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Prendergast et al.

[11] **3,838,286**

[45] **Sept. 24, 1974**

[54] **X-RAY TABLE WITH SELF-STORING TOMOGRAPHIC COUPLING BAR**

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[21] Appl. No.: **416,590**

[52] **U.S. Cl.** **250/445,** 250/490, 250/525

[51] **Int. Cl.** **G01n 23/00**

[58] **Field of Search** ..... 250/439, 444, 445, 445 T, 250/446, 447, 490, 523, 525

[56] **References Cited**

UNITED STATES PATENTS

2,491,224 12/1949 Staua ..... 250/445 T

3,708,664 1/1973 Bock et al. ..... 250/445 T

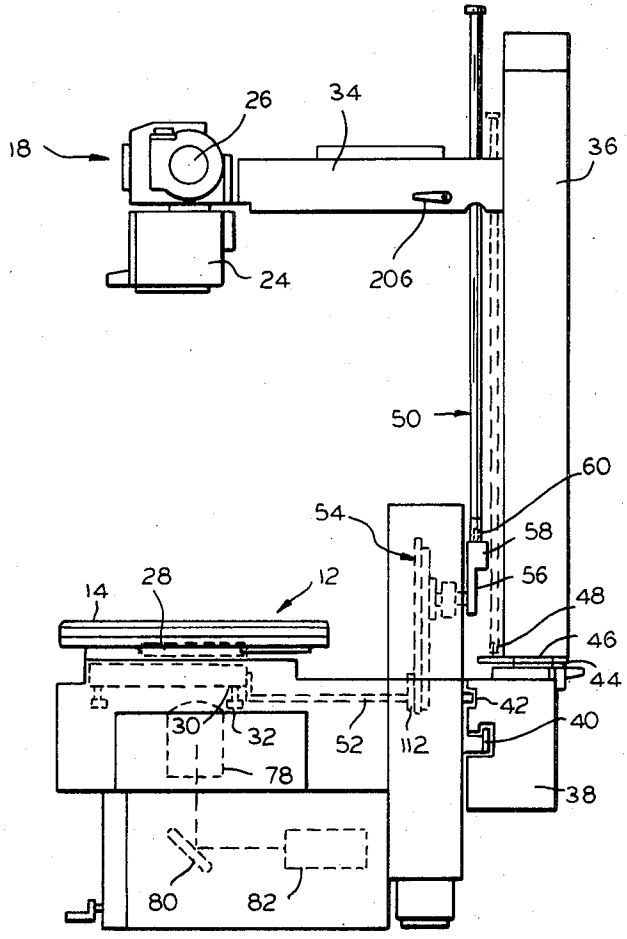
Primary Examiner—William F. Lindquist

Attorney, Agent, or Firm—Ralph G. Hohenfeldt; Fred Wiviott

[57] **ABSTRACT**

An X-ray tube is mounted over an X-ray table on a horizontally extending shaft means which enables the X-ray tube to be angulated as it is translated longitudinally of the X-ray table top for tomographic and angular radiographic procedures. A clamping mechanism is provided for connecting the coupling bar to the rotational axis of the X-ray tube so that the bar may be engaged selectively positively or slidably or may be completely disconnected. The coupling bar is detachable from the tomographic fulcrum assembly and when it is completely separated from the tube rotational mechanism, the coupling bar may be re-engaged with a stationary pin in a storage position.

