

June 5, 1956

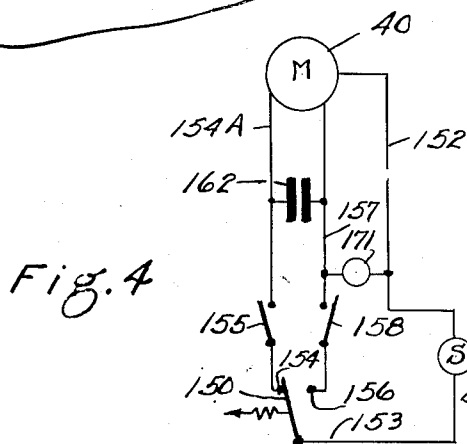
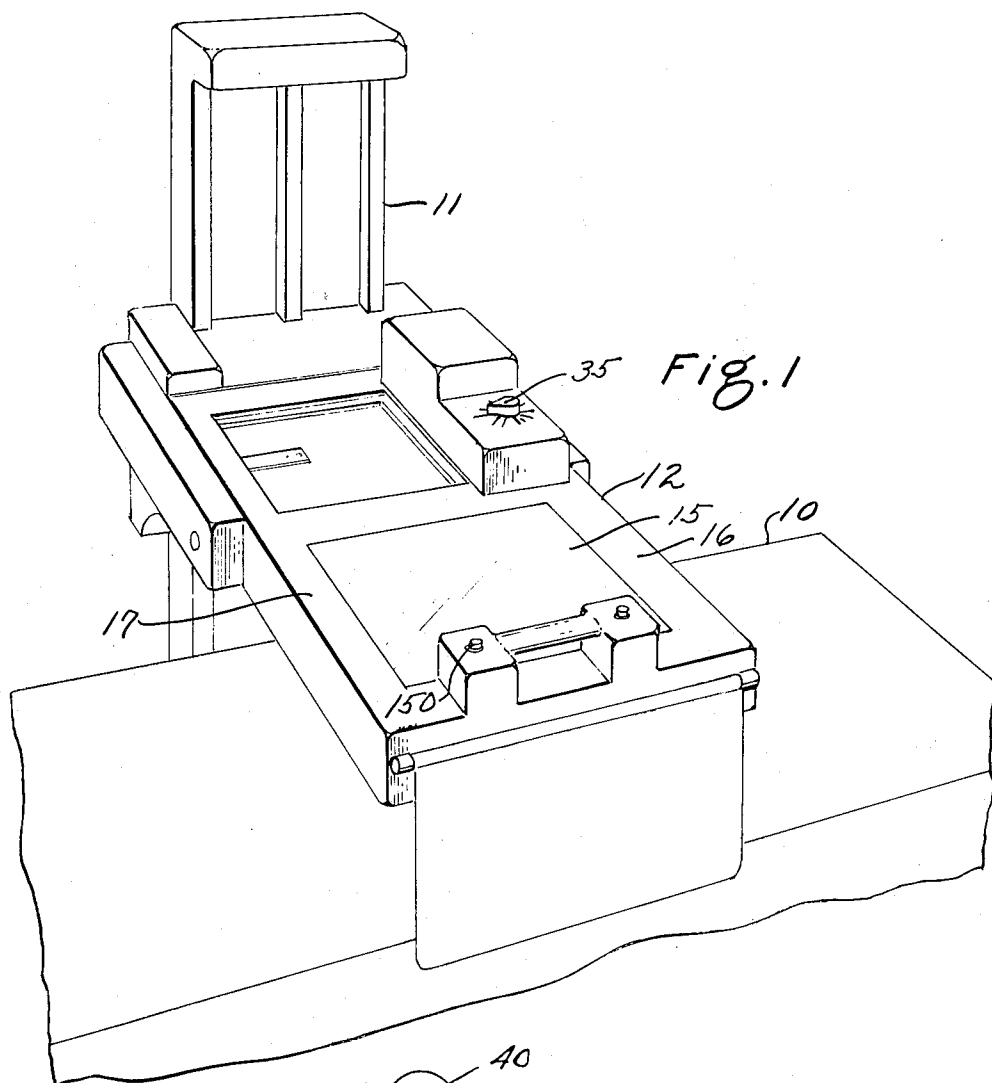
R. J. STAVA ET AL

2,749,445

X-RAY APPARATUS

Filed May 11, 1951

8 Sheets-Sheet 1



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BY EDGAR J. BASTIN

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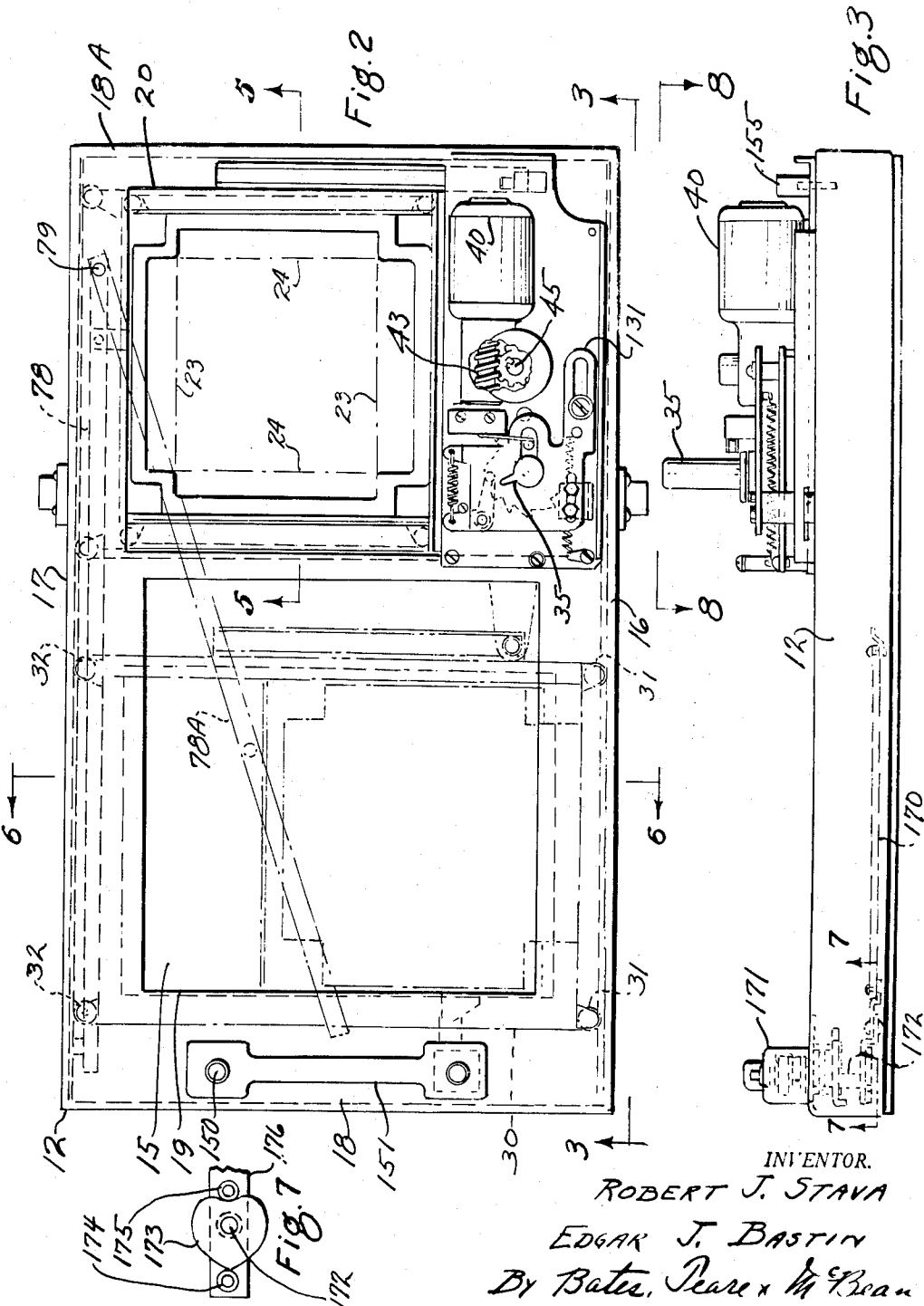
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X-RAY APPARATUS

