Nov. 1, 1938. G. R. STRUCK 2,135,019

X-RAY APPARATUS

Filed July 2, 1936 2 Sheets-Sheet 1

Fig. 1.

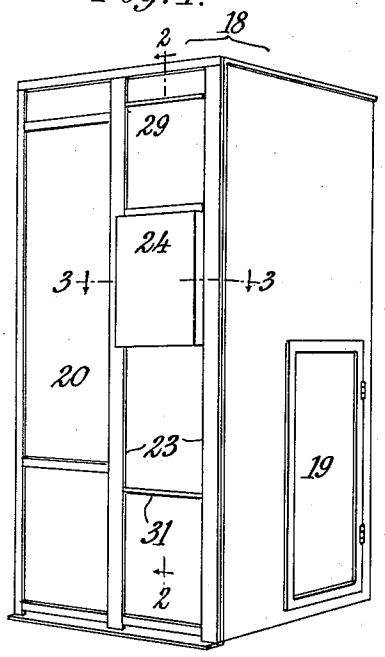


Fig. 7.

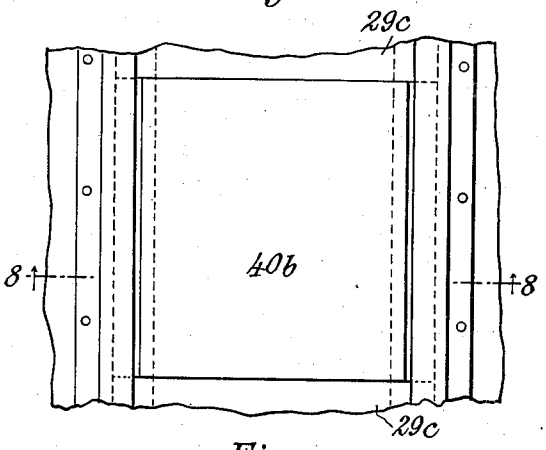


Fig. 8.

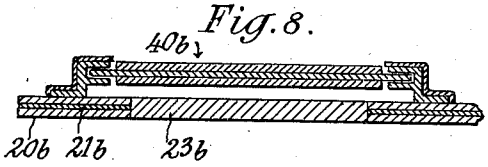


Fig. 5.

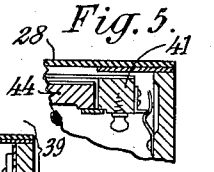


Fig. 3.

Fig. 4.

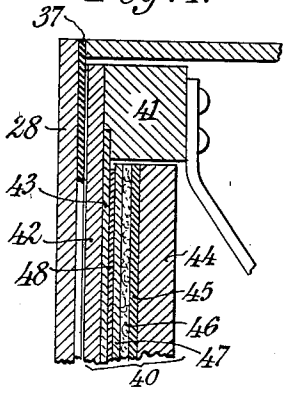
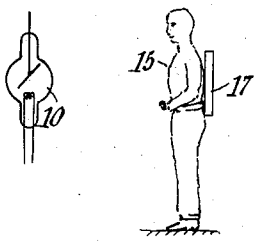
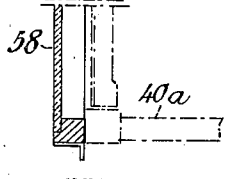


Fig. 9.





INVENTOR

George R. Struck

By Fraser, Myers & Manley

ATTORNEYS.

Nov. 1, 1938. G. R. STRUCK 2,135,019

X-RAY APPARATUS

Filed July 2, 1936 2 Sheets-Sheet 2

Fig. 2.