10 Claims, 12 Drawing Figures



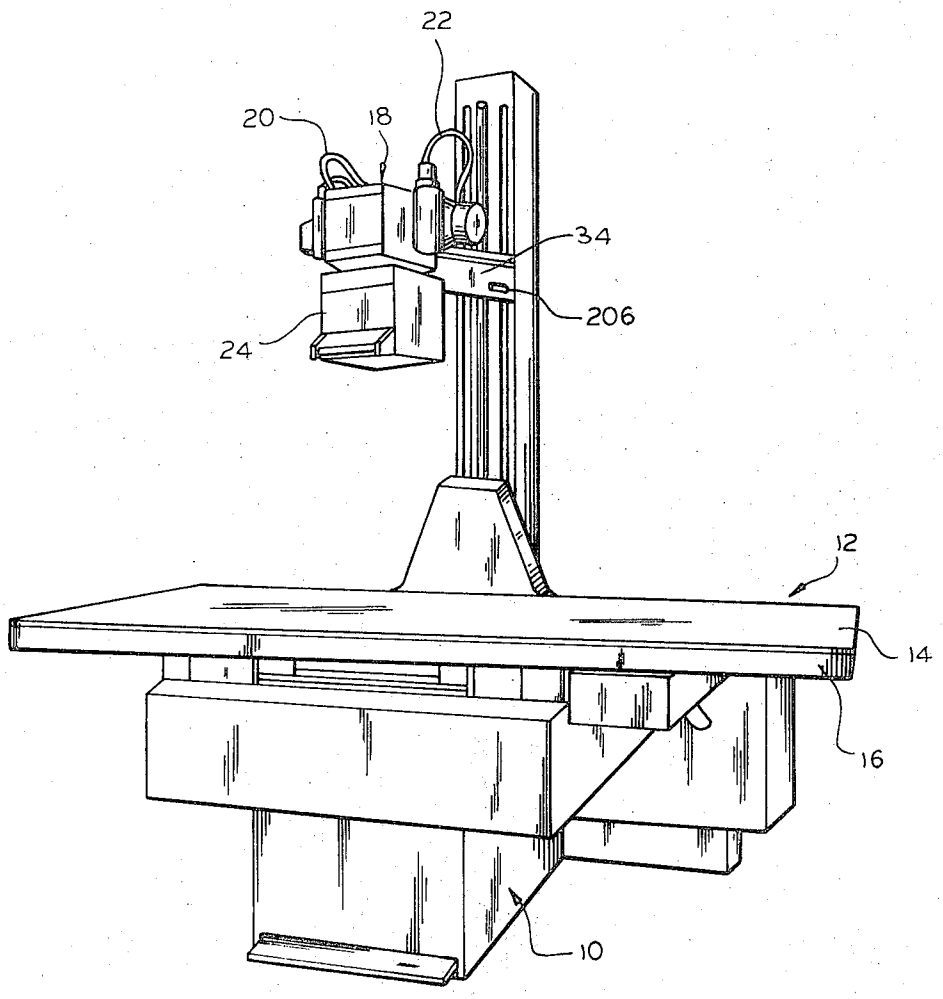


FIG.1

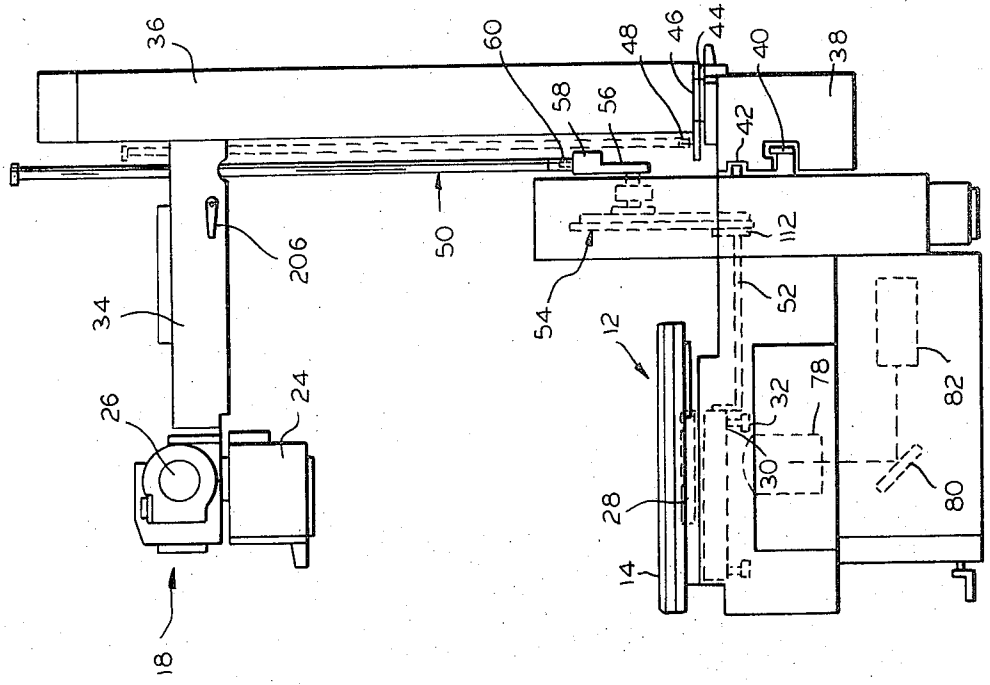

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FIG.3

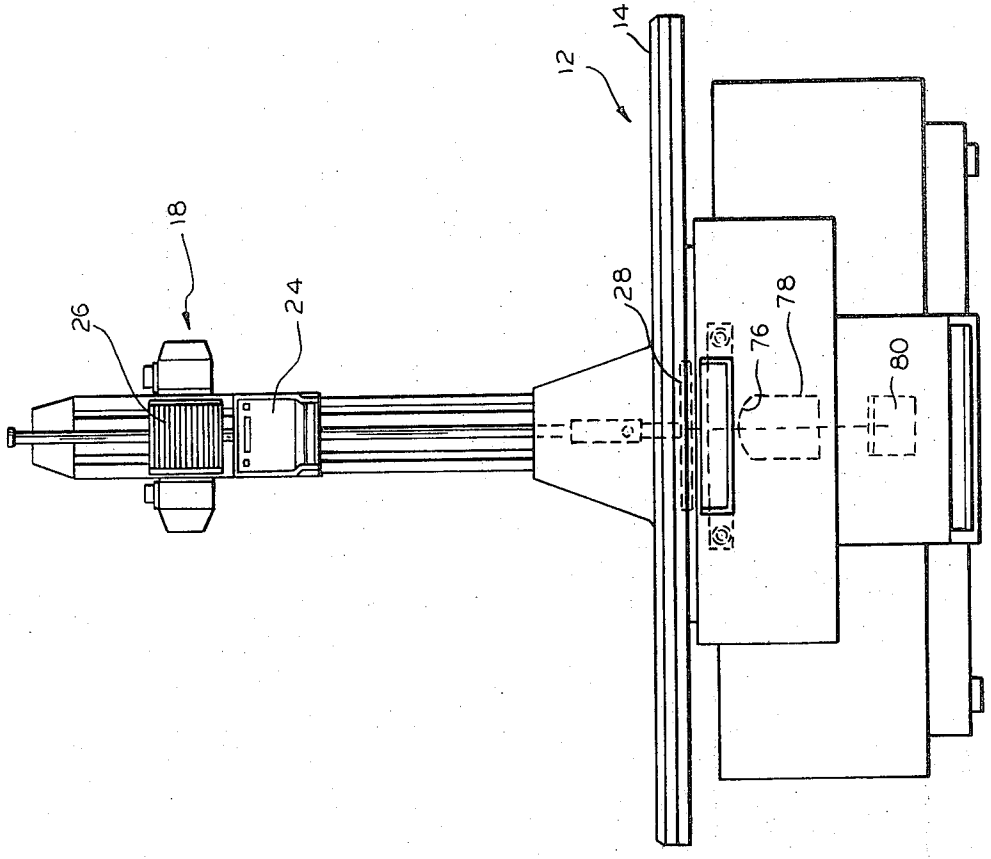
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FIG.2

