H. C. SNOOK & E. W. KELLY.

FLUOROSCOPIC APPARATUS.

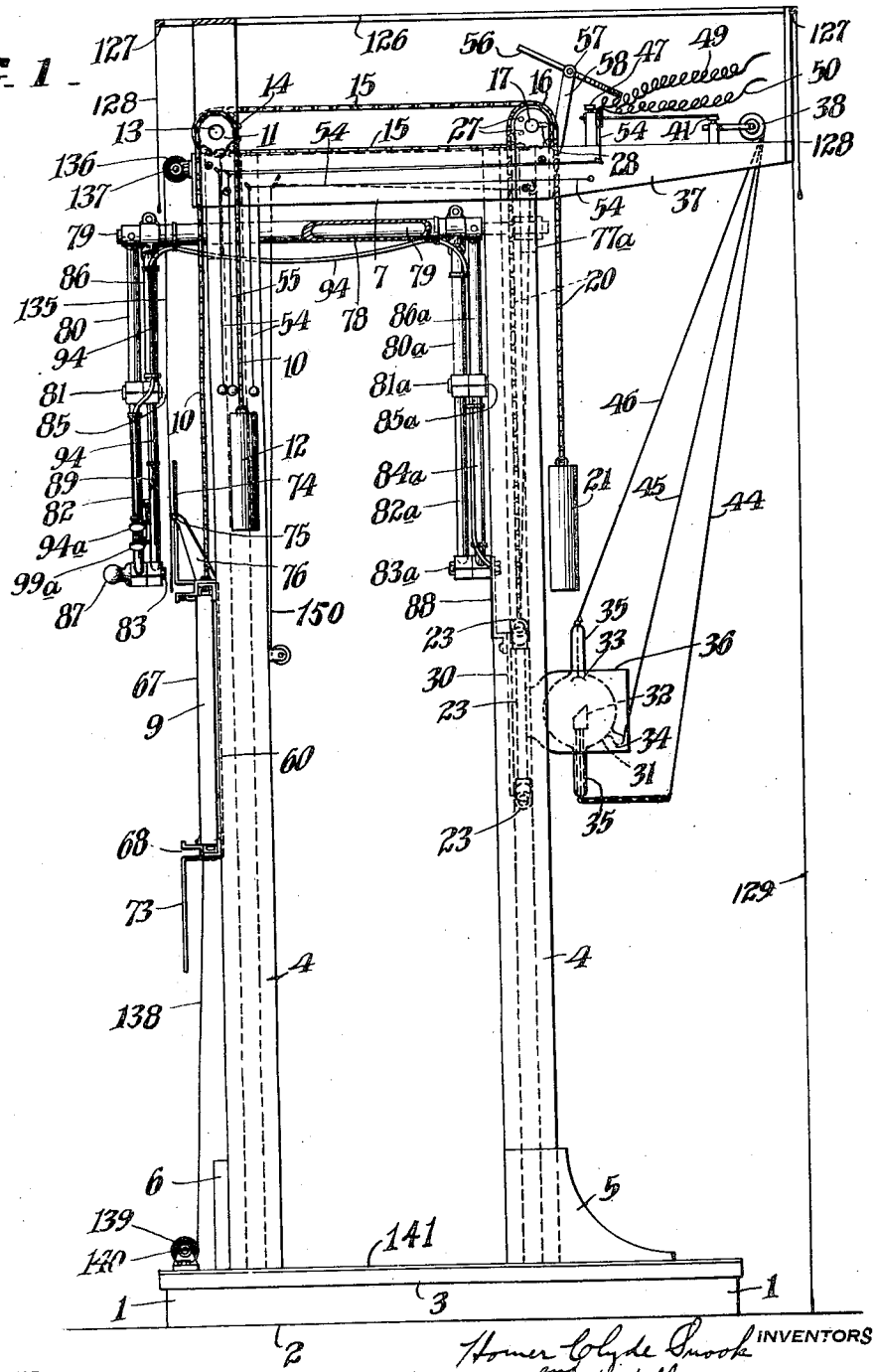
APPLICATION FILED DEC. 26, 1911.

1,117,266.

Patented Nov. 17, 1914.

5 SHEETS—SHEET 1.

FIG. 1.



WITNESSES

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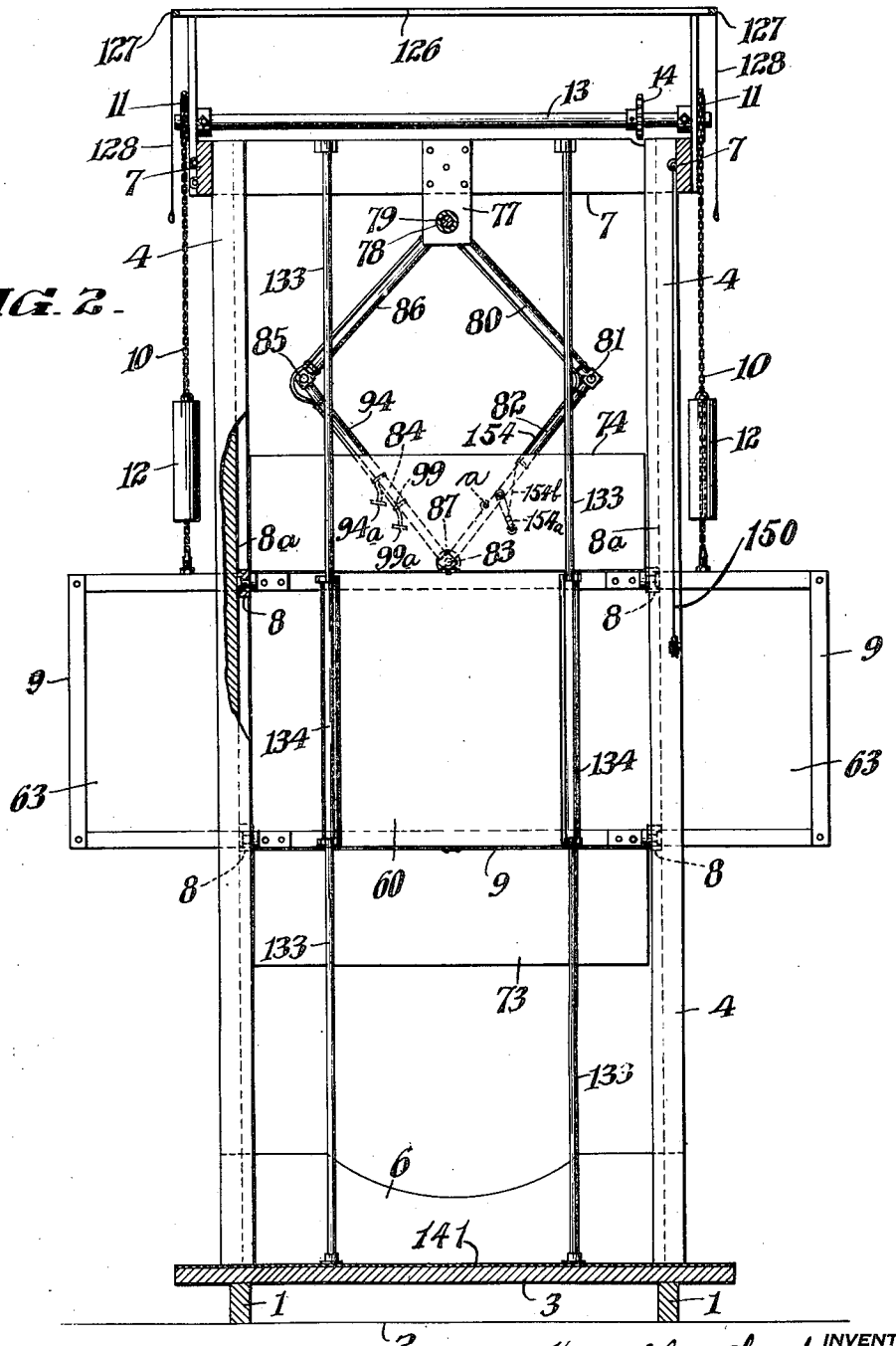
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5 SHEETS—SHEET 2.

