Feb. 26, 1924. 1,484,663

A. MUTSCHELLER

X-RAY FILTER

Filed Sept. 16, 1921 5 Sheets-Sheet 1

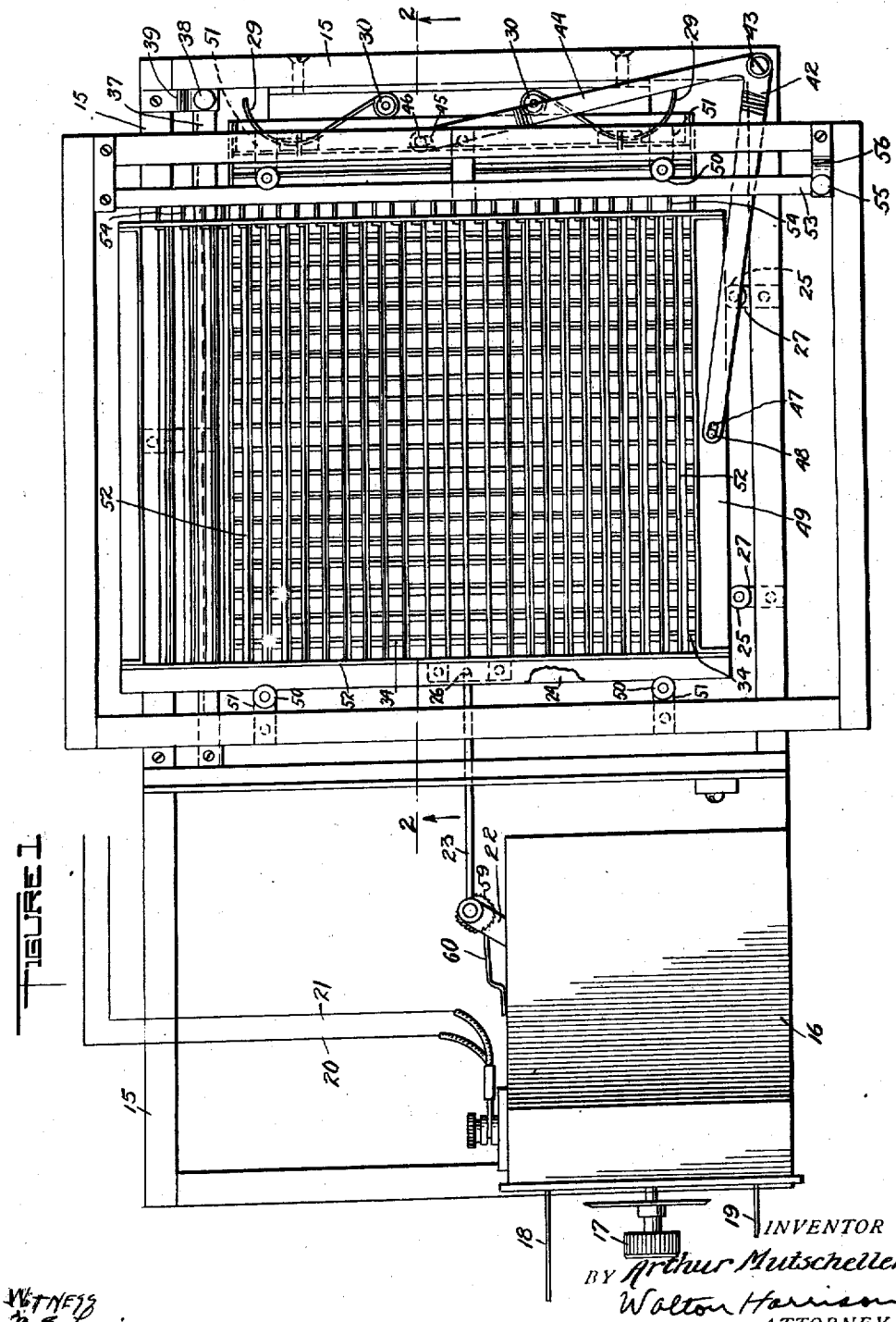


FIGURE 1

WITNESS
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1,484,663

X-RAY FILTER

Filed Sept. 16, 1921

5 Sheets-Sheet 2

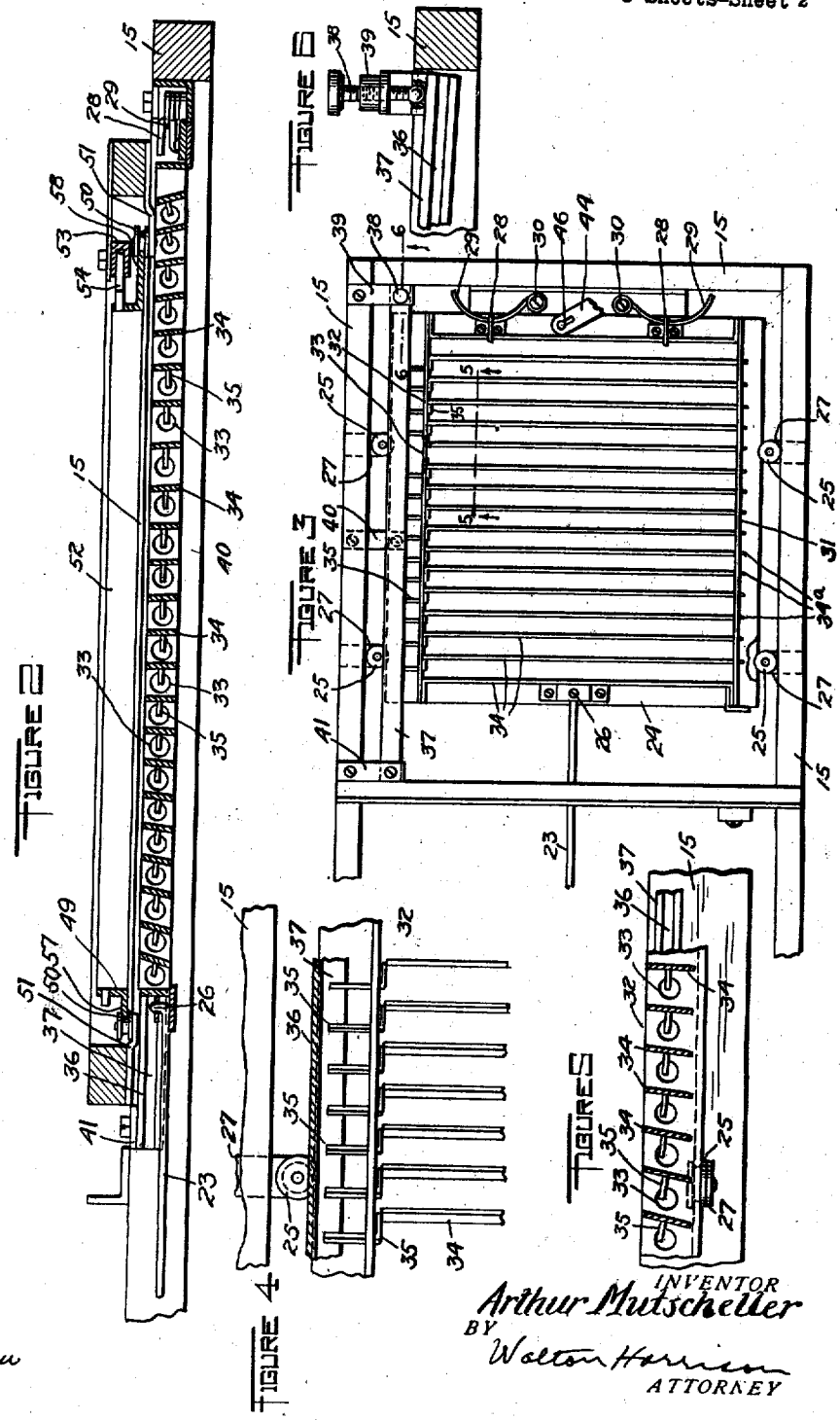


