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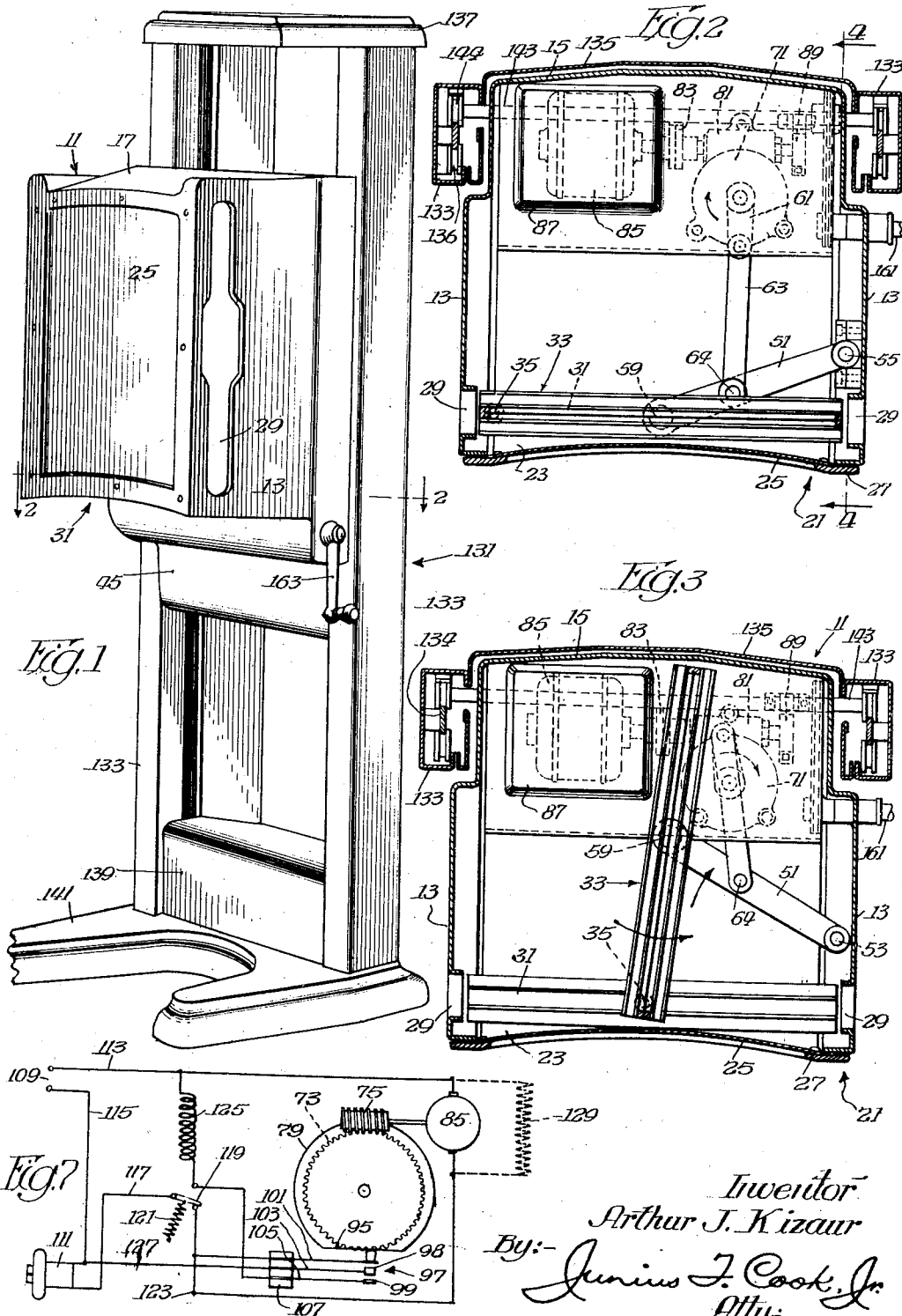
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2,277,330

