Sept. 24, 1940. A. SIMON 2,215,654

FLUOROSCOPIC APPARATUS

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Fig. 1.

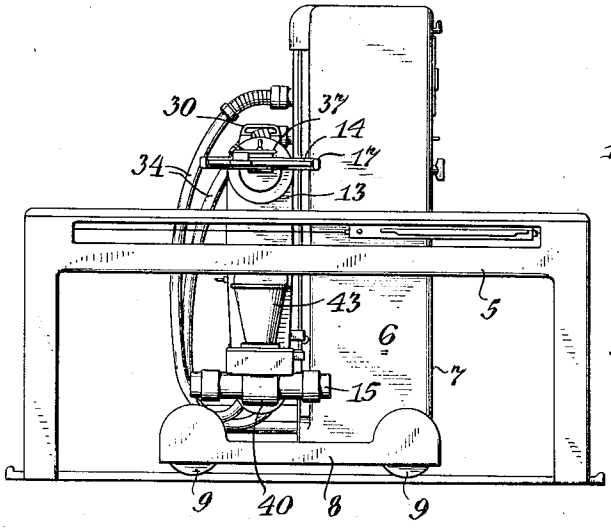


Fig. 2.

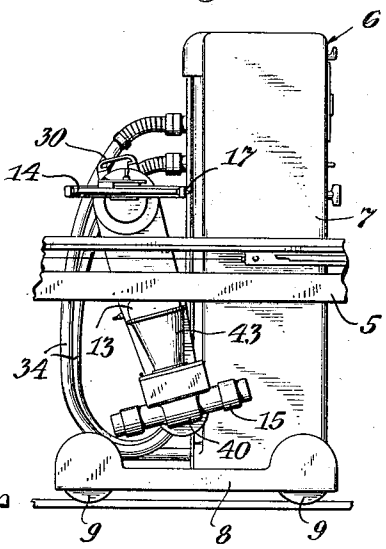


Fig. 6.

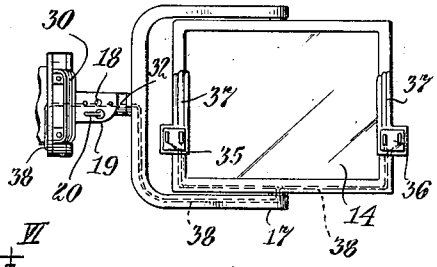


Fig. 3.

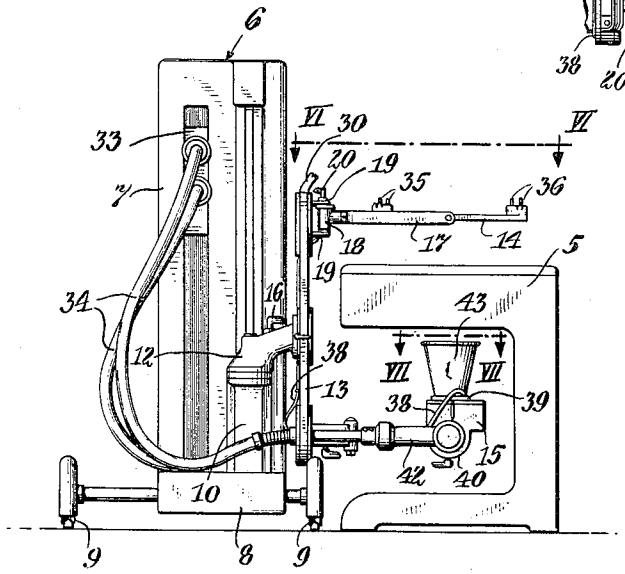
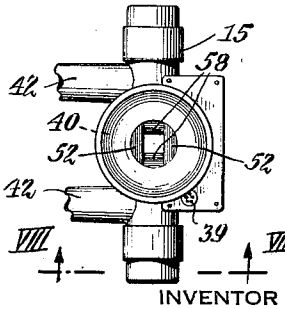


Fig. 7.



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Fig. 4.