FIGURE 2

FIGURE 3

FIGURE 4

FIGURE 5

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X-RAY FILTER

Filed Sept. 16, 1921 5 Sheets-Sheet 3

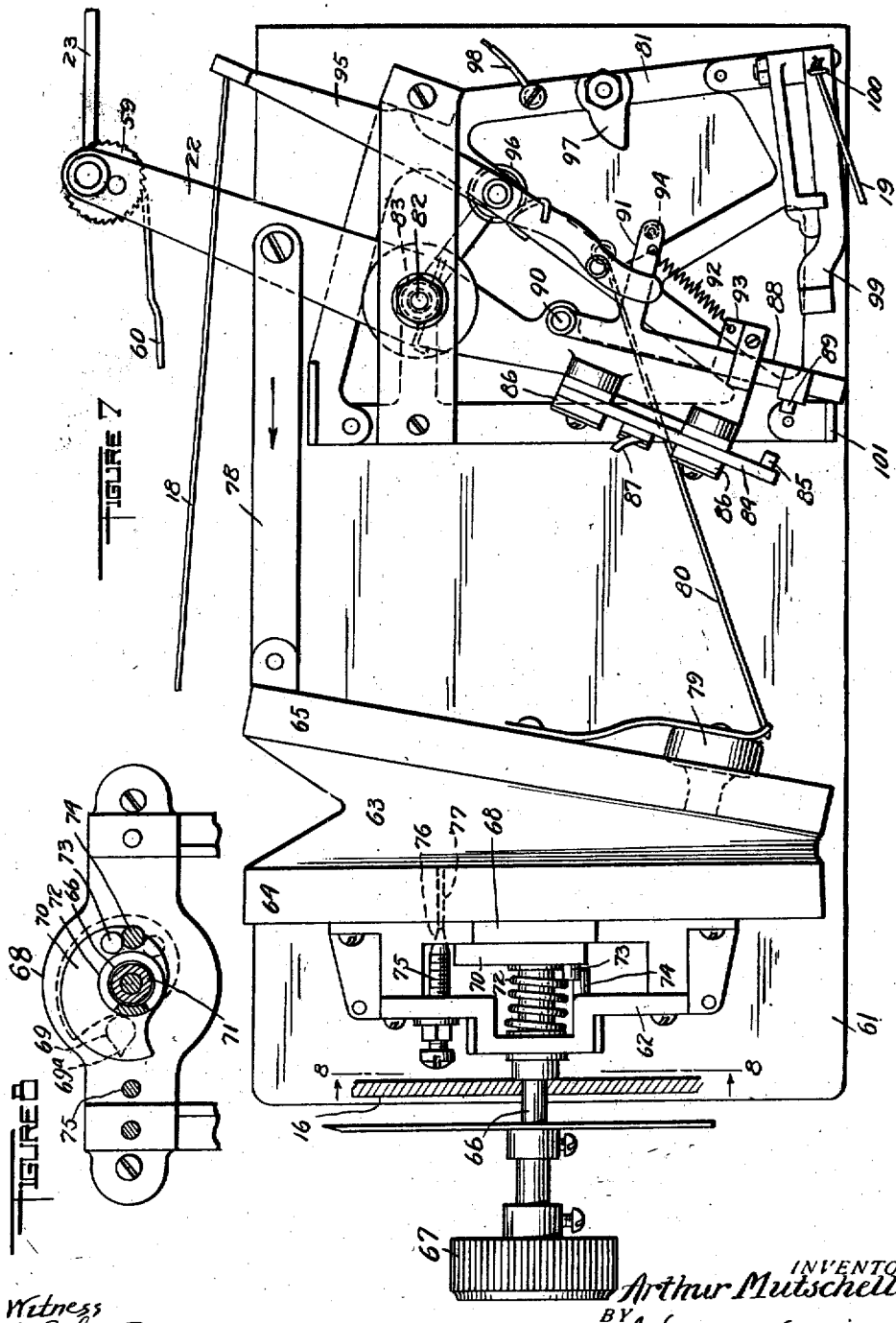


FIGURE 7

FIGURE 8

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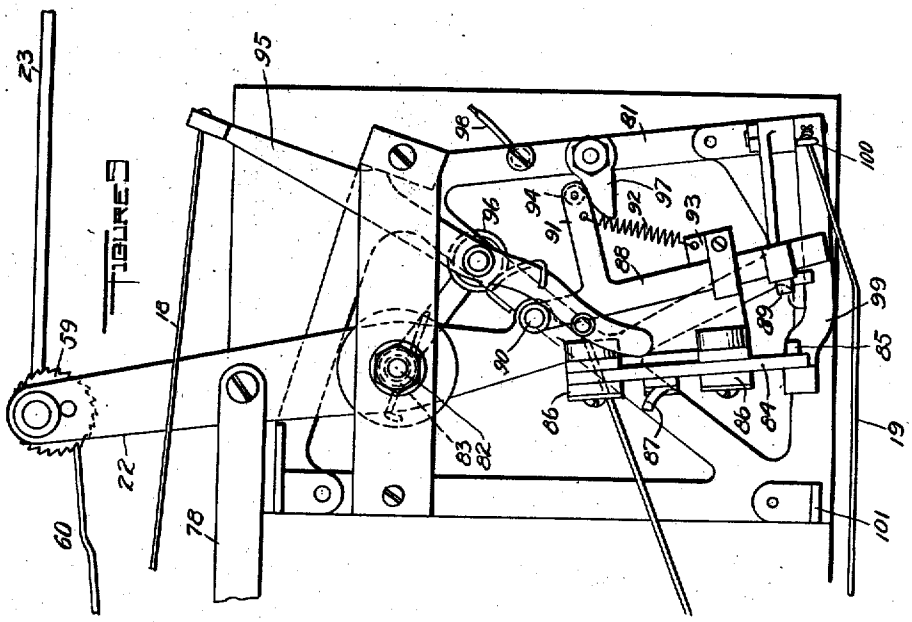
A. MUTSCHELLER