FIG. 2.



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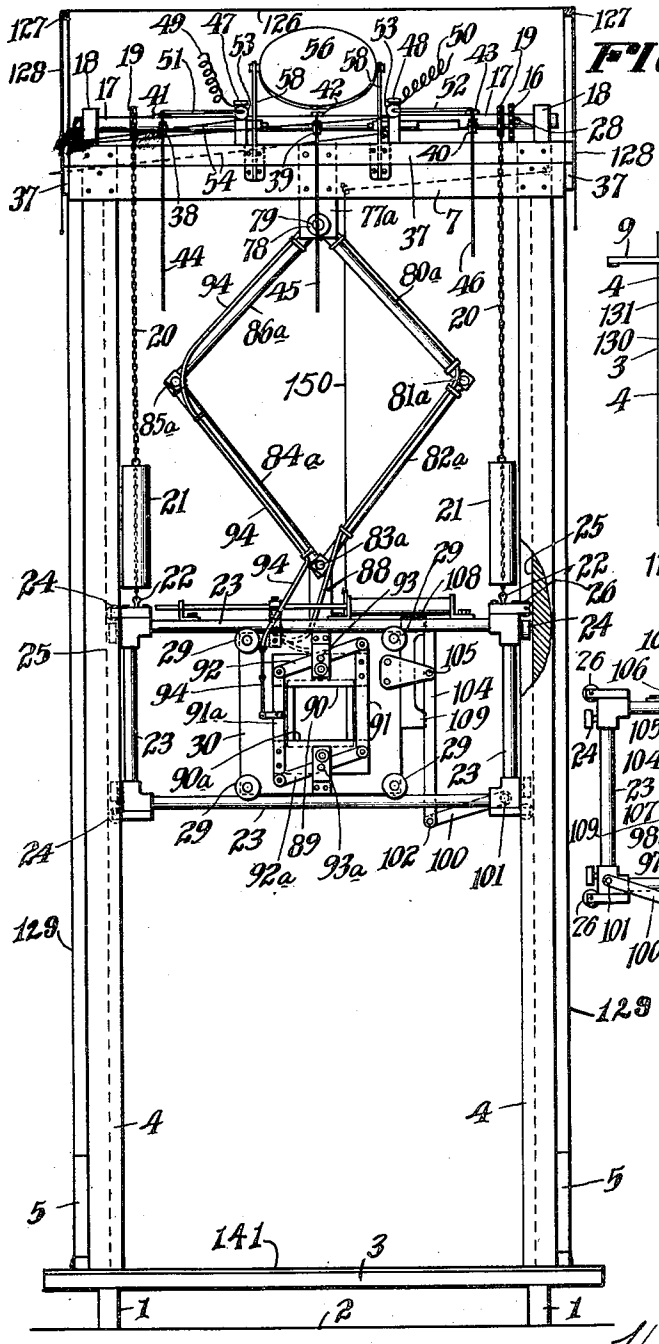


FIG. 3.

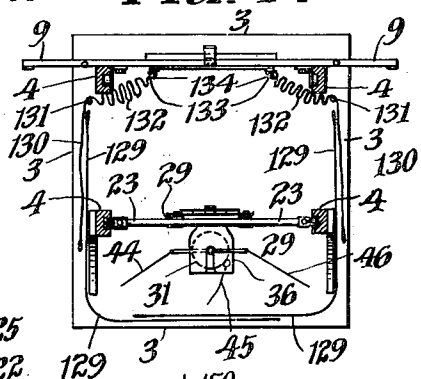


FIG. 4.

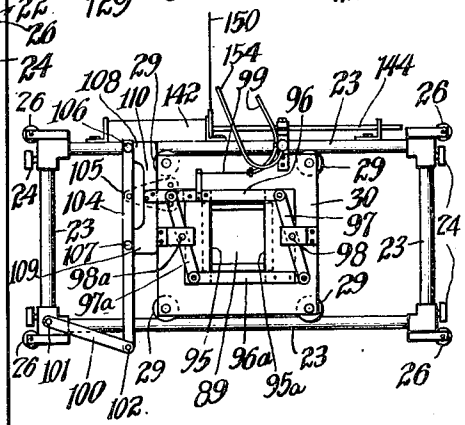


FIG. 5.

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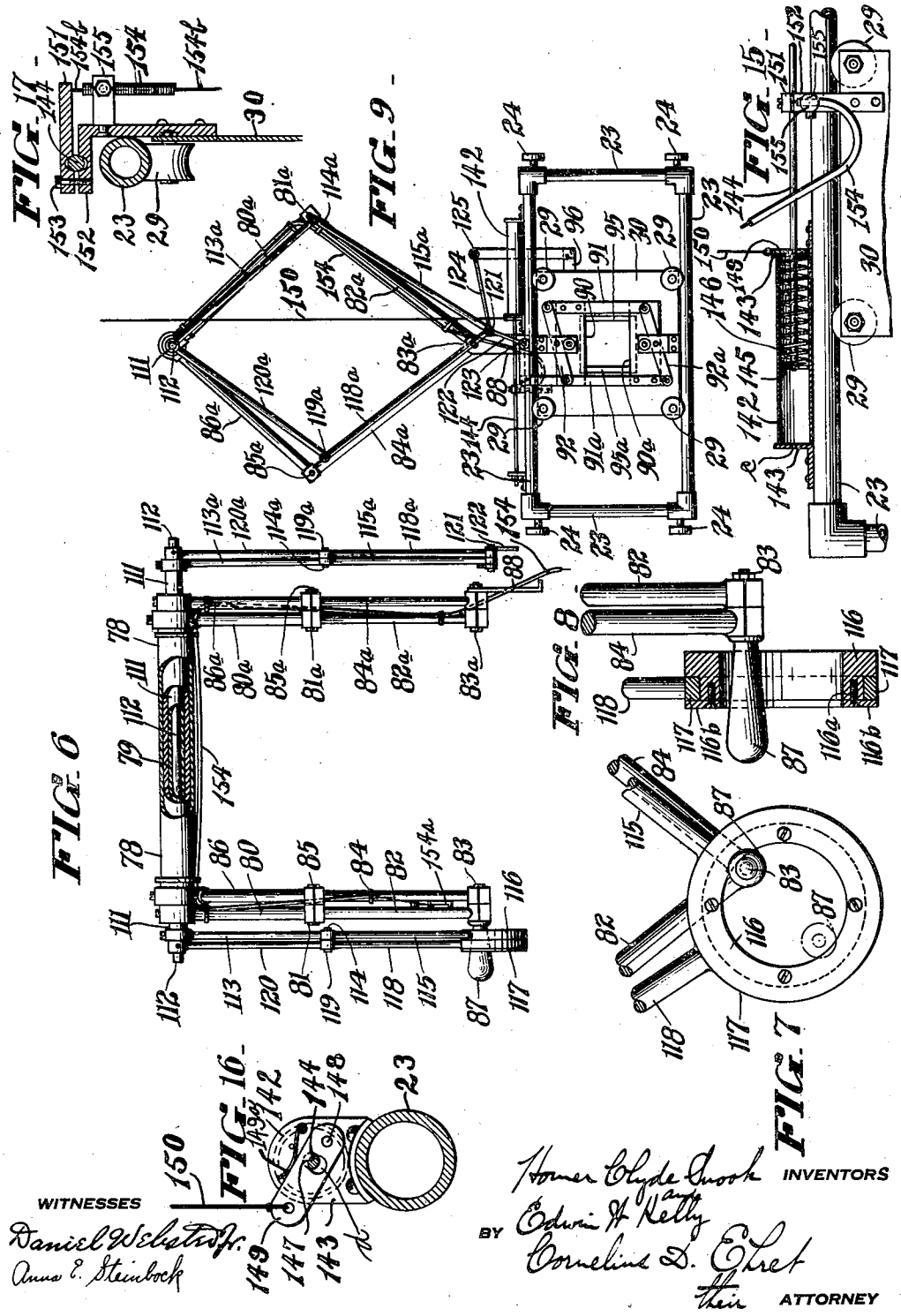
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5 SHEETS—SHEET 4.