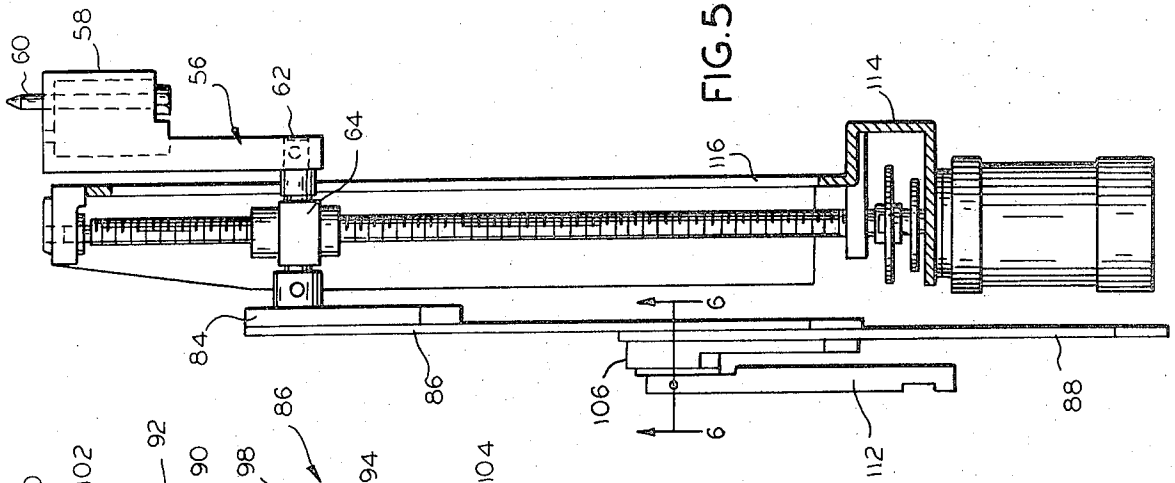


FIG.5

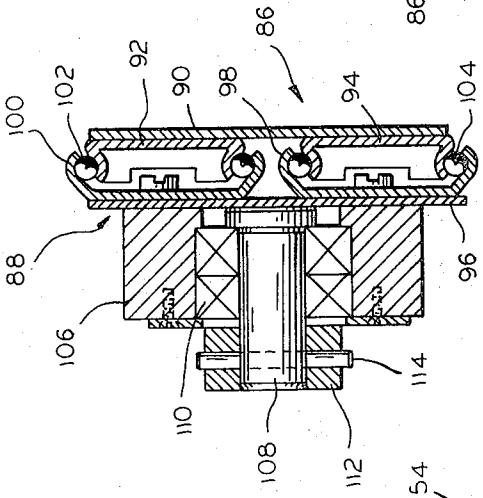
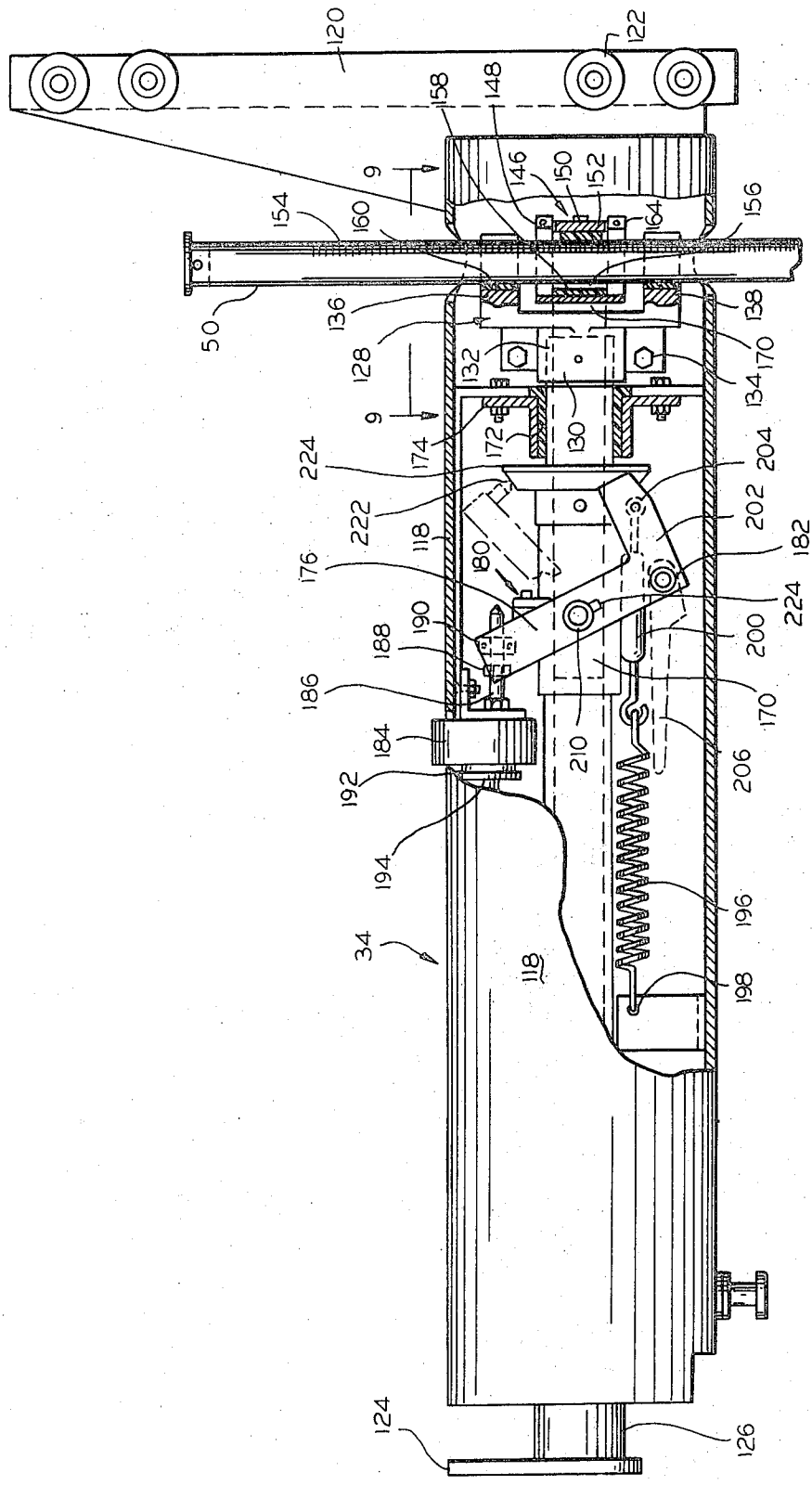