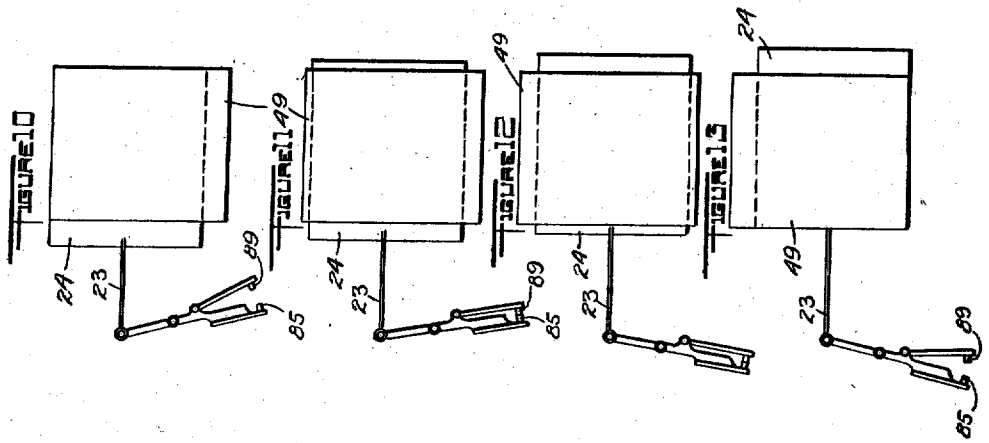
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X-RAY FILTER

Filed Sept. 16, 1921

5 Sheets-Sheet 4





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Feb. 26, 1924. 1,484,663

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X-RAY FILTER

Filed Sept. 16, 1921 5 Sheets-Sheet 5

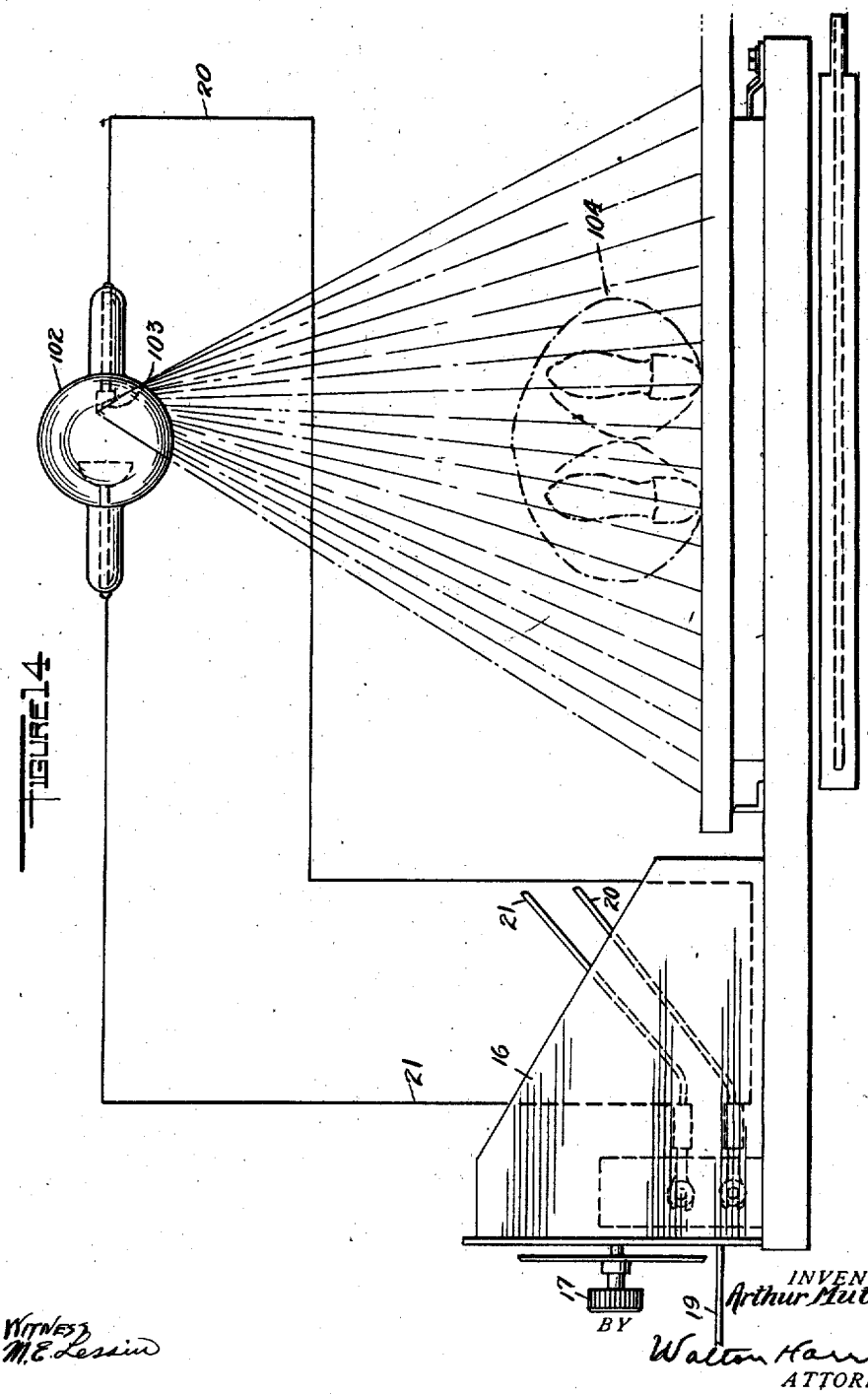


FIGURE 14

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Patented Feb. 26, 1924. 1,484,663

UNITED STATES PATENT OFFICE.

ARTHUR MUTSCHELLER, OF NEW YORK, N. Y., ASSIGNOR TO WAPPLER ELECTRIC CO., INC., A CORPORATION OF NEW YORK.

X-RAY FILTER

Application filed September 16, 1921. Serial No. 501,091.

To all whom it may concern:

Be it known that I, ARTHUR MUTSCHELLER, a citizen of the United States, residing in the city of New York, county of New York, and State of New York, have invented certain new and useful Improvements in X-Ray Filters, of which the following is a full, clear, and concise description.

My invention relates to X-ray filters; that is to devices used in connection with X-ray tubes, for the purpose of preventing secondary X-rays from reaching an object to be operated upon by the primary X-rays, and yet allowing the primary rays to reach the object with facility.

More particularly stated, by my invention, I seek to improve upon X-ray filters of the type heretofore used for the purpose of reducing the amount of fogging upon X-ray plates and fluoroscopic screens.

X-ray filters of the kind here contemplated have often been used in medical X-ray and fluorgraphic work; that is, where a photograph was to be made so as to exhibit the bony structure of a patient's body or a part thereof, the idea being to intercept as far as practicable such of the secondary X-rays as tended to reach the plate, and yet allowing the primary rays, as far as practicable to pass through the filter unobstructed.

