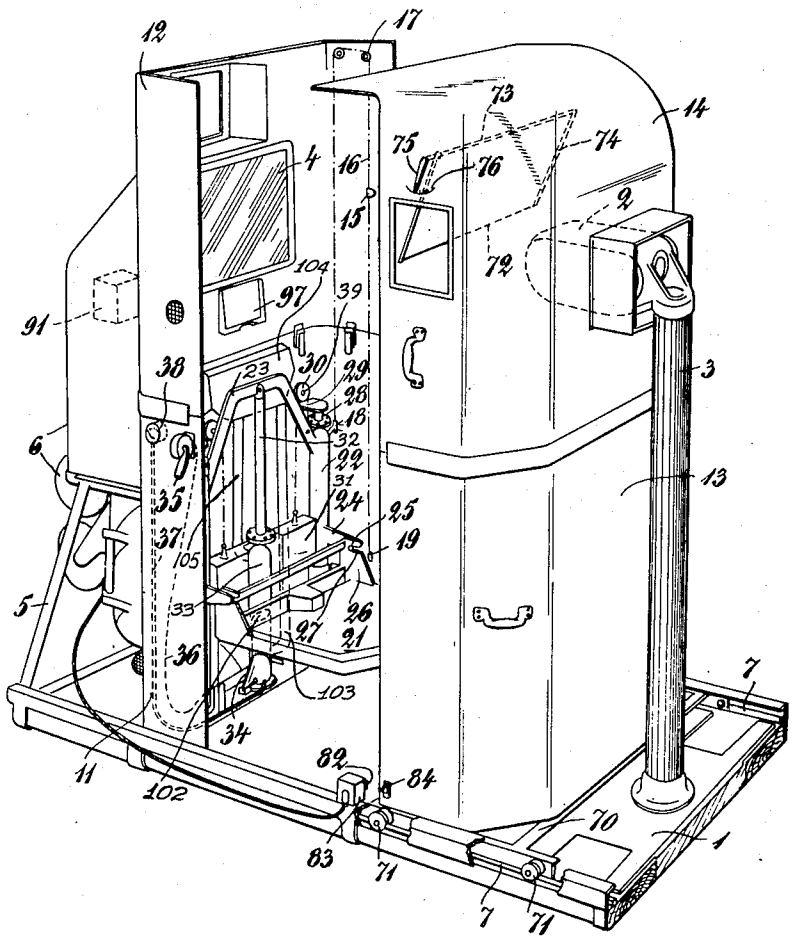
July 21, 1953 K. W. W. NOSCHIS 2,646,514

ROENTGEN APPARATUS

Filed May 12, 1948 3 Sheets-Sheet 1

Fig. 1.



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ROENTGEN APPARATUS

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Fig. 2.

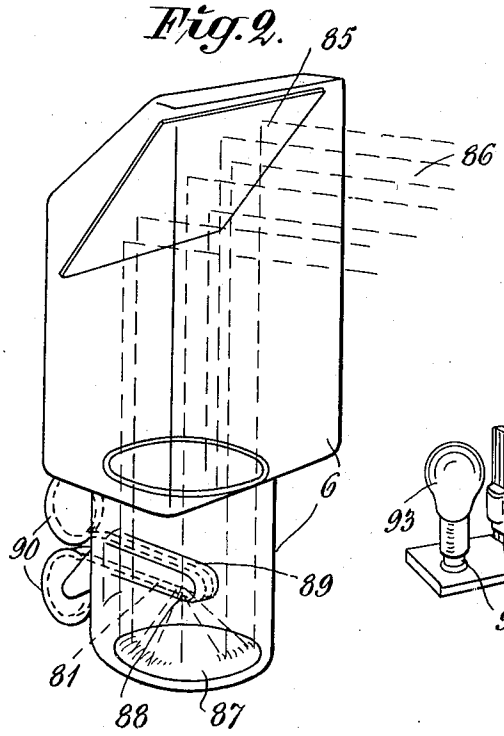


Fig. 3.