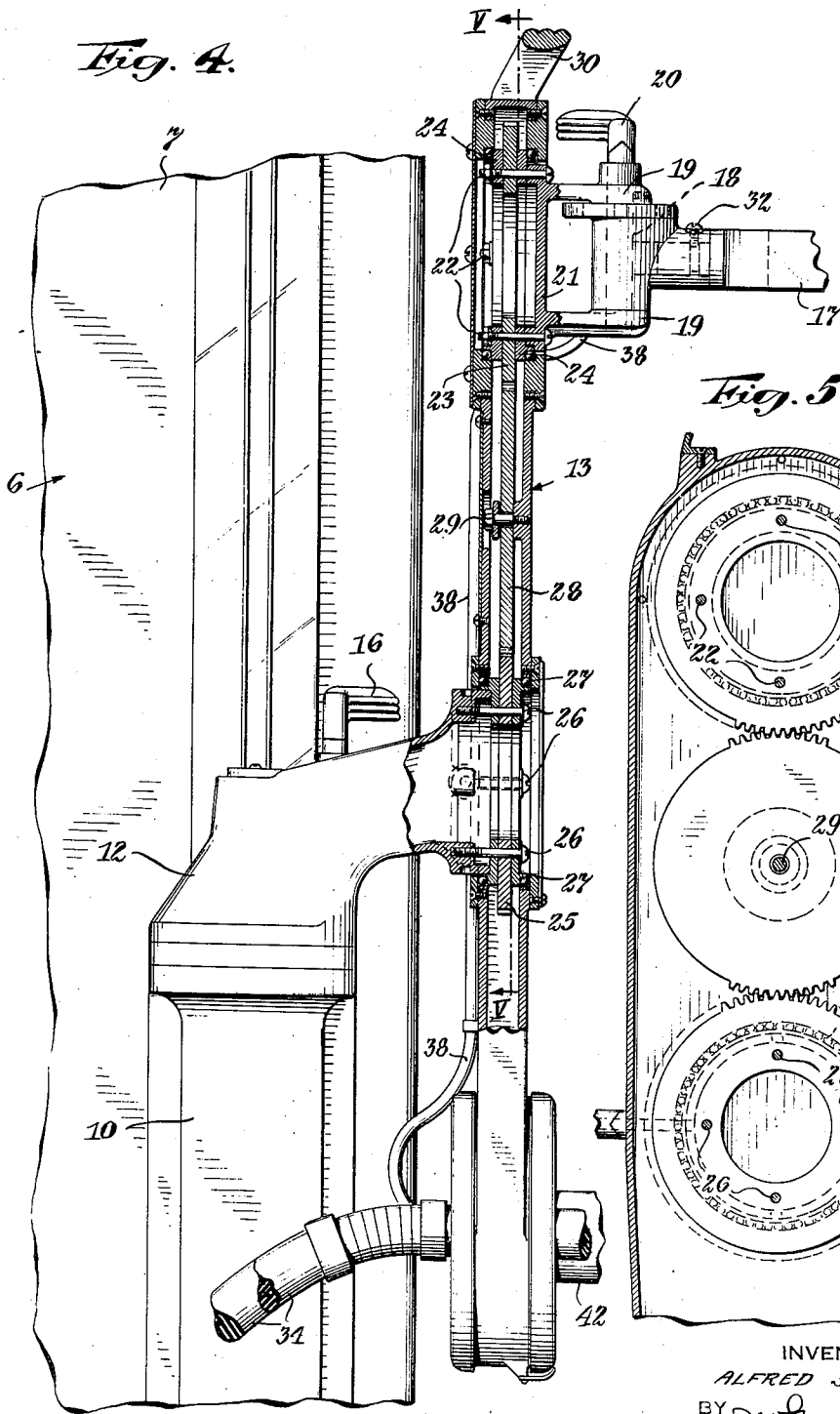


Fig. 5.

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Fig. 8.