All X-ray filters heretofore employed in practice have been based upon the idea that, since the X-rays always tend to travel in straight lines and are never, to any material extent at least, either reflected or refracted, and since the secondary rays are given off by the bony parts of the body when such parts are exposed to the action of the primary X-rays, a large proportion of the secondary X-rays necessarily travel in directions different from those of the primary X-rays, so that under suitable conditions the secondary rays may be intercepted while the primary rays are allowed to pass freely. This has been accomplished by means of a grid provided with openings so arranged as to allow the primary rays to pass through it in the simplest manner possible, the grid being of a somewhat cellular form and thus provided with partitions made of metal or other material opaque to X-rays and so arranged as to its position relatively to the patient's body or the part thereof to be photographed, that the secondary rays are in great measure intercepted for the reason that they tend to pass through the filter in radial directions such as to cause them to be obstructed by the partitions of the filter. With such an arrangement, secondary rays are intercepted to a greater extent than primary rays, for the simple reason that while the primary rays are all projected from the anti-cathode or target of an X-ray tube and consequently radiate practically from a single point, the secondary rays are projected in practically all directions and from an infinite number of points, all of which, being within the patient's body or part to be photographed are some distance away from the source of primary rays; and hence the interception of a large proportion of the secondary rays can be accomplished without a proportionate interception of the primary rays. In other words, a primary ray may have such direction that it can pass freely through an opening, whereas a secondary ray, originating at a point some distance away from the source of the primary ray, may have such direction as to prevent it from finding its way through the opening.

In some instances, the X-ray filter has been curved, its curvature approximating that of a mutilated sphere, and so arranged relatively to the X-ray tube as to bring the target into the center of curvature of the filter. The openings in the filter have usually been merely cellular openings more or less analogous in form to the compartments of a box for shipping eggs. The filter while in active use must be kept in motion, in order to prevent the casting of a shadow upon the sensitive plate.

In other instances, the filter carries a number of strips disposed parallel with each other and each extending edge wise in a direction radial to the target of the X-ray tube as a center. The filter just mentioned must also be moved continuously while in use, in order to prevent the casting of a shadow.

With filters of the two types just mentioned, it is necessary to maintain a considerable distance between the patient's body or other object to be photographed, and the sensitive plate to be exposed to the X-rays. Because of the distance required for the purpose just indicated, the photographic results have not been very satisfactory, the plate frequently exhibiting a considerable amount of blurring. Again it has been

found almost impossible to confer upon the filter such a motion as to prevent the formation of a shadow of some sort upon the plate, due to the partitions or other members employed for intercepting the secondary rays.

By my invention I seek to remedy, or at least to alleviate, the necessity for the troubles above mentioned. Among the objects sought to be accomplished are the following:

I. To provide an X-ray filter comprising among other things a grid and means for moving the same bodily while in action, the grid being provided with slats each journaled to turn slightly upon an axis of its own, and to provide means for thus turning the slats, in order to maintain each slat exactly edgewise relatively to the position of the target, and for coordinating the turning movement of the slats with the bodily movement of the grid.

II. To so position and arrange the slats just mentioned in the general form of a plane so that the grid as a whole is flat and can be brought into relatively close proximity to the patient's body in order to obtain sharpness of detail upon the plate, the mechanism for turning the slats each upon its own axis being adapted to actuate said slats when thus arranged in the form of a plane.

III. To provide means, controllable at the will of the operator, for adjusting the slats of the grid relatively to each other, for the purpose of adapting the grid for different distances from the target of the X-ray tube, and in so doing to correspondingly adjust the turning movements of the respective slats.

IV. To employ together a plurality of grids of the kind just mentioned, movable bodily in directions crossing each other, the bodily movements of the grids and the turning movements of the slats thereof being correlated so that the turning movements of the slats, being derived from the bodily movements of the grids, are rendered practically automatic.

V. To provide for placing and maintaining the grids just mentioned as closely as possible to each other, in order to diminish the distance between the patient's body and the sensitive plate, the filter being thus adapted to diminish the time otherwise required for exposure.

VI. To provide for operating my improved X-ray filter in connection with a timing apparatus for controlling the duration of exposure of the plate, so as to cause the period of exposure to begin while the movable parts of the X-ray filter are in action, and to continue until after said movable parts are brought to rest, thus preventing any blurring from the slats of the grid acting otherwise than by moving uniformly and continuously; in other words, preventing the slats from casting shadows, either sharply defined or nebulous.

VII. To make provision for adjusting the various movable parts of the filter, and of controlling their movements, as to reconcile the filter as a whole for use with an adjustable timing device for controlling the exposure of the plate. so that a relatively short exposure of the plate is associated with a correspondingly short period during which the action of the movable parts of the filter can have any effect upon the X-rays, the speed of travel of the grids being thus related to the time of exposure, and the turning movement of each slat being slow or rapid according to the time allowed for exposure.

VIII. To provide a special connection between the timing mechanism and the movable parts of the filter, to enable the movable parts of the filter to be driven by the movable parts of the timing mechanism.

IX. To interpose between the timing mechanism and the movable parts of the filter a connecting member the length of which is varied automatically and to an extent controllable by chance, so as to enable the grids to be brought to and started from positions which are uncertain and haphazard, so that for photographic work of a kind requiring repetition of exposures, shadows cannot be cast upon the plate in consequence of any fixedness in the positions of the slats at the beginning or end of the exposures.

X. To provide various parts and combinations thereof for increasing the general efficiency of the filter mechanism.

Reference is made to the accompanying drawings forming a part of this specification, and in which like reference numerals indicate like parts throughout all of the figures.

Figure 1 is a plan view of my improved X-ray filter and a timing device connected for use therewith.

Figure 2 is a section on the line 2—2 of Figure 1, looking in the direction indicated by the arrows.

Figure 3 is a plan view of the lower grid and parts immediately associated therewith.

Figure 4 is a fragmentary horizontal section, showing parts appearing in the upper portion of Figure 3.

Figure 5 is a section on the line 5—5 of Figure 3, looking in the direction indicated by the arrows.

Figure 6 is a section on the line 6—6 of Figure 3, looking in the direction indicated by the arrows.

Figure 7 is a plan view of the timing mechanism as adapted for use with my improved filter.

tilting bar 37 has a slight tilting or rocking movement upon the bracket 40 as a center, this rocking movement being limited by the bracket 41. When, therefore, the screw 38 is adjusted, the tilting bar 37 is affected accordingly, so as to be slightly tilted in different positions and held in such positions until further adjustment of the screw.