PLATE CHANGER

Filed May 25, 1940

2 Sheets-Sheet 1



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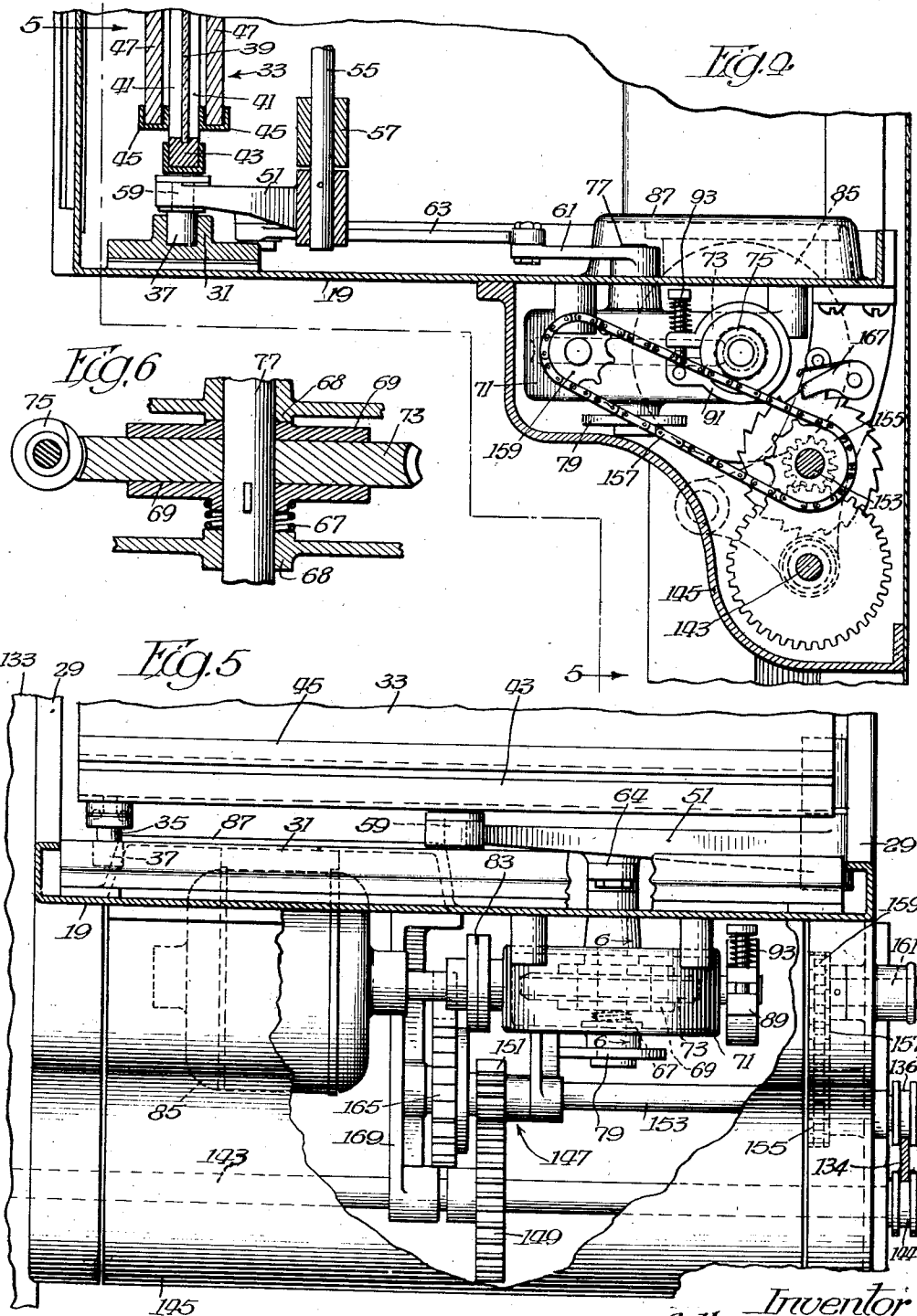
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UNITED STATES PATENT OFFICE

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PLATE CHANGER

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13 Claims. (Cl. 250—66)

My present invention relates in general to apparatus for shifting sheets or plates of sensitive material in order to position the same successively for exposure in making pictures, and my invention has more particular reference to apparatus of the character mentioned for use in the production of radiographic or X-ray pictures of stereoscopic character.

Another important object is to provide apparatus for successively presenting a plurality of sheets or plates of material sensitive to X-rays or other rays in position for exposure; a further object being to provide plate changing apparatus of rugged and relatively simple construction, occupying a minimum amount of room.