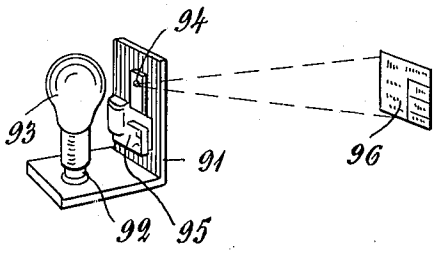
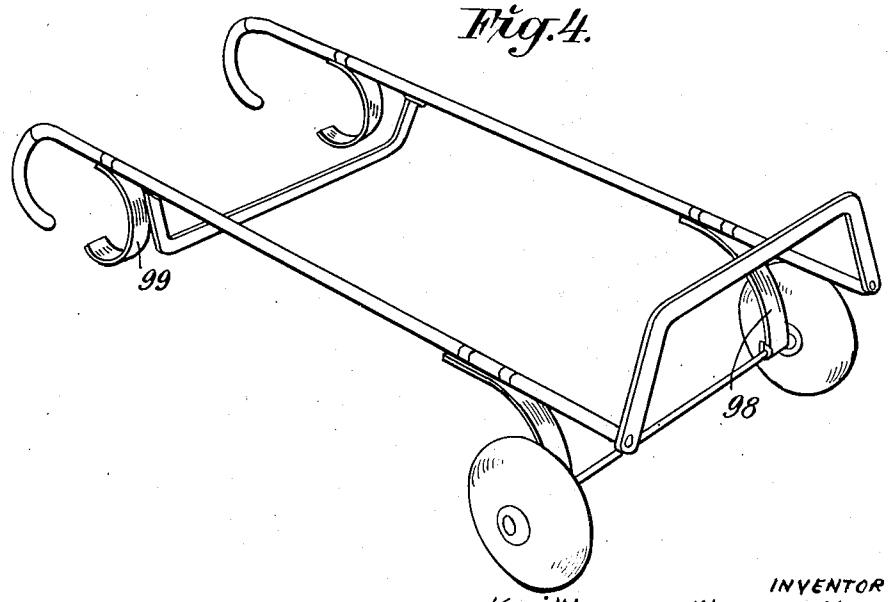


Fig. 4.



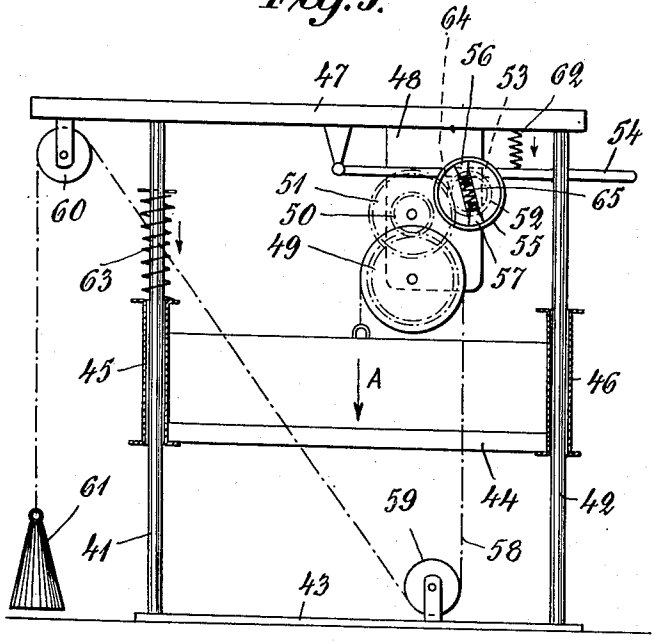
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Fig. 5.



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ROENTGEN APPARATUS

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12 Claims. (Cl. 250—50)

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The present invention relates to certain new and useful improvements in apparatus for Roentgen photofluorography, especially of the lungs of a patient, and has particular reference to apparatus of the transportable or mobile type for mass radiography. In addition to the Roentgen radiation source a photofluorographic apparatus consists mainly of a camera with accessories and a photofluorescent or image screen. The patient leans his breast against one side of the screen and at the other side, which carries a fluorescent material, an image is formed by the Roentgen rays passing through the breast of the patient. This image is photographed in the usual optical way by the camera and an auxiliary optical system which may be used. Furthermore, the apparatus has to be equipped with protecting screens or hoods containing lead for shielding persons in the vicinity of the apparatus.

In addition to the requirement of radiation-proofness transportability and mobility mass radiography apparatus should be light in weight and operate rapidly. The transportable ones should be readily disassembled and reassembled and the mobile one should be compact in structure so as to take up minimum space and be readily loaded in a bus or trailer or other vehicle.