FIG.6

FIG.4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172
174
224
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222
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118
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FIG. 7

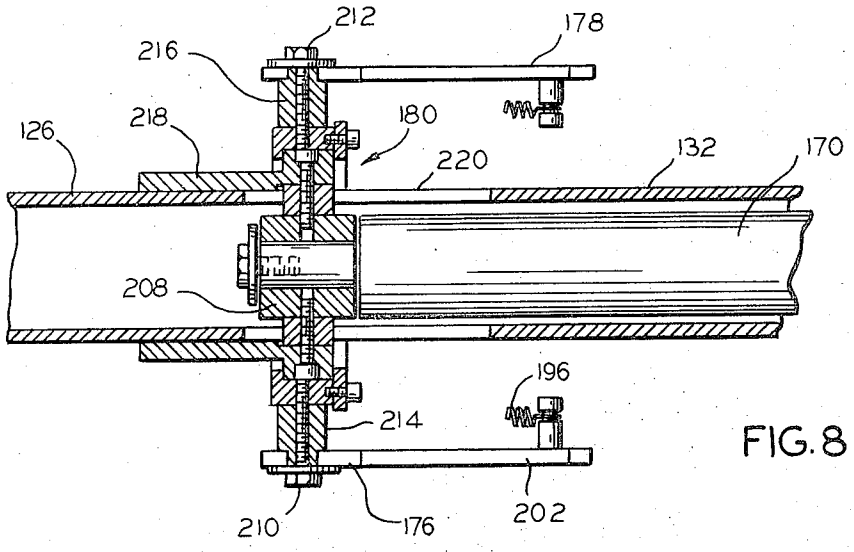
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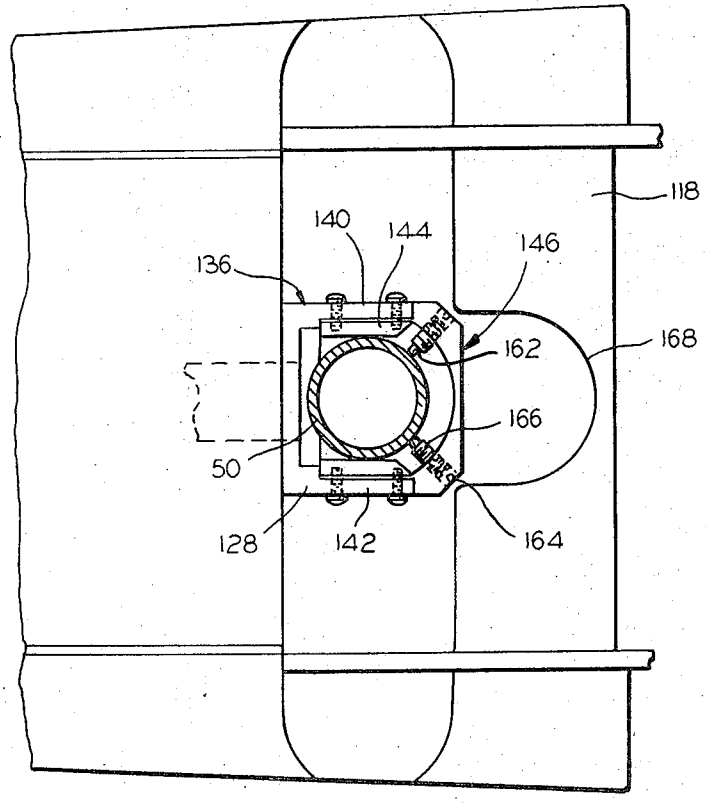
FIG. 8


118
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146
136
162
168
166
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128
142
164