WITNESSES

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5 SHEETS—SHEET 5.

FIG. 10.

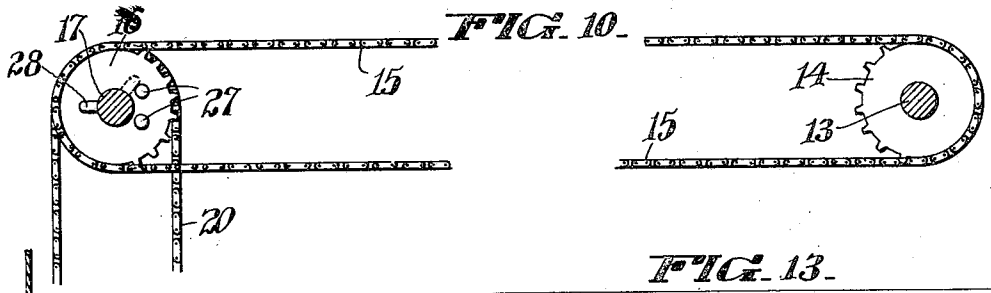


FIG. 13.

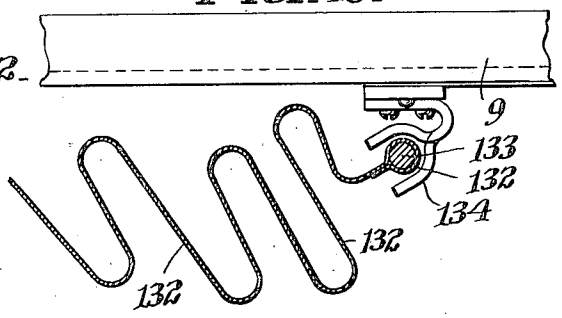


FIG. 12.

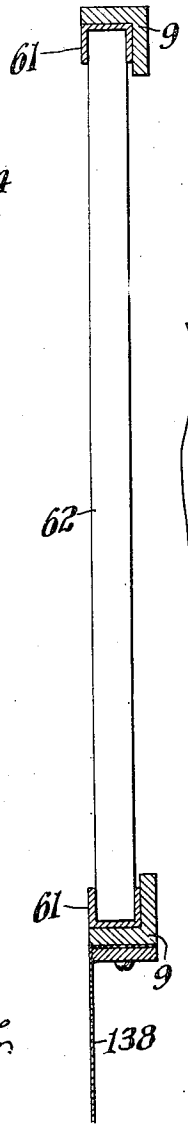


FIG. 11.

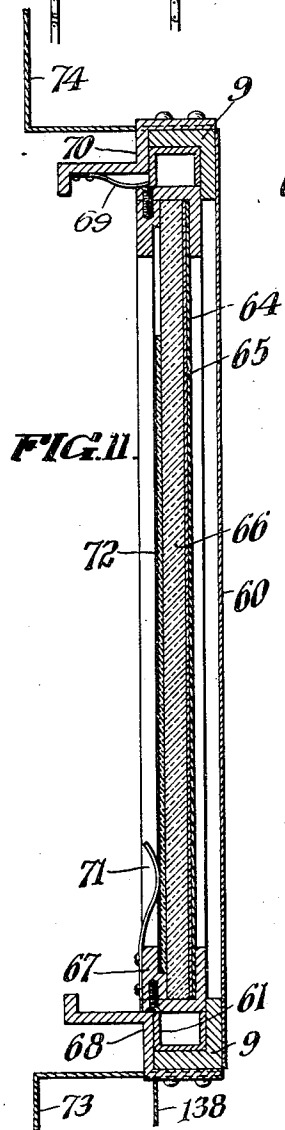
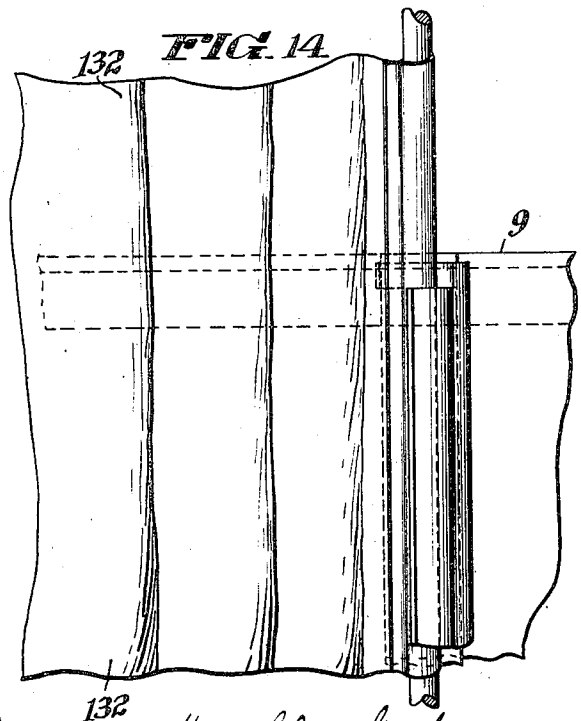


FIG. 14.



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UNITED STATES PATENT OFFICE.

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FLUOROSCOPIC APPARATUS.

1,117,266. Specification of Letters Patent. Patented Nov. 17, 1914.

Application filed December 26, 1911. Serial No. 667,691.

To all whom it may concern:

Be it known that we, HOMER CLYDE SNOOK and EDWIN W. KELLY, citizens of the United States, residing at Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented new and useful Improvements in Fluoroscopic Apparatus, of which the following is a specification.

Our invention relates to apparatus for the rapid, accurate, safe and convenient examination or radiography of patients or objects under X-rays.

One of the principal features of our invention is the provision of means for shielding the operator or physician from X-rays emanating directly from the source, as well as from the secondary, tertiary, etc., sources. Many objects subjected to direct X-rays become sources of secondary rays projected in directions different from those taken by the direct rays. Tertiary rays again emanate from objects in the path of the secondary rays. From this state of facts it follows that a physician or operator, though shielded from the direct X-rays may be subjected to secondary and tertiary rays coming from directions other than those taken by the direct X-rays, and, as stated, our invention resides in means for protecting an operator or physician as completely as possible.