Since the side wall 32 is stationary, and since the several cranks 35 extend through the openings 33 and into the slot 36 of the tilting beam 37, it follows that the tilting movements of this tilting beam, under control of the adjusting screw 38, must affect the various cranks 35, and must affect them in slightly different ways and to different extents. It also follows that all of the slats 34 must be correspondingly affected. Thus with the tilting beam 37 in one position the slats 34 might occupy the positions indicated for them respectively in Figure 2. If, however, with the slats occupying such positions the adjusting screw 38 be turned, so as to depress the adjacent end of the tilting beam 37 (see Figure 6) and thus to raise the opposite end of the tilting beam, the slats 34 will be affected by this adjustment. That is to say, the slats which are farthest to the right according to Figure 2 are each turned slightly in a contra-clockwise direction, the slats farthest to the left according to this figure being turned slightly in a clockwise direction and all of the intermediate slats except those in the proximate middle of the figure, are also turned slightly, the degree of rotation being less and less the closer the slats are located to the middle. Again, if the adjusting screw be turned in the direction opposite to the one in which it had been turned before, the reverse action takes place, the slats being turned slightly as before, but in the opposite direction of rotation. Thus the extent of inclination between consecutive slats may within reasonable limits be varied at the will of the operator. The parts just described are so proportioned and arranged that whatever be the adjustment of the screw 38 and whatever be the position of the tilting beam 37 relatively to the frame, the planes of all the slats always extend in such directions that all of the slats are exactly edge-on with reference to some particular point a little distance above the apparatus, the distance of such point above the slats, however, being variable with different positions of the tilting beam 37. Such being the case if an X-ray tube be placed over the slats and in a fixed position, the operator may by adjustment of the screw 38 so cause the slats to be adjusted that the plane of each slat extends straight toward the target of the X-ray tube. It also follows that if the X-ray tube be shifted to some other position away from or toward the slats, the operator by simply adjusting the screw 38 can cause the slats to be again brought into proper position relatively to the target of the X-ray tube.

Suppose, next, that with the various movable parts occupying the positions indicated for them in Figures 2 and 3, the grid frame 24 be now shifted to the left according to these figures. This shifting of the grid frame will cause a very slight rocking movement of the slats, each turning a trifle in a clock-wise direction; and when the reverse action takes place, namely when the grid frame is shifted to the right according to Figures 2 and 3, the slats are again turned slightly, but each in a contra-clockwise direction. Thus the various slats carried by the grid frame have a tendency to extend toward the target of the X-ray tube, or at least to extend toward a given point fixed relatively to the frame.

By virtue of the arrangement just described, the open spaces between the slats are always open to their utmost limits for the purpose of enabling X-rays from the X-ray tube to pass through them freely and without obstruction, and that, too, independently of the various positions into which the grid frame may be moved, the direction of its travel or the speed of its movement. In other words, the construction is such that the slats move automatically in order to accommodate themselves to different distances of the grid frame from the X-ray tube, as well as to different distances of travel and different speeds of movement of the grid frame.

A bell crank lever 42 is journaled upon a bolt 43, the latter being mounted upon one corner of the frame 15. The bell crank lever is provided with a portion 44 having a slot 45, and extending through this slot is a pin 46, carried by the grid frame 24. The bell crank lever 42 is further provided with a slot 47, and extending through this slot is a pin 48. This pin 48 is carried by another grid frame 49, similar to the grid frame 24 above described, but mounted over the latter and extending crosswise thereof, as may be understood from Figure 1.

The grid frame 49 is engaged by guide wheels 50, mounted in brackets 51, and is adapted to move in the direction of travel crossing that of the grid plane 24. The grid frame 49 carries a number of slats 52, similar to the slats 34 above described with reference to the grid frame 24.

The two grid frames 24 and 49 are by means of the bell crank lever 42 so geared together that whenever the grid frame 24 is moved in either direction of its travel, it rocks the bell crank lever 42 and thereby causes the grid frame 49 to travel in a manner and to an extent controllable by an analogous movement of the grid frame 24. Thus it follow that whenever the grid frame 24 is by action of the lever 22 drawn to the left according to Figure 1, the grid frame 49 is correspondingly drawn in a direction

Figure 8 is a section on the line 8—8 of Figure 7, looking in the direction indicated by the arrows.

Figure 9 is a view somewhat similar to the right hand portion of Figure 7, but showing the movable parts as occupying positions different from those they occupy in said Figure 7.

Figure 10 is a diagram indicating the relative positions and conditions of the grids and the contact mechanism for closing the main circuit of the X-ray tube, these parts being shown as they appear normally while out of action and up to the moment when the movable parts are thrown into action.

Figure 11 shows the same parts as Figure 10, but as they appear after the grids begin their movements, and at the instant when the contact mechanism closes the tube circuit.

Figure 12 is a diagram showing these same movable parts as they appear when the exposure is nearly finished, and the contact mechanism is about ready to open the tube circuit.

Figure 13 shows the same parts again, but as they appear when the grids have finished their respective movements and the contact mechanism has opened the tube circuit.

Figure 14 is a side elevation, partly diagrammatic showing the general manner in which my device is used in connection with an X-ray tube and a photographic table upon which rests the body of a patient.

A frame 15 made of metal, preferably of steel, supports most of the working parts, including the timing mechanism 16 for controlling the duration of the period during which the X-ray tube is in action. This timing mechanism is of the general type disclosed in Patent No. 1,209,273, dated Dec. 19, 1916, to Charles Fayer, the construction and action of the timer being modified to some extent, as hereinafter described, in order to adapt it for use in connection with my invention.

The timer is provided with a knob 17, controllable at the will of the operator for controlling the duration of the exposure. The timing mechanism is further provided with a cord 18 to be pulled by the operator in order to set the timing mechanism, and with another cord 19 to be pulled by the operator in order to release the timing mechanism for purposes of an exposure. A pair of conductors 20, 21, constituting a part of the circuit through the X-ray tube, are energized and deenergized by action of the timer. The timing mechanism is provided with a lever 22, hereinafter described more particularly and adapted to make a single slow continuous movement during each exposure. Connected with this lever is a rod 23. This rod is also connected with a grid frame 24 constituting a part of my improved X-ray filter and is shown more particularly in Figure 3.

The grid frame 24 is engaged by guide wheels 25, and supported by these wheels in such manner that the grid frame may be moved in the general direction of its length—that is, to the right and left according to Figure 3, and with a minimum of friction. A pivot 26 is used for connecting the rod 23 with the grid frame 24, in order to allow for a slight lateral play of the rod 23, due to its connection with the lever 22. The guide wheels 26 are supported by brackets 27, mounted upon the frame 15.

The grid frame 24 is provided with a pair of eyes 28, and extending through these eyes are springs 29, supported upon the frame 15 by appropriate mountings 30. These springs are so arranged as to be always under tension, so as to have a tendency to pull the grid frame 24 to the right, according to Figure 3. The purpose of these springs is to assist the timing mechanism in moving the grid frame 24, together with various movable parts connected with and controllable thereby.

The grid frame 24 is provide with a pair of side walls 31, 32, having the general form of thin strips and made of metal, preferably steel. The side wall 32 is provided with a number of openings 33, each circular in form as shown more particularly in Figure 5. These circular openings are arranged in a single row extending length wise of the side wall.