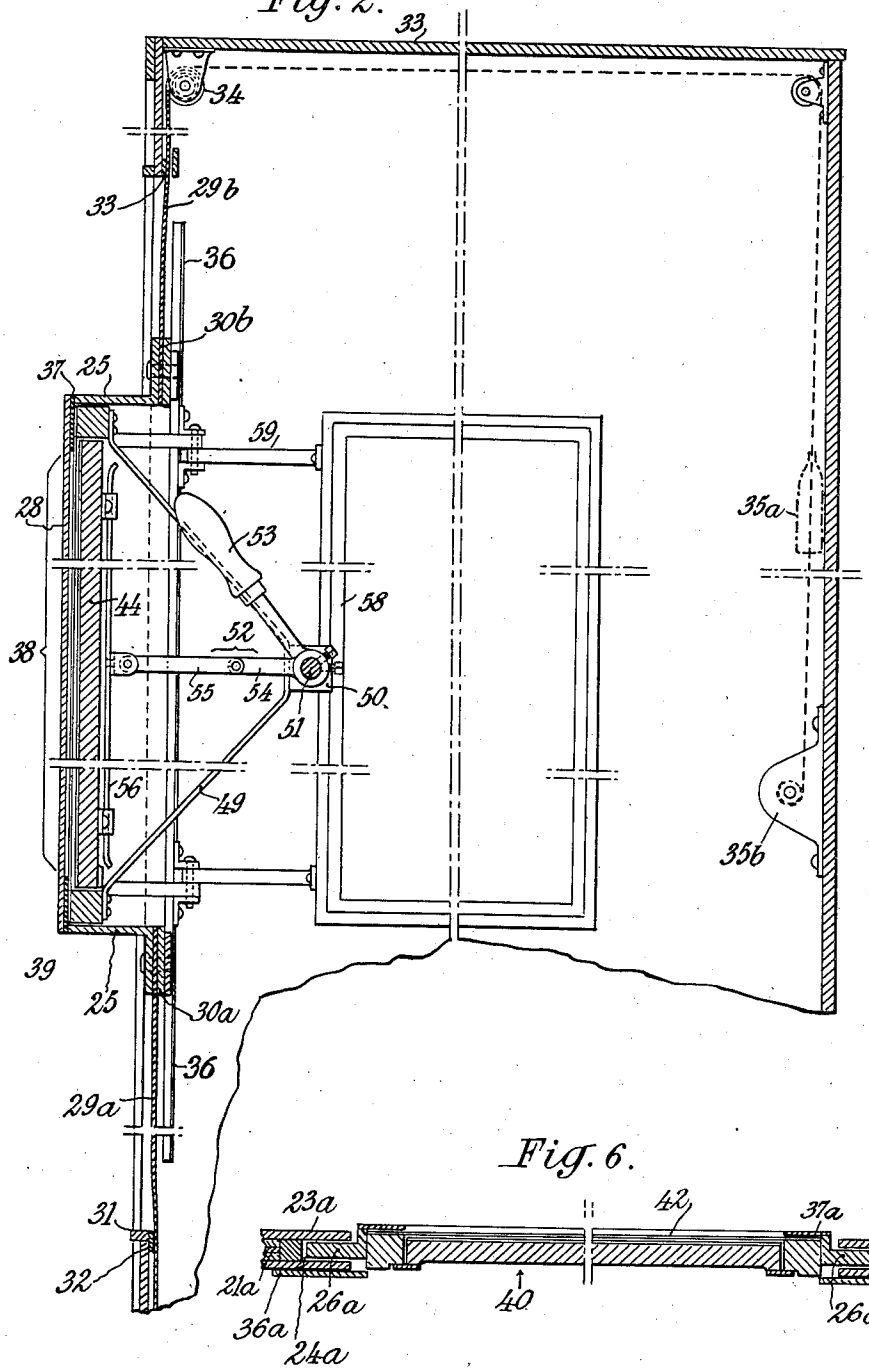


Fig. 6.

INVENTOR
George R. Struck

By Fraser, Myers & Manley
ATTORNEYS.

Patented Nov. 1, 1938 2,135,019

UNITED STATES PATENT OFFICE

2,135,019

X-RAY APPARATUS

George R. Struck, Manhasset, N. Y., assignor to George R. Struck and Edward M. Wharf, Jr., a partnership doing business as Precision Radiographs, Chicago, Ill.