FIG. 9

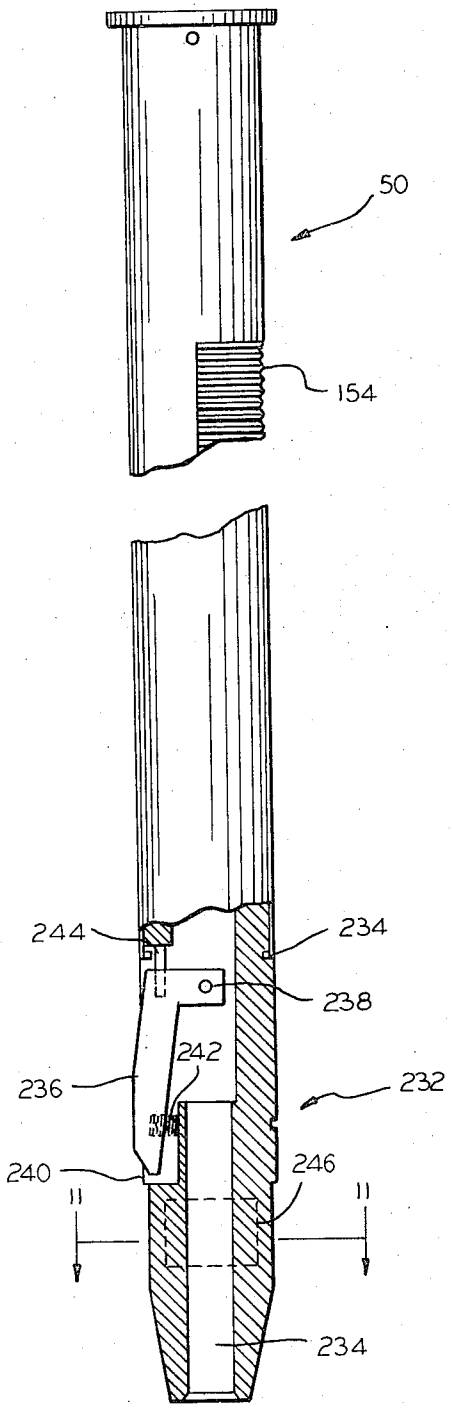

FIG.10

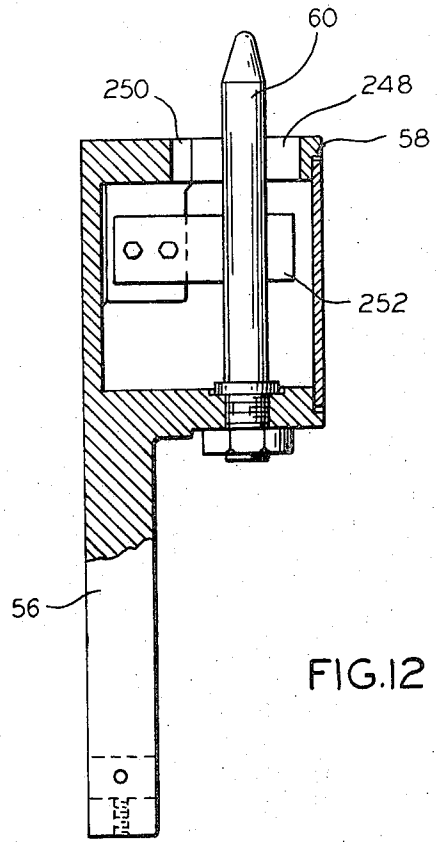

FIG.12

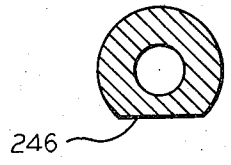

FIG.11

X-RAY TABLE WITH SELF-STORING TOMOGRAPHIC COUPLING BAR

BACKGROUND OF THE INVENTION

This invention relates to diagnostic X-ray tables and, particularly, to tables that are adapted for performing angular fluoroscopy, angular radiography and tomography technics. The invention is concerned primarily with simplifying the matter of using a tomographic coupling bar and with a convenient way of storing it in association with the X-ray table.

It is known to equip an X-ray table for performing tomography and angular radiography by supporting an X-ray table top. For tomography, the X-ray tube is moved longitudinally over the X-ray table top usually along a horizontal line while it is simultaneously angulated to keep the central X-ray confuse from the tube directed at the center of a film in a cassette under the table top. The X-ray tube is mounted for rotation on a laterally extending axis and is coupled to a carriage underneath the table top which supports the film cassette. When the X-ray tube is moved longitudinally in one direction over the table top, the fulcrum axis for the coupling bar is at such level as to shift the film cassette in the opposite direction. The fulcrum axis is set at a level such that it extends through the plane of a patient on the table top which is to be recorded sharply on the film. All planes above and below the axis plane undergo relative motion and are blurred on the film so as to not donfuse the detail in the plane of interest.

For angular radiography, the X-ray tube is shifted from the center of the table and angulated so that the X-ray beam is directed through an organ or portion of the patient's anatomy which may be underneath what would be an otherwise interfering organ if vertical radiography were used. During angular radiography, the tomographic coupling bar is connected and the fulcrum axis is positioned at a level coincident with the plane of the film. The X-ray tube is swung through an arc and angulated such that the central ray is always pointed at the center of the film and the focal spot to film distance remains constant.

In prior art X-ray tables equipped for tomography and angular radiography, either one of two cases existed. In the first case, the tomographic coupling bar was semi-permanently attached to the fulcrum mechanism and the X-ray tube was limited in its positioning capabilities to those positions normally within the range of positioning required during tomographic procedures. In the second case, the tomographic coupling bar between the X-ray tube and the fulcrum point had to be completely removed from the system to permit angulating the tube 90° for vertical Bucky stand work wherein the X-ray beam is parallel to the floor and directed toward an independent Bucky stand which supports a film cassette vertically. The coupling bar also had to be removed for rotation of the X-ray tube stand vertical column such as is required during lateral radiography across the table top. For vertical radiographic technics, the coupling bar is disconnected since the X-ray tube must be free to angulate beyond the range permitted with the coupling bar engaged. In prior art X-ray tables, changing over from the tomographic and angular radiography modes to a vertical radiography mode required the operator to loosen some clamping screws and separate the tomographic coupling bar from the apparatus. This was followed by carrying the coupling bar to a place of storage remote from the X-ray table. If the next patient to be examined required tomographic procedures, the bar had to be retrieved and reinstalled and fastened by the operator which involved considerable effort. Removing and reinstalling the tomographic coupling bar in some prior art X-ray tables was so burdensome that some hospitals dedicated an entire X-ray table exclusively to tomographic procedures in which case the bar could remain installed at all times. An extra table had to be on hand for performing vertical radiography. Thus, two tables were often employed where one would have sufficed but for the inconvenience of handling the tomographic coupling bar.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a tomographic X-ray table with means for selectively engaging the coupling bar with the X-ray tube rotational shaft so that the coupling bar may selectively slide relative to the axis of tube rotation during tomography or so it will not slide for angular radiography.

A further and important object of the invention is to provide means for disconnecting the coupling bar and for storing it on the X-ray tube support such that the operator is only required to manipulate one end of the coupling bar to make a quick engagement or disengagement with the coupling bar fulcrum mechanism while another end of the coupling bar is in proximity with the X-ray tube supporting shaft for rapid and automatic re-engagement.

How the foregoing and other more specific objects of the invention are achieved will appear in the course of the more detailed description of a preferred embodiment of the invention which will be set forth hereafter.