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8 Sheets-Sheet 2



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X-RAY APPARATUS

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8 Sheets-Sheet 3

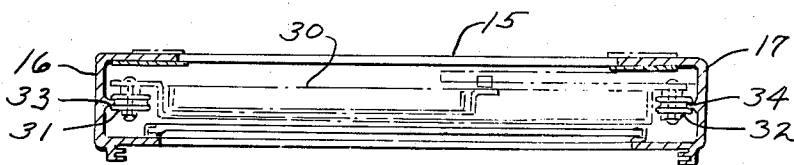


Fig. 6

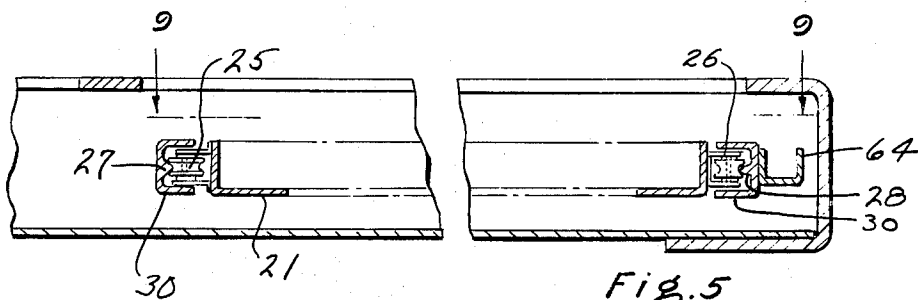


Fig. 5

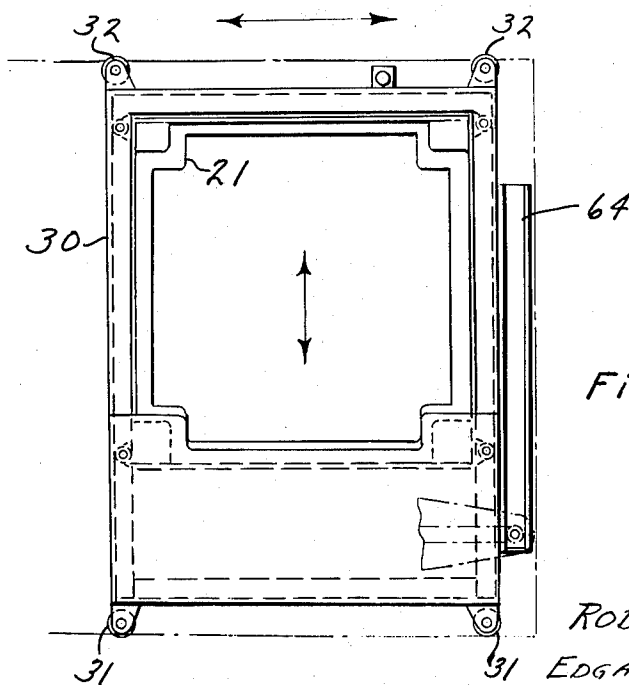


Fig. 9

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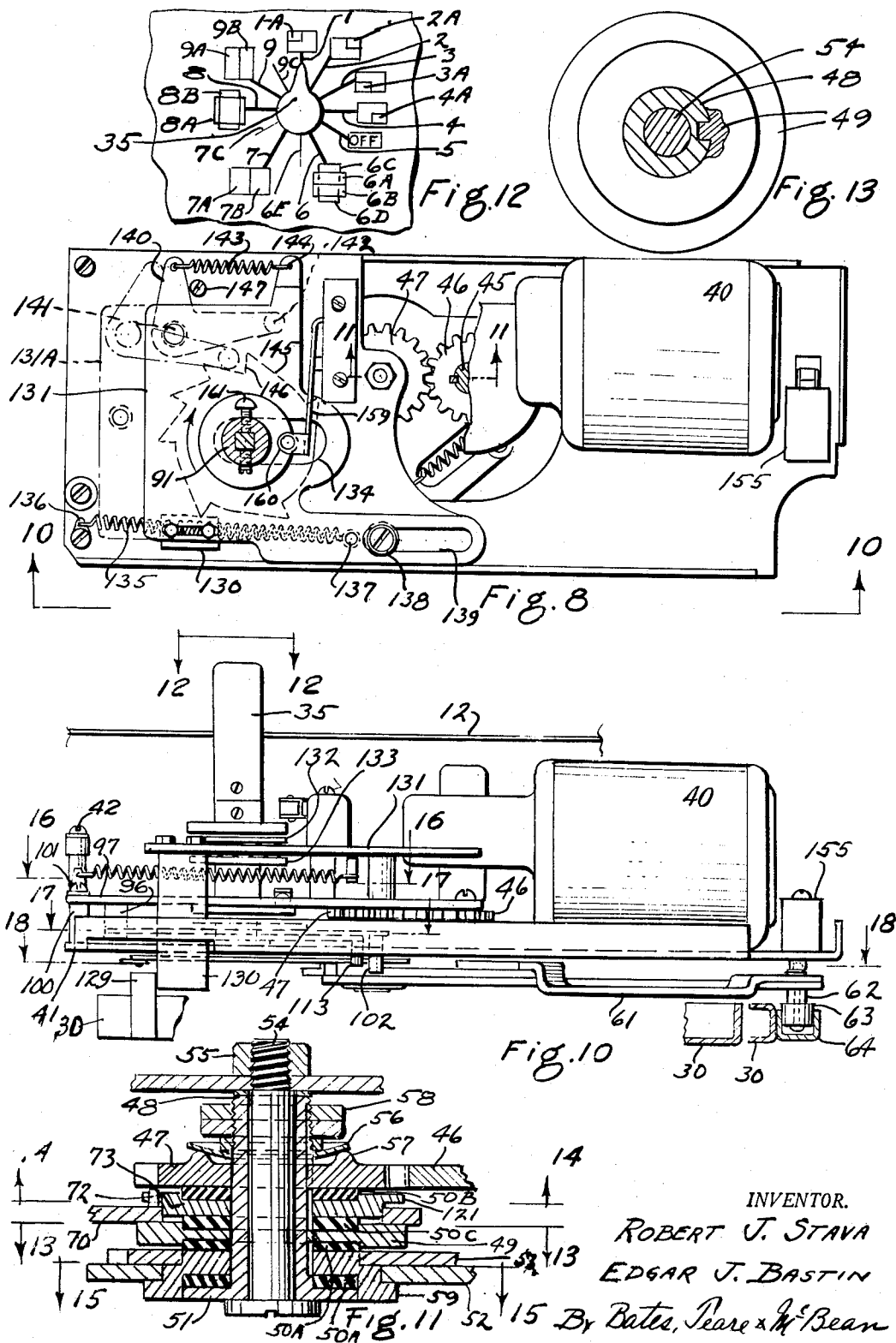
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2,749,445

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June 5, 1956

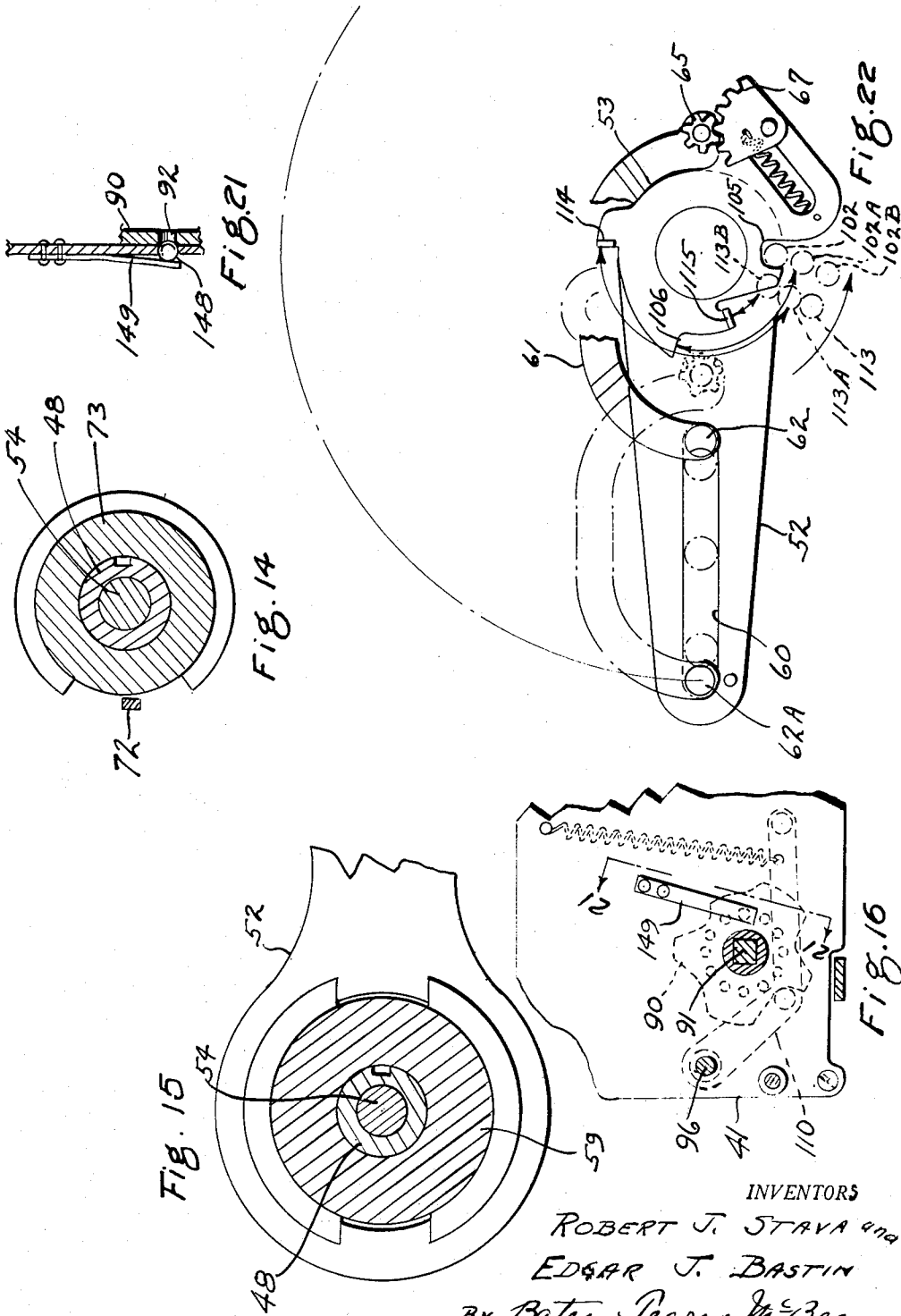
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X-RAY APPARATUS

