

Feb. 3, 1959

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2,872,584

X-RAY APPARATUS

Filed Dec. 27, 1955

6 Sheets-Sheet 1

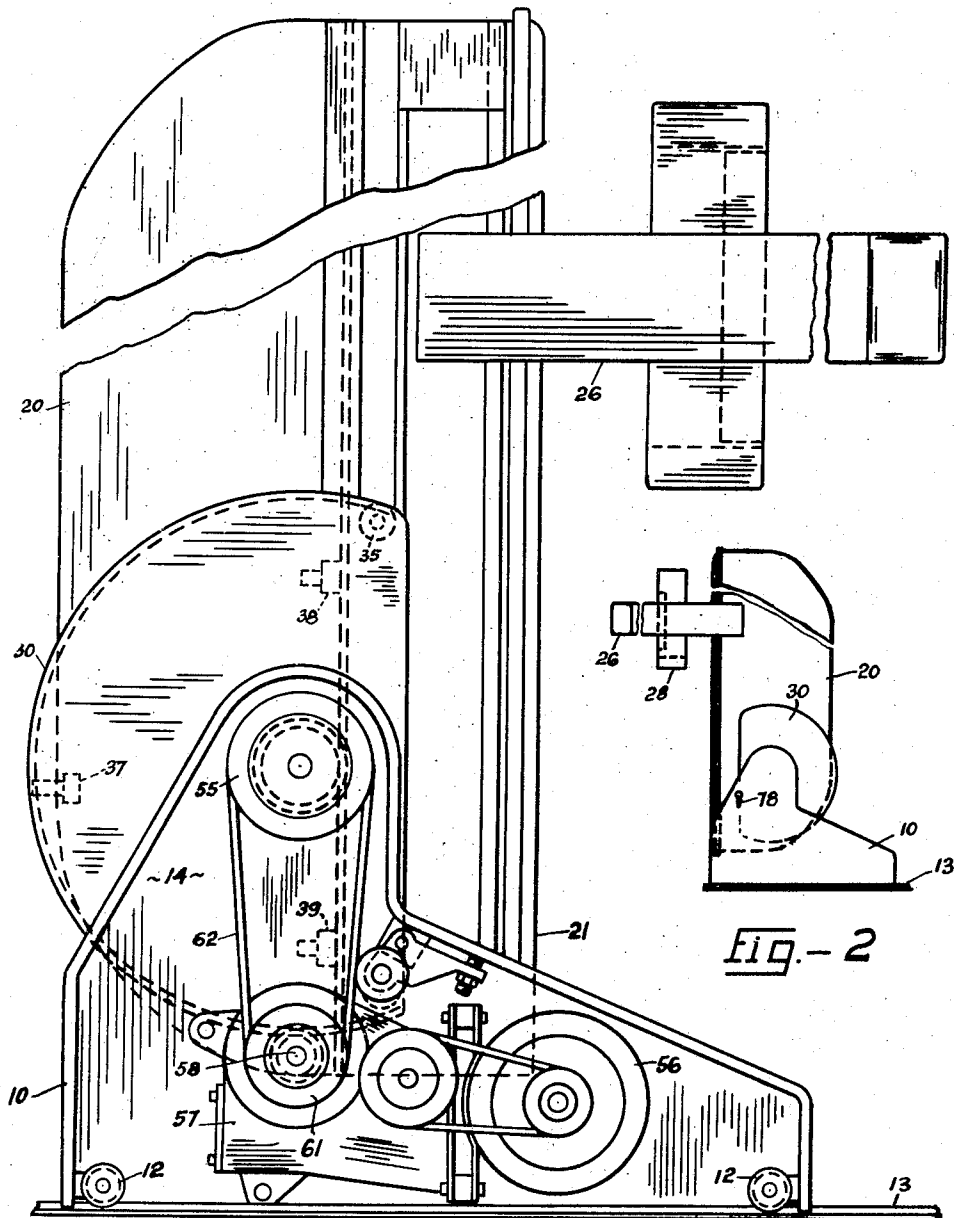


FIG. 1.