Another principal feature of our invention resides in means for causing the source of X-rays, as the X-ray tube, to follow the movements imparted by the operator to the fluorescent screen, photographic plate, or other object upon which he desires the X-rays to impinge.

Another principal feature of our invention resides in the operating mechanism for the diaphragm associated with the X-ray tube; and resides further in means for automatically changing the extent of opening of the diaphragm in response to certain movements of the fluorescent screen, photographic plate, or other means upon which the X-rays are to impinge.

Our invention resides in the features above referred to and to other novel features of construction and operation hereinafter described and claimed.

For an illustration of one of the forms our invention may take, reference is to be had to the accompanying drawings, in which:

Figure 1 is a side elevational view of apparatus embodying our invention. Fig. 2 is a vertical elevational view, partly in section, looking from within the frame toward the front thereof. Fig. 3 is a rear elevational view of apparatus embodying our invention, a part being shown in section. Fig. 4 is a top plan view, some parts in horizontal section, on reduced scale, of the frame and some coöperating parts. Fig. 5 is an elevational view of the tube carrier apparatus, diaphragms, etc., looking from within the frame toward the rear thereof. Fig. 6 is a side elevational view, parts shown in section, of the double quadrilateral movement. Fig. 7 is a fragmentary front elevational view of a part of the double quadrilateral movement. Fig. 8 is a side elevational view of the parts shown in Fig. 7, some parts in vertical section. Fig. 9 is a rear elevational view of the quadrilateral movements with their connections to the X-ray tube carrying apparatus and to the diaphragms. Fig. 10 is a fragmentary side elevational view of part of the control apparatus. Fig. 11 is a vertical sectional view through the screen and plate holder frame. Fig. 12 is a similar sectional view to that of Fig. 11, some parts omitted, but showing a plate holder in position. Fig. 13 is a fragmentary top plan view, part in section, showing mode of application of the curtain. Fig. 14 is a side elevational view of the same. Fig. 15 is a fragmentary side elevation of the tube carrying frame with a longitudinal sectional view, parts in elevation, of the motive device for the tube. Fig. 16 is an end elevational view of part of the motive device shown in Fig. 15, with part of the frame being shown in cross section. Fig. 17 is a cross sectional view, some parts in elevation, of part of the apparatus shown in Fig. 15, illustrating means for clamping the tube carrying member in desired relation with respect to the movable member of the motive device.

Referring to the drawings, the base timbers or members 1 rest upon any suitable support as, for example, a floor 2. Upon these members 1 is disposed a platform 3

upon which a patient may stand or sit upon a suitable stool during his observation by the operator, who stands in front of the apparatus, that is, to the left of the apparatus as shown in Fig. 1. Extending vertically from the platform 1 are the risers or upright timbers 4, four in number. To give stability to the frame and attached parts the floor 3 and members 1 extend to the rear of the rear posts or uprights 4, as shown in Fig. 1, and braces 5 are attached to the rear uprights 4 and to the platform 3. Across the front at the bottom extends the member 6 for strengthening purposes. To the tops of the posts 4 are secured the horizontal members 7. The parts thus far described may be of wood and preferably of some insulating material, though not necessarily so.

In slots or channels 8^a extending longitudinally of the two front posts 4 engage rollers 8 upon the frame 9. This frame 9 is supported by chains or cords 10 attached to and passing upwardly over the pulleys or sprocket wheels 11, and downwardly to the counterweights 12, to which they are attached, and which balance the frame 9 and attached parts, so that it will remain in any position to which it is vertically adjusted. These pulleys or sprocket wheels 11 are secured upon the horizontal shaft 13 upon which there is also secured a third pulley or sprocket wheel 14 over which passes the cord or chain 15 passing to the rear of the frame where it passes over a sprocket wheel or pulley 16, pivoted loosely upon the horizontal shaft 17 mounted in the bearings 18 carried by the frame. Secured upon the shaft 17 are the sprocket wheels or pulleys 19 over which pass the chains or cords 20 each secured at its one end to a balance or counterweight 21 and at its other end at 22 to the frame 23 which carries the X-ray tube, diaphragms, and associated parts. This frame 23 has guide rollers 24 engaging in vertical channels or grooves 25 in the rear posts or standards 4. Laterally bearing rollers as 26 may also be provided. The weights 21 are of such size as to balance the frame 23 and attached parts, so that the latter will remain stationary in any position to which it is vertically adjusted. As before stated, the sprocket wheel or pulley 16 is loose upon the shaft 17. This sprocket wheel 16, however, has one or more projections 27, see Fig. 1, adapted to engage a pin 28, see Fig. 3, secured upon the shaft 17, such engagement taking place after a certain free movement of the sprocket wheel 16 with respect to the shaft 17, for a purpose hereinafter described.

The rollers 29 roll upon the upper and lower members of the frame 23, which may be made of metal tubing. These rollers 29 carry the member 30 which carries the X-ray tube and the diaphragm apparatus. The X-ray tube is shown at 31, Figs. 1 and 4, being omitted for the sake of clearness in Figs. 3 and 5. This X-ray tube has the usual anode or target 32 and the usual cathode 33 and the vacuum regulator terminal 34. The X-ray tube is supported by the engagement of its stems 35 by clamps, not shown, secured upon the member 30. The X-ray tube 31 is inclosed in the lead glass or other X-ray absorptive shield 36 which is also secured to the member 30. This mode of supporting an X-ray tube and shield is illustrated in copending application Serial No. 574,045, filed by one of us on July 27, 1910. These details of construction are here omitted for the sake of clearness.

Extending rearwardly from the tops of the two rear posts 4 is the bracket 37 upon which are disposed the three reels 38, 39 and 40 in electrical communication respectively with the terminals 41, 42, and 43. Electrically connected to these reels 38, 39 and 40 are the flexible electrical conductors 44, 45 and 46 connected, respectively, as shown in Figs. 1 and 4, with the anode, vacuum regulator, and cathode of the X-ray tube 31. Upon the bracket 37 are the main binding posts or terminals 47 and 48 with which connect respectively the conductors 49 and 50 extending to the source of high potential current which operates the X-ray tube. Pivoted to each terminal 47 and 48 are the switch arms 51 and 52 respectively, which rest normally upon the terminals 41 and 43, respectively. Upon the pivots of the switch arms 51 and 52 are pulleys or drums 53 to which are attached cords 54 extending to the front near the operator who may then actuate the switch arms 51 and 52 to bring either of them into contact with the regulator terminal 42, and a third cord 55, Fig. 1, extends to a sliding bar in communication with one of the terminals as 48, to bring the same nearer to the terminal 47, to test by the parallel spark the resistance of the X-ray tube. This switching mechanism above described, is set forth in Snook & White Patent No. 1,010,197.