Application July 2, 1936, Serial No. 88,508

7 Claims. (Cl. 250—34)

The invention relates to the science of radioscopy, and in its more particular aspects to improvements in the apparatus used for holding an X-ray sensitive member in a desired relationship to a subject and a source of the X-rays.

The diagnosis of pulmonary diseases such as tuberculosis, silicosis and the like, can satisfactorily be made only by means of radioscopic studies of the subject's chest; and such studies are particularly desirable where the disease is in an incipient stage. Thus, it has been proposed to make radioscopic examinations of the chests of all school children whereby those showing any tendency towards tuberculosis may take such steps as are necessary to avoid or stop the development of the disease. Similarly, it has been proposed to subject all classes of industrial workers in the so-called silicotic industries to the same type of examination. The latter is of particular importance not only to the individual workers, but likewise to employers and to insurers of the employers. While both of these proposals are of inestimable importance from a humanitarian standpoint, the latter one presents certain definite economic problems to the employer and to his insurer. Thus, silicosis, unlike most diseases, is classified as an industrial hazard within the provisions of the Workmen's Compensation Acts. Accordingly, the employer may be liable to an employee who has contracted the disease; and in order to determine his liability it is essential to know whether the disease was contracted before or after the employee entered his service. Thus, it is of prime importance for the employer to know the physical condition of his employees. The employer's insurer is, of course, primarily interested in his contingent liability in order to enable him to establish proper insurance rates. Thus, he too, wishes to know the physical condito of all of the insured's employees.

While the need and desirability for such large scale studies have been well recognized, the cost thereof has been so great as to be prohibitive. The reasons for this high cost are to be found in one or more of the following factors. Generally speaking, the groups of possible subjects are situated at such widely varying points as to make the use of a few permanent laboratories impracticable; and the quantity and cost of the necessary apparatus has precluded the establishment of large numbers of relatively small laboratories. Further, the actual time consumed in the taking of radiographs, using equipment heretofore available, has been inordinately great, so great, in fact, as to make it substantially impossible ever to complete such a project even though it were once started.

The present invention, in the main, proposes what, in effect, may be termed a portable laboratory which may readily be transported about the country and easily set up at the location of a relatively small group, a factory employing a few hundred people, for example, whereby they may be radiographed, and the resulting plates afterwards examined by any available diagnostician. However, as will later be brought out, some of the particular features of the apparatus may be utilized to excellent advantage in permanent laboratories.

The principal object of the invention is to provide a holder for an X-ray sensitive member which is so mounted as to be readily accessible from within a dark room whereby it may readily and easily be loaded or unloaded without exposure to light, and at the same time which is so located that a subject, not necessarily within the dark room, can be positioned adjacent the member and an X-ray shadow of his internal organs cast thereon.

It is a further object of the invention to so mount the holder for the X-ray member that its vertical position may be changed to conform to the height of any given subject, and also so that it may be accessible to an operator in the dark room in order that the latter may load and unload the holder.

Other objects and various features of the invention will be more apparent from the following description when read in connection with the accompanying drawings in which—

Figure 1 is a perspective view of a portable dark room having a holder for an X-ray sensitive member located in one wall thereof in accordance with the principles of the present invention;

Fig. 2 is a sectional view taken on the line 2—2 of Fig. 1;

Fig. 3 is a sectional view taken on the line 3—3 of Fig. 1;

Fig. 4 is a fragmentary view in section, and on an enlarged scale, of a portion of the X-ray holder shown in Fig. 2;

Fig. 5 is a sectional view, on an enlarged scale, of another fragment of the apparatus shown in Fig. 3;

Fig. 6 is a plan view partly in section of a modified form of the apparatus shown in Fig. 3;

Fig. 7 is an elevational view of the rear surface of a portion of a cabinet wall embodying a modified form of the invention;

Fig. 8 is a sectional view taken on the line 8—8 of Fig. 7 and looking in the direction indicated by the arrows.