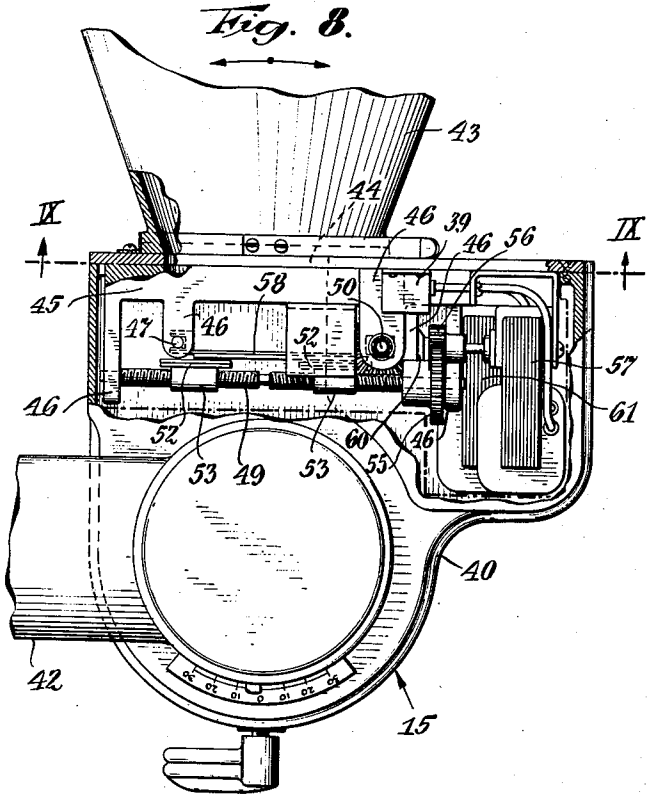
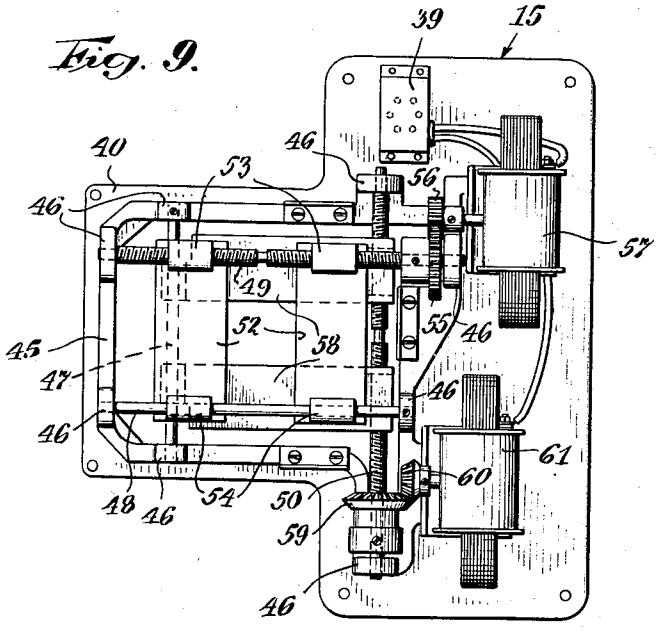


Fig. 9.



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2,215,654

UNITED STATES PATENT OFFICE

2,215,654

FLUOROSCOPIC APPARATUS

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Application October 12, 1938, Serial No. 234,564

6 Claims. (Cl. 250—58)

The present invention relates to X-ray apparatus and has particular reference to what is known in the art as fluoroscopic apparatus as commonly employed with X-ray tables and vertical fluoroscopes for the making of fluoroscopic examinations.

This type of examination is sometimes performed by the roentgenologist with the patient lying prone upon an X-ray table during which the X-ray tube and fluoroscopic shutters are disposed below the table top and the fluorescent screen is above the table top and patient. In other instances, due to the character of the examination, it can be made with the patient standing, and the table is consequently rotated to a vertical position where it becomes essentially what is known in the art as a vertical fluoroscope.