At the top of the frame and near the rear there is a mirror 56 pivoted at 57 in the standards 58, whereby the operator standing in front of the apparatus may see the X-ray tube 31 and note whether current therethrough is in the proper direction, the condition of the vacuum in the tube by the nature of the glow, etc. On the side of the frame 9 toward the patient there is a sheet of aluminum 60 occupying the substantially middle third of the frame 9. In the upper and lower sides of the frame 9 are channel members 61 in which may slide transversely of the frame, plate holders as 62, see Fig. 12. Normally the plate holders are in the end thirds of the frame 9 inclosed between plates 63 of steel or other material opaque

to X-rays, whereby when the plates are in these end thirds they are completely protected from the X-rays. But when moved to position in the middle third back of the aluminum plate 60 they are in position to be affected by the X-rays. At the front side of the middle third of the frame 9 is supported the fluorescent screen comprised of the transparent protective coating 64 behind which is the fluorescent material 65 spread in a sheet upon the plate of lead glass 66 or other material transparent to ordinary light but absorptive of X-rays. These parts, 64, 65 and 66 are held in the screen frame 67 whose lower side rests in the bracket 68 carried by the frame 9 and whose upper edge is adapted to be engaged and held by the spring 69 carried by the extension 70 upon the frame 9. By means of springs 71 on the frame 67 a plate of glass 72 or other suitable material may be placed against the lead glass 66, so that an operator may trace upon the glass or member 72 an outline of any figure or organ appearing upon the fluorescent screen.

Depending from the lower side of the frame 9 is a shield 73 of lead or other material absorptive of X-rays. And a similar shield 74 extends above the upper edge of the frame 9 and is pivoted at 75 in brackets 76 carried by the frame 9. By means of these shields 73 and 74 the operator is protected from all radiation directed from the X-ray tube for any diaphragm openings and positions of the X-ray tube. Secured to the front member 7 is a bracket 77 forming a bearing for the hollow shaft or tube 78 within which is movable the shaft 79. At the front of the apparatus there is secured to the shaft 78 the link or arm 80 pivoted at 81 to the link or arm 82 which is, in turn, pivoted at 83 to the link or arm 84 which latter is pivoted at 85 to the link or arm 86 secured to the shaft 79. To the pivot pin 83 there may be secured an operator's handle or grip 87. At the rear of the frame and secured to the rear member 7 is a bracket 77^a. The shafts 78 and 79 extend rearwardly and are similarly supported at the rear by the bracket 77^a. The shafts 78 and 79 are out of the way of and above the patient who may stand upon the platform 3. At the rear end of the shaft 78 there is secured an arm or link 80^a pivoted at 81^a to the arm or link 82^a pivoted at 83^a to the arm or link 84^a which latter is pivoted at 85^a to the arm or link 86^a which is secured to the shaft 79. Connected to the pivot pin 83^a is the bar or strap 88 secured to the member 30 which carries the X-ray tube and its diaphragms. The operator by moving the handle 87, can through these quadrilateral movements move the X-ray tube to any desirable position, within the limits of the apparatus, to bring the focus spot of the X-ray tube opposite any portion of the patient or of the fluorescent screen or photographic plate. Whatever movement is given to the handle 87 is partaken of by the pivot 83^a at the rear, and from this pivot a lateral movement equivalent to the lateral component of the movement of the handle 87 is communicated in corresponding lateral movement of the member 30 upon the frame 23; and the vertical component of the movement of the handle 87 is communicated by similar vertical movement of the pivot 83^a to the entire frame 23 which moves upwardly and downwardly just as far as the handle 87. It follows that the X-ray tube follows in movement exactly the movement of the handle 87. By this construction, the operator by moving his handle 87 can direct the X-rays through any suitable portion of the patient on to the fluorescent screen 65, which he is observing.

The frame 9 and attached parts are not connected to the quadrilateral movement. The frame 9 and the frame 23 are interconnected only through the chains and sprocket wheels, and particularly through sprocket wheel 14, chain 15 and sprocket wheel 16. If the frame 9 is moved vertically to so great a distance that, with the maximum opening of the diaphragms later to be described, the X-rays are to extend above the shield 74 or below the shield 73, the pin 28 upon the shaft 17 comes into engagement with one or the other of lugs or pins 27 upon the sprocket wheel 16 to correspondingly elevate or lower the frame 23 carrying the X-ray tube. By this construction X-rays direct from the focus spot on the target or anode of the X-ray tube can never pass above or below the screen or the shields 74 and 73, so that the operator is automatically protected from moving the frame 9 and attached parts to any such position as would place him in the path of such direct X-rays, it being well understood that direct X-rays are particularly harmful to an operator particularly if he is repeatedly subjected to them.

Upon the member 30, which also carries the X-ray tube, are disposed vertically and horizontally movable diaphragm members. As shown in Figs. 3 and 5, the diaphragm opening 89 is rectangular, so that the beam of X-rays passing through the same is in the nature of a rectangular pyramid. The diaphragm, it is to be understood, intervenes between the X-ray tube and the patient and the frame 9 and attached parts.

The vertically movable diaphragm comprises the two plates 90 and 90^a, Fig. 3, of steel or other material opaque to X-rays. The plate 90 is secured at its right hand end, Fig. 3, to the vertically disposed link 91, while the diaphragm member 90^a is secured at its left hand end to the link 91^a. These

links 91 and 91ª are pivoted at their upper ends to the link 92 pivoted at 93 to a bracket fixed upon the member 30. At the lower ends the links 91 and 91ª are pivoted to the link 92ª pivoted at 93ª to a similar bracket secured on the member 30. It follows that any rocking motion given to any of these links will cause the diaphragm members 90 and 90ª to move in a vertical direction either toward each other or away from each other. Such motion may be communicated through the member 94, secured to the link 91ª. The member 94 is here shown as a flexible Bowden antinous cable which extends around two sides of the rear quadrilateral movement, thence to the front quadrilateral movement and along two sides thereof and terminates in the pressure handle 94ª. When the operator operates this handle 94ª a vertical movement will be given to the link 91ª causing the approach or departure of the diaphragm members 90 and 90ª to or from each other. In Fig. 5 the laterally moving diaphragm members 95 and 95ª are shown secured respectively to the links 96 and 96ª. The links 96 and 96ª are pivoted at their right hand ends to the link 97 pivoted at 98 to a bracket secured upon the member 30. At their left ends the links 96 and 96ª are pivoted to the link 97ª pivoted at 98ª to a similar bracket secured upon the member 30. Any pivoted movement communicated to these four links will cause a lateral movement of the diaphragm members 95 and 95ª to cause them to approach each other or to recede from each other. Such movement may be given by attaching a member 99 to the link 96, such member 99 being the movable core of the antinous member 94 heretofore described. This member 99 also extends to the front of the apparatus and terminates in the operator's handle 99ª, Figs. 1 and 2. By actuating this handle 99ª the diaphragm members 95 and 95ª may be caused to move horizontally to approach each other or to recede from each other. Thus, the operator from the front of the apparatus may change the diaphragm opening at will, from a complete closure to a predetermined maximum opening.

It will be understood from the disclosure of the links for moving the diaphragm members, that they constitute parallelogram motions, and that both diaphragm members of a pair move at the same rates and through the same distances.

If the operator should move the X-ray tube, as by the handle 87, to such a distance to the right or left transversely of the frame as to allow direct X-rays to pass the vertical edges of the lead shields 73, 66 and 74 and of other parts attached to the frame 9, the passage of such direct X-rays is prevented by means which automatically close the diaphragm opening, particularly by moving the laterally movable diaphragm members 95 and 95ª so that no such direct rays can reach the operator. This is accomplished by the following means. A link 100, Figs. 3 and 5, is pivoted at its one end at 101 to the frame 23 and at its other end at 102 to the link 104 pivoted at 105 to the member 30. At equal distances above and below the pivot 105 the link 104 carries pins or rollers 106 and 107 engaged respectively by the stops 108 and 109 on the member 110 secured to an extension of the link 96, Fig. 5. It is seen that any pivotal movement of the link 104 upon its pivot 105 will actuate either stop 108 or stop 109 to move it laterally with resultant approach of diaphragm members 95 and 95ª toward each other. And it is seen that any lateral movement of the member 30, carrying the X-ray tube, will cause a transverse movement of the pivot 105 with a resultant rocking of the lever 104 and, therefore, a resultant movement of the diaphragm members 95 and 95ª. The parts are so proportioned that these members 95 and 95ª approach each other at such rate that any rays escaping from the tube target past the inside vertical edges of the members 95 and 95ª will never strike the frame 9 or attached parts outside of a protected area.