Fig. 9 is a diagrammatic view of the apparatus used in radioscopy showing the relation of the source of X-rays, the patient and the X-ray sensitive member.

Radioscopic work is done not by examining or photographing an image of the organ under examination, but by casting a shadow of the organ upon an X-ray sensitive member and then studying the shadow. Thus, as is shown in Fig. 9, the patient **15** is interposed between a source of X-rays such as a Coolidge tube **10**, and an X-ray sensitive member **17** which may be a fluorescent screen, photographic film or the like, whereby rays from the tube pass through the body of the patient in proportion to the density of the different organs thereof. Obviously, the more dense portions, such as the bones, the heart, calcific deposits, etc., resist the passage of X-rays therethrough to a greater extent than do the less dense portions of the body, and hence they cast their shadows upon the X-ray sensitive member **17**. A diagnostician, by examining the shadows, can tell whether variations thereof are the results of natural causes or are produced by disease.

It is of little moment whether the subject and the X-ray tube are located in a brightly lighted space or in a dark room. However, in so far as the X-ray sensitive member is concerned, this must be located in a darkened space. Thus, in fluoroscopy, substantially all light must be excluded from the screen so that difference in fluorescence thereof may be appreciable to the human eye. Similarly, where radiographs are being made,—that is, the exposure of a photographic film or plate by X-rays,—it is obvious that all light must be excluded from the plate. In the latter instance the plate is usually mounted within a light-tight box, termed a "cassette", which is made of a material permeable to X-rays but not to light. Thus, assuming that radiographs are being taken, the cassette is loaded (a photographic film is placed therein) in the dark room, brought out and exposed, and is then returned to the dark room for unloading and reloading. Obviously, the distance between the dark room and the point of exposure will, in large part, determine the length of time necessary to load the cassette, carry it to the exposure room, and return it for reloading. If there are a number of exposures to be made, and the process is to be even fairly continuous, then there must be a relatively large number of cassettes available, and several assistants to perform the various functions. Since these cassettes are relatively expensive—costing about $75.00 each at present—then it is evident that the initial investment for even a very few of them will run into considerable money; and it is further obvious that the number of assistants required will result in an unduly great operating cost. The present invention proposes to avoid the use of more than one cassette by mounting the same immediately adjacent, and preferably as a constituent part of, the wall of the dark room, whereby it may be accessible to an operator in the room for the purpose of unloading and loading the same and whereby the subject may be positioned on the outside of the dark room, adjacent the cassette, and the X-ray exposure made.

Considering the drawings,—referring, first, to Fig. 1,—the numeral **18** designates a relatively small cabinet having four walls, a top, and a bottom,—all of which, preferably, are so hinged one to another that the cabinet may be folded up and easily transported. Further, the walls are so related that when in the set-up position shown in Fig. 1, they occupy a light-tight relationship one to the other. Access to the inside of the cabinet may be had through a suitable door **19** in one wall of the cabinet.

Since the cabinet is to be of a portable nature, it is preferably of very light construction. Consequently, such materials as plywood and duralumin (or other light alloys) are generously used, even though other less expensive substances would serve equally as well.