A number of slats 34 are supported by the side walls 31, 32, and for this purpose are provided with pintles 34ª extending through holes in the side walls. Thus the slats are journaled upon the side walls, and so adapted to be rocked relatively thereto. Each slat 34 carries a crank 35, secured rigidly upon it and extending through some one of the adjacent holes 33 in the side wall 32, as shown more particularly in Figures 4 and 5.

The cranks 35 extend outwardly beyond the side wall 32 for a little distance, as indicated in Figure 4, and into a slot 36 with which a beam 37 is provided. This beam has a slight tilting movement and hence is known as the tilting beam. A screw 38 is connected with the tilting beam at a point adjacent one end thereof, as indicated in Figure 6, and is used for tilting the tilting beam into slightly different positions relatively to the plane 15 and for holding the tilting beam in such position. The screw 38 is thus an adjusting screw. It extends through and is supported by a bracket 39, mounted rigidly upon the frame 15. There are two other brackets, 40 and 41, also mounted upon the frame. The

vided with a hole 69, and with a channel 69ª which merges into this hole. The revoluble stem 66 carries a snail cam 70, mounted rigidly upon it, and adapted to slowly cover or uncover the hole 69 and channel 69ª. The snail cam carries a sleeve 71, and engaging this sleeve is a spiral spring 72, which constantly presses the snail cam against the disk 68. A lug 73, carried by the snail cam, and a lug 74 mounted upon the spider bar 62, serve as limiting stops defining the limits of travel of the snail cam.

A screw 75 extends through the spider bar and into a passage 76 of substantially frusto-conical form, the latter being connected with and virtually forming a continuation of an air hole 77 through the fixed board 64 of the bellows. The hole 69 and channel 69ª also constitute an air hole through the fixed board 64 of the bellows. The operator, by turning the stem 66 by means of the handle 67, can bring the snail cam 70 into position to partially cover the hole 69 and passage 69ª, so as to restrict to any desired extent the capacity of the bellows for taking in air. The screw 75 is also adjusted for further controlling the air intake of the bellows, and the air intake, regulated and controlled, as described, is the means employed for controlling the speed with which the bellows is operated.

A connecting rod 78 extends from the movable board 65 of the bellows into engagement with the rocking lever 22, for the purpose of actuating the latter. The bellows is provided with an air valve 79 and with a cord 80 connected with this air valve. The air valve 79 is normally closed, but is opened whenever the cord 80 is drawn to the right according to Figure 7. This movement is for the purpose of periodically venting the bellows, in order to allow its movable parts to be quickly restored to normal position.

A frame 81 supports a portion of the timing mechanism. Mounted upon this frame is a shaft 82, upon which the rocking lever 22 is journaled. A spiral spring 83 encircles the shaft 82, and is connected with the rocking lever 22 and with the frame in such manner that the spring is always under tension, and that the tendency of the rocking lever 22 is to rock in a clockwise direction according to Figure 7.

The rocking lever 22 carries a contact plate 84, insulated by blocks 86 made of insulating material, the contact plate being provided with a contact boss 85 and connected with a conductor 87 leading therefrom to the X-ray tube. The contact lever 88 carries a contact boss 89 mating the contact boss 85, and adapted to be brought into and out of contact therewith. The contact lever 88 is mounted upon a pin 90, carried by the rocking lever 22, in such manner as to be adapted to swing upon this pin 90 as a center. The contact lever 88 carries an arm 91, and connected with this arm is a spring 92, which is also connected with an extending portion 93 of the rocking lever 22. The arm 91 carries a roller 94 extending laterally from it and used as hereinafter described.

A setting lever 95 is journaled to rock upon the frame. A coil spring 96, connected with the setting lever 95, is used for the purpose of retracting the setting lever into its normal position. The tendency of the spring 96 is to rock the setting lever 95 in a clockwise direction according to Figure 7, whereas a pull upon the cord 18 by hand has a tendency to rock the setting lever 95 in a contra-clockwise direction according to this figure.

Mounted upon the frame 81 is a metallic finger 97. This finger is so positioned as to be slidably engaged by the roller 94, as indicated in Figure 9. The finger 97 is adapted to hold the contact lever 88 in the position indicated for this lever in Figure 9, for a moment after the releasing of the rocking lever 22 at the beginning of each period of exposure. A conductor 98 is connected with the X-ray tube, along with the conductor 87 above described.

A latch 99 is mounted upon the frame 81, and carries a pin 100 extending laterally from it, and to which the releasing cord 19 is secured.

A limiting stop 101 is so mounted upon the frame 81 and so positioned that the contact lever 88 can lodge against it whenever the rocking lever 22 is rocked to the limit of its travel in a clockwise direction according to Figure 7.

The operation of the timing mechanism may be briefly described as follows:

The operator first adjusts the air inlet mechanism of the bellows 64, which he does by turning the handle 67 and the screw 75 as above described. The adjustment thus made controls the time period of the exposure, in that it controls the speed at which the movable board 65 of the bellows can swing away from the fixed board 64 thereof. This adjustment being made, the operator pulls by hand upon the setting cord 18. This rocks the setting lever 95 contra-clockwise according to Figure 7. This movement of the setting lever causes the cord 80 to open the air valve 79, and also causes the contact lever 88 to be moved bodily to the right according to Figure 7, so as to shift the rocking lever 22 to the limit of its travel in a contra-clockwise direction, as indicated in Figure 9. This same movement of the parts brings the roller 94, carried by the arm 91, into engagement with the finger 97. This prevents the contact lever 88 from im-

lateral to the direction of travel of the grid frame 24; and when the grid frame 24 makes its reverse movement, that is, when it moves to the right according to Figure 1, the grid frame 49 is moved in direction contrary to the one in which it was moved as just stated. The relative movements of the grid frames 24 and 49 may be understood by a study of Figures 10 to 13 inclusive.

Located adjacent the grid frame 49, to the right of the same according to Figure 1, is a tilting beam 53 like the tilting beam 37 above described. A row of cranks 54 are disposed adjacent the tilting beam 53, and extend into the slot thereof, as above described with reference to the manner in which the cranks fit into the slot 36. The tilting beam 53 is adjustable by means of an adjusting screw 55, revolubly mounted in a bracket 56, after the manner of the screw 38, mounted in the bracket 39 above described.

The operator, by adjusting the screw 55, can adjust the tilting bar 53 in such manner as to control the rocking movements of the slats 52, in the same manner that the tilting bar 37 is adjusted to control the rocking movements of the slats 34 as described.

Thus it is an easy matter for the operator to so adjust the two screws 38 and 55 that the slats 34 and 52 will each and all extend exactly edgewise toward the target of an X-ray tube, no matter at what distance the X-ray tube may be placed above the filter. It follows as a corollary that whenever the two screws 38 and 55 are thus properly adjusted relatively to the position of the target of the X-ray tube, any movement or movements made by the grid frames will be so co-related with rocking movements of the two sets of slats 34 and 52 that the slats will rock so as to continue to extend directly edgewise toward the tube target. In fact, each individual slat, wherever found in either grid frame, has a compositional movement so arranged that no amount of sliding of the grid frames back and forth can cause the slat to do anything else except keep its general plane extending straight toward the tube target.