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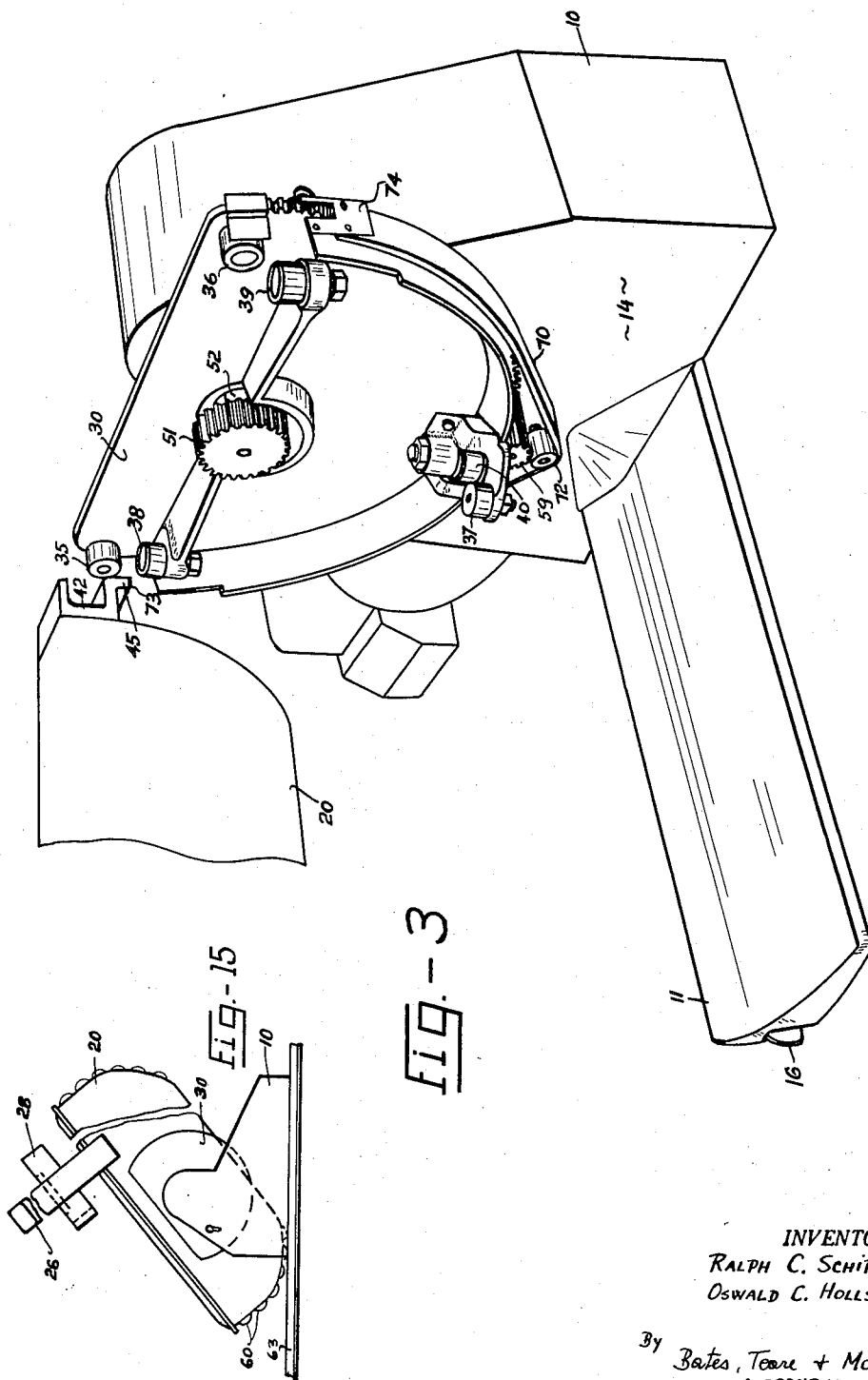
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6 Sheets-Sheet 2