In the making of a fluoroscopic examination it frequently becomes necessary to restrict the beam of X-rays to a definite area which is done by the adjustment of fluoroscopic shutters. To facilitate the examination, control knobs are disposed adjacent the fluorescent screen, or in some instances upon the screen, which knobs are rotated by the roentgenologist to control the adjustment of the fluoroscopic shutters. However, this necessitates removal of the hands from the screen handles and, in manipulating the control knobs, the position of the fluorescent screen relative to the patient is disturbed.

Moreover, in fluoroscopic devices of the prior art, although the fluorescent screen usually follows movement of the X-ray tube, it has heretofore been necessary for the roentgenologist to adjust the screen by hand in order to position it parallel to the body of the patient each time the X-ray tube is moved to an angular position. Also, to prevent dropping of the fluorescent screen when moved to certain positions, particularly while making an examination of a patient while in an erect position, the screen has heretofore been counterbalanced which added to the weight and complexity of the apparatus.

It is accordingly an object of the present invention to provide a fluoroscopic apparatus wherein the fluorescent screen is automatically maintained parallel with respect to the patient support regardless of the angulation of the X-ray tube and fluoroscopic shutters.

Another object of the present invention is the provision of a fluoroscopic apparatus wherein the fluorescent screen is maintained in fixed positions without the necessity of a counterbalance.

Another object of the present invention is the provision of a fluoroscopic apparatus wherein the fluoroscopic shutters are automatically adjustable by the operator without removing his hands from the fluorescent screen.

Another object of the present invention is the provision of a fluoroscopic apparatus wherein the adjustable fluoroscopic shutters are motor driven and controlled by push buttons carried by the fluorescent screen.

A further object of the present invention is the provision of a fluoroscopic apparatus provided with motor driven fluoroscopic shutters which are controlled by push buttons carried by the fluorescent screen so as to be operated by an operator with either hand without removing his hands from the screen.

Still further objects of the present invention will become obvious to those skilled in the art by reference to the accompanying drawings wherein:

Fig. 1 is a side elevational view of an X-ray tube stand provided with a fluoroscopic apparatus constructed in accordance with the present invention and disposed adjacent an examination table;

Fig. 2 is a view similar to that of Fig. 1 with a part of the supporting table broken away and showing the parallel position of the fluorescent screen with respect to the patient support and an angular position of the X-ray tube;

Fig. 3 is an end view in elevation of the apparatus as shown in Fig. 1;

Fig. 4 is an elevational view partly in cross-section and on an enlarged scale of the mechanism for automatically maintaining the fluorescent screen parallel to the patient support with a portion of the apparatus broken away to better illustrate the mechanism;

Fig. 5 is a sectional view taken on the line V—V of Fig. 4;

Fig. 6 is a plan view of the fluorescent screen showing the position of the control buttons for the fluoroscopic shutters and looking in the direction of the arrows VI—VI of Fig. 3;

Fig. 7 is a plan view of the X-ray tube unit looking in the direction of the arrows VII—VII of Fig. 3 with parts of the device broken away to better illustrate the same;

Fig. 8 is a view partly in section and on an enlarged scale taken on the line VIII—VIII of Fig. 7 with part of the device broken away for illustrative purposes, and

Fig. 9 is a sectional view taken on the line IX—IX of Fig. 8.

Referring now to the drawings in detail, the device shown in Fig. 1 comprises a table 5 upon which a patient reclines during a diagnostic

examination. Disposed adjacent one side of the table is a tube stand shown generally at 6. This tube stand as shown comprises a vertically disposed substantially rectangular standard 7 supported by a base 8 with the latter being provided with suitable casters 9 to facilitate movement of the stand longitudinally of the table to enable complete examination of a patient from one extremity to the other.

The tube stand 6 is provided with a laterally extending bracket 10 to which is pivotally connected an angularly disposed member 12 which, together with the bracket 10, forms a support. This angularly disposed member 12 has a member or arm 13 pivotally connected thereto which carries at one extremity a fluorescent screen 14 and an X-ray tube assembly 15 at its other extremity. Rotation of the arm 13 about its pivot accordingly disposes the X-ray tube assembly 15 below the table with the fluorescent screen 14 above, as shown in Figs. 1, 2 and 3, or the X-ray tube assembly may be moved above the table and the fluorescent screen below, and secured in place by a lock 16.