Another important object is to provide apparatus for shifting the relatively heavy frames or cassettes in which sensitive material is preferably mounted for convenient handling and exposure; a further object being to provide apparatus for shifting relatively heavy cassettes smoothly and without jar; a still further object being to provide apparatus of the character mentioned which does not require critical balancing or adjustment.

Another important object is to provide plate changing apparatus in which the weight of the cassettes is not a factor in the operation of the apparatus; a further object being to provide plate changing apparatus to perform its plate changing cycle whether or not cassettes are mounted therein.

Another important object is to provide plate changing apparatus in which the motion of the plate changing parts may be interrupted during the operating cycle of the device without danger of damage to the device or injury to the person of the operator, the apparatus being arranged to permit immediate stoppage of motion in the event that an arm, hand or other body member becomes positioned in the path of operating movement of the plate changing mechanism.

Another important object is to provide apparatus of the character mentioned which will perform its operating cycle instantly in response to pressure applied on a release button; a further object being to provide apparatus adapted to complete its operating cycle, whether or not the actuating button is held down throughout the operating cycle; a still further object being to provide for the prevention of a repeat cycle of the apparatus in the event that the button is held down after the completion of the plate changing operation.

Another important object is to utilize a motor

driven reversible plate holder for plate changing purposes; a further object being to provide non-positive driving means, preferably in the form of a friction clutch, between the motor and the reversible plate holder in order to allow the reversing movement of the plate holder to be interrupted without damage to the equipment at any stage in the reversing cycle of the apparatus.

Another important object is to provide for reversing the plate holder by a lever system in which there is no "dead center" position of the parts.

Another important object resides in the provision of simplified mechanism for reversing a plate holder in which the plate holder is pivoted for turning movement on a slide which, in turn, is mounted in a way extending parallel with respect to the plane of the reversible holder, and including lever means actuated from a suitable power source for drawing portions of the holder remote from its pivoted axis on the slide in a lateral direction with respect to said way in order to obtain the reversal of the plate carrier in place.

These and numerous other important objects, advantages, and inherent functions of the invention will be fully understood from the following description, which, taken in connection with the accompanying drawings, discloses a preferred embodiment of the invention.

Referring to the drawings:

Figure 1 is a perspective view of apparatus embodying my present invention;

Figures 2 and 3 are sectional views taken substantially along the line 2—2 in Figure 1, showing the apparatus in two positions during the plate changing movement;

Figure 4 is a sectional view taken substantially along the line 4—4 in Figure 2;

Figure 5 is a sectional view taken substantially along the line 5—5 in Figure 4;

Figure 6 is an enlarged sectional view taken substantially along the line 6—6 in Figure 5; and

Figure 7 is a diagram of electrical connections.

To illustrate my invention, I have shown on the drawings plate changing apparatus 11, comprising suitable frame means forming the opposite side walls 13, the back wall 15, a top wall 17, and a bottom wall 19 of a casing 21. The casing 21 may conveniently be formed of sheet metal, but, of course, any other suitable material may be utilized to form the casing in which is disposed the operating parts of the plate changing equipment. Where used in making X-ray pictures, the casing may, if desired, be formed of

material impervious to X-rays, or may be lined with such material, although such refinement is by no means essential, nor is the invention necessarily restricted to a casing, the casing being preferred for the purpose of housing the plate changing equipment and affording an attractive appearance.

The front of the casing is provided with an opening 23 which, in the illustrated embodiment, is closed by means of a curved panel 25 of X-ray transparent material, which is secured in the opening in any suitable or preferred fashion as by means of a finishing strip 27 held, as by suitable fastening means such as screws, upon the edges of the panel and on the edges of the casing which define the opening 23.

Side walls 13 are provided with elongated slot-like openings 29 adjacent the forward edges of said side walls, and means forming a way 31 is secured within and on the bottom wall of the casing 21 in position extending between the opposite side walls 13 at the lower ends of the openings 29, a similar way being secured to the upper wall 17 in position extending between the upper ends of the openings 29, whereby said ways are facing and parallel within the casing 21.