In keeping with the above outlined precept as to weight limitations, the wall **20** as shown in the preferred embodiment (Fig. 3), comprises a relatively thin layer of lead **21**, or other comparably opaque material (when the term "opaque" is used it is to be understood to mean a material which is impervious both to light, to X-rays, and to rays produced by any radioactive substance) which is supported and protected on both sides by layers **22** of wood or the like. An opening **23** extends vertically of the wall, and is provided along one oppositely disposed pair of its edges with duralumin channels **24**. Disposed within this opening is a holder for an X-ray sensitive member, comprising a frame, generally designated **25**, of substantially rectangular proportions and having laterally extending flanges **26** slidably disposed within channels **24**. In order to avoid any possibility of light passing between the surfaces of the channel and the surfaces of the flange **26**, a strip of felt, or other comparable material **27** is preferably interposed between the end of the flange and the bottom of the channel. The front end of the frame **25** is intended to serve as an X-ray window, as will later be apparent, and accordingly is covered with an appropriately shaped piece of Bakelite **28**, or other comparable material. Such a material, for purposes herein considered, may be termed "semi-opaque", and where this term is used it is to be understood to mean any substance which is penetrable by X-rays or the like but is impervious to light. The remaining parts of the opening **23** are covered by a curtain **29** which is preferably made of an opaque material. In the preferred embodiment this curtain comprises two pieces of flexible lead-rubber fabric. The lower of these pieces **29***a* is attached, as shown in Fig. 2, to the vertically extending flange **30***a* (formed along the bottom edge of the frame **25**) and extends downwardly, beyond the edge **31** of the wall defining the lower end of the opening **23**. The weight of the fabric, in the preferred embodiment, is sufficient to hold it firmly against the felt pad **32** (along the lower edge **31**) and thereby to maintain a light-tight joint between the curtain and the edge of the wall. The upper part of the curtain, **29***b*, is comparably attached to the flange **30***b* and extends upwardly beyond the edge defining the upper end of the opening **23**. Light-tight relationship between the curtain and the upper edge of the opening is secured by passing the curtain over an appropriate pad of felt **33**. The upper end of the curtain is passed over the roller **34** which extends across the cabinet near the ceiling thereof. In the preferred form this roller is of the well known spring type, and is, in constructional details, very similar to well known shade rollers. Thus, the spring of the roller (not shown) is adapted to counterbalance the weight of the holder and of the curtain.

While this form has certain advantages the curtain 29*b*, if desired, may be passed over the roller 34, and an extension thereof (shown in dotted lines) attached either to a counterweight 35*a* or to a well known spring 35*b*.

Considering Fig. 3, it will be noted that a strip of lead 36 is applied to the rear of wall 20 along the channel portion thereof, and that a marginal strip 37 of the same material is interposed between the front edge frame 25 and the cover 28. Each of these strips, as can be seen, overlaps another. Thus, 36 overlaps 21, and 37 overlaps 36. Likewise, the marginal strip 36 overlaps the edges of the opaque screen 29 (see Fig. 2). Thus, the only point at which X-rays may penetrate the wall 20 is through that portion of the cover 28 defined by the edges of the marginal strip 37, and this portion, or area, will hereinafter be referred to as the "window" 38 in the wall or curtain.

With the foregoing construction in mind it will be apparent that the holder may be moved up and down in the opening 23, and the X-ray window accordingly moved with respect to the wall. Thus, the window may be adjusted to conform to the height of any particular subject to be studied. At the same time the flexible curtain and the flanges 26 effectively preclude the entrance of light into the cabinet 18.

The holder, generally designated 39, is adapted to receive, on the dark room side thereof, an X-ray sensitive member which, for example, may be either a photographic film or plate, a fluorescent screen, or the like. When the former is to be used, a cassette 40 is placed within the holder, and held therein by any appropriate means. The cassette comprises, as may be seen particularly in Figs. 3 and 4, a marginal frame portion 41 having a front cover 42 of Bakelite, or other comparable material, immediately behind which is a front intensifying screen 43; and a back 44 hingedly affixed to the frame 41, upon the front surface of which are superposed, successively, a sheet of lead 45, a cushion of felt 46, and a back intensifying screen 47. At this point it may be noted that the marginal strip 37 extends inwardly so as to overlap the layer 45 on the back of the cassette. Thus, the various strips of lead are all disposed in overlapping relationship so as to preclude the passage of X-ray radiations substantially beyond the film 48 and into the cabinet 18. When the hinged back is opened a sheet of photographically sensitive material may be inserted between the two intensifying screens, and when the back is closed these screens should be pressed in a tight relationship with the surfaces of the material, as is clearly shown in Fig. 4. The opening and closing of the back of the cassette for the purposes of loading and unloading the same may be accomplished in a most rapid manner by the use of a toggle mechanism, shown particularly in Figs. 2 and 3. This mechanism comprises a pair of brackets 49 affixed to the side edges of the cassette 40 and extending rearwardly therefrom. The rear extremity of each of the brackets is provided with bearing portions 50 which are adapted to accommodate the opposite end portions of a rock shaft 51. One or more toggle mechanisms 52 are interposed between the shaft 51 and the back 44 of the cassette whereby when the shaft is rocked, as for example, by means of the handle 53, the toggles may be broken and the back accordingly opened. The toggles may be of any well known design, comprising, for example, a link 54 rigidly attached at one of its ends to the shaft 51, and at the other of its ends pivotally connected to one end of a second link 55. The forward end of the second link is pivotally attached to a leaf spring 56, and the latter is slidably engaged by a clip on the back of the cassette as shown in Fig. 3. Suitable stop elements are, of course, provided for the purpose of limiting the movement of the links 54 and 55 in at least one direction.