Some types of apparatus of this kind, therefore, are provided with a vertically-movable platform for the patient, a so called patient elevator, by which the patient can be put in correct position relative to his height.

For complying with the above requirements the present invention suggests substantially the following improvements.

The patient platform should be provided with a counterload keeping it in elevated position when unloaded, and with a speed regulator limiting its downward speed when occupied by the patient. The patient will thereby very rapidly be brought into position for exposure, and this position of the apparatus may be secured by an arresting device. Without much delay the time of exposure and/or intensity of radiation necessary may be ascertained or automatically conveyed to appropriate means in the apparatus by combining with said platform a weight sensitive member, e. g. a balance device, responsive to the weight of the patient. The weight of a person has been found by experience to be substantially proportional to the dose of radiation required. It is also possible in combination with a movable rear part of the apparatus to use means responsive to the breast depth of a patient.

Said rear part preferably comprises a portion

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of an exposure box surrounding the place where the patient stands during exposure. According to an embodiment of the invention this box is divided into a front part at the image screen and a rear part reciprocably movable relative to said front part. The fact that the entire rear part is movable reduces the space necessary as compared with boxes having doors and reduces the total weight of the apparatus, as in this case the box can be made shorter. Another advantage obtained by this movability is the fact that it can be made use of for releasing the film shifting in the camera so that the latter will take place automatically as soon as the box is opened to let out the patient who has been photographed.

In order to reduce the time of exposure without increasing the radiation intensity, which is particularly important in the present kind of apparatus, and gain other advantages it has been suggested to employ the mirror optic known from astronomical instruments. The distance between the camera and the photofluorescent screen will, however, then be too great so that the total length of apparatus becomes very inconvenient, in particular for loading into a bus or the like. Further the weight of apparatus will be excessively great due to the large lead protection needed between the image screen and the camera. These drawbacks will be overcome according to the invention by arranging a light-ray deflecting optical system, such as a mirror or a prism, ahead of the image screen to project the image sideways, preferably downwards, and placing the camera correspondingly with its axis at an angle, preferably at about right angles to the X-rays.

Relating to this arrangement of the camera is an improvement of the method of Roentgenogram identification constituting a part of this invention. In mass photoroentgenography the patient usually brings his identification card on which is noted, among other things, his name and list number. It is now suggested that the card be inserted into a receptacle at the photofluorescent screen in such way that the identifying text, facing the camera, will come within the image field of the screen at the same side as the camera and be lighted up by a concealed light source placed behind a very small rapid shutter coordinated with the shutter or any other similar means of the camera.

Through the cooperation of various means dealt with above a complete transportable or mobile photofluorographic apparatus can be made shorter than 2 meters in length, e. g. 1.7 to 1.8 meters, about 2 meters in height and 0.8 to

0.9 meter broad. It can be formed in relatively light sections so that a single man can in about 5 minutes assemble or disassemble the entire apparatus. By the various weight saving means the total weight of the apparatus can be reduced considerably.

The invention will now be described with reference to the accompanying drawings illustrating an embodiment thereof, but it is to be understood that the invention is not limited thereto.

In the drawings Figs. 1 to 4 are perspective representations, Fig. 1 illustrating the total apparatus according to the invention and Figs. 2 and 3 showing details of the apparatus of Fig. 1, viz. a photographic camera unit and lighting set, respectively, and Fig. 4 shows an accessory transport carrier. Fig. 5 is a diagrammatic representation of a movable patient platform, which is an alternative of that shown in Fig. 1.

On the base plate 1 are mounted the Roentgen radiation source 2 by means of the stand 3, the lower piece 11 of the stationary front part of a patient box, the upper piece 12 of which carries the photofluorescent screen 4, and the framework 5 carrying the photographic camera unit 6. Longitudinally of the base plate 1 are secured rails 7 for the movable rear part of the patient box, comprising a lower piece 13 and an upper piece 14.