The plate changing mechanism within the casing 21 comprises a carrier 33 formed with pivot means 35 defining an axis adjacent one end of the frame about which axis the frame is turnable, said pivot means, at the lower edge of the frame, including a slide pin portion 37 which extends in the way 31 and including, at the upper edge of the frame, a similar slide pin portion extending in the upper way.

The carrier 33 comprises a panel embodying a plate 39 of material, such as lead, impervious to X-rays, which is held by and between a pair of supporting layers 41, the edges of the plates 39 and 41 being secured together by edge pieces 43 defining the edges of the carrier. The opposed faces of the carrier carry plate supporting means 45 at or adjacent and preferably parallel with respect to the opposed upper and lower edges of the carrier. In the illustrated embodiment, the plate supporting means 45 comprise channel members forming facing grooves on the opposed faces of the carrier in which grooves the upper and lower edges of a plate or film enclosing cassette 47 may be received, whereby a pair of cassettes 47 may be mounted on the opposed faces of the carrier, the cassettes, when mounted, facing outwardly of the carrier in opposite directions.

It will be seen that the cassettes 47 may be easily mounted on the carrier 33 by inserting the same through the openings 29 when the carrier is in position between and parallel with respect to the guide means 31. It will be seen also that when the carrier is in cassette receiving position with the pivot means 35 at one end of the guideways, one of the cassettes will be in exposable position in the opening 23. By tilting the carriage about the pivot means 35 while moving the same along the guideway to the opposite end thereof, the position of the carriage will be reversed, thus presenting the other cassette in exposable position in the opening 23.

In making an exposure, the patient or other object to be pictured is placed in front of the curved panel 25, said panel being curved, more particularly, to facilitate the placement of the chest portions of the patient closely adjacent the cassette which, when in exposable position on the carrier 33, is disposed immediately behind the

panel 25. Obviously, the panel 25 could be omitted but is preferred in order to aid the patient in maintaining unchanged position with respect to the apparatus without interfering with the plate changing movement of the carriage. This is accomplished by pressing the patient upon the panel 25, and the patient may, if necessary, be strapped in place.

The exposure, of course, may be made in accordance with usual radiographic technique by placing a source of X-rays at a predetermined distance directly in front of and in line with the opening 23, so that X-rays from the source may penetrate the patient and impinge upon the sensitive material in the cassette 47, which is in position facing the opening. Thereupon, the carriage 33 may be reversed to present the other cassette in exposable position while the position of the patient is maintained unchanged; and thereupon the second exposure may be made.

In making stereoscopic X-ray pictures, the position of the light source is slightly changed by shifting the same so that in successive exposures, X-rays from the source impinge on the sensitive material at unlike angles. It is apparent, however, that immobility of the patient is essential to the production of successful stereoscopic pictures, and I have therefore provided plate changing equipment for reversing the position of the carriage 33 substantially without jar or vibration.

To this end, the frame forming the casing 21 is of rugged construction, and provision is made for supporting the casing firmly in place. An important feature of the present invention resides in the provision of mechanism for accomplishing the reversal of the carriage 33 with utmost smoothness.

The carriage reversing mechanism comprises an arm 51 pivoted, as at 53, on one side of the casing 21, the arm 51 being preferably fastened on a vertical shaft 55 suitably journaled at or adjacent its opposed ends in suitable spaced bearing means 57 rigidly mounted on the casing 21. The end of the arm 51 remote from the pivot 53 is turnably connected on the carrier 33 intermediate the opposed sides of the carriage, the connection preferably comprising axle means 59 in the form of a pin on the carriage preferably at the lower edge thereof, said pin being journaled in the arm 51. If desired, the axle means 59 may comprise another pin at the upper edge of the carriage and received in an arm similar to the arm 51 and fastened on the shaft 55.

Figure 2 of the drawings shows the carriage in position presenting one of the cassettes in exposable position in the opening 23. After such cassette has been exposed, the other may be presented in position to be exposed in the opening 23. By rocking the arm 51 in a clockwise direction, viewing Figure 2, the medial portions of the carriage will swing about the pivot 35 in a counter-clockwise direction, and the pivot means 35 will be simultaneously drawn toward the right, viewing Figure 2, thereby imparting a turning movement to the carriage 33. When the pivot means 35 reaches the right-hand end of the guideway 31, the carriage will have turned about completely to present the cassette, containing unexposed film, in position to be exposed in the opening 23. It will be seen, however, that during substantially the first half of the turning movement, the arm 51 will move in a clockwise direction but will return in a counter-clockwise direction dur-

ing substantially the terminal half of the carriage turning movement.