As will be noted more clearly from Fig. 6, the screen 14 is pivotally supported by a bifurcated member 17 which telescopically engages a spindle 18 journalled in a pair of outwardly projecting lugs 19. Thus by rotation of the screen in a vertical plane and rotating the spindle 18 in a horizontal plane, as viewed from Figs. 3 and 6, the screen can be positioned out of range of the underside of the table and locked by means of a handle 20 when the X-ray tube 15 is positioned above the table.

Also in many instances a fluoroscopic examination is made while the patient is in a standing position which requires that the arm 13 be moved to the horizontal. In the absence of any provision to the contrary, this would place the spindle 18 in a horizontal position with the entire weight of the screen 14 on the lock 20. Should the lock release for any reason or the operator neglect to tighten it, the screen would drop by gravitation, which might result in serious injury to a patient or the roentgenologist.

To prevent this, as well as to maintain the screen parallel to the patient support, the apparatus is provided with an arrangement as shown more particularly in Figs. 4 and 5, wherein the lugs 19 form an integral part of a plate or the like 21. This plate is rigidly secured, such as by bolts or the like 22, to a gear 23, the latter of which is journalled in suitable bearings 24 within the arm 13. Also within the arm 13 and concentric with its axis of rotation about the member 12 is another gear 25. This latter gear is rigidly secured to the member 12, such as by means of cap screws or the like 26, so that the arm 13 rotates thereabout upon bearings 27.

A further freely rotating gear 28, which meshes with both gears 23 and 25, is journalled at 29 within the arm 13, so that when the roentgenologist rotates the arm 13 about its pivot constituting the bearings 27 by grasping a handle 30, the gear 28 describes planetary movement about the gear 25. Assuming the fluoroscopic apparatus, comprising the fluorescent screen 14 and the X-ray tube unit 15, to have initially been in the position shown in Fig. 1 and the X-ray tube unit is shifted, upon rotation of the arm 13 by the operator to that shown in Fig. 2, this accordingly positions the X-ray tube in angular relation with respect to the table 5.

The gear 28, however, during its planetary movement about the gear 25 will cause rotation of the gear 23 and, since all the gears are of the same diameter and pitch, the degree of rotation of the arm 13 about its pivot (gear 25) will cause the same degree of rotation of the gear 23. Inasmuch as the spindle 18, carrying the bifurcated member 17 and screen 14, is connected to the gear 23, the screen 14, once it is positioned parallel with the top of the table 5, is maintained in this position regardless of the angulation of the X-ray tube unit with respect thereto.

When necessary, the bifurcated member 17 and screen 14 can be rotated independently of the spindle 18 and integral plate 21 due to the telescopic engagement thereof, but sufficient friction is maintained therebetween by a set screw or the like 32 to prevent slippage so that the screen is maintained, as above noted, parallel to the table top regardless of the angular position of the X-ray tube unit. This accordingly facilitates the making of a diagnostic examination without the necessity for the roentgenologist endeavoring to properly reposition the screen each time the fluoroscopic apparatus is shifted as required during such an examination. Moreover, when the apparatus is moved to a horizontal position during the making of an examination while the patient is in an erect position, the spindle 18 is moved to a vertical position, thus eliminating a strain on the lock 20 so that the screen is not dependent thereon and cannot drop by gravitation by rotation of the spindle about the lugs 19.

As is customary in fluoroscopic apparatus it is movable vertically with respect to the stand 6 and, in the particular apparatus shown, the fluoroscopic apparatus is counterbalanced by the high voltage transformer 33 encased within the stand and which supplies high voltage electrical energy to the X-ray tube unit through cables 34. However, since the details of this particular structure form no part of the present invention, but are fully shown and claimed in my copending application Serial No. 234,891, filed Oct. 14, 1938, it is believed unnecessary to further describe the same herein.