In the lower piece 11 of the front part the vertically movable platform 21 is arranged. The platform proper is detachably mounted in a frame comprising two vertical supports 22 connected to each other by an upper bar 23 and each having projecting arms 24 for pins 25 about which the platform 21 is pivoted by slots 27 in lugs 26 so that it may be detached when turned up and lowered. The supports 22 slide on guides 28 and the frame is suspended by strings 29 running over pulleys 30 journalled in pins 39 of the lower front part 11 and carrying at their free ends counter-weights 31 which may weigh, for instance, 25 kilograms. The counter-weight will then normally tend to keep the platform 21 at its upper position. Connected to the bar 23 is the rod 32 fixed to a piston 102 movable in the cylinder 33 which contains a suitable pressure liquid, such as oil or a glycerol mixture, or possibly a gaseous pressure medium. At the bottom of said cylinder is an outlet valve operated by a lever 34 which is preferably actuated over a Bowden cable 36 by a handle 35 fitted at a convenient position to be operated by the personnel using the apparatus. Through an outlet valve line 103 the cylinder 33 communicates with a container or reservoir 104 preferably situated above the cylinder. The container may also communicate with the cylinder 33 over an inlet valve 105 of greater capacity than said outlet valve so as to expedite the upward movement of the platform.

A convenient implement is the patient height indicator provided on the front part 12 of the patient box at its entrance. This implement may consist of a pointer 15 secured to a cord 16 which is passed over rollers 17 near the ceiling of the box and secured at a convenient point, such as arm 18, on the frame of the platform. The cord 16 carries at its free end a spring or a weight 19 to keep it stretched. If appropriately positioned on the cord 16 this pointer 15 compared with some characteristic point on the patient, for instance his shoulder, will be helpful to warn the operator to arrest the platform in its upward movement according to the height of the patient.

Fig. 5 shows an alternative platform device having only mechanical implements. The device has two vertical guides 41 and 42 secured to a bottom plate 43. A patient platform 44 is arranged to move along the guides by means of steering members 45 and 46. The upper ends of the guides are connected by a cross bar 47. On a bracket 48 are pivoted a geared driver wheel 49 and cooperating therewith a double toothed gear 50, 51 in turn acting on a toothed gear 52, on the shaft of which is also journalled a braking drum 64 cooperating with a braking shoe 53 on a release lever 54. On said shaft is also a centrifugal brake device consisting of two sliding shoes 56, 57 rotating in a brake casing 55. Shoes 56, 57 are pressed against the inside cylinder surface of the brake casing with greater force the faster is their rotary movement. At a given speed of rotation equilibrium is attained between the driving and the braking forces and the downward movement of the patient platform 44 connected to this system, due to the weight of the patient, becomes uniform. The platform 44 is connected to this braking system by means of a wire 58 which engages the driver wheel 49 and passes over guide pulleys 59 and 60 and carries at its other end a counter-weight 61. The brake shoe 53 is pressed against the brake drum by a spring 62 so as to lock the platform 44. Another spring 63 acts as a shock absorber for the upward movement of the platform 44 due to the counter-weight 61 when the patient has left the platform. In the upward movement of the platform the driver wheel may preferably be arranged, in a maner flnown per se, to be released from the braking system. The entire device constitutes a unit per se and may thus be used in connection with different kinds of Roentgen apparatus. The appropriate initial position should then be in each case separately adjustable. By way of example it may be mentioned that at a height of 45 centimeters above the floor surface the patient platform has been found to have a suitable upper position.

In operation, the patient climbs the platform 44, the weight of the patient being indicated in the figure by the arrow A. The photographer moves the lever 54 upwards against the action of spring 62 so as to release the brake shoe 53 from the brake drum 64 and the platform descends with uniform speed until the photographer moves the lever 54 into braking position at the desired position of the patient relative the image screen. Simultaneously the counter-weight 61 is lifted. When the patient leaves the platform, the latter, influenced by the counter-weight, returns to its upper position until the spring 63 comes into action which, preferably, takes place somewhat before the counter-weight reaches the bottom.

The described device is to be considered as an example not limiting the scope of the invention. Thus, its elements may be varied as to structure in many ways. The centrifugal brake may, for instance, comprise paddles rotating in a closed chamber filled with liquid, the paddles being, if desired, adjustable for different resistances against the liquid during rotation so as to obtain the desired speed of the patient platform. Then a regulation may, of course, also be obtained in the braking device described by controlling the initial pressure of the sliding shoes against the brake casing, for instance, by regulating the spring 65 between the brake shoes.

If desired, an auxiliary lifting device, e. g. a hydraulic arrangement may be attached to the device described to permit the patient platform to be raised for adjustment of position while the patient stands on it.