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6 Sheets-Sheet 3

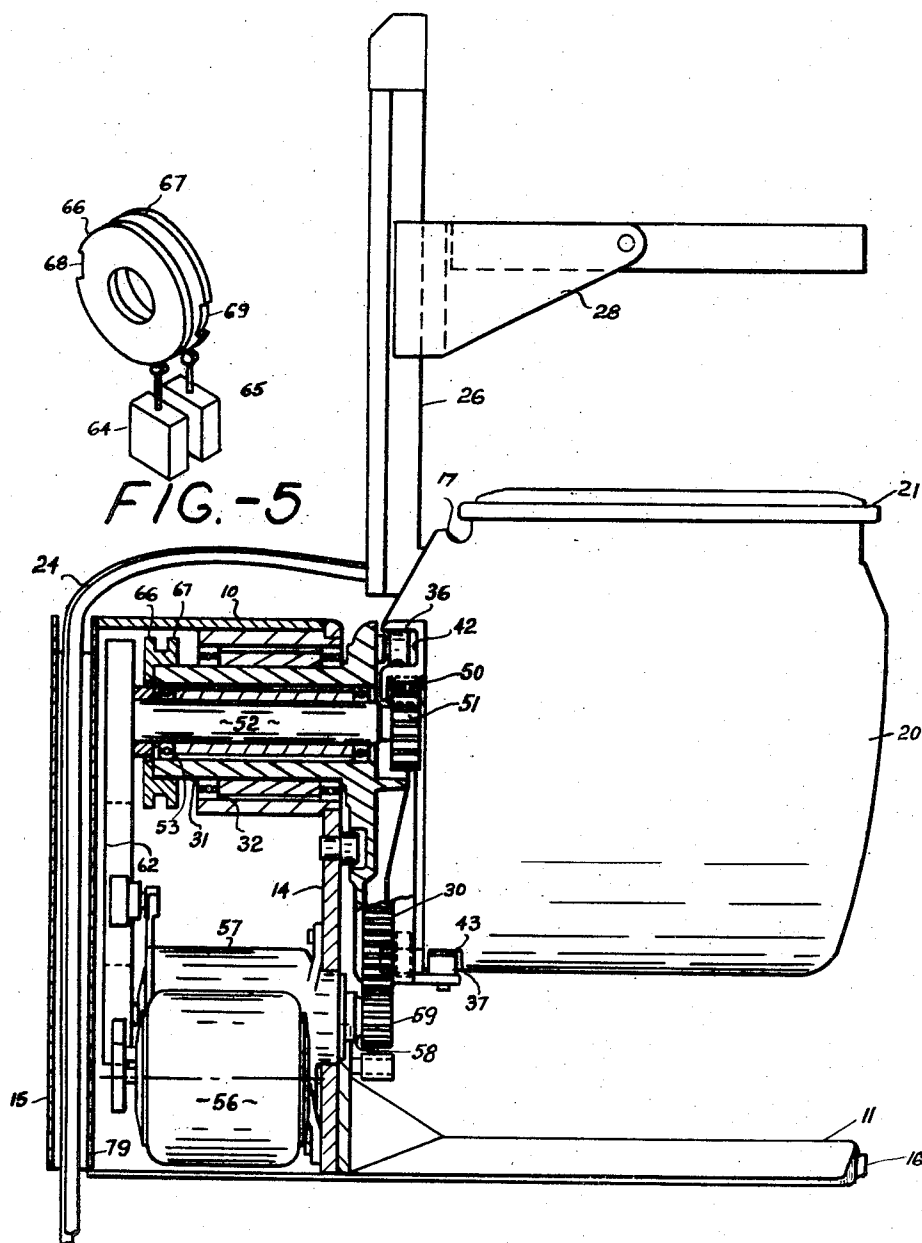


FIG. - 4

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6 Sheets-Sheet 4

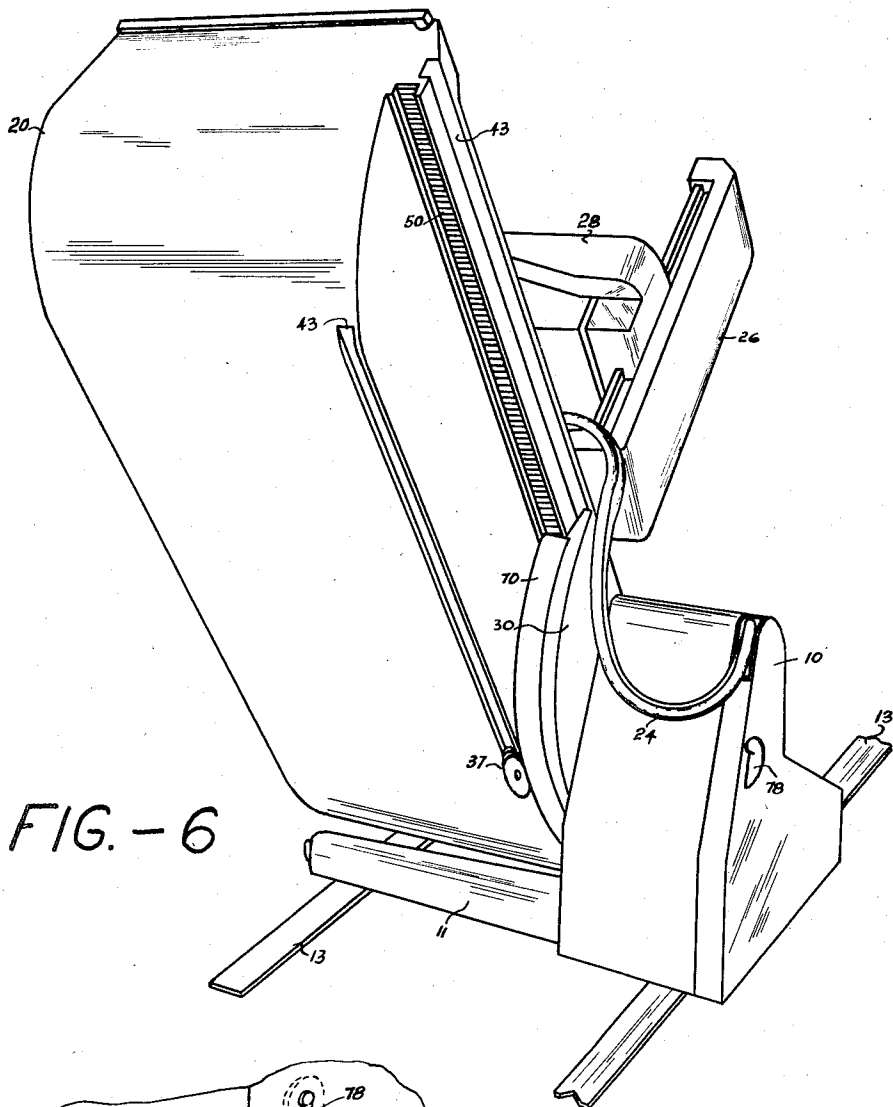


FIG. - 6

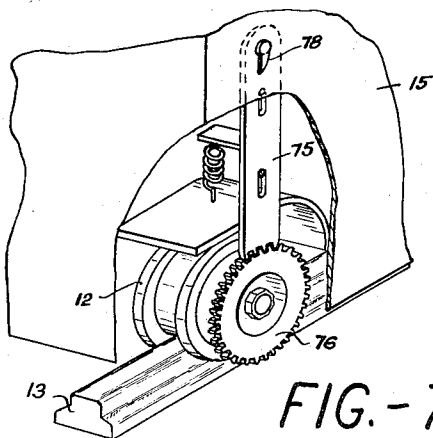


FIG. - 7

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X-RAY APPARATUS

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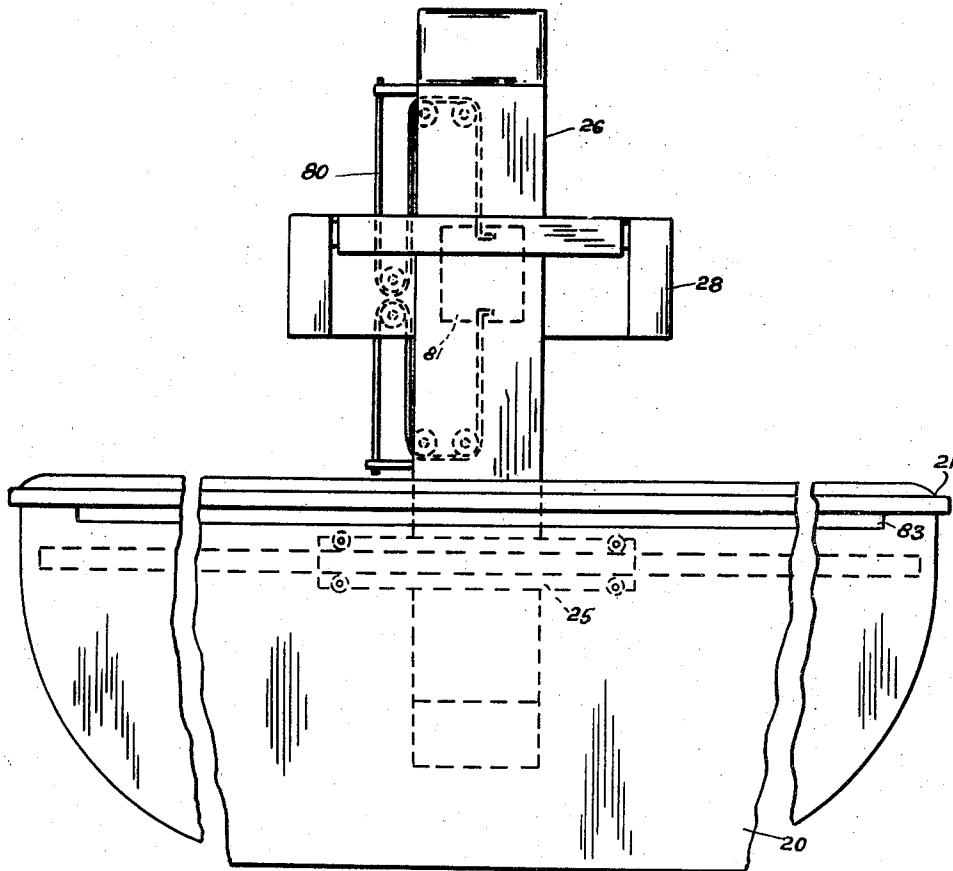


FIG. - 8

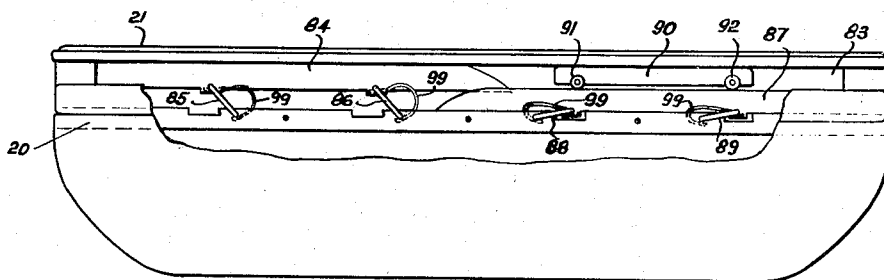


FIG. - 9

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6 Sheets-Sheet 6

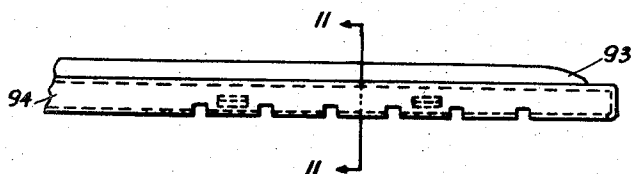