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8 Sheets-Sheet 5



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X-RAY APPARATUS

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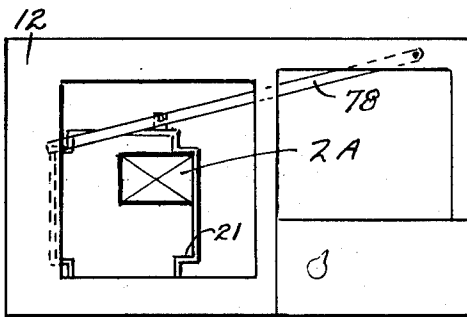
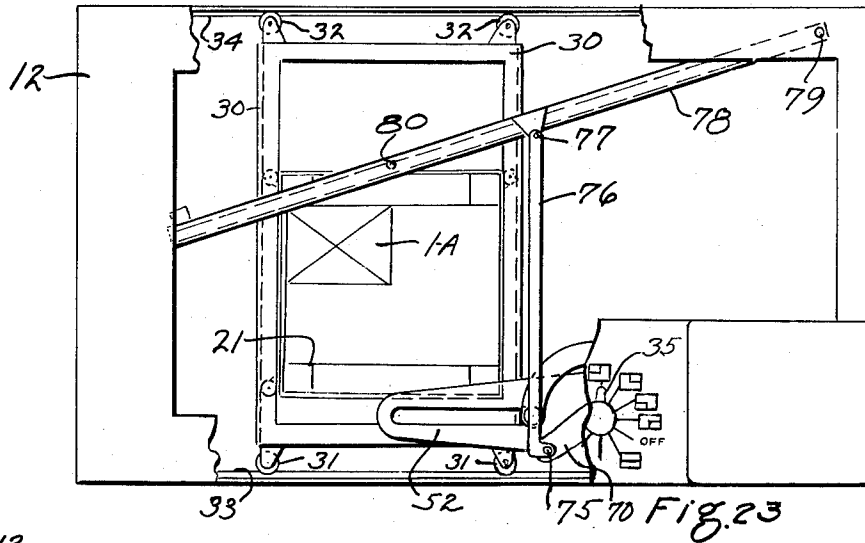


Fig. 24

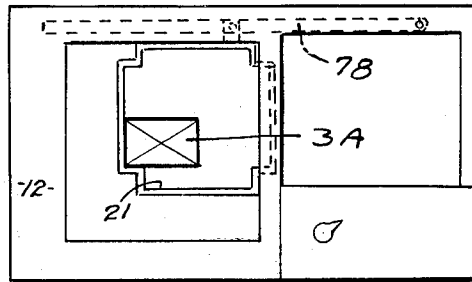


Fig. 25

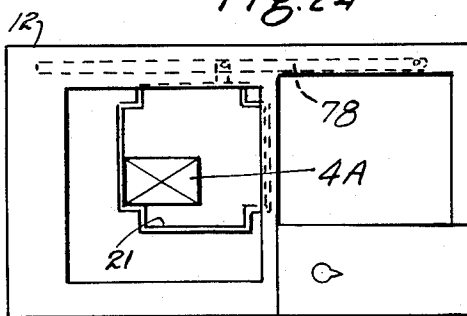


Fig. 26

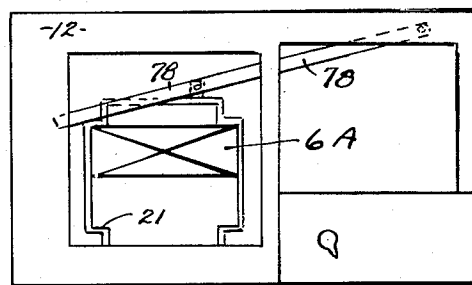
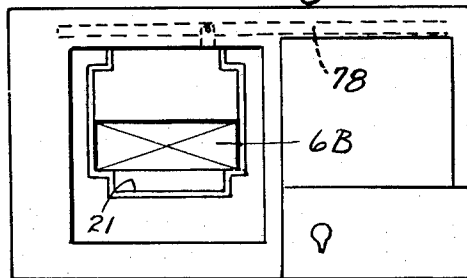


Fig. 27



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X-RAY APPARATUS

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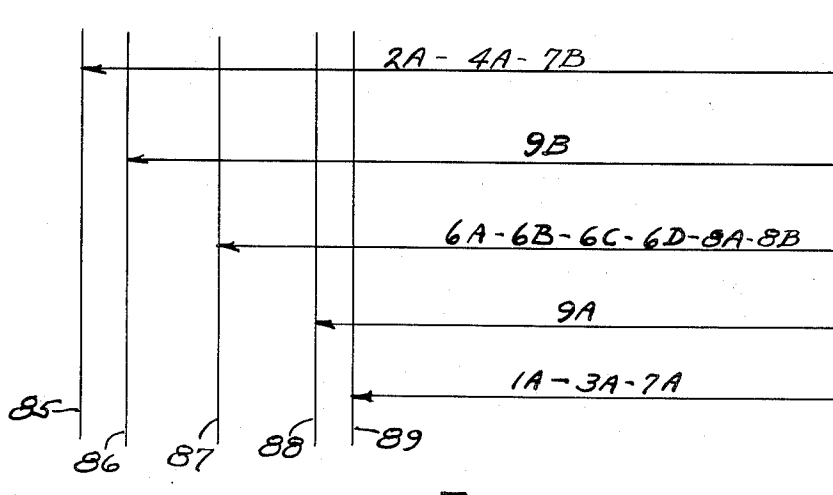


Fig. 29

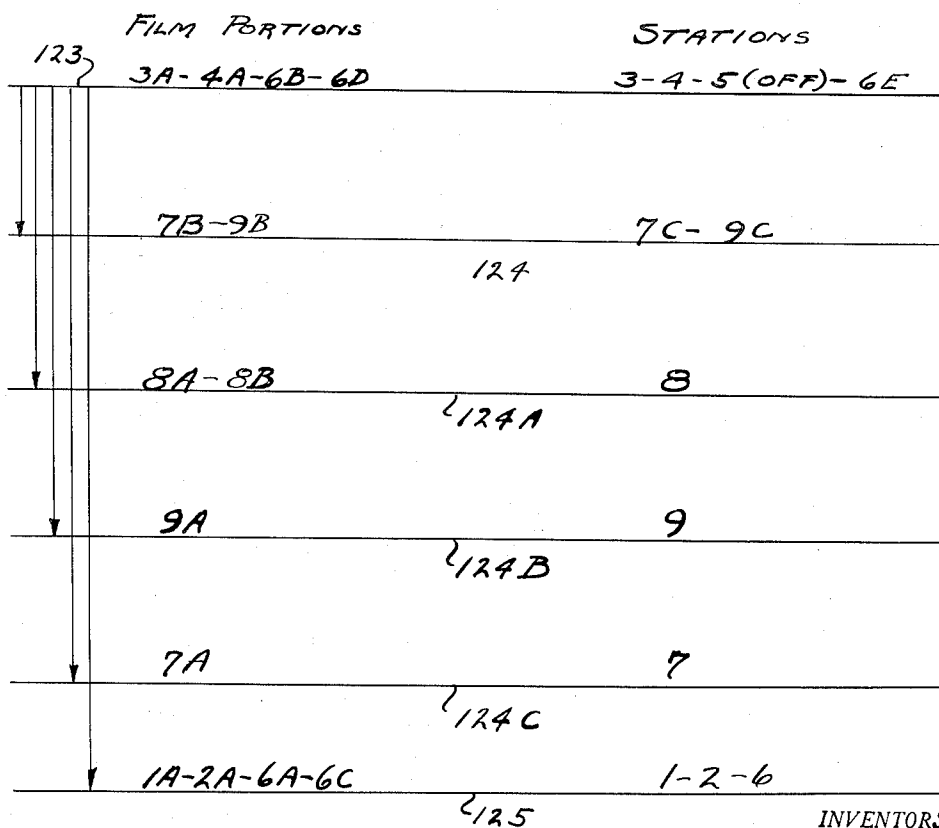


Fig. 30

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2,749,445

X-RAY APPARATUS

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Application May 11, 1951, Serial No. 225,777

13 Claims. (Cl. 250—66)

This invention relates to X-ray apparatus and particularly to equipment which is known in the trade as a "spot film" device.