The diaphragm members may be moved by means other than the members 94 and 99, as, for example, by means illustrated in Figs. 5 to 9 inclusive. Here an extra pair of quadrilateral movements is provided for the purpose. The quadrilateral movement shown in Figs. 1, 2 and 3 is shown in Fig. 6 by the same reference characters. Within the shaft 79, (79 here being also a hollow shaft) is the independently movable hollow shaft 111 within which in turn is the independently movable shaft 112. At the front there is secured upon the shaft 111 the link 113 pivoted at 114 to the link 115 terminating at its lower end in the ring 116 having a pivotal bearing on the ring 117 to which latter is secured the link 118 pivoted at 119 to the link 120 which is in turn secured upon the shaft 112. As viewed in Figs. 7 and 8, the ring 117 bears upon the outer bearing surface 116ª of the ring 116 and the ring 117 is held in this bearing position by the ring plate 116ᵇ secured upon the front edge of the ring 116. The handle 87 of the first quadrilateral movement extends through the free opening in the rings 116 and 117. At the rear end of the shaft 111 is secured the link 113ª pivoted at 114ª to the link 115ª pivoted at 121 to the link 118ª in turn pivoted at 119ª to the link 120ª which is secured upon the shaft 112. It will be understood that the pivot 121 will describe any movement given to the center of the rings 116 and 117 to which the pivot 121 is opposite or coaxial. In Fig. 9 the two

rear quadrilaterals are shown associated with the diaphragm apparatus. Pivoted on the pivot 121 is a link 122 pivoted at 123 to a member rigid with the extension of the link 91ª for giving vertical movement to the diaphragm members 90 and 90ª. Pivoted on pivot 121 there is also a link 124 pivoted at 125 to an extension of the link 96 which imparts, as previously described in connection with Fig. 5, a horizontal or transverse movement to the diaphragm members 95 and 95ª. From this construction it follows that when the operator moves the rings 116 and 117 with respect to the handle 87, the diaphragm members are opened or closed by the second quadrilateral movement. By having the handle 87 extend through the opening in the rings 116, 117, the amount of movement of the second quadrilateral system is limited and correspondingly the amount of movement of the diaphragm members is limited. Thus, when the handle 87 is moved to any given position the X-ray tube target is moved to corresponding position, as hereinbefore described. Then, by shifting the rings 116 and 117 to suitable position a desired extent of diaphragm opening may be obtained, the diaphragms of course moving with the X-ray tube as previously described. In Fig. 9 the diaphragm is shown at full opening. If, for example, the rings 116 and 117 should be shifted so that they occupy with respect to the handle 87 the position indicated by the dotted handle 87 in Fig. 7, the diaphragms will be entirely closed. Since the rings have free movement in any direction, within the limit of their opening, the shape of the diaphragm opening may be changed from square, as shown in Fig. 9, to a rectangle whose ends and sides may be varied in proportion.

In order that the diaphragm leaves shall not move, but shall maintain the same diaphragm opening when the handle 87 is moved, one or more pivots of the levers moving the diaphragm leaves is or are given enough friction so that the movement of the handle 87 will be transmitted through one quadrilateral movement to the bar or plate 88, and thence to the plate 30, to move the same, and this movement, due to the excess of friction in the diaphragm levers over the friction of the second quadrilateral movement, will cause the second quadrilateral movement to move without movement of the diaphragm leaves, thus keeping the rings 116 and 117 in the same relative position to the handle 87. This will be understood from the fact that the force exerted upon the handle 87 is transmitted through the first quadrilateral movement, thence through the diaphragm operating levers through the second quadrilateral movement back to the front of the frame to the rings 116 and 117. If there were not this excess of friction in the levers of the diaphragm movement, a movement of the handle 87 causing a movement of the plate 30 would cause, due to the friction in the second quadrilateral movement terminating in the rings 116, 117, a movement of the rods 122 and 124 which would, of course, cause a change in the opening of the diaphragm; but the friction in the diaphragm levers being made sufficiently large, this movement will not take place and the movement of the plate 30 will be communicated to the second quadrilateral movement keeping the diaphragm opening the same. It follows from this that when exploring by moving the handle 87, the diaphragm opening will remain unchanged and will be changed only by a relative movement of the rings 116 and 117 with respect to the handle 87.

Inasmuch as exposure of the operator to secondary radiations of X-ray (not direct X-rays but rays emanating from and transmitted in new directions from the patient, or any object upon which the direct X-rays impinge) is undesirable, we have provided further means for giving the operator a maximum of protection even against the secondary radiations. To this end we provide curtains of rubber, or other material opaque to the secondary radiations. As viewed in Figs. 1, 2 and 3, such a curtain is shown at 126, extending across the top of the frame upon supports 127 carried by that frame. The curtain 126 may have the vertically hanging flaps 128 extending downwardly a suitable distance on all sides of the frame.

As shown in Fig. 4, similar rubber or other curtains 129 extend partially around the sides of the frame and across the rear of the same back of the X-ray tube and extend from the floor to a height at least as high as the lower edges of the flaps 128. Additional side curtains 130 are provided which are secured at the front corners of the frame upon vertical rods 131. From these rods the same curtain 130 or other curtains 132 folded as shown in Fig. 4 and Figs. 13 and 14 to be flexible and extensible, terminate on vertical rods 133 located approximate the sides or edges of the fluorescent screen. Upon the frame 9 are the U-shaped pieces 134 which embrace the rods 133, but do not contact therewith or with the curtain 132 upon said rods 133. In other words, the frame 9 may be moved upwardly and downwardly freely, and yet the U-shaped members 134 remain in the relative position shown in Fig. 13 during all such movements. The members 134 so embracing the rod 133 and curtain 132 prevent any stray radiations passing out from between the end of the curtain 132 and the frame 9. As seen in Figs. 1 and 4, there is a further rubber curtain 135 upon spring roller 136 pivoted at 137 to the top of the

frame. This spring roller tends to roll the curtain upwardly. The lower edge of the curtain 135 hangs down overlapping the shield 74. A further curtain 138 is attached at its upper edge to the lower side of the frame 9 and extends down to the spring winding roller 139 pivoted at the lower part of the frame at 140. A further rubber or similar means for absorbing secondary or tertiary radiations is shown at 141 on the bottom or floor 3 of the frame. By this complete curtaining, the operator is shielded from secondary or tertiary radiations emanating from the patient himself or from any other source. The flexible folds 132 enable the operator to grasp the patient standing within the frame by pushing such flexible folds against the patient and grasping the patient. The operator may suitably position the patient without displacing the curtains. And this he may do by reaching up under the curtain 135 and over the top edge of the shield 74.