In addition to the provision of the above noted mechanism for automatically maintaining the screen in parallelism with the table, the X-ray tube unit is provided with fluoroscopic shutters which are automatically controlled by pairs of push buttons carried by the fluorescent screen. Each pair of push buttons 35 and 36 are disposed immediately above the screen handles 37 so as to be operated by the thumb with one set controlling opening and closing of one set of shutters, while the other set controls opening and closing of the remaining shutters.

By reference more particularly to Figs. 4 and 6 it will be seen that a cable 38 is concealed in the screen frame and bifurcated member 17 and is supported by the arm 13. At the pivot point of this arm 13 the cable extends through the arm with the high voltage cables 34 where it connects to a terminal block 39 (Figs. 8 and 9) carried by the X-ray tube unit 15. As shown more particularly in Figs. 8 and 9, the X-ray tube unit comprises a housing 40 pivotally supported by arms 42 extending from the arm 13 and provided with the customary direction cone 43. Also within the casing 40, between the X-ray tube (not shown) and the opening 44 adjacent the direction cone 43, is a framework 45 (Figs. 8 and 9) provided with depending lugs 46. One pair of these lugs 46 supports a stationary shaft 47, while another pair of these lugs supports a

further stationary shaft 48. Also a rotatable threaded shaft 49 is journalled in a further pair of lugs 46, as is another rotatable threaded shaft 50.

As can be seen more clearly in Fig. 9 the rotatable shafts 49 and 50 are threaded each side of their centers with right and left hand threads. A pair of X-ray opaque shutters 52, which for the sake of simplicity will be referred to as horizontal shutters, are provided with threaded collars 53 engaging the threaded shaft 49 and collars 54 having openings therein of slightly greater diameter than the stationary shaft 48 so as to be readily slidable thereon. A gear 55 is rigidly secured to the rotatable shaft 49 and for the purpose of rotating the latter, this gear meshes with a gear 56 carried by the armature of a reversible electric motor 57.

Since the electric motor 57 is connected by one or the other push buttons of one pair to a suitable source of electrical energy of the usual commercial potential (not shown), the motor is caused to rotate in either direction. For example, if one of the push buttons of the pair 35 is moved by the thumb of the roentgenologist, the motor 56 rotates in one direction, which causes the horizontal shutters to move toward each other due to their threaded connection with the threaded shaft 49 and sliding engagement with the stationary shaft 48. Also, if the other push button of the pair 35 is moved or depressed, the shutters 52 move away from each other, thus increasing the spacing therebetween.

Another pair of X-ray opaque shutters 58 are also provided which will be hereinafter referred to as vertical shutters. These shutters are identical in construction and operation as that previously described with respect to the shutters 52, and engage the threaded shaft 50 and stationary shaft 47 in the same manner as the shutters 52 engage their respective shafts 48 and 49. The threaded shaft 50 is provided with a beveled gear 59 engaging a gear 60 carried by the armature of a further reversible electric motor 61 which is under the control of the other pair of push buttons 36 carried by the fluorescent screen 14.

It will thus be seen that by operation of one pair of push buttons 35 the horizontal shutters 52 are automatically moved back and forth depending upon the will of the operator, and in a similar manner the vertical shutters 58 are caused to move up or down. This accordingly confines the beam of X-rays emanating from the X-ray tube to any desired area of the patient's anatomy.

It thus becomes obvious to those skilled in the art that a fluoroscopic apparatus is herein provided in which the fluorescent screen is automatically maintained in parallelism with the patient support regardless of the angular position of the X-ray tube unit. Moreover, the fluoroscopic shutters which are carried by the X-ray tube unit are automatically adjustable from the fluorescent screen without the necessity for the operator to remove his hands from the screen handles and regardless of the angular position of the X-ray tube unit with respect to the patient support.

Although one embodiment of the present invention has been shown and described, it is to be understood that other modifications thereof may be made without departing from the spirit and scope of the appended claims.