In general terms, the invention involves an X-ray table which has a stand or column adjacent the table body for supporting an X-ray tube on an arm which extends laterally over the X-ray table top. The column is mounted on a carriage which permits it to be shifted longitudinally in either direction from the center of the table top. A mechanism including a fulcrum axis which is adjustable in elevation is affiliated with the X-ray table. The tomographic coupling bar connects between a crank arm rotatable about the fulcrum axis and the axis of the X-ray tube. The lower end of the fulcrum mechanism drives a Bucky carriage which supports the film cassette under the table top in accordance with the longitudinal positions of the X-ray tube.

The X-ray tube is supported for rotation about a lateral axis on a shaft mechanism which terminates in a yoke in which the coupling bar may nest. The coupling bar also passes through a clamping collar which is on an axially moving shaft. Means are provided to drive the shaft and clamping member in a direction to force the coupling bar tightly into the yoke whereupon the bar will rotate the yoke but not slide in it. The shaft is also movable through a first short distance to release the coupling bar for sliding. It is further movable to completely disengage from the yoke so that the X-ray tube may rotate freely about the laterally extending axis. When the coupling bar is completely disengaged from the yoke, the bar still passes through the connecting or clamping assembly which retains it in a desired vertical position. The operator can then, after disconnecting the lower end of the coupling bar from the ful-

crum assembly crank, drop the coupling bar onto a pin adjacent to the X-ray tube supporting column for storage in association with the X-ray table. When the coupling bar is in storage position, the column is still free to turn so as to permit lateral radiography.

A preferred embodiment of the invention will now be described in reference to the drawings.

DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of an X-ray table embodying the new coupling bar mechanism and storage means;

FIG. **2** is a front elevation view of the X-ray table shown in the preceding figure;

FIG. **3** is a side elevation view of the table;

FIG. **4** is a view of the tomographic arm fulcrum assembly isolated from the X-ray table;

FIG. **5** is a side elevation view of the assembly in FIG. **4** with some parts removed;

FIG. **6** is a section taken on the line **6—6** in FIG. **5**;

FIG. **7** is a side elevation view, partly in section of an X-ray tube supporting cross arm isolated from the table assembly shown in FIGS. **1–3**;

FIG. **8** is a partial horizontal sectional view taken on the line **8—8** in FIG. **7**;

FIG. **9** is a partial plan view of a part of the tomographic coupling bar mechanism in the X-ray tube supporting arm shown in FIG. **7**;

FIG. **10** shows the coupling bar, partially in section, and with a portion of the bar length broken away;

FIG. **11** is a section of the coupling member taken on the line **11—11** in FIG. **10**;

FIG. **12** is a fulcrum crank arm assembly in respect to which the lower end of the tomographic coupling bar shown in FIG. **10** may be selectively engaged for tomography and angular radiography or disengaged for being placed in storage position.

DESCRIPTION OF A PREFERRED EMBODIMENT

The general features of a typical X-ray table in which the invention may be incorporated will now be described in reference to FIGS. **1–3.** The table comprises a body or base which is generally designated by the reference numeral **10.** Mounted on the body is an X-ray table top assembly **12** which comprises an X-ray permeable patient supporting top panel **14** which is mounted on a metal framework composed of members such as **16** joined at their corners. Top assembly **12** is mounted on body **10** in such manner that the top may be shifted longitudinally and laterally to a limited extent to position a patient supported thereon in the X-ray beam projected from the focal spot of an X-ray tube over the table top through the patient to an X-ray visualizing or recording medium under the table top.

The X-ray tube is in a tube casing **18** and is supplied with power by means of cables **20** and **22** which are visible in FIG. **1.** The X-ray tube casing has a beam collimator **24** fastened to it. The collimator may be a conventional type which has shutter blades, not shown, for defining the boundaries of the X-ray beam. In FIGS. **2** and **3** the longitudinal and lateral position of the X-ray tube focal spot is marked **26.** In these figures, the patient supporting top assembly **12** is centered directly under the focal spot both longitudinally and laterally.

The X-ray image may be recorded on a film in a cassette **28** underneath the table top. The cassette is shown as a dashed line rectangle in FIGS. **2** and **3.** It is supported on Bucky carriage **30** which has rollers such as **32** which run on tracks, not shown, to enable the Bucky to be translated longitudinally underneath the table top. For most radiographic technics, the Bucky carriage and cassette can remain centered with the table top as shown in FIGS. **2** and **3.** For tomography, as is known, the Bucky carriage and film translate beneath the table top in a direction opposite to that in which the X-ray tube is moved longitudinally on a horizontal line above the table top.

As can be seen particularly well in FIG. **3,** X-ray tube casing **18** is mounted on a tube supporting arm **34** which engages with a column or stand **36.** Tube arm **34** is vertically adjustable on column **36** and locking means, not shown, but which may be conventional are provided for selectively locking tube arm **34** at a fixed elevation on column **36.** When the locks are released, of course, arm **34** is free for being adjusted to a desired vertical elevation. The arm and tube casing and affiliated parts have a counter weight system, not shown, in column **36** so that the arm can be positioned manually rather than with a power mechanism.

Column **36** is supported on a carriage **38** which is adapted for traversing longitudinally of the table body on rails such as those marked **40** and **42.** Column **36** joins carriage **38** with a swivel coupling **44** which permits the column to be rotated about a vertical axis so that the tube arm **34** will swing and project longitudinally of the table rather than laterally as it is depicted in FIG. **3.** When the tube arm is longitudinal, the X-ray tube casing may be rotated 90° so as to project its beam laterally of the table top for lateral radiography. Lateral radiography involves use of a cassette, not shown, located along the front of the X-ray table to record the image formed by projecting the radiation through a patient lying on the table top. Of pertinence to the present invention is the presence of a plate **46** near the swivel assembly **44** at the lower end of column **36.** This plate carries an upstanding pin **48** which is used to store the tomographic coupling bar which is generally designated by the numeral **50** in FIG. **3** and whose structural and functional features will be described in greater detail hereinafter.