Heretofore an effort has been made to center the serial films on the axis of the primary or X-ray beam, but distortion has occurred due to the fact that the film being 8" x 10" would, when divided into quarters and placed in either longitudinal or transverse position, have the centers of the respective quarters disposed in off-center position with the respect to the axis of the primary beam. As a result, the image cast upon the film is not in the same order as that visualized in the fluoroscopic screen and fluoroscopic examination.

The primary object of the present invention is the provision of mechanism which operates automatically for centering as nearly as possible either the quarter or half sections of an 8" x 10" film with respect to the primary beam, wherever such sections are intended for exposure serially to the primary beam. The invention contemplates automatic substantial centering of the film sections whenever the cassette containing the film is placed within the carrier either in a direction extending longitudinally of the screen frame or transversely thereof.

The invention also contemplates a mechanism which is compact in size and which will enable the overall dimensions of the housing to be kept within reasonable limits. The invention additionally contemplates a construction by means of which the screen may be positioned as closely as possible to the patient in order to reduce the manifestation between what is seen visually in the screen and what is obtained upon the X-ray film. It is desirable additionally to keep the screen as closely as possible to the patient in order to reduce secondary radiation which tends to cause the image to be less distinct.

The invention additionally contemplates the construction of a reciprocating grid which is also small and compact in construction, and which is intended for the purpose of increasing the sharpness of the image during radiography.

Briefly, the invention embodies a fluoroscopic screen housing which is movable along the tube stand under the control of the operator, and which is adapted to extend across the face of the table. The housing has a fluoroscopic screen mounted in one end thereof, together with an opening at the other end through which the cassette is inserted onto a carrier by means of which the film may be moved beneath the screen whenever radiography is desired. The mechanism forming the present invention is so arranged as to operate automatically under the action of an electric motor to advance the cassette carrier in sequence—where sequence is desired—and to move the carrier with the associated cassette both longitudinally and laterally if necessary with respect to the housing and to stop it automatically in such a position that the center of the portion of the film to be exposed will be substantially centrally positioned with respect to the axis of the primary beam.

The screen housing also contains the mechanism for reciprocating the bucky grid, and briefly, embodies an

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electric motor, the shaft of which is disposed vertically and is adapted to operate a heart-shaped cam which, in turn, is arranged to engage followers that are mounted upon an arm. The arm in turn is fixed to the grid whereby rotation of the motor effects reciprocation of the grid.

Referring now to the drawings, Fig. 1 is a perspective view showing X-ray apparatus having the present invention associated therewith; Fig. 2 is a top plan view of the fluoroscopic screen housing having a portion thereof removed to show the mechanism for actuating the cassette carrier; Fig. 3 is a side elevation of the screen arm shown in Fig. 2, taken in the direction shown by the arrows 3—3 in Fig. 2; Fig. 4 is a wiring diagram; Figs. 5 and 6 are sections taken on planes indicated by the correspondingly numbered lines in Fig. 2; Fig. 7 is a section taken on a plane indicated by the line 7—7 in Fig. 3; Fig. 8 is a top plan view partly in section of the mechanism shown in Fig. 2, but on a scale larger than that shown in Fig. 2; Fig. 9 is a top plan view of the cassette carrier taken on a plane indicated by the line 9—9 in Fig. 5; Fig. 10 is a sectional view partly in elevation showing the mechanism of Fig. 8 taken in a direction indicated by the line 10—10 in Fig. 8; Fig. 11 is a vertical section taken on a plane indicated by the line 11—11 in Fig. 8; Fig. 12 is a top plan view of an indexing panel; Figs. 13, 14 and 15 are sections taken on planes indicated by the lines 13—13, 14—14 and 15—15 respectively in Fig. 11; Figs. 16, 17 and 18 are horizontal sections taken on planes indicated by the respective lines 16—16, 17—17 and 18—18 in Fig. 10; Figs. 19 and 20 are sectional views illustrating two of the cams used in the automatic control mechanism, the views being taken in a direction looking down in Fig. 18; Fig. 21 is a section taken on a plane indicated by the line 21—21 in Fig. 16; Fig. 22 is a top plan view of the actuating arm for effecting longitudinal travel of the cassette carriage; Figs. 23 to 26 are top plan views illustrating the relative positions of the cassette carrier with respect to the screen arm for four serial positions of the film during exposure; Figs. 27 and 28 are similar views for two consecutive exposures but the film arranged for exposing half sections; Fig. 29 is a chart showing the various positions of longitudinal travel of the cassette carriage with respect to a base line (retracted position) for the selections of film illustrated; Fig. 30 is a similar chart showing positions of cross travel of the cassette tray with respect to the carriage.

The apparatus shown in the drawings is illustrated in connection with a table 10, a tube stand 11, and a screen arm 12 which is movable along the tube stand in any suitable way. The arm 12 carries a fluoroscopic screen 15, the center of which is substantially in line with the axis of the X-ray or primary beam. The arm includes a housing in the form of a hollow rectangular frame having side portions 16 and 17 and end portions 18 and 18A respectively. The top face of the housing has an opening 19 through which the screen is visible and has another opening 20 through which the film carrying cassette may be inserted into a tray or carrier 21. The film normally used is 8" x 10" hence, the tray 21 has an opening shaped to receive the cassette with the long dimension of the film extending either longitudinally of the arm or transversely of the arm. In the former position, the longitudinal edges of the cassette would be in the position indicated by the broken lines 23 in Fig. 2 and when positioned transversely of the arm, the long edges of the cassette would be indicated by the broken lines 24 in Fig. 2.

The cassette tray 21 is mounted for movement in a direction extending transversely of the screen arm, preferably by means of rollers 25 and 26 (Fig. 5) which engage tracks 27 and 28 respectively within a carriage indicated in general at 30. The carriage, in turn, is mounted for movement in a direction extending longitudinally of the screen arm, preferably by rollers 31 and 32 which are

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adapted to move along tracks 33 and 34 on the side portions 16 and 17 respectively of the screen arm housing. Thus the film carrying cassette may be moved beneath the screen upon movement of the carriage 30 along its trackway, and may be moved transversely of the screen arm upon movement of the tray 21 along the trackway within the carriage 30. The present invention includes mechanism for automatically stopping the longitudinal movement of the carriage as well as the transverse movement of the tray at predetermined positions in accordance with the pre-selected portion of the film to be exposed, the mechanism operating to center as nearly as possible that portion of the film to be exposed in alignment with the axis of the primary beam.

Film patterns

By using an 8" x 10" film, and by placing the cassette either in longitudinal or transverse position with respect to the screen arm, various portions of the film can be exposed and in pre-selected sequence of operation. Thus, by reference to Fig. 12 with the pointer 35 in the position shown at 1 the upper left hand quarter of the film indicated at 1-A would be exposed. Similarly, extending in a clock-wise direction around Fig. 12, the next station indicated at 2 would expose the upper right hand quarter 2-A of the film, the next station 3 would expose the lower left hand quarter indicated at 3-A, and the next station 4 would expose the lower right hand quarter indicated at 4-A. At stations 1, 2, 3 and 4 the film extends longitudinally of the screen arm. Station 5 is an "off" position, which interrupts the flow of current through the actuating motor for operating the cassette carrier. At station 6, the upper half of the longitudinally extending film indicated at 6-A would first be exposed and then at station 6-E the lower half 6-B would be exposed. On the other hand when the film extends transversely of the screen arm, then in the first exposure at station 6 the upper half 6-C would be exposed, while on the succeeding operation at station 6-E the lower half 6-D would be exposed.

At station 7 the film extends longitudinally of the screen arm but is divided transversely so that the first operation would expose the portion 7-A and the second operation at station 7-C would expose the portion 7-B.

At station 8, when the film extends longitudinally of the arm, then it would be in the position indicated at 8-A, and when it extends transversely of the screen arm, it would be in position indicated at 8-B.

At station 9, the film extends transversely of the screen arm, and the first operation would expose the left hand portion 9-A and the second operation at station 9-C would expose the right hand portion 9-B.

The mechanism is arranged to expose stations 1 to 4 in sequence, so that an operator may quickly take exposures serially. By having the "off" position next in sequence after station 4, then an operator working in a dark room would not be apt to make a double exposure.

Longitudinal travel

An electric motor 40 mounted on a base plate 41 which, in turn, is fastened to the top face of the housing, by securing members 42 operates through reduction gearing 43 to drive a vertically disposed shaft 45. The gear 46 fixed to the shaft 45 meshes with the gear 47 which is fixed to a sleeve or spindle 48, to which is keyed a clutch plate 49.