FIG. -10

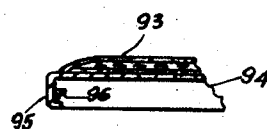


FIG. -11

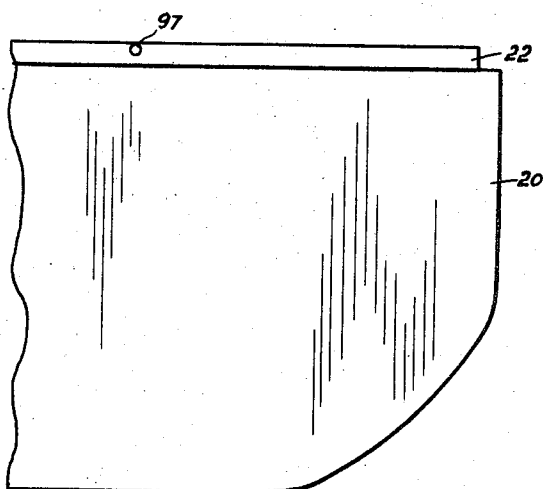


FIG. -12

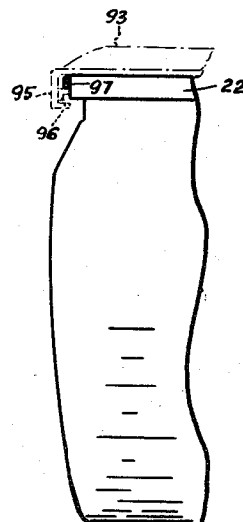


FIG. -13

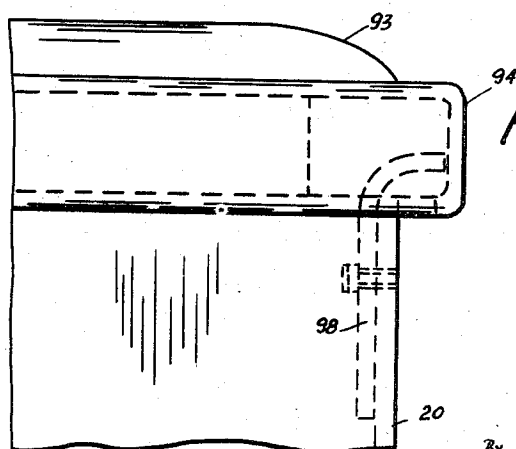


FIG. -14

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## X-RAY APPARATUS

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12 Claims. (Cl. 250—55)

This invention relates generally to an X-ray tilt table and more particularly relates to an improved arrangement for selectively tilting an X-ray table to any angular position including the vertical position in either direction from the horizontal.