Such being the case, it follows that the spaces between the slats offer the best possible paths for X-rays from the tube target to pass through, but that the slats are more or less in the paths of the secondary X-rays, which emanate from a multiplicity of other points some distance below the X-ray tube. Usually the secondary X-rays radiate from the bones of a patient who rests on a table as indicated in Figure 14, and owing to the nondescript positions occupied by these bones, the secondary rays have not much chance to find their way unobstructed between the slats of the filter. Hence while some of the secondary rays get through the filter, the proportion of such rays is small relative to the primary X-rays which pass through.

I will now describe my device in its relation to the timing mechanism—that is, to the mechanism used for timing the exposure of the sensitized film or plate to the action of the X-rays.

While my device may be employed in connection with timing devices of various kinds, I prefer to use it in connection with timing devices of the type shown in Patent No. 1,209,273, dated Dec. 19, 1916, to Charles Fayer.

In order to elucidate the connection between my invention and the timing mechanism shown in the patent just mentioned, I will briefly describe a portion of the timing mechanism, as shown in my Figures 7, 8, 9.

The rod 23, used for actuating the grid frames as above described is connected with the lever 22, which is the rocking lever of the timing device, in the manner indicated in Figure 7. The rod 23 is pivotally connected with a ratchet wheel 59, the latter being journaled upon the rocking lever 22 and adapted to be turned. A spring pawl 60, mounted upon the frame work, is detachably engaged to the ratchet wheel 59, so as to prevent retrograde turning of the ratchet wheel in one direction.

As a result of this arrangement, there is a certain amount of relative movement between the rod 23 and the rocking lever 22, due to step by step rotation of the ratchet wheel 59, so that the rod 23 is virtually lengthened and shortened, to an extent more or less haphazard. Such being the case, the grid frames do not always start from the same point, and the point from which they do start is a matter of uncertainty.

The purpose of the arrangement just described is to prevent the movable slats from being repeatedly exposed in the same position, when the device is used for repeating exposures. Suppose for instance, that half a dozen short exposures are made in succession, upon the same sensitized plate, as is frequently done in X-ray work. Manifestly, the metallic slats are less apt to produce objectional shadows upon the film if the general positions of the grids and consequently of the slats carried thereby are so shifted as to occupy different positions at the respective beginnings of the several time periods of exposure.

Supported upon a base 61 is a spider bar 62 and a bellows 63, this bellows having a fixed board 64 and a movable board 65. A revoluble stem 66, carrying a handle 67, extends through a hole in the spider bar 62 and is adapted to be turned by hand. The revoluble stem 66 also extends through a hole in the disk 68. The disk 68 is pro-

mediately executing a retrograde movement. That is to say, the contact lever 88, because of the engagement of the roller 94 with the finger 97, is turned slightly in relation to the rocking lever 22, because the setting lever 95 rocks back into its normal position. The rocking lever 22 starts to rock backwardly, toward its normal position, but is unable to do so because the contact plate 84 is held by the latch 99. The device will remain any length of time in the condition just described. The contact bosses 85 and 89 are now separated, and consequently the electric circuit through the X-ray tube is open. The setting lever 95 is in its normal position; and hence, the cord 80 being relaxed, the valve 79, used for venting, is closed.

Suppose now that the operator pulls upon the releasing cord 19. This disengages the latch 99 from the contact plate 84, and thus releases the rocking lever 22. The rocking lever 22 now turns slowly in a clockwise direction, at a rate of speed determined by the air inlet of the bellows, this being adjusted, all as above described. The contact lever 88, by its movement away from the finger 97, now causes the disengagement of the roller 94 from the finger 97, but not until the rocking lever 22 has executed a portion of its rocking stroke back toward its normal position, and up to this time the contact bosses 85 and 89 still remain separated. As soon, however as the roller 94 is disconnected from the finger 97, the contact lever 88 is left free to swing relatively to the rocking lever 22, and under tension of the spring 92 the contact lever 88 snaps into such position as to leave the contact boss 89 lodged against the contact boss 85. This closes the circuit through the X-ray tube, and it is obvious that the closure of the circuit does not take place until after the rocking lever 22 is in motion. This is an important point, as it means that the grid frames above described, in making their sliding movements under control of the rocking lever 22, are actually moving, and that the slats carried by them are actually turned, at the instant when the X-ray tube circuit is closed. This prevents the slats from being in fixed positions at the time when the X-rays are turned on. Thus any shadows cast by the slats can do no material harm toward affecting the sensitized plate or film to which the X-rays are directed.

The same movement of the rocking lever 22 being continued, however, brings the contact lever 88 into engagement with the limiting stop 101, but at an instant before the rocking lever 22 reaches the limit of its stroke. The result is that since the rocking lever 22 continues its movement to the end of its stroke, and since the contact lever 88 is abruptly stopped in its travel as indicated at the bottom of Figure 7, the contact boss 85 moves out of engagement with the contact boss 89, so that the tube circuit is thus opened, and is left open for the time being.

In Figures 10, 11, 12, 13, I have indicated the several successive positions for the contact mechanism used for energizing and de-energizing the tube circuit, and have shown the various relative positions of the grid frames 24 and 49 as related to the different positions of the contact mechanism.

Figure 10 shows the condition of the contact mechanism, and the relative positions of the grid frames 24 and 49, at the instant when the timing mechanism is set, as indicated in Figure 9, by the operator pulling and releasing the setting cord 18. It will be noted that while the contact bosses 85 and 89 are separated, the grid frames 49 and 24 are in their extreme positions; that is they are at the limits of their travel, respectively, in one direction of travel.

In Figure 11, the same parts are shown as they appear immediately after the release takes place. The grid frames 24 and 49 are now in motion, travelling in two directions crossing each other, and the contact bosses 85, 89 are in engagement.

In Figure 12, the progressive movement of the respective grid frames is followed a little further, the contact bosses 85 and 89 being still in engagement.

In Figure 13, the grid frames have each finished this bodily movement and reached their normal position, the contact members 85, 89 being now separated, so that the tube circuit is open.

Thus it will be noted that while the grid frames 24, 49 are always in motion while the X-ray tube is in action, the movements of the grid frame are neither quick nor jerky, but relatively slow and uniform. It will also be noted that the rocking movements of the slats are relatively slow, and are quicker for some positions of the X-ray tube than for other positions thereof. That is to say, the operator, by adjusting the screws 38 and 55 as above described, can so adjust the rocking movements of the slats that the slats, in rocking, turn more rapidly if the X-ray tube is in close proximity to the filter mechanism than if a little further away therefrom.

An X-ray tube is shown at 102, and is provided with a target 103, as may be understood from Figure 14. The body of a patient is shown at 104. As may readily be understood from the figure just mentioned, the primary rays have a much better chance of getting through the filter mechanism than is the case with such secondary rays as may emanate from the bones of the patient's body.