In Fig. 11 the clutch plate 49 is shown as being positioned intermediate the gear 47 and the lower end of the spindle 48. Such spindle has a flange 51 adjacent the lower end thereof and is held in rotatable position by means of a stud bolt 54, the head of which engages the lower end of the spindle and the upper end of which is threaded to receive a nut 55.

The clutch plate 49 operates through suitable clutch facings to drive units for effecting longitudinal travel of

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the carriage and for effecting cross travel of the cassette tray with respect to the carriage. The unit for effecting longitudinal travel is disposed beneath the plate 49 while the unit for effecting cross travel is disposed above the plate 49 (Fig. 11). Suitable clutch facings are utilized for making the driving connection, and tension may be placed upon the clutch members as a unit by means of a resilient disk-like member 56, which rests upon an annular rib or projection 57 on the driven gear 47. Pressure may be exerted against the disk by means of nuts 58 which are threaded onto the spindle 48.

The driving unit for longitudinal travel includes an arm 52 which is shown as a flat plate-like member having a slot 60 extending radially thereof and adjacent the outer end thereof (Figs. 18 and 22). The plate 52 is keyed to a clutch plate 59 which is free to turn on the spindle 48, and which has clutch facings 50 and 50A interposed between it and the plate 49 and flange 51 respectively.

A shift lever 53 is positioned on the plate 59 above the arm 52 and is free to turn on the plate 59 and is not in contact with the clutch facings. The shift lever, 53, is however, connected to the arm 52 by means of a link 61 which embodies a curved arm (for clearance purposes) and which carries a pin 62 adjacent the outer end thereof for extending through the slot 60. The pin 60 carries a roller 63 which is adapted to move in a channel-like guideway 64 upon the carriage 30. The inner end of the link 61 terminates in a gear sector 65 and is pivoted at 66 to the shift lever 53. The gear sector is arranged to mesh with a gear sector 67 which is mounted for oscillation on the shift lever by a pin 68. A spring 69 having one end attached to the shift lever and the other end to the gear sector 67 tends to urge the gear sector in a counter-clockwise direction, as viewed in Fig. 18. By utilizing the intermeshing gear sectors, we are able to amplify the extent of motion of the shift lever length with respect to the driving lever 52.

The foregoing arrangement is such that whenever the motor 40 is actuated, the driving lever, through the intermediary action of the clutch, swings in a counter-clockwise direction as viewed from the top in Fig. 18 and thereby moves the carriage 30 along its trackway to advance the film beneath the screen. The extent to which the driving plate is permitted to function is dependent upon the location at which the forward motion of the carriage is to be arrested. That mechanism, however, will be later described.

Cross travel of film

As previously stated, the cassette tray is mounted for movement within the carriage 30 and in a direction extending transversely of the screen arm. The mechanism for effecting such movement includes a cross travel lever or arm 70 which comprises a flat plate-like member and which is positioned intermediate the clutch plate 49 and a clutch plate 73. Clutch facings 50B and 50C are disposed between the plate 73 and the gear 47 and plate 49 respectively. The member 70 is not in contact with any clutch facing but has a lost motion connection with the clutch plate 73, the connection taking the form of a lug 72 on the lever and an arcuate slot 71 in the plate 73 (Fig. 17).

The outer end of the cross travel arm 70 is pivotally connected at 75 to a cross travel link 76 (Fig. 23), the other end of which is pivotally connected at 77 to an inverted channel-shaped guideway 78. One end of the guide way is pivoted at 79 to the screen arm housing while the tray has a connection therewith in the form of a roller 80 which is carried by the tray and extends into the guide way 78. Thus, angular movement of the arm 70—in a counter-clockwise direction as viewed in Fig. 23—swings the guide 78 about its pivot 79 and thereby moves the cassette tray transversely within the carriage 30. The extent of such movement is determined in accordance with the particular portion of the

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film to be exposed, but the mechanism for effecting such movement and of correlating it to the longitudinal travel will hereinafter be described.

Mechanism for controlling the longitudinal travel

Fig. 18 shows, in full lines, the position of the longitudinal driving arm 52 and its associated mechanism for the retracted position of the carriage 30. The driving arm 52 may be swung 180° for its maximum extent of travel, at which time the trackway 64 on the carriage occupies the dotted lines indicated at 64A in Fig. 18. At such time, the center line passing through the axis of the pin 62A is indicated by the dot and dash line 85. That extent of travel is utilized for making exposures on the film portions designated 2A, 4A and 7B respectively in Fig. 12.

Provision is made for stopping the angular movement of the driving lever 52 at distances short of that indicated at 52A, such distances being indicated by the dot and dash lines 86, 87, 88 and 89 respectively. The line 86 indicates the position of the axis of the pin 62 for making an exposure on that portion of the film indicated at 9B in Fig. 12. The line 87 indicates the line on which the axis of the pin 62 would stop for making exposures on the film portions indicated at 6A, 6B, 6C, 6D, 8A and 8B of Fig. 12. The line 88 indicates the line on which the axis of the pin 62 would stop for making an exposure on the portion of the film indicated at 9A in Fig. 12, and the line 89 indicates the line on which the axis of the pin 62 would stop for making an exposure on the portions of the film indicated at 1A, 3A and 7A of Fig. 12.

The mechanism for selectively stopping the axis of the pin 62 on any of the predetermined lines 85 to 89 respectively includes a cam 90 (Figs. 18 and 20), which is mounted upon an indexing spindle 91 at the upper end of which is mounted the indexing pointer 35. The cam 90 has a series of indentations on the periphery thereof (Fig. 20), and a series of substantially equally spaced holes 92, the latter of which are utilizable for indexing purposes in coaction with an indexing ball which will hereinafter be described more in detail.

In the position shown in Fig. 20, which would be the position for stopping the longitudinal travel at the line 89, the pin 93 on lever 94 engages indentation 95 on cam 90. The other indentations and lands are suitably angularly spaced on the cam 90 to effect stoppage at the various other lines 85 to 88 inclusive, as desired.

The lever 94 is pivoted at 96 on a pin which extends between the stationary base plate 41 and the top plate 97. The top plate 97 is held in spaced relationship to the base plate by means of sleeves or bushings 100 through which threaded fastening members 101 extend. The lever 94 carries, at its free end, a pin 102 and the lever is urged in a counter-clockwise direction, as viewed from the top by means of a spring 103 one end of which is fastened to the lever, and the other end of which is anchored at 104 to the top plate 97. The pin 102 extends downwardly from the lever 94, as viewed in Fig. 20, and its function is to engage suitably spaced shoulders on the shift lever 53.

In the position shown in Fig. 18, the pin 102 extends into a shouldered recess 105 (Fig. 22), whereby angular movement of 53 is prevented. At such time, whenever the motor 40 is started, the clutch operates to rotate the driving lever 52 and the arrangement is such that the pin 62 will stop on the line 89. That conforms to station 1A of Fig. 12.

Upon the selection of other stations in Fig. 12, the cam 90 swings the lever 94 about its pivot 96 and thereby causes the pin 102 to occupy different angular positions with respect to that shown in full lines in Fig. 20, thereby enabling the pin to engage shoulder 106 on lever 53 which would cause the longitudinal travel to stop on the line 87, at which time the pin 102 occupies the position 102A

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(Figs. 20 and 22). The third position shown at 102B allows the lever 53 to swing through entire 180° with the driving lever 52.

The pin 102, therefore, controls three positions, that is, stoppage on the lines 89, 87 and 85 respectively.

The mechanism for causing the pin 62 to stop on the lines 86 and 88 respectively, includes a cam 107 which is also mounted on the indexing spindle 91 and which has an indented portion 108 on its periphery. The cam follower 109 on the lever 110 is urged against the cam by means of a spring 111, which is shown as a U-shaped member having one end bearing against a fixed pin 112, and the other end bearing against a pin 113 adjacent the free end of the lever. The other end of the lever is pivoted at the pin 96. In the position shown in Figs. 18 and 19, the pin 109 engages a land on the cam 107 and thereby holds the pin 113 in a position such that it will not engage any shoulder on the lever 53. This takes place while the pin 102 is positioned either in the recess 105 or in engagement with the shoulder 106 on the lever 53. In other words, the pin 113 is held out of the path of travel of any shoulder on the lever 53 so long as the pin 102 is in any position to engage 53.

Conversely, the pin 102, when in the position 102B is active to permit the 180° travel of the lever 53 provided the pin 113 is in the position shown in the full lines in Fig. 19. When, however, the pin 102 is in the position 102B, then the pin 113 can occupy the positions 113A or 113B, at which time the follower 109 will occupy some portion of the indentation 108. When the pin is in the position 113A, then it is in position to engage a shoulder 114 on 53, whereby angular movement of the lever 53 is then arrested. At such time, the pin 102 occupies the position 102B. In the position 113B, the pin is interposed in the path of travel of the lever 53 so as to engage the shoulder 115 (Fig. 22). Again at such time, the pin 102 is in the position 102B.