In FIG. **3** it will be evident that Bucky carriage **30** may be urged longitudinally of the table top by applying an appropriate force to a driving bar **52.** Bar **52** derives its driving force from a fulcrum mechanism which appears in dashed line in FIG. **3** and is designated generally by the numeral **54.**

FIGS. **4–6** show the fulcrum mechanism in detail. Coupling bar **50** is shown disconnected in these figures but it will be understood that it connects to a crank arm **56** having a socket **58** in which there is a coupling bar engaging arm **60.** The details of items **58** and **60** will be described later. Crank arm **56** is pinned to a shaft **62** which is journaled in a vertically movable cross head **64.** The axis **66** of shaft **62** projects in a lateral direction relative to the X-ray table top and constitutes the fulcrum axis of the system. Head **64** is threadingly engaged with a lead screw **68** which is driven by a motor **70** through a drive train **72.** There is also a stationary smooth guide rod **74** on which head **64** runs. Fulcrum axis **66** may be positioned at any selected elevation along the lead screw by operation of reversible motor

70. In the position in which it is shown in FIG. 4, the fulcrum axis 66 would extend laterally over the table top 14 and through a horizontal plane in a patient supported thereon. The fulcrum axis can be variously lowered so it extends through the film plane in cassette 28 and even low where it extends through the input surface 76 of an image intensifier 78 which is shown in dashed line in FIG. 2. The X-ray image intensifier is essentially a fluoroscopic device that converts the X-ray image into an optical image which is reflected by a mirror 80 to a television camera 82 as evidenced in FIG. 2. The television camera operates a monitor, not shown, on which the fluoroscope image may be visualized.

Considering the mechanism in FIGS. 4–6 further, it will be seen that there is another arm 84 pinned on fulcrum shaft 62 to which crank arm 56 is pinned. Arm 84 is fastened to a link 86 which is slidable relative to a cooperating link 88. Links 86 and 88 are interlocked so they remain in alignment with each other and with the axis of the coupling bar which connects to crank arm 56. In the FIG. 6 sectional view, it is evident that link 86 comprises a flat strip 90 on which a pair of channel members 92 and 94 are affixed. Link 88 comprises a flat member 96 and a pair of channel members 98 and 100. The channel members on the two links are shaped so that they retain bearing balls such as 102 and 104 between them for reducing sliding friction.

As is evident in FIGS. 4 and 5, link 88 has a bearing supporting member 106 fastened to it. As is evident in FIG. 6, there is a shaft 108 journaled in bearing member 106 on bearing elements 110. Shaft 108 has an arm 112 fastened to it by means of a pin 114. Arm 112 constitutes the driving member which engages bar 52 in FIG. 3 for moving the Bucky carriage 30 longitudinally of the X-ray table. The axis of shaft 108 for arm 112 extends laterally through the plane of the film cassette and is maintained in that plane at all times regardless of the angle through which the links 86 and 88 are swung since the Bucky carriage to which arm 112 is coupled by means of bar 52 in FIG. 3 is constrained to move only longitudinally of the X-ray table because the Bucky carriage is on tracks. It will be evident in FIG. 4 that if the tomographic coupling bar 50 which connects to pin 60 is rotated clockwise with the fulcrum axis 66 remaining fixed, film plane axis 108 will move horizontally and links 86 and 88 will slide relative to each other to compensate for the distance change which occurs between fulcrum axis 66 and axis 108 during swinging of the tomographic coupling bar. The fulcrum mechanism shown in FIGS. 4 and 5 is supported in a housing 114 which is stationary and centrally located with respect to the X-ray table body. Housing 114 has a slot 116 in its back wall so that shaft 62 going through cross head 64 can move vertically without interference.

The mechanism for engaging the X-ray tube support with the fulcrum mechanism by means of the coupling bar 50 will now be discussed in reference to FIG. 7. The X-ray tube arm 34 may be seen in FIG. 7 to comprise a housing 118 which is mounted on a carriage 120 provided with several sets of rollers such as 122. By means of carriage 120, tube arm 34 may be moved vertically on tube supporting column 36 with which it is engaged. It will be understood that electrically operated locks, not shown, are situated in column 36 for locking carriage 120 in any selected vertical position. The locks may also be released to permit carriage 120 to move vertically when the X-ray tube arm 34 is translated longitudinally under some circumstances.

In FIG. 7, the X-ray tube casing 18 is omitted but will be understood to be fastened to a plate element 124 which is affixed to the end of a tubular shaft 126. Thus, means are provided for allowing the X-ray tube to rotate about a laterally extending axis passing through its focal spot 26 whereby the tube may be angulated for angular radiography and tomography correspondingly with shifting of the tube. The tube is rotated by coupling bar 50 which swings through an angle about its fulcrum axis 66 when the vertical column 36 is shifted in either direction from the center of the X-ray table. During tomography, carriage 120 is locked relative to column 36 so that when the column shifts, the X-ray tube will stay in the same horizontal plane. This means that tomographic coupling bar 50 must slide relative to the X-ray tube axis so as to compensate for the greater radius between fulcrum axis 66 and the X-ray tube focal spot when the latter is moved horizontally. For angular radiography, however, it is desirable to let the X-ray tube swing through an arc so as to maintain a constant distance from the X-ray tube to the fulcrum axis 66 and hence to the film plane. To allow the X-ray tube to swing through an arc for angular radiography, the vertical carriage 120 is unlocked and the coupling bar 50 is rigidly attached to tube arm 34 but in a manner that allows the tube to be rotated about the axis of shaft 126. In other words, during angular radiography, the tube arm does not slide relative to tomographic coupling bar 50. The mechanism for permitting making a sliding connection or a nonsliding connection between the coupling bar and the X-ray tube and for facilitating storage of the coupling bar will now be discussed in further detail with reference to FIGS. 7–9. As depicted in FIGS. 7 and 8, coupling bar 50 is nested in a yoke 128 which has an integral hub 130 that is split axially for clamping it to a tubular shaft 132 by means of a pair of clamping bolts such as 134. It will be evident that when tube arm 34 is shifted longitudinally while coupling bar 50 is engaged with yoke 128 the shaft 126 and the X-ray tube supported thereon at the other end of arm 34 will be caused to angulate.