In order to rock the arm 51, I provide a crank 61 drivingly connected with motor means 85, and a connecting rod 63 pivotally secured at its opposite ends, respectively, on the crank 61 and on the arm 51 intermediate the pivot means 53 and 59. By rotating the crank through one complete turn from the position shown in Figure 2, the arm 51 first will be rocked in a clockwise direction until the position shown in Figure 3 is reached, after which the continued movement of the crank will cause the arm 51 to be returned in a counter-clockwise direction. It will be noted that utilization of the crank 61 in this fashion imparts substantially simple harmonic motion to the arm 51. Carriage turning movement thus starts slowly, the carriage attaining maximum turning speed when the parts are in position shown in Figure 3, and thereafter being decelerated with the motor connected crank 61 operating, in effect, as a brake to bring the carriage to a stop gently at the conclusion of its turning movement. Since the carriage has appreciable weight, its momentum, when traveling at maximum speed in the position shown in Figure 3, will always carry the carriage past the only dead center position afforded by the mechanism.

After completion of the carriage reversing cycle, it is not necessary to reset the mechanism to a starting position, but after the operating cycle of the mechanism has been completed, with the exposure of the film on both sides of the carriage, the film containing cassettes may be dismounted from the carriage through the openings 29, and cassettes containing unexposed film may then be mounted on the carriage without resetting the same, since the reversing mechanism is operable to reverse the carriage, starting from the position shown in Figure 2, with the slide pivot 35 at the left-hand end of the track 31, or from the reverse position in which the slide roller is at the right-hand end of the track.

The bottom 19 of the casing 21 forms a mounting for a housing 71 containing reduction gearing comprising a worm wheel 73, and a worm 75. The worm wheel is drivingly connected on a shaft 77 which projects through the wall 19 and to the end of which the crank 61 is drivingly connected. The opposite end of the shaft 77 projects from the housing 71 and carries a control disk 79. Preferably the wheel 73 is drivingly connected with the shaft 77 in non-positive fashion, permitting the shaft 77 to turn with respect to the wheel in the event that the wheel movement be blocked for any reason, as by the entanglement of a body member of the patient or operator with the cassette carriage 33 during the reversing movement of the carriage. To this end, the wheel 73 is loose on the shaft 77, being clampingly secured thereon by and between friction plates 69 splined or otherwise drivingly connected with the shaft. Means is provided for pressing these plates 69 together on the shaft and into frictional engagement with the opposite sides of the wheel 73 in any suitable fashion, as by means of an abutment 68 and spring means 67 on the shaft and operating to press the plates 69 together on the wheel 73.

The worm 75 is housed in a cylindrical extension 81 of the housing 71 and is formed or otherwise fastened on shaft means projecting at the opposite ends of the extension 81, whereby the worm 75 may be coupled, as at 83, with motive means 85, preferably an electric motor supported

on the under side of the casing wall 19 which is preferably formed with an offset inverted pan portion 87. The worm 75 may also be connected with brake means 89 comprising a split collar 91 suitably supported on the wall 19 and encircling an extension of the worm shaft, said split collar being provided with spring means 93 normally closing the collar upon the worm shaft, means being provided for releasing the brake against the braking urge of the spring 93.

The control disk 79 is generally circular, as shown in Figure 7, but has a flattened edge 95 on one side which edge, when the equipment is in normal or standby condition, faces switch means 97 comprising a pair of normally open switches 98 and 99. These switches comprise spring arms 101, 103 and 105 mounted in a suitable insulating block 107, the arms 101 and 103 forming the switch 98 and the arms 103 and 105 forming the switch 99. The control disk 79, being drivingly connected through the worm wheel and worm with the motor 85, will turn with the shaft 77 during the operating carriage reversing cycle of the apparatus. When the flattened edge 95 of the disk is in position facing the switch means 97, the switches 98 and 99 are open but will close as soon as the disk is turned from the standby position shown in Figure 7, and will remain closed until the disk again reaches standby position after having turned through a complete revolution, whereupon the switches will open.