Assuming that the cassette 40 is mounted within the holder 24 as shown in Fig. 2, and that the latter has been adjusted to conform to the height of a patient whose chest is to be examined, it is evident that the excitation of an appropriately placed X-ray tube will direct a stream of X-rays through the patient's body through the window portion 38 of the Bakelite cover 28, and will produce a shadow of his internal organs upon the film 48.

In this connection it will be noted that in the preferred embodiment (Figs. 1, 2 and 3) the holder frame extends forwardly from the wall 20. Thus, a patient may be positioned directly against the cover 28 of the holder without causing any physical discomfort. This is particularly desirable when chest exposures are being made for, in that case, the holder will pass under the subject's chin and avoid requiring him to tilt his head back into an unnatural position.

The particular features of the device so far described may best be understood by considering one practical problem. Assume, for example, the existence of a cement plant located in a small town having no X-ray laboratory and employing three hundred workmen. The employer, and his insurer, wish to know, for reasons previously brought out, the physical condition of their employees. Obviously, they could not afford to purchase the equipment necessary to establish an X-ray laboratory, nor could they afford to maintain such. Thus, heretofore, they were precluded from gaining this very necessary knowledge. However, with the present invention, the cabinet 18 can readily be shipped to the plant, set up in a very few minutes, and the employees lined up for examination. The radiologist, an employee of the company owning the cabinet, would, of course, assume a position on the outside of the cabinet and have his X-ray tube appropriately set up adjacent thereto. The first of the subjects would then step in front of the cabinet. The radiologist would immediately, and from the outside of the cabinet, adjust the height of the X-ray aperture to the height of the subject, and then excite the X-ray tube. Obviously, the X-rays will pass through the subject's body through the window 38 and expose the film 48. Immediately an assistant located on the inside of the cabinet, constituting the dark room, upon receiving an appropriate signal, would open the cassette, remove the exposed film, insert a new one therein, close the cassette, and signal the radiologist. In the meantime the latter will have changed the position of the subject for a second exposure, or have placed a second subject in front of the window; and, upon receiving his assistant's signal indicating that the cassette had been reloaded, will again excite the X-ray apparatus and make another exposure. The total time necessary for making any one exposure with an apparatus such as hereinbefore described has in practice been found to be less than thirty seconds. Thus, assuming that only one exposure is to be made of each of the 300

employees, it is apparent that the entire job can be done in 150 minutes, representing a total expenditure of time of 2½ hours. When the exposures have all been made, the radiologist and his assistant can then immediately develop the films, and the latter can thereafter be analyzed by any competent diagnostician.

At this point it may be well again to note that the assistant located within the dark room is completely protected from the effects of the X-rays. Each portion of the front surface of the wall, except for the window, is completely protected by a layer of lead or other opaque material, and the rear of the cassette is likewise protected, so that there is no single point at which the X-rays can get through the front wall beyond the film and to the person located within the cabinet. The thickness of the various layers of lead and their location are, in accordance with well-known practice, such as to absorb substantially all X-ray radiation, whether it be of direct or of secondary origin.