X-ray techniques require moving a patient supporting table into horizontal, vertical and intermediate positions. The usual X-ray apparatus includes a tilt-table that is adapted for movement into one or more of these positions, but for the most part the attainable positions are restricted because of space limitations and the complexity of table construction.

Accordingly, a principal object of this invention relates to the provision of an improved arrangement for tilting an X-ray table through a complete range of angular positions from the horizontal to an upright position in either direction without exceeding optimum space limitations or increasing the complexity of the table construction.

A further object of this invention relates to the provision of an improved arrangement for tilting an X-ray table to an upright vertical position in either direction from the horizontal which does not require increasing the minimum desired overall height from the table top to the supporting floor.

A still further objective relates to the provision of a cantilever support for an X-ray table which also supports a table tilting mechanism at one side of the table and out of its path as it is tilted to various angular positions between one upright vertical position and another in the opposite direction.

Another object of this invention relates to the provision of an improved arrangement for counterbalancing a fluoroscopic screen arm on a vertical supporting column.

Still another object of this invention relates to the provision of an improved arrangement for automatically closing the remaining portion of the table Bucky slot when the Bucky carriage is positioned adjacent either end of the table.

An additional object of the invention relates to the provision of an improved separable top for an X-ray table which may be easily mounted and removed from the table frame.

Briefly, in accordance with this invention, there is provided a cantilever support for an X-ray tilt table which rotatably supports a driven segmental gear having circumferentially spaced rollers adapted to engage suitable guides on the adjacent side of the table body to provide a multiple-point relatively movable support for the table. The cantilever support also operatively carries a driven gear which is adapted to engage a straight-line rack disposed along the adjacent side of the table and the rotation of the gear is so related to the rotation of the gear segment that the table body is positioned longitudinally along the rollers during tilting movement to cause the lower end of the table to clear the floor. In another embodiment, the rack is eliminated so the table is free to move longitudinally and the table carries floor engag-

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ing rollers at each end whereby it will shift itself during tilting movement. All of the table tilting mechanism is disposed within the cantilever support and out of the path of the table to permit free tilting movement of the table without requiring an increase in the overall height of the table top from the supporting floor.

In addition, a fluoroscopic screen arm is supported for movement along a vertical column and is counterbalanced by means of a compound pulley arrangement so that it is only necessary to counterbalance one-half the total moving load. The Bucky slot is provided with retractable closure plates which are automatically positioned to close that portion of the slot remaining when the Bucky carriage is positioned adjacent either end of the table, and an improved table top construction utilizes a separable table top which may be removably mounted on the table frame.

In the drawings:

Fig. 1 is a front elevation of an X-ray tilt-table embodying the present invention tilted to one vertical position and having the drive for the tilting mechanism exposed;

Fig. 2 is a front elevation of the tilt-table at a reduced scale showing the table tilted to the other vertical position;

Fig. 3 is a perspective view of the inner side of the table supporting base illustrating the table tilting mechanism;

Fig. 4 is an end view, partly in section, of the tilt table shown in Fig. 1, but with the table in a horizontal position;

Fig. 5 is a perspective view of a limit switch mechanism for controlling the tilt-table drive;

Fig. 6 is a perspective view of the tilt table showing it elevated to an intermediate inclined or Treudenburg position;

Fig. 7 is a partial perspective view of the table base showing a roller engaging latch for holding the apparatus in fixed position on supporting rails;

Fig. 8 is another front elevation of the tilt table illustrating the counterbalance arrangement for the fluoroscopic screen arm;

Fig. 9 is a partially exposed view of the Bucky slot closure mechanism;

Fig. 10 is a side elevation of a part of the table top;

Fig. 11 is a partial section taken on a plane indicated by the lines 11—11 in Fig. 10;

Fig. 12 is a front elevation of a portion of the table bed;

Fig. 13 is a fragmentary end view of the table bed;

Fig. 14 is a front elevation of a portion of one end of the table bed showing the top assembled thereon;

Fig. 15 is a front elevation of another embodiment of the tilt-table at a reduced scale and tilted to an intermediate angular position.

Referring now more particularly to Figs. 1, 2, 3 and 15 of the drawings there is shown a table supporting base embodying a vertical frame pedestal 10 having an extended horizontal base portion 11 which may rest in fixed position upon the floor or otherwise be mounted for movement on rollers 12 and guided by suitable rails 13. The pedestal 10 has spaced inner and outer walls 14 and 15 defining a housing for enclosing a self-contained table tilting mechanism. The X-ray table includes a top 21 mounted on a table body 20 which is in turn supported in cantilever fashion beside the inner wall 14 of the pedestal 10 and overlying the horizontal base 11. An X-ray tube carriage 25 is mounted for longitudinal movement within the table body 20 and carries a vertical column 26 which extends from one side of the table to support a vertically movable fluoroscopic screen arm 28 in a conventional manner.