Means is provided for energizing the motor 85 from a suitable power source 109 under the control of a push button switch 111. To this end, a power conductor 113 from one side of the source to one side of the motor 85 is provided. Another conductor 115 adapted for connection with the other side of the power source extends to one side of the push button switch 111. The other side of the switch may be connected, as by the conductor 117, to the blade of a double pole switch 119. This switch preferably is normally biased, as by the spring 121, to make connection with the motor 85 through a conductor 123. By closing the push button switch 111, power may thus be delivered to the motor through the switch 119. As soon as the motor starts in operation, it will turn the shaft 77 and start the carriage reversing movement by turning the crank 61. At the same time, the control disk 79 will be turned, thus causing closure of the switches 98 and 99. Upon the closure of the switch 98, the push button and the switch 119 will be short circuited, thus connecting the conductor 115 directly through the switch 98 to the conductor 123, thereby insuring operation of the motor until the switch 98 opens at the conclusion of the operating cycle when the flat edge 95 of the disk reaches the standby position shown in Figure 7. Upon the closure of the switch 99, a circuit is completed from the conductor 113 through a relay coil 125 and through the switch 99 and a conductor 127 to the conductor 115, whereby to energize the relay coil and keep the same energized until the switch 99 is opened at the conclusion of the operating cycle of the apparatus. The relay coil 125 is operatively associated with the switch 119 to open the same upon the closure of the switch 99 and thus cut out the push button 111 from controlling connection with the motor 85 during the operating cycle of the equipment, thereby obviating the necessity of holding the button switch down during the operating cycle.

It will be noted that when the switch 119 is in shifted position under the influence of the relay coil 125, it completes a circuit from the conductor 115, through the button switch 111, the conductor 117, and the relay coil 125, to the conductor 113, so that if the button switch is held closed throughout the operating cycle of the apparatus and after the conclusion thereof, the coil 125 will continue to be energized and to hold the switch 119 in position to disconnect the button switch from the motor, thereby preventing a spurious repetition of the operating cycle; but in order to obtain a repetition of the operating cycle, it is necessary to release and repress the button after the conclusion of a preceding cycle.

Where braking means 89 is used, a brake releasing relay coil 129 may be connected between the conductors 113 and 123 as shown, whereby the brake 89 may be released against the urge of the spring 93 as soon as the motor 85 is energized, the brake releasing force being discontinued and the brake being allowed to close under the influence of the spring 93 as soon as the motor 85 is stopped by the opening of the switch 98 at the conclusion of the operating cycle of the apparatus.

Suitable means is provided for supporting the plate changing mechanism 11 at a suitable elevation and, to this end, I preferably provide mounting means permitting the elevation of the equipment 11 to be adjusted. As shown on the drawings, the mounting preferably comprises a support frame 131 comprising a pair of spaced uprights 133 on and between which the casing 21 is supported for adjustable vertical movement. The uprights 133 may conveniently be formed as sheet metal channels which are interconnected, braced and held in spaced relationship by means of a plate or panel 135 and by means of a cap 137 interconnecting the upper ends of the uprights 133 and a brace member 139 interconnecting the lower portions of the uprights. If desired, the support frame 131 may be fastened or anchored directly on a building wall, or it may be mounted on a suitable support pedestal or stand 141 so that the apparatus may be self-supporting in vertical position in any location in which it is desired to use the same.

The uprights 133 form track means comprising guide rails 134. The casing 21 is provided with rollers 136 for supporting the same movably on the rail means and carries a shaft 143 journaled in the casing 21 with the opposed ends of the shaft extending into the channel members 133 and carrying rollers 144. Each of the wheels 144 co-operates with a wheel 136 on the opposite sides of a sheet metal strip forming the rail means 134 so that the wheels 144 have tight frictional contact with the rail means 134 to form frictional driving connection therewith. Obviously, the member 144 and the rail portions with which it co-operates may be formed, respectively, as pinion and rack means, although I find it simpler to make the parts as rollers frictionally engaging the rail in order adequately to support the mechanism in adjusted position and to move the same on the uprights 133.