Obviously, the rapid production of radiographs with this apparatus reduces the cost thereof. Further, it will be at once apparent that this particular apparatus requires the use of only one cassette, and since, as was hereinbefore pointed out, these elements are relatively costly, it is quite evident that the initial cost of this apparatus is a great deal less than would otherwise be necessary.

Occasionally it is desirable, even in large scale work, to make a fluoroscopic examination of the subject's chest before radiographs are taken. In such instance the present apparatus lends itself very well to such a procedure, as may be seen in Figs. 2 and 3. Thus, the cassette **40** may be hinged, as at **57**, on one side of the holder and when it is swung out of position the fluorescent screen **58**, suitably hinged as at **59** to the other side of the frame, may be swung in place. Appropriate frictional locking means, as shown in Fig. 5, are provided for holding either the screen or cassette in their proper relationship to the holder. When the screen is in place and the X-ray tube excited, a physician, radiologist, or his assistant, any one of whom may be located within the cabinet, can then study the shadow on the screen and decide at what angles, and at what X-ray energy, radiographs are to be made.

The hinged arrangement shown in Fig. 3 may also be used where it is desirable to further reduce the time between exposures. Thus, if desired, a second cassette **40***a*, indicated in dotted lines, may be substituted for the fluorescent screen **58**. In such event, while one cassette screen is being exposed, the other may be reloaded. Usually, however, the time saved will be of no particular importance, except in cases where it is desired to make two exposures of the same subject's chest taken from slightly different angles in order to produce a stereoscopic effect. In the latter instance the two exposures must be made at very short time intervals, and it is not feasible to wait for reloading a single cassette. Hence, this structure may then be used to excellent advantage.

While, as is shown in Figs. 1, 2, and 3, the front wall **20** of the cabinet is provided with a holder into which a cassette may be mounted, it is quite evident that, as shown in Fig. 6, the cassette itself may be set directly into the opening **23**. In such instance the opposite edges of the cassette would be provided with appropriate angles **26***a* adapted to fit within the channels **24***a*, the curtain being fixed to the top and bottom edges thereof in substantially the manner hereinbefore described; and the front cover **42** of the cassette would then serve as the X-ray window. Similarly, if desired, the construction of the apparatus may be such as to avoid the use of an actual opening **23** in the front wall **20**. In this modification (Figs. 7 and 8) that portion **23***b* of the wall 20b, corresponding in area to the opening **23** in the wall **20** of Fig. 1, is made of a semi-opaque material whereby it may serve as an X-ray window in the wall, and the cassette **40***b* is slidably mounted on the inner side of the wall and immediately behind the window. A curtain **29***c*, comparable to curtain **29** of Fig. 1, is affixed to the upper and lower edges of the cassette (or its holder) and extends upwardly and downwardly therefrom so as to cover all parts of the X-ray window except that occupied by the cassette. Hence, with this modified structure the cassette may still be adjusted vertically of the wall, and it may be loaded, or unloaded, from within the dark room. Further, the curtain, and appropriate strips of lead, effectively exclude light or X-rays from the occupied portion of the dark room.

While the invention has hereinbefore been considered in connection principally with a portable dark room, it is quite evident that an element made in accordance with the description of the front wall **20** could be utilized to serve as a wall of the wark room in a permanent laboratory. In such instance all of the advantages of speed in taking the radiographs, and of reduction of initial investment would be achieved.

Since certain changes which are within the skill of an ordinary mechanic may be made in the embodiment of the invention, it is intended that the foregoing shall be construed in a descriptive rather than in a limiting sense.