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The supporting connection between the table body 20 and the pedestal 10 is accomplished through the table tilting mechanism which includes a large segmental gear 30 having an integral tubular shaft 31 which extends through the inner wall 14 and is rotatably journaled in a suitable bearing 32 secured on the interior of the housing (Fig. 4). The segmental gear 30 carries circumferentially spaced rollers 35 through 40 which engage suitable guide tracks fastened to the side of the table body 20 so that the table is movable relative to the segmental gear and transverse to its axis of rotation. The rollers 35 and 36 are disposed on horizontal axes and guide a longitudinal track 42 disposed and fastened along the adjacent side of the table body 20. The roller 37 is disposed on a vertical axis and guides a similar longitudinal track 43 disposed along the bottom of the table body as best shown in Fig. 4 of the drawings. In the preferred form shown, additional rollers 38, 39 and 40 are mounted for rotation on vertical axes adjacent each roller 35, 36 and 37 respectively. The rollers 38 and 39 guide a track formed by the side panel of the table and a depending flange 45 of the guide track 42 while the roller 40 engages the side panel beside the track 43 and carries the load. These additional rollers coast with the rollers 35, 36 and 37 to provide a stable supporting connection for the table 20 on the pedestal 10.

In the preferred form shown in Figs. 1 and 2, transverse movement of the table is accomplished by providing a straight-line rack 50 on the underside of the track 42 and engaging this rack with a driven pinion 51. The pinion 51 is keyed on a shaft 52 which is rotatably journaled in bearings 53 in the tubular shaft 31. One end of the shaft 52 extends through the segmental gear 30 to expose the pinion 51 to the rack 50 while the other end carries a sprocket wheel 55. Power is supplied to the segmental gear 30 and the sprocket wheel 55 from a drive motor 56 disposed in the lower part of the pedestal housing.

The motive power from the drive motor 56 is transferred to a reduction gear box 57 which has a shaft 58 having one end extending outwardly through the inner wall 14. This extended end of the shaft 58 carries a pinion 59 which engages and rotates the large segmental gear 30. The other end of the shaft 58 extends from other side of the gear box and carries a sprocket wheel 61 which is connected by a roller chain 62 to the sprocket wheel 55. It will be readily apparent that the motor 56 will drive both the segmental gear 30 and the rack to simultaneously rotate and position the table transverse to the axis of rotation. With this arrangement, the speed and direction of rotation of the pinion 51 is related to that of the gear segment 30 in a manner to permit the lower end of the table body 20 to clear the base portion 11 as the table is tilted to the vertical position in either direction.

In the embodiment shown in Fig. 15 of the drawings the rack 50 and pinion 51 are eliminated and the height of the pedestal 10 is such that the ends of the table body 20 will engage the floor when tilted to an angular position in either direction. The ends of the table are provided with suitable rollers 60 which may be guided by a track 63 and, since the table body 20 is free to move longitudinally, it will shift itself along the table tracks 42 and 43 during tilting movement towards an upright vertical position in either direction. In this embodiment the track 63 preferably intersects the base portion 11 and the cantilever-type pedestal support would not interfere with either end of the table as it is tilted to an upright vertical position. Suitable limiting means in the form of conventional stops may be mounted in the tracks 42 and 43 to prevent further shifting of the table after the ends have cleared the floor as it is tilted back to a horizontal position. In the embodiment of Figs. 1 and 2, the extent of rotation of the table in either direction is controlled by limit switches which coast in the conven-

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tional energizing circuit of the motor 56 to limit the travel of the table. As best shown in Fig. 5, the limit switches 64 and 65 are operated by a pair of disc surfaces 66 and 67 which are mounted coaxially on the shaft 31 and provided with notches 68 and 69 in their respective peripheries displaced 180 degrees from each other to accommodate the respective switch arms in non-operative position whenever the table is tilted to the extreme vertical position in either direction. With this arrangement, the table is automatically stopped when it attains the vertical position in either direction and it is only necessary to re-activate the drive motor in the reverse direction to return the table to its horizontal position. There is also provided a foot switch 16 which operatively projects from the extremity of the base portion 11 and can be positioned to the right or left by an operator's foot to energize the drive motor and cause the table to tilt in a corresponding direction.

All of the tilting mechanism is enclosed within the pedestal 10 out of the path of travel of the table. Thus, the distance between table-top 21 and the floor may be kept to a minimum and the multiple-point roller suspension of the table body 20 together with the simple gear drives provides a smooth and continuous tilting movement of the table to an upright vertical position in either direction from the horizontal.

The preferred form of the apparatus includes additional desirable features such as the provision of protective flexible band or tape 70 which overlies the segmental gear teeth and has its ends connected to brackets 73 and 74 at diametrically opposed points on the upper portion of the segmental gear 30. The intermediate portion of the protective band 70 extends about an idler roller 72 which acts to separate the band from the segmental gear teeth at the point of engagement with the drive pinion 59. Another feature relates to the construction of the table side panel adjacent the cantilever support so that it provides a gutter-type trap 17 just below the table top to receive and guide excess barium solution to the ends of the table, thus preventing it from dripping into the tilt mechanism.