As will be understood, the invention also comprises a method for controlling the Roentgen radiation required for the correct exposure of the patient to be photographed as a function of his weight, by using a load sensitive member in connection with the platform.

For carrying out this method only a very simple device is required. It consists, for instance, of a balance, the scale of which consists of the platform on which the patient stands while being photographed. The balance occupies different positions in height depending on the weight of the patient and these positions are then transmitted in a suitable way, for instance, by levers, pressure tubes, electrically etc., to a device known per se registering the position of the balance as the time of exposure corresponding thereto. The device registering the balance position may also be arranged to influence the voltage controller of the X-ray tube. In this case for instance, the time of exposure may be constant while the intensity of the radiation is varied by varying the working voltage of the X-ray tube as a function of the balance position. Also combinations of intensity and time control may come into consideration. In order to eliminate erroneous results the balance should preferably be arrested until the vertically movable patient platform has reached its correct position in height, when such a platform be used.

Returning now to the apparatus shown in Fig. 1, another means for exposure control in response to the weight of patient will be described. Attached to the pressure room of the cylinder 33 is a pipe 37 transmitting the pressure prevailing therein to a pressure indicator 38 which is preferably graduated in voltage or seconds or the like so as directly to show the exposures corresponding to the weight of the person standing on the platform. In addition to or instead of the indicator 38 an arrangement may be attached to pipe 37 for the automatic actuation of the means controlling the time of exposure or the intensity of the X-ray beam, for instance, by influencing the voltage impressed on the X-ray tube used.

The patient box according to the invention consists of the stationary front part 11, 12 and the horizontally movable rear part 13, 14 mounted on a frame 10 having rollers 71 adapted to roll on the rails 7. The Roentgen radiation source 2 being stationary, the upper piece 14 of the rear part has an opening through which said source 2 projects. When advanced to its foremost position the rear part 13, 14 forms in cooperation with the front part 11, 12 a completely enclosed exposure box.

In one embodiment the invention makes use of the movability of the rear part for ascertaining the correct exposure conditions by means of a feeler member is arranged in said rear part. Feeler member consists of a rod 73 provided in the side walls of the rear part and having secured thereto two arms 74 between the free ends of which is stretched a cord 72 or the like. When the rear part is advanced cord 72 will contact the back of the patient standing on the platform 21 and will cause the rod 73 to rotate in response to the thickness of the patient's breast. The deflection may be indicated by a pointer 75 on a scale 76 or may be automatically conveyed to

the exposure controls as explained above with reference to the pressure pipe 37.

In an alternative arrangement, a rod may be resiliently mounted in said rear part of the box at the level of the patient's breast or the photofluorescent screen and perpendicularly thereto. When the rear part is advanced the rod will contact the back of the patient and, owing to its resiliency, will move relative to the rear part as the latter is further advanced. The rod may conveniently project at the back of the rear part and the thickness of the patient's breast will then be easily ascertained from the increase in the projecting length of the rod.

The movability of the rear part may be also utilized for effecting the shifting of the photographic image receiving material, such as a film 81, in the camera 6. A device for that purpose may consist of a hook device arranged so as in the closed position of the rear part relative the front part to hook a wire or the like for the film shifter of the camera (fitted in said front part) to a cooperating member fitted in said rear part, and during the opening movement of said rear part to pull said wire or the like a distance necessary for shifting the film and then to release it from said rear part.

As illustrated, the shifting device may alternatively consist of a coupling lever 82 pivoted in a box 83 secured to the base plate 1 or some part connected thereto. At the same level the lower piece 13 has a pin 84 or the like so arranged as to catch said lever 82 and turn it when it is passed.

The photographic camera unit illustrated is a hole mirror camera the axis of which is disposed vertically. At the top of the unit 6 is a mirror 85 which is at the same level as the photofluorescent screen 4 when the unit is positioned on its support 5. The mirror is preferably of the surface metallized, e. g. surface aluminized or silver plated, type. Optical systems of less rapidity may be used or the time of exposure may be shortened. The mirror stands at an angle of 45° to the light beams 86 from the screen image and the mirror reflects the beams vertically. At the bottom of the unit is a concave mirror 87 which directs the light rays to the film window 88 of the film holder 89 which is connected to the film magazines 90.