I claim:

1. The combination with a patient supporting means, of a fluoroscopic unit comprising a standard disposed adjacent to said patient supporting means and perpendicular thereto, a support movable vertically of said standard above and below the level of said patient supporting means, a member pivotally secured to said support and provided with a fluorescent screen at one end thereof and an X-ray tube unit at the other end thereof, and means operable by movement of said member about its pivot to maintain said fluorescent screen in parallelism with said patient supporting means regardless of the angular position of said X-ray tube unit with respect thereto.

2. The combination with a patient supporting means, of a fluoroscopic unit comprising a standard disposed adjacent to said patient supporting means and perpendicular thereto, a support movable vertically of said standard above and below the level of said patient supporting means, a member pivotally secured to said support and provided with a fluorescent screen pivotally connected to one end thereof and an X-ray tube unit pivotally connected to the other end thereof and movable simultaneously with said support toward or away from the level of said patient supporting means, and means carried by said member and operably connected to said fluorescent screen and operable upon rotation of said member about its pivot to maintain said fluorescent screen in parallelism with said patient supporting means regardless of the angular position of said X-ray tube unit relative thereto.

3. The combination with a patient supporting means, of a fluoroscopic unit comprising a standard disposed adjacent to said patient supporting means and perpendicular thereto, a support movable vertically of said standard above and below the level of said patient supporting means, a member pivotally secured to said support and provided with a fluorescent screen pivotally connected to one end thereof and an X-ray tube unit pivotally connected to the other end thereof, and mechanism carried by said member including a gear train operably connected to said fluorescent screen and rotatable upon movement of said member about its pivot to maintain said fluorescent screen in parallelism with said patient supporting means regardless of the angular position of said X-ray tube unit relative thereto.

4. The combination with a patient supporting means, of a fluoroscopic unit comprising a standard disposed adjacent to said patient supporting means and perpendicular thereto, a support movable vertically of said standard above and below the level of said patient supporting means, a member pivotally secured to said support and provided with a fluorescent screen pivotally connected to one end thereof and an X-ray tube unit pivotally connected to the other end thereof and movable simultaneously with said support toward or away from the level of said patient supporting means, and mechanism disposed interiorly of said member including a stationary gear rigidly connected to said support and forming a pivot about which said member rotates, a second rotatable gear engaging said stationary gear and adapted to describe planetary movement relative to said stationary gear upon movement of said member about its pivot, and a third gear operably connected to said fluorescent screen and engaging said rotatable gear and operable to maintain said fluorescent screen in parallelism with said patient supporting means in all angular positions of said X-ray tube unit relative thereto.

5. The combination with a patient supporting means, of a fluoroscopic unit comprising a standard disposed adjacent to said patient supporting means and perpendicular thereto, a support movable vertically of said standard above and below the level of said patient supporting means, a member pivotally secured to said support and provided with a fluorescent screen at one end thereof and an X-ray tube unit including a set of fluoroscopic shutters at the other end thereof, means operable by movement of said member about its pivot to maintain said fluorescent screen in parallelism with said patient supporting means regardless of the angular position of said X-ray tube unit with respect thereto, and means carried by said fluorescent screen for remotely controlling operation of said fluoroscopic shutters in all angular positions of said X-ray tube unit about its pivot.

6. The combination with a patient supporting means, of a fluoroscopic unit comprising a standard disposed adjacent to said patient supporting means and perpendicular thereto, a support movable vertically of said standard above and below the level of said patient supporting means, a member pivotally secured to said support and provided with a fluorescent screen at one end thereof and an X-ray tube unit including a set of fluoroscopic shutters at the other end thereof and movable simultaneously with said support toward or away from the level of said patient supporting means, means operable by movement of said member about its pivot to maintain said fluorescent screen in parallelism with said patient supporting means regardless of the angular position of said X-ray tube unit with respect thereto, means carried by said X-ray tube unit for opening and closing said fluoroscopic shutters, and means carried by said fluorescent screen for remotely controlling operation of said last mentioned means in all angular positions of said X-ray tube unit about its pivot.

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