When it is desired to make stereoscopic negatives, the patient is explored by moving the frame 9 and the handle 87 until the desired organ is projected upon the fluorescent screen. Then, the fluorescent screen and attached parts are moved outwardly toward the front on the brackets 68 and a plate holder moved from one of the plate spaces, for example, the one at the right, Fig. 2, along the channels 61 into the position previously occupied by the screen. An exposure is then made. Then the plate holder is returned to its opaque compartment at the right and the plate holder containing the fresh plate in the plate space 63 at the left is moved into position. The X-ray tube having been shifted a space of about two and one-half inches, in the meantime, the second exposure is made by again energizing the tube.

The motive device for the X-ray tube is illustrated in Figs. 15, 16 and 17.

Upon the frame 23 is secured a tube 142, by brackets 143. One end of the tube, the left shown in Fig. 15, is closed by part of the bracket 143 and has a small perforation *c* for allowing slow egress of air for retardation purposes. Extending through the right hand end of the tube 142, Fig. 15, is a rod 144 carrying on its inner end within the tube a piston or plunger 145 fitting snugly within the tube. A spring 146, shown under compression in Fig. 15, is adapted to move the plunger and rod toward the left. The rod 144 has a notch 147, see Fig. 16, in which is adapted to engage the latch 149 pivoted at 148 to the bracket 143. With the latch so in engagement in the notch, the spring 146 is held under compression. When the string 150, attached to the latch 149, is pulled from the front end of the frame near the operator, the latch is raised out of the notch and the rod may then pass freely through the opening *d* in the latch 149 and move toward the left, Fig. 15, under the influence of the spring 146. The extent of this movement may be made anything desired, but for stereoscopic purposes is preferably two and one-half inches, the average distance between the human eyes.

Engaging the rod 144 is a clamp comprising the members 151 and 152, see Figs. 15 and 17. The member 152 is secured to the plate 30 which caries the X-ray tube and the diaphragms. The clamp member 151 also embraces the rod 144 and has freedom of movement upon the screw 153 passing through the member 151 and engaging in the member 152. A Bowden cable is secured by its jacket 154 to the bracket or post 155 upon the clamp member 152. This Bowden cable having the core wire 154^b extends to the front of the frame within access by the operator. The operator in manipulating the handle 154^a pivoted on the bar 82, in moving the same in a clockwise direction, as viewed in Fig. 2, causes a pull upon the core wire 154^b which at its other end is attached to the clamp member 151, and this pull, therefore, clamps the clamping member to the rod 144. The parts are held in clamped position by the handle 154^a passing what may be called a dead-center position, and coming to rest against the stop *a*, Fig. 2. The plate 30 and attached parts, including the X-ray tube and diaphragms, is now clamped to the rod 144. The first exposure is now made. String 150 is then pulled unlatching the rod 144 and the spring 146 then moves the X-ray tube and associated parts to new position and the second exposure is made. By returning the handle 154^a to the position shown in Fig. 2, the plate 30 and attached parts are unclamped from the rod 144. By such construction the plate 30 and parts carried thereby may be caused to move from any position to another, and so may be positioned at will with respect to a fluoroscope or plate holder occupying any position on frame 9. The spring 146 may be set to position shown in Fig. 15 by moving the lever 154^a to clamping position, and then moving the frame 9 in proper direction, such movement being transmitted to the member 30 and through the clamp to the rod 144, thus compressing the spring which is then latched by the action of the spring 149^a, Fig. 16, moving the latch 149 into the notch 147.

For the sake of brevity, we shall refer in the claims to the frame 9, or its equivalent, as an "observation frame" whether it be used with a fluorescent screen, a photographic plate, or any other observation means. And for like reasons, we shall refer to the member 30 as the "tube carrier" or

"diaphragm carrier", and shall refer to the frame 23, or its equivalent, as a "tube frame".

While we have herein referred to the quadrilateral movements, here shown as composed of four pivoted levers or bars, it is to be understood that we do not wish to limit ourselves by the term "quadrilateral" to an arrangement employing four side levers or members, but include in such term any operative arrangement which may include any other number of levers or bars.

It is to be understood that we no not wish to be limited by the terms "vertical" and "horizontal" as employed in the appended claims, where they are used simply as a convenient method of indicating relative directions.

What we claim is:

1. In apparatus of the character described, a main frame within which an object to be observed may be placed, of an observation frame on said main frame at the front thereof, an X-ray tube carried by said main frame at the rear thereof, means shielding the operator in front of said observation frame from direct rays from said X-ray tube, and means absorptive of rays of lesser degree including said main frame and the object under observation.

2. In apparatus of the character described, a main frame within which an object to be observed may be placed, an observation frame on said main frame at the front thereof, an X-ray tube on said main frame at the rear thereof, means carried by said observation frame absorptive of direct rays from said X-ray tube of shielding an operator therefrom in front of said observation frame, and material absorptive of X-rays of lesser degree inclosing said frame and the object under observation.

3. In apparatus of the character described, a man frame, an observation frame and an X-ray tube carried thereby, means for moving said observation frame and X-ray tube on said main frame, means absorptive of direct rays from said X-ray tube carried by said observation frame, a diaphragm for said X-ray tube, and means for automatically varying the opening of said diaphragm in response to relative movements of said observation frame and said X-ray tube for restricting the direct rays from said X-ray tube within the area of said material absorptive of direct rays carried by said observation frame.

4. In apparatus of the character described, an observation frame, means carried thereby for shielding an operator from primary or direct X-rays, means absorptive of secondary and tertiary X-rays attached to said frame and movable therewith, and means for taking up and paying out said absorptive means.

5. In apparatus of the character described, the combination with a main frame, of an observation frame movable thereon, a source of X-rays, a member absorptive of direct X-rays carried by said observation frame, a curtain of material absorptive of secondary and tertiary rays secured at its one edge to said main frame, a rod supported by said main frame and receiving the other edge of said curtain, said rod disposed approximate the edge of said member absorptive of primary or direct rays, and absorptive means carried by said observation frame and loosely embracing said rod.

6. In apparatus of the character described, an observation frame, a tube frame, an X-ray tube supported by the latter, a diaphragm associated with said X-ray tube, and a shield absorptive of direct rays supported to one side of said observation frame and of such extent that for a relative movement of said observation frame with respect to said X-ray tube said diaphragm will prevent direct rays passing beyond said shield.

7. In apparatus of the character described, an observation frame, a tube frame, an X-ray tube supported by the latter, a diaphragm associated with said X-ray tube, a shield absorptive of direct rays supported to one side of said observation frame and of such extent that for a relative movement of said observation frame with respect to said X-ray tube said diaphragm will prevent direct rays passing beyond said shield, and a lost motion device between said observation and tube frames, whereby said tube frame moves with said observation frame after such free relative movement between said observation and tube frames as would allow direct rays to pass through said diaphragm and past said shield.

8. In apparatus of the character described, the combination with a main frame, of a tube frame movable thereon, a tube carrier supported by and movable with respect to said tube frame, and means attached to said tube carrier actuated by the operator for transmitting to said tube carrier and said tube frame a movement corresponding with the movement of said operator actuated means.

9. In apparatus of the character described, the combination with a main frame, of a tube frame movable thereon, a tube carrier supported by and movable with respect to said tube frame, and a quadrilateral movement attached to said tube carrier, whereby any movement given to said quadrilateral movement by the operator is similarly partaken of by said X-ray tube.