Outside the camera unit at about the level of the lower portion of the image screen 4 is the illuminating box 91, preferably detachably secured. It has a holder 92 for an ordinary electric bulb 93 the light of which can be passed through the small shutter 94 which is operated by a mechanism 95 simultaneously with the Roentgen photographic exposure so as to illuminate the identification card 96 inserted into the receptacle 97 in the upper piece 12 of the front part of the patient box. The photographic image on the film 81 will then also contain an image of the appropriate part of the card.

It is possible to arrange the Roentgen section proper horizontally, which is advantageous when the patient is placed upright, and the photo optical section, and the camera section may be arranged vertically. The greater part of this section will thus be brought out of the region of the Roentgen rays and lead protection around this section may be dispensed with altogether, while only small lead protection outside the mirror or prism deflecting the image rays will absorb the X-rays when they have served their purpose.

Owing to the increase of length of the camera cone possible according to the invention it will, again, be possible to use a hole mirror camera wherein the correction may be carried out by spheric or aspheric surfaces, for instance by a Schmidt correction plate.

According to an embodiment of the invention the optical system consists of one or more curved mirrors, preferably curved in only one plane. The curvature is preferably such that it will wholly or partly correct the false reproduction met with particularly in cameras of great rapidity. Then, of course, even other means of correction may come into use.

The corrections required should, of course, be carried out in two directions perpendicular to one another. Since mirrors curved in more than one plane will not very well come into consideration, the correction may with advantage be carried out according to the invention in one direction at one place and in the other direction at another place. Thus two mirrors arranged at right angles to each other may be used in the path of the light beams but in that case reflection losses are suffered in two mirrors and even if the mirrors are of the surface reflecting type, it is preferred to use only one mirror. Therefore, especially when using hole mirror cameras, it is possible to use one or, if desired, more curved mirrors in combination with a curved photofluorescent screen. It is then possible to use a plane film or a curved film. It is thus evident that the correction can be effected by bending one or more of elements of the constellation: photofluorescent screen, mirror and photographic reception material.

It being an object of this invention to provide a readily transportable apparatus which is disassemblable in parts conveniently packed for transport and easily handled by a single operator, the front and rear parts of the patient exposure box are made in pieces 11, 12 and 13, 14 respectively. The camera unit is removable as a unit and, containing the most fragile units, it is during transport preferably tied to a resilient transport cart as shown in Fig. 4. The cart has a frame connected at the front to the cart wheels over springs 98 and resting at the back on springs 99.

Should, however, the mirror 85 happen to break during transport the hole mirror 87 will be saved if a cover or damper is inserted between said mirrors. Such cover or damper may be arranged automatically to be inserted as soon as the camera unit is removed from its support 5.

What is claimed is:

1. A patient-supporting device for roentgenography comprising a vertically-movable platform for supporting and adjusting the vertical position of the patient to be roentgenographed, a counterweight connected with said platform and arranged normally to move said platform upwardly but to permit downward movement of the platform under the weight of the patient, a speed controlling member, and means for arresting the platform at a desired level when the platform moves downwardly, said speed controlling member comprising a piston connected to said platform and a cylinder to receive said piston, there being an enclosure in said cylinder limited at one side by said piston, and an outlet in communication with said enclosure.

2. Apparatus as defined in claim 1, further comprising a container and communication means between said outlet and said container.

3. Apparatus as defined in claim 2, further comprising an inlet conduit between said container and said enclosure of greater capacity than said communication means.

4. A patient-supporting device for roentgenography comprising a vertically-movable platform for supporting and adjusting the vertical position of the patient to be roentgenographed, a counterweight connected with said platform and arranged normally to move said platform upwardly but to permit downward movement of the platform under the weight of the patient, a speed controlling member, and means for arresting the platform at a desired level when the platform moves downwardly, said speed controlling member comprising a piston connected to said platform and a cylinder to receive said piston, there being an enclosure in said cylinder limited at one side by said piston, and an outlet in communication with said enclosure, said outlet having an opening of adjustable cross-sectional area.

5. A patient-supporting device for roentgenography comprising a vertically-movable platform for supporting and adjusting the vertical position of the patient to be roentgenographed, a counterweight connected with said platform and arranged normally to move said platform upwardly but to permit downward movement of the platform under the weight of the patient, a speed controlling member, and means for arresting the platform at a desired level when the platform moves downwardly, said speed controlling member comprising a piston connected to said platform and a cylinder to receive said piston, there being an enclosure in said cylinder limited at one side by said piston, and a closable outlet in communication with said enclosure.