In addition, when the pedestal 10 and its base 11 are mounted for longitudinal movement along guide rails 13 as shown in Figs. 1 and 2 and 6, the entire X-ray apparatus may be fixed in position on the rails by providing a lever operated latch-plate 75 having teeth for engaging a toothed wheel 76 disposed on the adjacent face of one of the track engaging rollers 12 so that the rollers are latched against movement in either direction as best shown in the partial perspective view of Fig. 7 of the drawings. The latch-plate 75 is spring-biased into latching position and may be retracted out of engagement with the toothed wheel 76 by turning the handle lever 78 operatively supported on the outer wall 15 and having a rocker arm connection to the latch-plate 75. As best shown in Figs. 4 and 6, another wall partition 79 separates the outer housing wall 15 from the tilt mechanism and forms a secondary housing or guide channel for the high tension power cables 24. These cables pass from their source connections upwardly through this channel and out through an opening at the top from where they are looped directly up to the X-ray tube head carriage where they may be clamped in fixed position. This eliminates the problem of having such cables dragging after the tube head inside the table body 20 and yet all that can be seen outside the table is a small cable loop to the channel in the pedestal housing.

There is also provided an improved arrangement for counterbalancing the fluoroscopic screen arm 28 on its supporting column 26 as best shown in Fig. 8 of the drawings wherein the column 26 is extended to permit the use of a double pulley arrangement indicated generally at 80 for supporting the counter-weight 81 which travels twice as far as screen arm 28. With this arrangement, only one half of the total moving load applied by the

screen arm 28 on its supporting carriage is required to be counterbalanced and the total moving load on the horizontal fluoroscope is reduced by one quarter.

Another improvement in the table construction relates to the provision of automatically retractable closure plates for the Bucky slot 83 at the front side of the table. As best shown in Figs. 8 and 9 of the drawings, this arrangement includes a pair of plates one of which 84 is pivotally connected to the table body 20 by links 85 and 86 and the other 87 by links 88 and 89, each of the links being biased with springs 99 to raise the plates 84 and 87 upwardly into closure position overlying the corresponding portion of the Bucky slot. The Bucky carriage 90 carries a pair of rollers 91 and 92 which ride along the top edges of the respective plates 84 and 87 to successively depress them whenever the carriage 90 is positioned to the right or left end of the table. Thus, when the Bucky carriage 90 is positioned to the right end of the table, plate 84 is allowed to rise and close that portion of the Bucky slot 83 between the carriage and the left end of the table. Similarly, whenever the Bucky carriage 90 is disposed at the left end of the table, the plate 84 is depressed and the plate 87 is allowed to rise and close the right hand portion of the Bucky slot. It will be apparent that when the Bucky carriage is centrally located on the table both plates are depressed until either one or the other of the carriage rollers 91 or 92 clears an end of either one or the other of the plates 84 or 87.

Referring now more particularly to Figs. 10 through 14 of the drawings, there is shown an improved table top construction in the form of an integral unit that may be readily removed from the table bed frame 22. The top 21 has a sealed cover 93 presenting rounded edges and corners to eliminate barium collecting cracks or crevices. The sealed cover 93 is fixed on a marginal frame 94 having inturned flanges 95 (Fig. 11) which carry inwardly directed brackets 96 spaced longitudinally along the internal flange face for interlocking coaction with outwardly projecting pins 97 on the table bed frame 22 in the manner shown in Fig. 13 of the drawings. It will be readily apparent that the improved table top 21 can be placed onto the table bed frame so that the pins 97 will clear the inwardly directed brackets 96 on the corresponding flange and then, by sliding the table top 21 longitudinally along the table bed frame, the pins 97 can be slid into interlocking engagement over each inwardly directed bracket 96. The arrangement is such that when the top 21 is properly positioned on the table bed frame, one end of the table top will abut against the corresponding end of the table bed frame and the entire top may then be secured to the table bed frame by attaching suitable end-plates 98 as best shown in Fig. 14 of the drawings.

Thus, there has been provided an improved X-ray table construction that may be tilted in either direction from a horizontal position to an upright vertical position or to any intermediate position by means of a tilting mechanism that is entirely enclosed within a cantilever support and out of the path of the tilting table. The roller suspension and gear drive provides a smooth and continuous tilting movement of the table while at the same time shifting the table to clear the floor. An improved screen arm counterbalancing arrangement reduces the load required to be counterbalanced to further increase the ease of operation, and the Bucky slot is automatically closed to reduce scattered radiation from the inactive portion of the slot.

We have shown and described what we consider to be the preferred embodiments of our invention along with modified forms and suggestions, and it will be obvious to those skilled in the art that other changes and modifications may be made without departing from the scope of this invention as defined by the appended claims.

We claim:

1. An X-ray tilt-table comprising, a pedestal base, 75

a table body adapted to be rotatably supported at one side on the pedestal base for tilting movement in either direction, table-tilting means operably supported on the pedestal base adjacent said one side of the table body, said table-tilting means including a driven member mounted for rotation on the tilt axis and having a plurality of spaced table supporting members engaging the table body adjacent the top and bottom of said one side, and means co-acting with said tilting means to simultaneously move the table body along said table supporting members and transverse relative to the tilt axis to maintain clearance between the floor and the table movement throughout the tilting movement in either direction.

2. The X-ray tilt-table of claim 1 wherein said driven member includes a driven segmental gear operatively supported on the pedestal for rotation about the tilt axis, said segmental gear having a plurality of rollers spaced circumferentially from each other along the segmental gear periphery to form said table supporting members, and said table frame having longitudinally disposed guide tracks at the top and bottom of one side for receiving and guiding the corresponding roller, said rollers coacting with said tracks to rotate the table with the segmental gear while permitting free relative table frame movement transverse to the tilt axis.