The shaft 143 preferably extends in a housing 145 fastened on the bottom wall 19 of the casing 21, said housing forming an enclosure for the shaft 143 and driving mechanism 147 which is drivingly connected with the shaft 143 and also the housing 145 enclosing the gear box 71, the motor 85 and the brake means 89.

The driving mechanism 147 for adjusting the

elevation of the plate changing apparatus comprises a gear 149 drivingly connected with the shaft 143 within the housing 145 and a pinion 151 drivingly connected with the gear 149 and fastened on a shaft 153 which is journaled in the housing 145. The shaft 153 carries a sprocket 155 which is drivingly connected, as by means of a chain 157, with a sprocket 159 on a stub shaft 161 which is journaled in an end wall of the housing 145 and has an end extending outwardly thereof and carrying a crank 163. In order to secure the mechanism in adjusted position, the shaft 153 carries a ratchet wheel 165 with which is associated a holding pawl 167, said pawl being pivoted on a bracket 169, which is fastened on the bottom wall 19 of the casing 21 and which forms support for bearings in which the shaft 143 and an end of the crank shaft 163 are journaled. The pawl 167 is normally spring-pressed toward operative engagement with the ratchet wheel 165, which is preferably frictionally held on the shaft 153 so that the mechanism is supported in adjusted position on the uprights 133 by the latching pawl 167 through the frictional grip of the wheel 165 on the shaft 153, the ratio between the gears 149 and 151 being such that this frictional grip is able to support the relatively large weight of the mechanism. Turning of the handle 163, however, in a direction to lower the casing 21 on the uprights 133 will cause slippage of the friction clutch means between the wheel 165 and the shaft 153, thus permitting the housing and its enclosed mechanism to be lowered to any desired position. In raising the housing, the wheel 165, of course, will turn with the shaft 153, the pawl 167 simply slipping over the teeth of the ratchet wheel 165.

It is thought that the invention and its numerous attendant advantages will be fully understood from the foregoing description, and it is obvious that numerous changes may be made in the form, construction, and arrangement of the several parts without departing from the spirit and scope of the invention, or sacrificing any of its attendant advantages, the form herein described being a preferred embodiment for the purpose of illustrating the invention.

The invention is hereby claimed as follows:

1. A plate shifter for X-ray sensitive material comprising panel means, means for supporting sensitive material on the opposite sides of said panel means, and driving means connected with said panel means and operable to reverse said panel means in place, whereby to successively present light-sensitive material on the opposite sides of said panel means in position for exposure.

2. A plate shifter for X-ray sensitive material, comprising panel means, means for supporting sensitive material on the opposite sides of said panel means, driving means connected with said panel means and operable to reverse said panel means in place, including track means forming a track, follower means on the panel means for connecting the same at one end for sliding movement along and relative angular movement with respect to said track means, and means connecting said driving means on said panel means in spaced relationship with respect to said follower means.

3. A plate shifter for X-ray sensitive material, comprising panel means, means for supporting sensitive material on the opposite sides of said panel means, driving means connected with said panel means and operable to reverse said panel means in place, including means for mounting

the panel means for pivotal and sliding movement about an eccentric axis in a predetermined path, said driving means being connected to exert pressure on the panel means in a direction laterally with respect to said path of movement, whereby to turn the panel means about said axis and move the same in said path in order to reverse the panel means in place.

4. A plate shifter for X-ray sensitive material, comprising panel means, means for supporting sensitive material on the opposite sides of said panel means, driving means connected with said panel means and operable to reverse said panel means in place, wherein the driving means is pivotally connected on the panel means at the medial portions thereof, whereby to draw the central portions in a direction laterally with respect to the said path along which the guided portions of the panel means are moved.

5. A plate shifter for X-ray sensitive material, comprising panel means, means for supporting sensitive material on the opposite sides of said panel means, driving means connected with said panel means and operable to reverse said panel means in place, wherein said driving means comprises a rotatable crank connected with the panel means to impart simple harmonic motion thereto in turning the same so that the panel means may be uniformly accelerated from and decelerated to stationary position to thus accomplish reversal of the panel means without jar.

6. A plate shifter for X-ray sensitive material, comprising panel means, means for supporting sensitive material on the opposite sides of said panel means, driving means connected with said panel means and operable to reverse said panel means in place, wherein the driving means comprises motor means drivingly connected with the panel means through a slip clutch to prevent damage to the panel means if obstructed during its cycle of reversing movement.