6. A patient-supporting device for roentgenography comprising a vertically-movable platform for supporting and adjusting the vertical position of the patient to be roentgenographed, a counterweight connected with said platform and arranged normally to move said platform upwardly but to permit downward movement of the platform under the weight of the patient, a speed controlling member connected to and arranged yieldingly to counteract the downward movement of said platform, a motion responsive member connected to and arranged to move in response to the vertical downward movement of said platform, and arresting means arranged to engage said motion responsive member.

7. A patient-supporting device for roentgenography comprising a vertically-movable platform for supporting and adjusting the vertical position of the patient to be roentgenographed, a counter-weight connected with said platform and arranged normally to move said platform upwardly but to permit downward movement of the platform under the weight of the patient, a speed controlling member connected to and arranged yieldingly to counteract the downward movement of said platform comprising a wheel, a flexible member in driving engagement with said wheel, one end of said flexible member being attached to the platform and the other end being subjected to a pulling force, a centrifugal regulator connected to said wheel and a stopper arranged to engage said speed controlling member, a motion responsive member connected to and arranged to move in response to the vertical downward movement of said platform, and arresting means arranged to engage said motion responsive member for arresting the platform at a

desired level when the platform moves downwardly.

8. A patient-supporting device for roentgenography comprising a vertically-movable platform for supporting and adjusting the vertical position of the patient to be roentgenographed, a counter-weight connected with said platform and arranged normally to move said platform upwardly but to permit downward movement of the platform under the weight of the patient, a speed controlling member connected to and arranged yieldingly to counteract the downward movement of said platform comprising a wheel, a flexible member in driving engagement with said wheel, one end of said flexible member being attached to the platform and the other end being subjected to a pulling force, a centrifugal regulator connected to said wheel, a brake connected to said brake arranged to be intermittently actuated, a motion responsive member connected to and arranged to move in response to the vertical downward movement of said platform, and arresting means arranged to engage said motion responsive member for arresting the platform at a desired level when the platform moves downwardly.

9. In an apparatus for roentgenography having a Roentgen-ray source and a Roentgen-ray sensitive image plate spaced therefrom to define a vertical patient-receiving space therebetween, a vertically-movable platform for supporting and adjusting the vertical position of the patient to be roentgenographed in said space relative to the image plate, a counterweight connected with said platform and arranged normally to move said platform upwardly but to permit downward movement of the platform under the weight of the patient, a speed controlling member connected to and arranged yieldingly to counteract the downward movement of said platform, a motion responsive member connected to and arranged to move in response to the vertical downward movement of said platform, and arresting means arranged to engage said motion responsive member for arresting the platform at a desired level when the platform moves downwardly.

10. In an apparatus for roentgenography having a Roentgen-ray source and a Roentgen-ray sensitive image plate spaced therefrom to define a vertical patient-receiving space therebetween, a vertically-movable platform for supporting and adjusting the vertical position of the patient to be roentgenographed in said space relative to the image plate, a counter-weight connected with said platform and arranged normally to move said platform upwardly but to permit downward movement of the platform under the weight of the patient, a speed controlling member connected to and arranged yieldingly to counteract the downward movement of said platform, a motion responsive member connected to said platform and arranged to move in response to the vertical downward movement of said platform, and arresting means arranged to engage said motion responsive member for arresting the platform at a desired level when the platform moves downwardly, means forming an entrance for subjects to be roentgenographed in said vertical space, a carrier movable vertically in response to the movement of said platform at said entrance, and a pointer secured to said carrier at a position at about breast level of the subject.

11. Apparatus for roentgenography comprising, a Roentgen-ray source and a Roentgen-ray sensitive image plate, a platform for carrying the object to be roentgenographed in the vertical space between said source and said image plate, a piston connected to said platform and a cylinder to receive said piston, there being an enclosure in said cylinder limited at one side by said piston, said cylinder being adapted to receive a fluid, pressure responsive means actuatable by the pressure of said fluid, and pressure registering means connected to said pressure responsive means.

12. Apparatus as defined in claim 11, said pressure responsive means being operatively connected to means for controlling the dosage of the Roentgen radiation from said source to said image plate, radiation time and intensity.

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