Inasmuch as the cams 90 and 107 are keyed to the same index spindle 91, the proper sequence of operation of the pins 102 and 113 is maintained regardless of the direction in which the pointer 35 is rotated.

Mechanism for controlling the cross travel

The cross travel of the cassette tray within the carriage 30 is controlled by the cross travel arm 70 by a cam 116 and by a control lever 117. The cross travel lever as previously stated, is mounted for limited travel with relation to clutch plate 73 and has its free end pivotally connected at 75 to the cross link 76. The cam 116 is fixed to the index spindle 91, whereas the lever 117 is pivoted to the pin 96. As shown in Fig. 17, the cross travel lever 70 is beneath the lever 117, and the latter is beneath the cam 116.

There is a co-action between the lever 117 and the lever 70 by means of a pin 118 which extends upwardly from the lever 70 and into a slot 119 adjacent the free end of the lever 117. There is also co-action between the lever 117 and the cam 116, by means of a pin 120 which is carried by the lever 117 and extends upwardly therefrom. The pin 120 is adapted to enter indented portions in the periphery of the cam 116, and, whenever the pin occupies such indented portions, the cam 116 cannot be manually rotated. Normally, when the carriage 30 is in the fully retracted position, the lever 70 occupies the full line position (Fig. 17) at which time the pin 120 has been moved outwardly to clear the cam slot under the action of the pin 118 and slot 119. At such time, the cam 116 can be freely rotated manually to any desired position. That shown in Fig. 17 is the position occupied by the cam for positioning the film for exposure of 1A (Fig. 12). The fullest extent of angular movement of arm 70 is indicated by the broken lines 70A. On the retractive movement, the lever 70 is swung back to the full line position by virtue of the reversal of direction of rotation of the motor 40, and such movement operates to lift the pin 120 out of the

groove or notch in the cam 116. Thereupon, the cam can be indexed to the next position, either automatically in case of a series, or manually, as desired.

As previously stated, the cross travel lever has a limited motion about the axis of the spindle 48 and has a limited motion with respect to the clutch plate 73. The limited motion is governed by the lug 72 which is disposed within the slot or recess 73A, and the arrangement is such that whenever the carriage is in the retracted position, the lug 72 is at the end of the slot 73A designated 73B. Then, as the carriage starts forwardly, whenever the screen arm is disposed horizontally, the clutch plate 73 is rotated until the end 73C of the slot 73A engages the lug 72. Thereafter, the plate 73 will drive the arm 70 provided the pin 120 is free to enter one of the notches in the cam 116.

The purpose of the pin and slot connection between the arm 70 and the clutch plate 73 is to diminish the torque required for initiating the travel of the carriage. In other words, the load incident to the cross travel movement, does not come upon the motor until after the longitudinal travel has been started to a predetermined extent.

There are various conditions under which the cross travel of the tray occur. The first is that no cross travel occurs or in other words, the tray partakes only of longitudinal motion with respect to the screen arm. Those are for the positions 3A, 4A, 6B and 6D in Fig. 12 respectively. The other conditions are where the tray stops at various intermediate positions in its path of travel transversely of the arm, and such positions are utilized for exposing the portions of the film indicated at 7A, 7B, 8A, 8B, 9A, and 9B respectively in Fig. 12. The extreme condition occurs in the furthestmost travel of the tray transversely of the screen arm and that occurs for exposing portions of film indicated at 1A, 2A, 6A and 6B respectively in Fig. 12. The foregoing conditions are illustrated diagrammatically in Fig. 30 in which the base line or position of no transverse travel of the tray is indicated at 123, and the lines of intermediate travel are indicated at 124, 124A, 124B and 124C, while the line of extreme travel is indicated at 125. The chart also shows the stations at which the portions to be exposed are located.

The mechanism for restraining the cross travel of the tray with respect to the carriage comprises the cam 116 which is shown as having peripheral slots therein such as 126, together with land portions such as 127. Thus, whenever the cam is rotated so that the land portion is beneath the pin 120, then the lever 70 cannot move angularly, notwithstanding the extent to which the longitudinal travel of the carriage may be permitted by movement of the driving lever 52. On the other hand, whenever the cam 116 is turned, for example, to the position shown in Fig. 17, the pin is free to enter one of the slots 126.

It is to be understood that on each retractive movement of the carriage 31, the cross travel lever 70 moves backwardly to the original position—assuming that it had been moved angularly during the forward movement of the carriage—at which time the pin 120 is in the position indicated in full lines in Fig. 17.

Thereafter, if the cam 116 is turned to present one of the land surfaces 127 to the travel of the pin, then such land prevents angular or downward movement of the pin, and thereby prevents angular movement of the lever 70.

The conditions under which the tray is to be moved transversely to the screen arm to the position indicated at any lines between 123 and 125 would be controlled by the shallower notches 128, for example, on cam 116. Those notches would restrict the angular movement of the pin 120 about the pivot 96 and thereby restrict the angular movement of the pin 118 with consequent restriction of further angular movement of the arm 70.

Thus for an 8" x 10" film, there are certain conditions under which the tray performs no cross travel, and conditions under which it performs a limited and maximum travel respectively in order to maintain the center of that

portion of the film to be exposed in substantial alignment with the axis of the primary beam, whenever the carriage has moved longitudinally of the screen arm to the required extent.

Indexing mechanism

Wherever automatic indexing is desired as, for example, in serially exposing the portions 1A, 2A, 3A, and 4A (Fig. 12), we provide a mechanism by means of which the indexing occurs automatically without the need for an operator to move the index pointer 35 until after the completion of the sequence. To effect such automatic sequential operation, we provide a member which is mounted on the carriage and which actuates the indexing pointer and its associated cam devices on the spindle 91 upon each return stroke of the carriage 31.

A preferred arrangement for accomplishing the aforesaid indexing, comprises an arm 129 which is carried by and projects above the carriage 31. Interposed in the path of the arm is a finger 130 which is fastened to and extends downwardly from an indexing plate 131. The plate 131 extends parallel to the plate 97 and is positioned above it. It is mounted for reciprocation with respect to the plate 97 preferably between upper and lower sets of ball bearings 132 and 133 respectively. The plate also has a slot 134 therein through which the indexing spindle 91 extends. A spring 135 having one end affixed to the plate 97 at 136, and the other end affixed to the plate 131 at 137 tends to urge the plate to the left as viewed in Fig. 8. Movement of the plate during reciprocation is stabilized by means of a pin 138 which extends upwardly from the plate 97 and extends through slot 139 in the plate 131.

The full line position of the plate 131 as shown in Fig. 8 illustrates its position in a fully retracted condition of the carriage 31. The broken line position 131A illustrates the position of the plate after the carriage has advanced a short distance forwardly, or to the left as viewed in Fig. 8. The plate carries a bell crank lever 140 which is pivoted at 141 thereto, and the lever 140 carries a pin 142 at one end thereof. The other end is connected to a spring 143 which in turn is anchored at 144 to the plate 131. Normally, the spring tends to swing the lever in a clockwise direction to move the pin 142 into a position where it strikes an indexing wheel 145, provided the wheel is at that time so turned that it presents the shoulder to the pin.

The indexing wheel 145 is keyed to the indexing spindle 91 and has an irregular peripheral portion as shown in Fig. 8. The peripheral portions include radial shoulders 146 wherefore if the wheel is so placed, that one of the shoulders is interposed in the path of the pin 142 during the movement of the plate from the position 131A to the full line position (Fig. 8), the indexing wheel will be advanced one station as, for example, from station 1 to station 2 (Fig. 12). During such advancing movement, the pin 142 is lifted out of engagement with the shoulder on the indexing wheel by contact of a stationary pin 147 with an arm of the lever 140. The loss of contact between the pin and the shoulder is arranged to occur simultaneously with the advancement of the indexing spindle to the next station.

A device for releasably holding the indexing spindle at the desired station, includes a ball 148 which is carried in the plate 97 and which has a diameter greater than the thickness of the plate 97, while a spring 149 operates to press the ball against the cam 90. The holes 92 in the cam are angularly spaced in accordance with the spacing required for the stations shown in Fig. 12.

By arranging the spacing of the shoulders on the indexing wheel 145, the film controlled by the stations 1 to 4 inclusive can be exposed serially. The next sequential indexing then occurs at station 5 which automatically cuts off the current to the motor 40, the purpose being to prevent the operator who is working in a dark room from

inadvertently attempting to move the pointer for a succeeding exposure. It is to be understood that the operation of the motor is controlled by a switch button which is shown at 150, at one end of the screen arm handle 151.

