope of the present invention to mount the casing 4 upon the tracks 8, in which case the counterweight would balance the additional weight of the casing and the parts contained therein. The ball bearings 36, in either event, receive the thrust of all the moving parts, including the tracks 8 and the parts supported thereby, the counterweight 44, and the casing 4 with the apparatus contained therein. As the tracks 8 are angularly or rotatably adjusted horizontally about the upright 6, the counterweight, acting through the cable 42 and the bracket 38, causes the casing 4 at the top of the upright to become angularly adjusted to correspond, the rotative movement of the tracks 8 becoming thus communicated to the casing.

In this manner, crossing of the conductors 16, 24 and 26 is prevented during the rotative adjustment of the tube 2 about the upright 6. To prevent their crossing during the vertical, horizontal and other adjustments of the tube, they are not allowed to become slack, but are always drawn taut. This result is attained, in the preferred embodiment of the invention, by providing spring-controlled reels 46 and 48. The conductor 16 is wound upon the reel 46 and the conductors 24 and 26 are wound upon the

reel 48. When the tracks 8 and the tube carried thereby are lowered, the reels are caused to unwind, in opposition to the action of their controlling springs. When the tracks are raised, the reels wind up again. Similar effects are obtained when the tube 2 is moved away from, or is returned towards, the upright along the tracks 8 and during other adjustments of the tube.

The reel 46 is detachably mounted upon the end of a bracket 52 secured to and extending out, on one side, beyond the casing 4. The reel 48 is detachably mounted upon a bracket 54 that extends out beyond the casing 4 on the other side, as shown in Figure 1. By having the reels mounted at opposite sides of the casing 4, a direct spring pull is obtained upon the conductors 16, 24 and 26 to maintain them taut.

The primary windings 56 and 58 of the transformers 3 and 5 are supplied with energy from an auto-transformer 60 contained within a control box 62, Figs. 1 and 2. The control box 62 is shown detached in Fig. 1, because there employed in connection with a tilt-table 64. In table apparatus of the illustrated character, the upright is movable along tracks 63 that are rigidly secured parallel to the table and the control box 62 is supported upon the table support. In other applications the upright is mounted upon a tripod 65, Fig. 2, and the control box is secured directly upon the upright to facilitate moving the whole apparatus as a unit. The auto-transformer 60 is connected to the line by line conductors 66 and 68, through a line switch 70 and a switch 72. The switch 72 may be of the push-button type, and may be mounted on the control box 62. The conductor 68 is directly connected to a terminal 74 of the auto-transformer 60. The other terminal 75 of the auto-transformer is adjustably connected to the conductor 66 by a switch 76. The voltage of the auto-transformer may be adjusted within small limits by means of the switch 76. A voltmeter 78 is connected in series with a resistor 80 to the terminals 74 and 75 of the auto-transformer. A pilot lamp 82 is connected across a short portion of the auto-transformer between the terminal point 75 and a tap 84.

One terminal 86 of the primary winding 56 of the transformer 3 is connected by a conductor 88, through a manually operable switch, as a foot switch 90, and a switch 92, to the terminal 74 of the auto-transformer. The switch 92 is adapted to tap the auto-transformer to any of a plurality of points, 94, 96, and 98, to subject the auto-transformer to any of a plurality of desired standard voltages, as 75, 92 and 110 volts. Variation from the standard value of the desired voltage may be compensated for by means of the switch 76. The other terminal

100 of the primary winding 56 is connected by a conductor 102 directly to the other terminal 75 of the auto-transformer. The primary winding 58 of the filament-heating transformer 5 is also connected, at one end, to the point 100, its other terminal 104 being connected by a conductor 106, in series with a filament-controlling or regulating resistor 108, adjustable by a switch 109, and by the conductor 68, to the other terminal 75 of the auto-transformer.