7. A plate shifter for X-ray sensitive material, comprising panel means, means for supporting sensitive material on the opposite sides of said panel means, driving means connected with said panel means and operable to reverse said panel means in place, wherein the driving means comprises a crank, means for turning the crank, and a connecting rod drivingly interconnecting the crank with said panel means.

8. A plate shifter for X-ray sensitive material, comprising panel means, means for supporting sensitive material on the opposite sides of said panel means, driving means connected with said panel means and operable to reverse said panel means in place, wherein the driving means comprises a shaft, means to turn the shaft, means drivingly connecting the shaft with said panel means, brake means normally holding the shaft in brake condition, and means for releasing said brake during the cycle of reversing movement of said panel means.

9. A plate shifter for X-ray sensitive material, comprising panel means, means for supporting sensitive material on the opposite sides of said panel means, driving means connected with said panel means and operable to reverse said panel means in place, wherein said driving means comprises an electric motor drivingly connected with said panel means, and switch means for controlling said motor, said switch means being controlled by said panel means.

10. A plate shifter for X-ray sensitive material, comprising panel means, means for supporting sensitive material on the opposite sides of said

panel means, driving means connected with said panel means and operable to reverse said panel means in place, wherein said driving means comprises an electric motor drivingly connected with said panel means, switch means for controlling said motor, manually operable means for starting said motor in operation, and control means controlled by the position of said panel for maintaining said motor in operation during the course of the reversing cycle of said panel means and operable to stop the motor at the conclusion of the reversing cycle.

11. A plate shifter for X-ray sensitive material, comprising panel means, means for supporting sensitive material on the opposite sides of said panel means, driving means connected with said panel means and operable to reverse said panel means in place, wherein said driving means comprises an electric motor drivingly connected with said panel means, switch means for controlling said motor, manually operable means for starting said motor in operation, and control means controlled by the position of said panel for maintaining said motor in operation during the course of the reversing cycle of said panel means and operable to stop the motor at the conclusion of the reversing cycle, said control means comprising a control member drivingly connected for movement with said panel means and operatively associated with said switch means to maintain the motor in operation during the reversing cycle of said panel means and to disable the motor at the conclusion of said cycle.

12. A plate shifter for X-ray sensitive material, comprising panel means, means for supporting sensitive material on the opposite sides of said panel means, driving means connected with said panel means and operable to reverse said panel means in place, wherein said driving means comprises an electric motor drivingly connected with said panel means, switch means for controlling said motor, manually operable means for starting said motor in operation, control means controlled by the position of said panel for maintaining said motor in operation during the course of the reversing cycle of said panel means and operable to stop the motor at the conclusion of the reversing cycle, said control means comprising a control member drivingly connected for movement with said panel means and operatively associated with said switch means to maintain the motor in operation during the reversing cycle of said panel means and to disable the motor at the conclusion of said cycle, separate manually operable switch means for starting the motor in operation, and interlock means associated with said separate switch means for preventing operation of the motor after the conclusion of an operating cycle until after said separate switch means has been manually released.

13. A plate shifter for X-ray sensitive material, comprising panel means, means for supporting sensitive material on the opposite sides of said panel means, driving means connected with said panel means and operable to reverse said panel means in place, wherein said driving means comprises an electric motor drivingly connected with said panel means, switch means for controlling said motor, manually operable means for starting said motor in operation, control means controlled by the position of said panel for maintaining said motor in operation during the course of the reversing cycle of said panel means and operable to stop the motor at the conclusion of the reversing cycle, said control means comprising

a control member drivingly connected for movement with said panel means and operatively associated with said switch means to maintain the motor in operation during the reversing cycle of said panel means and to disable the motor at the conclusion of said cycle, separate manually operable switch means for starting the motor in operation, interlock means associated with said separate switch means for preventing operation of the motor after the conclusion of an operating cycle until after said separate switch means has

5 been manually released, said interlock means comprising a holding relay adapted to disable motor control by said manual switch, and means, operable upon the commencement of the reversing cycle, to energize said relay and to deenergize the same at the conclusion of the operating cycle only in the event that said manual switch shall have been released at the conclusion of said operating cycle.

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