Electrical diagram

In Fig. 4 is shown an electrical diagram wherein the motor 40 has one line 152 connected to the source of powers, the other line from the source being indicated at 153 as connected to the movable switch arm 150. This is the arm which is controlled by the thumb of the operator as shown in Fig. 2. Normally that arm is spring pressed into position so as to make contact with a conductor 154 which is connected by conductor 154A to the motor 40. A switch 155 is interposed in the conductor 154A, such switch being automatically operated by the arm 52 as it is swung backward to the retracted position indicated in Fig. 18. Normally the connections just described cause a rotation of the motor in a direction to effect a retraction of the carriage, which condition prevails whenever the operator releases his pressure on the thumb switch 150, and whenever the switch 155 is in closed position. The switch 155 is automatically closed as soon as the lever 52 swings away and out of contact with it.

The direction of rotation of the motor to move the carriage in a forward direction is effected upon movement of the switch 150 into engagement with the contactor 156 which is also connected to the motor 40 through the conductor 157 whenever the switch 158 is closed. The last named switch is that controlled by station 5 in Fig. 12. Normally the switch 158 is biased to a closed position whenever the pointer 35 is at any station other than station 5. The contact arm for actuating the switch 158 is indicated at 159 in Fig. 8 as embodying a roller 160 which is engaged by the head of a screw 161, that is fixed to the indexing spindle. A condenser 162 is shown in the diagram as part of the motor system.

The foregoing arrangement is such that whenever the operator sets the indexing pointer to a given station, except station 5, and then depresses the push-button switch 150, the motor 40 is actuated in a direction to advance the carriage beneath the screen. At the completion of the exposure, the release of thumb pressure on the switch 150 automatically effects a reversal of rotation of the motor to retract the carriage.

Operation

Assuming that the pointer 35 is moved to station 1, and that a cassette has been placed within the tray with the longitudinal edges of the film extending longitudinally of the screen arm, as shown by the lines 23—23 in Fig. 2, then the operator adjusts the screen arm to the desired position with respect to the patient, and presses the button 150. This energizes the motor 40 and, through the medium of the reduction gearing and the clutch mechanism, operates to swing the driving lever 52 about the axis of the spindle 48. The setting of the pointer 35 at station 1 automatically places the cams 90 and 107 which control the movement of the lever 52 in such position that their respective pins 102 and 113 are so arranged to coact with the shift lever 53 to stop the axis of the pin 62 at the line 89 (Fig. 29). At the same time, the cam 116 is so positioned on the indexing spindle 91 that the pin 120 will enter the notch 126 and thus allow the cross travel lever 70 to swing downwardly to its fullest extent thereby effecting a maximum cross travel of the tray as indicated from the line 123 to 125 in Fig. 30. Thus the film portion 1A will be aligned with the axis of the primary beam, as indicated in Fig. 23. The operator then exposes the film, and after the completion of the exposure, releases his pressure on the thumb switch 150, which automatically causes a reversal of direction of motor rotation, thereby causing the arm 52 to swing back to the full line position of Fig. 18, and causing the arm 70 to swing back to the full line position A in Fig. 17.

As the carriage moves to the retracted position, it automatically indexes the pointer 35 and the cams associated with the index spindle 91 to station 2, by virtue of the contact between the arm 129 and the finger 130 and the consequent movement of the indexing plate 131. This in turn causes the pin 142 on the lever 140 to engage the shoulder 146 on the indexing wheel 145 and thereby advances the indexing wheel one notch, or one station. At the completion of the retractive movement, the current to the motor is automatically disconnected by contact of the driving lever 52 with the limit switch 155. Then, as the operator again presses the switch button 150, the carriage is again advanced beneath the screen but, at this time, a portion of the film indicated at 2A in Fig. 12 is brought into exposing position to the exclusion of all other portions of the film. The movement of the indexing spindle from station 1 to station 2 automatically sets the cams 90 and 107 which control the angular movement of the driving lever 52, and automatically sets the cam 116 which controls the movement of the cross travel lever 70, so that the longitudinal travel extends to a point where the axis of the pin 62 reaches the line 85, whereas the cross travel extends, as indicated in Fig. 30 from line 123 to 125. In other words, in going from station 1 to 2, the longitudinal travel has changed, but the cross travel has remained the same.

Upon release of the switch button 150, the carriage is again retracted and succeeding operations are performed automatically for stations 3 and 4 merely by pressing the push button 150 after the carriage has come to its stop at the end of the retractive movement. For exposing the portions of the film 3A, the pin 52 has travelled to the line 89 (Fig. 29), whereas there is no cross travel of the cassette tray. For station 4A the axis of the pin 62 stops at the line 85 whereas there is no cross travel for the cassette tray. The conditions for stations 3 and 4 are illustrated respectively in Figs. 25 and 26.

Figs. 27 and 28 indicate the positions of the apparatus for exposure of film portions 6A and 6B at stations 6 and 6E respectively. It is to be understood however that the first exposure at station 6 is for 6A (with the longitudinal dimension of the film extending length-wise of the screen arm), and that the indexing to the second position 6B, would move the pointer to the station indicated at 6E, where the portion 6B would be in position for exposure. Similarly if the film were turned so that its longitudinal dimension extended transversely of the screen arm, then the portion 6C would be in a position for exposure at station 6, and the portion 6D would be in position for exposure at the station 6E. It is also to be understood that the indexing wheel 145 is so formed that the indexing from station 6 to 6E occurs automatically upon the return motion of the carriage after completion of the exposure intended for station 6.

In like manner, station 7 is operated to expose the portion 7A of the film and on the succeeding stroke, to expose the portion 7B at which time the index has advanced automatically to the station 7C. The same is true for station 9 where if the portion 9A is exposed, then it is automatically advanced to 9C for exposure of that portion indicated at 9B.

Grid actuating device

To reciprocate the grid 170 during radiography we have shown an electric motor 171 (Fig. 3) which through reduction gearing actuates a vertically extending shaft 172. Affixed to this shaft is a heart-shaped cam 173 (Fig. 7) which is adapted to be engaged by followers 174 and 175 respectively. The followers are carried by an arm 176 which is affixed to the grid. Thus, whenever the motor 171 is actuated, the grid is reciprocated. The circuit for the motor 71 is so arranged that the motor is actuated whenever the push-button switch 150 is actuated to cause a rotation of the motor in a direction to move the carriage forwardly beneath the screen. A wiring

diagram illustrating that arrangement is Fig. 4 where the switch is also indicated at 159. In practice, this would be a double pole switch, one pole operating to control the circuit for the motor 40 and the other to control the circuit for the motor 171.

Advantages of serialfilmer

The present invention is advantageous in that the film is automatically substantially centered with respect to the axis of the primary beam even though serial exposures are made on fractional parts of the film in prearranged sequence. The invention results in a compact structure which enables the overall dimensions of the screen arm to be maintained within desirable limits, and is advantageous in that it is substantially fool-proof, and yet is flexible in the range of selection permitted for a given size of film. The foregoing and other advantages will be apparent to one skilled in this art and the essential features of the invention will be summarized in the claims.

We claim:

1. In X-ray apparatus, a frame having a fluoroscopic screen carried thereby, and having a cassette receiving space disposed alongside the screen, an X-ray tube positioned to direct a primary beam substantially at the center of the screen, said frame having a trackway extending longitudinally thereof, a carriage movable along the trackway to a position beneath the screen and retractable from said position to provide a working cycle, said carriage having a trackway extending transversely of the frame, a cassette receiving tray movable along said last mentioned trackway, an electric motor, a rotatable member driven by the motor, a clutch operated by said rotatable member, driven units adapted to be actuated by the clutch means, one of said units being operatively connected to the carriage for moving it along its trackway, the other of said units being operatively connected to the cassette receiving tray for moving it along its trackway in the carriage, a cassette having a sensitized member therein, a manually operable member carried by the frame and selectively settable with respect thereto, and means actuated by the settable member for automatically controlling the extent of movement of the carriage driving unit, and other means controllable by said settable member for automatically controlling the extent of movement of the tray driving unit, said controlling means being correlated with each other to position the cassette with respect to the carriage and to position the carriage with respect to the frame so as automatically to align the centers of successively presented portions of a sensitized member within the cassette with the axis of the primary beam on successive working cycles.

2. In X-ray apparatus, a frame having a fluoroscopic screen carried thereby, and having a cassette receiving space disposed alongside the screen, said frame having a trackway extending longitudinally thereof, a carriage movable along the trackway to a position beneath the screen and retractable from said position into said space to provide a working cycle, said carriage having a trackway extending transversely of the frame, a cassette receiving tray movable along said last mentioned trackway, an electric motor, a rotatable member driven by the motor, a slip clutch operated by said rotatable member, driving units adapted to be actuated by the clutch means, one of said units being operatively connected to the carriage for moving it along its trackway, the other of said units being operatively connected to the cassette tray for moving it along its trackway in the carriage, a manually operable member carried by the frame selectively settable with respect thereto, and a plurality of stop means adapted to be selectively activated by said settable member to independently limit the extent of movement of each of said driving units, and means for energizing said motor to automatically position the carriage and tray

into correlated positions corresponding to the pre-selected movements of each driving unit respectively.