The primary winding 58 of the filament-heating transformer 5 is thus subjected to a relatively fixed voltage of the auto-transformer, while the voltage of the primary winding 56 of the transformer 3 is controlled by the switch 92. A comparatively constant filament current is thus provided, irrespective of the voltage across the tube terminals 12 and 18. The penetration of the X-rays may therefore be varied by the switch 92 without varying their volume, insuring uniformity of results under widely ranging conditions. The filament winding is energized immediately upon the closing of the circuit of the auto-transformer by the switch 72, but the primary winding 56 is not energized until after the closing of the foot-controlled or other manually controlled switch 90.

The secondary winding 27 of the transformer 3 is composed of two portions, and is intermediately grounded, by a conductor 110, to the terminal 100 of the primary winding 56. A milliammeter 112 is connected between the portions of the secondary winding 27. The milliammeter is connected on one side at 114, by way of the conductor 102, to the conductor 110. On its other side, the milliammeter is connected directly to the other portion of the secondary winding 27 by a conductor 116.

In the modification of Figure 3, the reel 48 is replaced by two reels 49 and 51 mounted at the front of the casing 4 upon a detachable plate 53. The regulating resistor 108 may, in this modification, be mounted at the back of the plate 53, where it can not be accidentally disturbed. Two cords 55 and 57 are secured to opposite ends of the switch 109 (not shown in Figure 3). The ends of the cords are positioned near the table 64 so that the operator may manipulate them, to control the heating of the tube filament, while stationed in front of the machine. By this arrangement, the filament regulator is detachably located high up, out of harm's way, near the transformer, but it is controlled by means positioned near the X-ray tube. The milliammeter 112 is in this modification mounted upon the casing 4 so as to rotate therewith, thus always presenting its face to the operator stationed in front of the tube, in all positions of adjustment of the latter. This modification is not

claimed herein because constituting the subject matter of another application, Serial No. 495,395, filed August 25, 1921.

It will be understood that the invention is not restricted to the exact embodiments thereof that are illustrated or described herein. Other modifications may be made by persons skilled in the art, and such modifications are considered to be within the spirit and scope of the invention, as defined in the appended claims.

What is claimed as new is:

1. X-ray apparatus comprising an upright, an X-ray generator mounted upon the upright, a source of alternating-current energy of comparatively low voltage and comparatively low frequency, a translating device permanently mounted upon the upright above the X-ray generator at a height above the heads of persons of normal height, the translating device being adapted to translate alternating current energy at comparatively low voltage and comparatively low frequency into alternating-current energy at comparatively high voltage and comparatively low frequency, means electrically connecting the translating device with the source, whereby the translating device produces alternating-current energy at comparatively high voltage and comparatively low frequency, and means electrically connecting the translating device with the X-ray generator, whereby the generator is supplied with electrical energy by the translating device at comparatively high voltage and comparatively low frequency.

2. Apparatus of the character described comprising an upright, a translating device mounted upon the upright, a source of energy for the translating device mounted independently of and above the translating device upon the upright, and means whereby rotative movement relatively to the upright of one of said members is communicated to the said other member.

3. X-ray apparatus comprising an upright, an X-ray generator mounted upon the upright, a source of energy for the generator mounted upon the upright, the mountings of the generator and the source of energy being independent of each other, and means whereby the generator and the source of energy are rotatable together about the upright.

4. X-ray apparatus comprising a support, an X-ray generator and a source of energy for the generator mounted independently of each other upon the support, and means whereby rotative movement of the generator is communicated to the source of energy.

5. X-ray apparatus comprising a support, an X-ray generator and a source of energy for the generator movably mounted independently of each other upon the support,

each having spaced-apart terminals, conductors connecting corresponding terminals of the generator and the source of energy, the conductors being drawn taut, and means whereby movement of the generator is communicated to the source of energy.