I do not limit myself to the precise mechanism shown, as variations may be made

therein without departing from my invention, the scope of which is commensurate with my claims.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is as follows:

1. In an X-ray filter the combination, with a framework and a grid frame carried by said framework and movable relatively thereto back and forth in a predetermined plane, of a plurality of slats mounted upon said grid frame and made of material opaque to X-rays, said slats being inclined to different angles relatively to said grid frame, and means for causing said slats to rock while said grid frame is in motion, in order to facilitate the passage between said slats of primary X-rays proceeding directly from said X-ray tube.

2. In an X-ray filter the combination, with a framework and a grid frame mounted upon said framework and movable relatively thereto in a predetermined plane, of a plurality of slats journaled upon said grid frame and made of material opaque to X-rays, said slats being spaced apart to allow the passage between them of primary X-rays from the X-ray tube, and mechanism connected with said grid frame and with said slats for rocking said slats at a rate of speed commensurate with the speed of travel of the grid frame.

3. In an X-ray filter the combination, with a framework and a grid frame mounted upon said framework and movable relatively thereto in a predetermined plane, of a plurality of slats carried by said grid frame and made of material opaque to X-rays, said slats being spaced apart to allow the passage between them of primary X-rays directly from the X-ray tube, and mechanism connected with said slats and with said grid frame and driven by movements of said grid frame for rocking said slats at a rate of speed dependent upon the speed of travel of the grid frame.

4. In an X-ray filter the combination, with a framework and a grid frame mounted upon said framework and movable relatively thereto in a predetermined plane, of a plurality of slats carried by said grid frame and made of material opaque to X-rays, said slats being spaced apart in order to allow primary X-rays from the X-ray tube to pass between, means for rocking said slats at a rate of speed commensurate with the speed of travel of the grid frame, and mechanism controllable at the will of the operator for adjusting the rate of speed at which said slats are rocked, relative to the speed of travel of the grid frame.

5. In an X-ray filter the combination, with a framework and a grid frame mounted upon said framework and movable relatively thereto in a predetermined plane, of a plurality of slats journaled upon said grid frame and made of material opaque to X-rays, said slats being spaced apart to allow primary X-rays from the X-ray tube to pass freely between them, and mechanism connected with said grid frame and with said slats, and controllable at the will of the operator for shifting said slats respectively to different angles relatively to the grid frame, in order to render said slats exactly edgewise in position relatively to different positions occupied by said X-ray tube.

6. In an X-ray filter the combination, with a framework and a grid frame mounted upon said framework and movable relatively thereto in a predetermined plane, of a plurality of slats carried by said frame and made of material opaque to X-rays, said slats being spaced apart and tilted to different angles relatively to the plane of the grid frame in order to permit the passage of X-rays from the X-ray tube and between the slats, a number of cranks one connected with each slat for rocking the same, a tilting beam common to all of said slats and provided with a slot into which said cranks extend, said tilting beam being supported upon said framework and located adjacent said grid frame, and means controllable at the will of the operator for tilting said tilting beam to slightly different angles relatively to the plane of the grid frame in order to vary the rate of speed at which said slats are rocked relatively to the speed of travel of said grid frame.

7. In an X-ray filter the combination, with an X-ray tube and a framework disposed adjacent thereto, of a plurality of grid frames mounted upon said framework and each movable relatively thereto in a different plane, the planes crossing each other so that the grid frames travel in directions crossing each other, a plurality of slats carried by each grid frame, the slats of one grid frame crossing the slats of another grid frame, and connections for causing said grid frames to move simultaneously with reference to the framework.

8. In an X-ray filter the combination, with an X-ray tube and a framework disposed adjacent thereto, of a plurality of grid frames mounted upon said framework and each movable relatively thereto in a different plane, the planes crossing each other so that the grid frames travel in cross directions, a plurality of slats carried by each of said grid frames, the slats of one grid frame crossing the slats of another grid frame, connections for causing said grid frames to move simultaneously with reference to the framework, and means controllable by movements of the grid frames for causing said slats to rock relatively to the grid frames whereby they are carried.

9. In an X-ray filter the combination of a framework, a pair of grid frames each mounted thereupon and movable relatively thereto in a predetermined plane, the plane in which one grid frame moves crossing the plane in which the other grid frame moves, a plurality of slats carried by each grid frame and opaque to X-rays, the slats of each grid frame being spaced apart in order to allow X-rays from a predetermined point to pass freely between them and yet to reduce the number of secondary X-rays tending to pass between them from points other than said predetermined point, connections for enabling the movements of one of said grid frames to actuate the other of said grid frames, and mechanism controllable by movements of the respective grid frames for rocking the slats carried by the grid frames, respectively.

10. In an X-ray filter the combination of a framework, a pair of grid frames mounted thereupon and movable relatively thereto in different directions crossing each other, a plurality of filtering members carried by said grid frame and opaque to X-rays, these filtering members being spaced apart in order to allow X-rays from a predetermined point to pass between them and yet to reduce the number of X-rays tending to pass between them from other points, connections for causing said grid frames to move simultaneously and connections from said grid frames to said filtering members for enabling movements of said grid frames to shift the positions of said filtering members relatively to said grid frames, in order to maintain said filtering members in proper alinement with a source of primary X-rays.

11. In the X-ray art the combination of an X-ray tube, timing mechanism connected with said X-ray tube for controlling the period during which the X-ray tube is to be energized for the purpose of making a radiograph or the like, filter mechanism located between the X-ray tube and the surface where the radiograph or the like is to be made, said filter mechanism being provided with a pair of movable members mounted respectively in paths crossing each other for the purpose of sifting out secondary X-rays while permitting primary X-rays to pass through the filter mechanism, means for shifting said movable members along said paths thus crossing each other, and connections from said filter mechanism to the timing mechanism, so arranged that both of said movable members are always in action before the X-ray tube is energized, and remain in action for a moment after the X-ray tube is deenergized.

12. In a device of the character described, the combination of an X-ray tube, an electric circuit connected with said X-ray tube for energizing the same, timing mechanism connected with said electric circuit and controllable by the operator for predetermining the time period during which the circuit is to remain closed, filter mechanism provided with a plurality of movable parts for filtering out secondary X-rays while permitting the passage of primary X-rays, said movable parts being mounted to move along a plurality of paths crossing each other, means for actuating said filter mechanism during the entire period of time while the circuit is closed, and mechanism for maintaining the movements of the movable parts of said filter mechanism for a moment later than the expiration of said period of time, so that the movement of said movable parts of the filter mechanism is continued after the said circuit is de-energized.

13. In an X-ray filter the combination, with an X-ray tube and a frame work disposed adjacent thereto, of a plurality of grid frames mounted upon said frame work and each movable relatively thereto in a different plane, the planes crossing each other so that said grid frames travel in directions crossing each other, and connections for causing said grid frame to move simultaneously with reference to the framework.

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