3. The X-ray table of claim 2 wherein the upper guide track presents a compound channel having one portion facing outwardly towards the pedestal and another portion facing downwardly and wherein each of the rollers adapted for coaction with said upper guide track includes a pair of rollers disposed respectively on transverse horizontal and vertical axis for independent coaction with the outwardly and the downwardly facing channel portions respectively, and wherein the lower guide track presents a downwardly facing channel extending along the underside of the table frame and the roller adapted for coaction therewith is disposed on a vertical axis.

4. The X-ray tilt-table of claim 2 wherein a driven pinion drivingly engages the segmental gear and a flexible band has its ends secured at the diametrically opposed extremities of the segmental gear and has its intermediate portion overlying the segmental gear teeth, and roller means coacting therebetween to space the band from the gear teeth adjacent their meshing engagement with the driven pinion.

5. The X-ray tilt-table of claim 1 wherein said driven member includes a segmental gear operatively supported on the pedestal for rotation about the tilt axis and carrying the table frame for free relative movement transverse to the tilt axis, and wherein said last mentioned means includes a longitudinal rack carried by the table adjacent the pedestal, and driven means carried by the pedestal for cooperative driving coaction with the segmental gear and the longitudinal rack to cause the table frame to simultaneously move transverse to the tilt axis during tilting movement in a direction to maintain clearance between the lower end of the table frame and the floor as the table frame is tilted to a vertical position in either direction.

6. The X-ray tilt-table of claim 5 wherein said driven means includes a source of motive power, a pinion journaled for rotation in the pedestal in operative meshing engagement with said segmental gear, another pinion journaled in the pedestal for rotation in operative meshing engagement with said rack, independent means drivingly coupling each of said pinions for rotation in opposite directions by said motive power source, and means coacting between said independent coupling means to maintain a predetermined relationship between the rack speed and the segmental gear speed, whereby said table frame is moved transversely to the tilt axis during tilting movement in a direction to maintain clearance between the lower end of the table frame and the floor as the table is tilted in either direction.

7. In an X-ray tilt-table having a pedestal base and a

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table frame mounted in cantilever fashion at one side for tilting movement about a stationary horizontal axis, a self-contained table tilting and supporting mechanism carried by said pedestal base and comprising, a segmental gear operatively supported on the pedestal for rotation on the tilt axis, a plurality of rollers carried by the segmental gear in spaced circumferential relation from each other, said rollers adapted to engage and support the table frame to permit free movement of the table relative to the segmental gear and transverse to the tilt axis, and means including a longitudinal rack carried by the table and a pinion coacting therewith to move the table transverse to the tilt axis, and driven means for rotating said segmental gear and said pinion at speeds bearing a predetermined relation to each other to cause the lower end of the table to clear the floor when tilted to a vertical position in either direction.

8. The table tilting mechanism of claim 7 wherein said driven means includes an electrical motor having a limit switch adapted to deenergize the motor when activated and wherein cam means are carried by said segmental gear in operative relation to the limit switch, said cam means adapted to activate the limit switch when the table frame is tilted to an upright position in either direction.

9. In an X-ray apparatus having a vertical column operatively supporting a movable fluoroscope structure thereon the combination of, a pair of pulley wheels mounted on parallel axes in spaced vertical relation from each other on said column, a second pair of pulley wheels mounted on parallel axes on said fluoroscope structure, a counterweight, a first flexible means interconnecting the top of the column with the counterweight and intermediately extending over one pulley wheel on the fluoroscope structure and over the upper pulley wheel on the column, a second flexible means interconnecting the counterweight with a lower portion of the column and intermediately extending over the other pulley wheel on the fluoroscope structure and over the lower of the pulley wheels on the column, said counterweight and pulley system coacting between the column and the fluoroscope structure to cause the counterweight to move twice as far as the fluoroscope structure.

10. In an X-ray apparatus having an enclosed table frame supporting a carriage for longitudinal movement below the table top and provided with a longitudinal access opening along one side, movable closure means biased in position overlying said table opening and adapted for selective retraction from said position to expose the portion of the opening adjacent the attained position of said carriage, and means on said carriage coacting with said closure means to automatically retract

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the adjacent portion of the closure means in any attained longitudinal position within the table frame.

11. In an X-ray apparatus having an enclosed table frame supporting a carriage for longitudinal movement below the table top and provided with a longitudinal access opening along one side, a mechanism for automatically closing the portion of the opening exposed when the carriage is positioned towards either end of the table comprising, a pair of similar elongated plate members disposed in end to end relation overlying the table opening and having their adjacent ends overlapping in side by side relation adjacent the center of the table, a plurality of links spaced lengthwise along each plate member and each link having one end pivotally connected to the corresponding plate member and the other end pivotally connected to the table frame below the table opening, thereby permitting each plate member to be depressed below the table opening, resilient means independently coacting between the table frame and each plate member to urge the plate members upwardly in overlying relation over the table opening, and roller means carried by said carriage and adapted to engage the top edge of said plate members as the carriage is positioned longitudinally within the table frame, the weight of said carriage coacting through said roller means to depress one or both of said plate members when the carriage is positioned towards either end or at the center of the table respectively.

12. An X-ray table comprising in combination, a table frame having a raised rigid marginal boundary at the top thereof, a planular table top having a depending rigid marginal boundary complementary to the top of said table frame and adapted to be seated thereon, outward projections spaced from each other along the sides of the raised table frame boundary and inward projections spaced from each other along the depending table top boundary, said outward and inward projections adapted to interlock when the table top is seated on the table frame to secure the table top to the table frame.

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