10. In apparatus of the character described, the combination with a main frame, of a tube frame movable thereon, a tube carrier supported by and movable with re-

spect to said tube frame, and means attached to said tube carrier actuated by the operator for transmitting to said tube carrier a movement with respect to said tube frame and to said tube frame a movement at right angles to the movement of said tube carrier.

11. In apparatus of the character described, the combination with a main frame, of a tube frame movable thereon, a tube carrier supported by and movable with respect to said tube frame, and means actuated by the operator for transmitting to said tube carrier and said tube frame movements corresponding with components of the movement of said operator actuated means at right angles with each other.

12. In apparatus of the character described, the combination with an X-ray tube, of a diaphragm comprising diaphragm leaves movable in directions at an angle with respect to each other, parallel link motions for moving said diaphragm leaves, and means for communicating movement to said link motions.

13. In apparatus of the character described, the combination with an X-ray tube, of a diaphragm comprising diaphragm leaves movable in directions at an angle with respect to each other, parallel link motions for moving said diaphragm leaves, and means for giving to said link motions different degrees of movement for changing the shape of the diaphragm opening.

14. In apparatus of the character described, the combination with an X-ray tube, of a diaphragm movable therewith, means for moving said X-ray tube and diaphragm together, and means coöperating with said means and having limited movement with respect thereto for adjusting the opening of said diaphragm.

15. In apparatus of the character described, the combination with an X-ray tube, of a diaphragm movable therewith, means for moving said X-ray tube and diaphragm together, and means coöperating with said means and having limited movement with respect thereto for changing the shape of the opening of said diaphragm.

16. In apparatus of the character described, an X-ray tube, a diaphragm movable therewith, a quadrilateral movement for communicating motion to said X-ray tube, and a second quadrilateral movement for adjusting the opening of said diaphragm.

17. In apparatus of the character described, the combination with an X-ray tube, a diaphragm movable therewith, means for causing said X-ray tube to follow the movement of means actuated by the operator, and means for automatically reducing the opening of said diaphragm in response to certain degrees of movement of said X-ray tube in a given direction.

18. In apparatus of the character described, the combination with an X-ray tube, a diaphragm movable therewith, means for causing said X-ray tube to follow the movement of means actuated by the operator, and means for automatically proportionally reducing the opening of said diaphragm in a given direction in response to movement of said X-ray tube in the same direction.

19. In apparatus of the character described, a tube support, a tube carrier, an X-ray tube secured thereto, a motive device for moving said tube carrier with respect to said support, means for clamping said tube carrier to different positions with respect to the movable member of said motive device, and means for actuating said clamp from a distance.

20. In apparatus of the character described, the combination with a tube frame, a tube carrier movable thereon, an X-ray tube supported by said tube carrier, a diaphragm carried by said tube carrier, and links pivoted to said frame and to said tube carrier for controlling the opening of said diaphragm.

21. In apparatus of the character described, the combination with a tube frame, a tube carrier movable thereon, an X-ray tube supported by said tube carrier, a diaphragm carried by said tube carrier, and links pivoted to said frame and to said tube carrier for automatically proportionally reducing the diaphragm opening in a given direction upon movement of said tube carrier in said direction.

22. The combination with an X-ray tube, of a screen, and a lost motion connection between said tube and said screen, whereby said tube may move independently of said screen and thereafter with said screen.

23. The combination with an X-ray tube, of a screen, a lost motion connection between said tube and said screen, whereby said tube may move independently of said screen and thereafter with said screen, and means for moving said tube independently of said screen.

24. The combination with an X-ray tube, of a screen, a lost motion connection between said tube and said screen, whereby said tube may move independently of said screen and thereafter with said screen, a diaphragm movable with said tube, and means at a distance from said diaphragm for adjusting the same.

25. The combination with an X-ray tube, of a diaphragm therefor, means for moving said tube, means for adjusting said diaphragm, and a lost motion connection between said tube moving means and said diaphragm adjusting means.

26. In apparatus of the character described, the combination with a main frame, of an observation frame and a tube frame movable thereon, a lost motion connection between said observation and tube frames, a tube carrier movable on said tube frame, and means actuated by the operator for transmitting to said tube carrier and said tube frame movements corresponding with the components at right angles with each other of the movement of said operator actuated means.

27. In apparatus of the character described, the combination with a main frame, of an observation and a tube frame movable thereon, a lost motion connection between said observation and tube frames, a tube carrier movable on said tube frame, and means connected with said tube carrier adapted to be actuated by an operator for moving said tube carrier and said tube frame.

28. In apparatus of the character described, the combination with a main frame, of an observation frame and a tube frame movable thereon, a lost motion connection between said observation and tube frames, a tube carrier movable on said tube frame, means actuated by the operator for transmitting to said tube carrier and said tube frame movements corresponding with the components at right angles with each other of the movement of said operator actuated means, an adjustable diaphragm carried by said tube carrier, and means adjusting said diaphragm upon pre-determined movement of said tube carrier with respect to said observation frame.

29. In apparatus of the character described, a main frame, an observation frame and a tube frame movable thereon, independent counter-weights for said observation and tube frames, and means for causing said observation and tube frames to move with each other after predetermined movement independently of each other.

30. In apparatus of the character described, the combination with a main frame, of an observation frame and a tube frame carried thereby, a tube carrier movable on said tube frame, a motive device carried by said tube frame, means attached to said tube carrier for moving the same and said tube frame, and means for clamping said tube carrier in different positions with respect to the movable member of said motive device.

31. In apparatus for producing X-rays, the combination with an X-ray tube, of a diaphragm comprising a plurality of sets of interconnected diaphragm leaves movable in directions at an angle with respect to each other, and members connected with said sets of leaves for moving the same.

32. In apparatus for producing X-rays, the combination with an X-ray tube, of a diaphragm comprising a plurality of sets of inter-connected diaphragm leaves movable in directions at an angle with respect to each other, and means for giving to said sets of leaves different degrees of movement for changing the shape of the diaphragm opening.

33. In apparatus of the character described, the combination with a main frame, of an observation frame on said main frame, an X-ray tube carried by said main frame at a distance from said observation frame, the space between said X-ray tube and said observation frame adapted to be occupied by the object to be observed, means shielding the operator in front of said observation frame from direct rays of said X-ray tube, and means absorptive of rays of lesser degree intervening between the object under observation and the space in front of said observation frame occupied by the operator.

34. In apparatus of the character described, the combination with a main frame, of an observation frame on said main frame, an X-ray tube carried by said main frame at a distance from said observation frame, the space between said X-ray frame and said observation frame adapted to be occupied by the object to be observed, means shielding the operator in front of said observation frame from direct rays of said X-ray tube, and means absorptive of rays of lesser degree carried by said main frame and inclosing the object under observation, whereby the space in front of said observation frame occupied by the operator is shielded from said rays of lesser degree.

35. In apparatus of the character described, the combination with a main frame, of an observation frame on said main frame, an X-ray tube carried by said main frame at a distance from said observation frame, the space between said X-ray frame and said observation frame adapted to be occupied by the object to be observed, means shielding the operator in front of said observation frame from direct rays of said X-ray tube, and means shielding the space in front of said observation frame occupied by the operator from rays of lesser degree.

In testimony whereof we have hereunto affixed our signatures at the city of Philadelphia, State of Pennsylvania, this 23rd day of December, 1911, in the presence of the two subscribing witnesses.

HOMER CLYDE SNOOK.
EDWIN W. KELLY.

Witnesses:
E. D. MUENCH,
ANNA E. STEINBOCK.