What I claim is:

1. In an X-ray device of the character described, an element which is adapted to serve as a wall of a dark room, said wall being substantially opaque and having edge portions defining a vertically extending opening therein, a pair of channels extending along the vertically disposed edge portions of the opening; a holder disposed within said opening comprising a frame member having flange portions which are adapted to slide in said channels and other portions defining a recess accessible only from the dark room side of the wall and adapted to receive an X-ray sensitive film, and a front cover for said frame which is made of semi-opaque material whereby it may serve as an X-ray window; and a curtain of opaque material affixed to said frame, said curtain having its side edge slidably disposed within said channels and its opposite ends extending in light-tight relation over and beyond the upper and lower edges defining the opening in the wall whereby the holder may be adjusted vertically of said opening.

2. A portable dark room and holder for an X-ray sensitive member comprising, a cabinet capable of accommodating an operator and having an opaque front wall with top, bottom and side edges defining a vertically extending opening therein; a holder comprising a frame having marginal portions slidably engaging the vertical edges of a wall opening, other portions defining a cassette receiving recess accessible from the rear side of the wall, and a cover disposed over the front end of such frame made of semi-

opaque material whereby it may serve as an X-ray window; a curtain of flexible, opaque material attached to said frame with its side edges slidably disposed with respect to the side edges of the opening and with its end portions extending beyond and in light-tight relation with the top and bottom edges of said opening; and a cassette disposed within the recess of said holder and accessible only from the rear, dark room side of the wall.

3. The combination with a wall of a dark room in accordance with claim 2, further characterized in that the cassette has a hinged back portion so that it may be readily and rapidly opened from the rear side of the wall to permit a film to be inserted therein or withdrawn therefrom.

4. In combination with a holder adapted to be mounted in a supporting wall comprising a part of a dark room, said holder comprising a frame having flange portions of such dimensions as to be capable of extending through such wall from the dark to the light side thereof, and a cover of semi-opaque material attached to the front ends of said flanges so as to define a cassette receiving recess immediately therebehind and on the dark room side; of a pair of cassettes each hinged to an opposite side of such frame so as to be capable of being swung into such recess with its front surface disposed adjacent and parallel to said semi-opaque cover.

5. In combination with a holder adapted to be mounted in a supporting wall constituting part of a dark room, said holder comprising a frame having flange portions of such dimensions as to be capable of extending through such wall from the dark to the light side thereof, and a cover of semi-opaque material attached to the front ends of such flanges so as to define a cassette receiving recess immediately therebehind and on the dark room side; of a pair of cassettes each hinged to an opposite side of such frame so as to be capable of being swung into such recess with its front surface disposed adjacent and parallel to said semi-opaque cover; and means on said frame for frictionally engaging the free end of the one of the cassettes disposed within such recess.

6. In a cabinet which is adapted to serve as a dark room, an opaque front wall having edge portions defining a vertically extending opening therein, a pair of channels extending along the vertically disposed edges of the opening, a pair of pads affixed to the rear surface of the wall along the horizontally disposed edges defining the opening, a holder having a semi-opaque X-ray window slidably mounted in light-tight relation with said channels, a flexible curtain of opaque material affixed to the top and bottom edges of the holder with its side edges disposed in the channels and with its ends extending over said pads so as to exclude light from the cabinet, and counterbalancing means for supporting said curtain and said window.

7. A portable dark room and holder for an X-ray member comprising a cabinet capable of accommodating an operator and having an opaque front wall with edge portions defining a vertically extending opening therein, channels formed along the side edges of said opening, and pads affixed to the rear surface of the wall along the top and bottom edges of the opening; a holder for an X-ray sensitive member comprising a rectangular frame disposed within said opening with its rear end open to the side of the cabinet, and having flange portions slidably disposed in light-tight relation within said channels, and a semi-opaque cover disposed over the front end of said frame; a flexible curtain of opaque material affixed to the top and bottom edges of the holder frame with its side edges slidably engaging said channels in light-tight relation and its ends extending over said pads in light-tight relation with the top and bottom edges of the opening; and counterbalancing means for supporting the weight of said curtain and said holder.

GEORGE R. STRUCK.