6. X-ray apparatus comprising an upright, a track longitudinally adjustable along and rotatable about the upright, an X-ray generator mounted upon the track, a casing rotatably mounted upon the top of the upright, a source of energy for the generator contained in the casing, the generator and the source of energy each having spaced-apart terminals and the terminals of the source of energy being connected to spaced-apart points of the casing, conductors connecting corresponding terminals of the generator and said points of the casing, the conductors being maintained taut in all positions of adjustment of the track and the generator, and means whereby rotative movement of the generator is communicated to the casing.

7. X-ray apparatus comprising a hollow upright, an X-ray generator slidably mounted on the upright, a casing mounted upon the top of the upright having a bracket, a source of energy for the generator contained within the casing, a pulley mounted upon the bracket, a cable connected to the generator passing over the pulley into the hollow of the upright, a counterweight secured to the free end of the cable, and an anti-friction bearing between the casing and the upright by which the weight of the movable parts is supported.

8. X-ray apparatus comprising a table having a track, an upright slidable along the track, an X-ray generator mounted upon the upright, a source of alternating-current energy of comparatively low voltage and comparatively low frequency, a translating device permanently mounted upon the upright above the X-ray generator at a height above the heads of persons of normal height, the translating device being adapted to translate alternating-current energy at comparatively low voltage and comparatively low frequency into alternating-current energy at comparatively high voltage and comparatively low frequency, means electrically connecting the translating device with the source, whereby the translating device produces alternating-current energy at comparatively high voltage and comparatively low frequency, and means electrically connecting the translating device with the X-ray generator, whereby the generator is supplied with electrical energy by the translating device at comparatively high voltage and comparatively low frequency.

9. X-ray apparatus comprising a table, a support for the table having a track substantially parallel to the table, an upright

slidable along the track, an X-ray generator and a source of energy for the generator mounted upon the upright, and means for controlling the generator and the source of energy mounted upon the support.

10. In combination, a support, a track longitudinally movable along the support and rotatable about an axis at an angle to the support, a member movably mounted upon the track, a clamp at one end of the track for locking the track against longitudinal movement along the support and against rotatable movement about the said axis, a lever for actuating the clamp, a rod for actuating the lever, and unitary means for controlling the rod.

11. X-ray apparatus comprising a support, a track longitudinally movable along the support and rotatable about an axis at an angle to the support, an X-ray generator movably mounted upon the track, a clamp at one end of the track for locking the track against longitudinal movement along the support and against rotatable movement about the said axis, a rod disposed longitudinally of the track for actuating the clamp, and unitary means positioned near the other end of the track for controlling the rod.

12. X-ray apparatus comprising an upright, a track movable along the upright and rotatable about an axis at right angles to the upright, an X-ray generator supported by the track and against rotatable movement about the said axis, a clamp for locking the track against longitudinal movement along the upright, a lever for actuating the clamp, a rod for actuating the lever, and unitary means positioned near the free end of the track for controlling the rod.

13. X-ray apparatus comprising an upright, an X-ray generator rotatably mounted upon the upright, a casing rotatably mounted upon the top of the upright above the heads of persons of normal height, a source of energy for the generator contained within the casing, and means whereby rotative movement of the generator is communicated to the casing.

14. X-ray apparatus comprising an upright, an X-ray generator rotatably mounted upon the upright, a source of alternating-current energy of comparatively low voltage and comparatively low frequency, a translating device permanently mounted upon the upright above the X-ray generator at a height above the heads of persons of normal height, the translating device being adapted to translate alternating-current energy at comparatively low voltage and comparatively low frequency into alternating-current energy at comparatively high voltage and comparatively low frequency, means electrically connecting the translating device with the source, whereby the translating device produces alternating-current energy at comparatively high voltage and comparatively low frequency, means electrically connecting the translating device with the X-ray generator, whereby the generator is supplied with electrical energy by the translating device at comparatively high voltage and comparatively low frequency, and means whereby rotative movement of the X-ray generator is communicated to the translating device.

In testimony whereof, I have hereunto subscribed my name August 9, 1921.

CHARLES E. CAMPBELL.