3. In X-ray apparatus, a frame having a trackway carried thereby, a fluoroscopic screen carried by the frame, a carriage mounted for movement along the trackway, said carriage having a trackway extending transversely of the frame, a cassette tray mounted for movement along the carriage trackway, an electric motor, mechanism actuated by the motor for moving the carriage along its trackway to a position beneath the screen, other mechanism actuated by the motor for moving the cassette tray along its trackway in the carriage, and settable means for selectively conditioning each of said mechanisms for correlative operation to effect successive presentation of different selective portions of a sensitized member adapted to be positioned within the cassette, to substantially the identical position with respect to a fixed point on the screen.

4. In X-ray apparatus, a frame having a trackway carried thereby, a carriage mounted for movement along the trackway, said carriage having a trackway extending transversely of the frame, a cassette tray mounted for movement along the carriage trackway, an electric motor, mechanism actuated by the motor for moving the carriage along its trackway, other mechanism actuated by the motor for moving a cassette tray along its trackway in the carriage means for selectively stopping said carriage positioning mechanisms and other means for selectively stopping said tray positioning mechanism, and manually settable means for selectively conditioning each of said stop means for correlated operation in accordance with a predetermined set of exposure patterns.

5. In X-ray apparatus, a frame having a fluoroscopic screen carried thereby, and having a cassette receiving opening therein disposed alongside the screen, a frame having a trackway extending longitudinally thereof, a carriage movable along said trackway to a position beneath the screen and retractable to a storage position in said opening to provide a working cycle, said carriage having a trackway extending transversely of the frame, a cassette receiving tray movable along the trackway in said carriage, the cassette being adapted to hold a sensitized member on which exposures are to be made to a primary beam adapted to pass through the screen at a fixed point with respect to the frame, an electric motor, means operated by the motor for moving the carriage along its trackway, other means operated by the motor for moving the tray along its trackway in the carriage, an indexing spindle, cam means mounted on the spindle for co-action with the carriage moving means, other cam means mounted on the spindle for co-action with the tray moving means and stop members coacting with the respective cams for controlling the movement of each of said moving means, means for correlating the co-action between each of said cams and stop members to maintain the center of each portion of the sensitized member in substantial alignment with the axis of said primary beam successively in accordance with a prearranged exposure pattern.

6. In X-ray apparatus, a frame having a fluoroscopic screen carried thereby, and having a cassette receiving opening therein disposed alongside the screen, a frame having a trackway extending longitudinally thereof, a carriage movable along said trackway to a position beneath the screen and retractable from said work position to a storage position in said opening to provide a working cycle, said carriage having a trackway extending transversely of the frame, a cassette receiving tray movable along the trackway in said carriage, the cassette being adapted to hold a sensitized member on which exposures are to be made to a primary beam adapted to pass through the screen at a fixed point with respect to the frame, an electric motor, swingable means coacting with the carriage and operated by the motor for moving the carriage along its trackway, other swingable means coacting with

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the tray and operated by the motor for moving the tray along its trackway in the carriage, means for controlling the movement of the carriage moving means and the tray moving means independently of each other, an indexing member for selectively adjusting said last mentioned means to vary the controls in a correlated manner so that the center of each portion of the sensitized member in substantial alignment with the axis of said primary beam successively in accordance with a prearranged exposure pattern.

7. In X-ray apparatus, a frame having a fluoroscopic screen carried thereby and having a space therebeneath providing a work station, the frame having a space at one side of the screen providing a storage station, a carriage movable along the frame from the storage to the work station and retractable therefrom to provide a working cycle, a cassette receiving tray movable along the carriage, an electric motor, means operated by the motor for moving the carriage along the frame, other means operated by the motor for moving the tray along the carriage, a manually settable member carried by the frame and mechanism actuated by the member for controlling said carriage moving means and thereby the extent of movement of the carriage with respect to the frame, other mechanism controlled by the settable member for controlling said tray moving means and thereby the movement of the tray with respect to the carriage and means for automatically indexing the settable member upon the return of the carriage from the work to the storage station so as to present the cassette in different positions successively with respect to the carriage and frame in accordance with a prearranged exposure pattern.

8. In X-ray apparatus, a frame having a fluoroscopic screen carried thereby and having a space therebeneath providing a work station, the frame having a space at one side of the screen providing a storage station, a carriage movable along the frame from the storage to the work station and retractable therefrom to provide a working cycle, a cassette receiving tray movable along the carriage, an electric motor, means operated by the motor for moving the carriage along the frame, other means operated by the motor for moving the tray along the carriage, a manually settable member carried by the frame, mechanism including a coacting cam and stop member actuated by the settable member for controlling the extent of movement of the carriage moving means and thereby of the carriage with respect to the frame, and other mechanism including a coacting cam and stop member controlled by the settable member for controlling the tray moving means and thereby the movement of the tray with respect to the carriage, the operative settings of said settable member for actuating each of said mechanisms respectively being correlated in accordance with a predetermined set of exposure patterns.

9. In X-ray apparatus, a frame having a fluoroscopic screen carried thereby and having a space therebeneath providing a work station, the frame having a space at one side of the screen providing a storage station, a carriage movable along the frame from the storage to the work station and retractable therefrom to provide a working cycle, a cassette receiving tray movable along the carriage, an electric motor, a swingable arm operated by the motor for moving the carriage along the frame, and second swingable arm operated by the motor for moving the tray along the carriage, a manually settable indexing member carried by the frame, a cam actuated by the member for controlling the extent of movement of the carriage with respect to the frame, another cam controlled by the settable member for controlling the movement of the tray with respect to the carriage, and means for automatically indexing the settable member upon the return of the carriage from the work to the storage station.

10. In X-ray apparatus, a frame having a fluoroscopic screen carried thereby and having a space therebeneath

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providing a work station, said frame having a space alongside of the screen providing a storage station, a carriage movable within the frame from the storage to the work station and retractable therefrom to provide a working cycle, a cassette receiving tray movable along the carriage and transversely of the frame, an electric motor carried by the frame, a rotatable member driven by the motor and having a slip-clutch operated thereby, a swingable member driven by the clutch for moving the carriage longitudinally of the frame, another swingable member driven by the clutch for moving the tray with respect to the carriage, a manually settable member rotatable through 360°, indexing means for enabling said member to be positioned at different selective stations throughout its range of movement, some of said stations being arranged in groups of two or more exposure patterns successively and mechanism including cams and stop members selectively pre-set by said settable member for correlating the movement of the said swingable members so as to center successively and automatically the prearranged exposure patterns with a fixed point on said screen.

11. In X-ray apparatus, a frame having a fluoroscopic screen carried thereby and having a space therebeneath providing a work station, said frame having a space alongside of the screen providing a storage station, a carriage movable within the frame from the work to the storage station and retractable therefrom to provide a working cycle, a cassette receiving tray movable along the carriage and transversely of the frame, an electric motor carried by the frame, a rotatable member driven by the motor and having a slip clutch operated thereby, means driven by the clutch for moving the carriage longitudinally of the frame, other means independently driven by the clutch for moving the tray with respect to the carriage, a rotatable manually settable member carried by the frame, indexing means for positioning said member at different selective stations throughout its range of movement, some of said stations being arranged in groups of two or more exposure patterns successively, mechanism including cams and stop members pre-set by said settable member for correlating the movement of the said carriage and tray driving means so as to center successively and automatically the prearranged exposure patterns with a fixed point on said screen.

12. In X-ray apparatus, a frame having a fluoroscopic screen carried thereby and having a space therebeneath providing a work station, said frame having a space alongside of the screen providing a storage station, a carriage movable within the frame from the work to the storage station and retractable therefrom to provide a working cycle, a cassette receiving tray movable along the carriage and transversely of the frame, an electric motor carried by the frame, means driven by the motor for moving the carriage longitudinally of the frame, other means driven by the motor for moving the tray with respect to the carriage, a settable member mounted on the frame, and indexing means actuated by movement of the carriage and acting on said settable member to stop the carriage and tray at pre-selected positions, with respect to the work station.

13. In an X-ray apparatus, a frame having a fluoroscopic screen carried thereby, and having a cassette receiving space disposed alongside the screen, said frame having a track-way extending longitudinally thereof, a carriage movable along the trackway to a position beneath the screen and retractable from said position to provide a working cycle, said carriage having a trackway extending transversely of the frame, a cassette receiving tray movable along said last-mentioned trackway, an electric motor, a driving unit actuated by said motor and operatively connected to the carriage for moving it along its trackway, a second driving unit actuated by said motor and operatively connected to the cassette tray for moving it along its trackway in the carriage, a manually op-

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erable member carried by the frame and selectively settable with respect thereto, means actuated by the settable member to selectively condition each driving unit for a predetermined extent of movement, and means for energizing said motor to automatically position the cassette and tray into correlated positions corresponding to the preselected conditioning of each driven unit respectively.

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