Yoke 128 has two axially extending arms 136 and 138 in which coupling bar 50 may nest. Arm 136 is visible in FIG. 9 and is seen to comprise a pair of side members 140 and 142 which define a gap for accommodating coupling bar 50. The gap is open on its back or right side as viewed in FIG. 9 so that coupling bar 50 may be shifted in and out from between side members 140 and 142 to thereby disengage the coupling bar from the yoke when desired. The side members are lined with pads such as 144 which may be nonmetallic material such as nylon for reducing friction when the coupling bar is relatively slidable.

FIGS. 7 and 9 show how the coupling bar 50 is engaged between legs 136 and 138 of the yoke by means of a collar assembly which is generally designated by the numeral 146. The collar has a circular bore 148 and an end wall in which there is an integral insert 150. The insert is arcuate in cross section to conform with the radius of coupling bar 50 and the radially inward surface of the insert has fine serrations 152. When collar 146 is shifted to the left as shown in FIG. 7, the serrations engage with complementary serrations 154 on one-half of the coupling bar 50. These serrations are quite fine

and may have a depth and width of on the order of 1/16 inch. Thus, for one mode of operation collar **146,** when shifted to the far left as shown in FIG. **7,** serves a clamping element for retaining coupling bar **50** against sliding motion and for holding it securely in the yoke.

In FIG. **7** one may see that there is a small gap **156** between coupling bar **50** and a nylon or the like pad **158.** When it is desired that the yoke **128** slide relative to coupling bar **50,** clamping collar **146** is shifted sufficiently to the right in FIG. **7** to close the gap **156** between the periphery of the coupling bar and pad **158** in which case the serrations **152** on the insert separate from the serrations **154** on the coupling bar so that yoke **128** can slide relative to the coupling bar. Under these circumstances, coupling bar **50,** of course, remains engaged with yoke **128** so as to turn the yoke and slide in it when the tube arm **34** is shifted longitudinally of the X-ray table. When collar **146** is shifted axially through the first small amount to close gap **156,** a gap would be formed between insert **150** and the periphery of the coupling bar **50.** To avoid any free play and to assure that the bar will be pressed against nylon pad **160** in the yoke, spring biased plungers such as **162** and **164** are provided in clamping collar **146** as can be seen in FIG. **9.** These plungers are in socketed screws such as **166** and there is a spring, not visible, behind each one of the plungers. Thus, when the collar is backed off by the first slight amount, the plungers will press the coupling bar **50** into the yoke with a slight force sufficient to eliminate vibration and free play but insufficient to affect sliding action between the coupling bar and the yoke and collar.

Collar **146** may be shifted further to a third axial position where it drives coupling bar **50** out of engagement with the yoke. As seen in FIG. **9,** the top of housing **118** of arm **34** is provided with a slot **168** to permit the coupling bar **50** to move clear of the yoke. This disengagement is used when it is desired to store the coupling bar or deactivate it such as is the case when the apparatus is to be used for lateral radiography or in the vertical radiography mode at which time it is necessary to angulate the X-ray tube beyond the angular range permitted wherein the coupling bar is engaged in the yoke.

The manner in which coupling bar clamping means **146** is shifted will now be discussed in reference to FIGS. **7** and **8.** Note that collar **146** is supported on a shaft **170** which is internal to tubular shaft **132** to which yoke **128** is clamped. The outer yoke supporting tubular shaft is journaled in a bushing **172** which is supported in a fixed collar **174.** Yoke shaft **132** is effectively connected to the X-ray tube supporting shaft **126** at all times. When the coupling bar **50** is out of yoke **128** the yoke turns with manual turning of the X-ray tube and the tube may be turned sufficiently so it projects its beam horizontally or laterally over the table top when the tube arm is swung in parallelism with the table as mentioned earlier. Thus, the axially extending arms **136** and **138** of the yoke are spaced apart sufficiently to permit their rotation around collar **146** without interference.

Collar **146** does not provide tube rotational force and is only used to control coupling bar **50** in its first nesting or clamped position and its second sliding position and third fully released position relative to the yoke. Hence, shaft **170** supporting the clamping collar is rotatable within outer yoke shaft **132.**

The inner shaft is moved axially of the outer shaft by the actuation of a pair of levers **176** and **178** which can be seen in FIGS. **7** and **8.** The levers are mounted on a collar assembly **180.** The levers are mounted for pivoting on stationary studs **182** which project from opposite sides of tuge arm housing **118.** As viewed in FIG. **7,** when lever **176** is rotated clockwise through an angle of a few degrees or less, it will cause solid shaft **170** supporting collar **146** to move sufficiently to close gap **156** and separate the serrations on the coupling bar **50** and insert **150** to allow the coupling bar to slide in the yoke. When lever **176** is rotated through a larger angle, shaft **170** shifts axially and carries collar **146** with it sufficiently far to drive the coupling bar **50** out of the yoke **128.**

The first small angle rotation is obtained with a solenoid **184** which has an armature pin **186** extending from it. This pin strikes the head **188** of a screw which is turned in a bracket **190.** The amount of solenoid travel is indicated by the gap **192** between a plate **194** and the solenoid. When the solenoid is de-engerized, arm **176** returns to the small angle to its original position as shown in FIG. **7.** Arm **176** has a pair of springs **196** which are anchored at **198** and connect by means of a turnbuckle to the right angular leg **202** of the arm. The turnbuckle connection is at **204** and it will be seen to constitute an over-center spring arrangement such that when arm **176** pivots beyond a certain point, the force direction of the spring will be below pivot **182** and the arm will turn through a large clockwise angle, driving collar **146** axially and disengaging the coupling bar from the yoke.

Arm **176** is turned through the large angle by manually actuating a lever **206** which appears in hidden lines in FIG. **7** and is outside of tube arm **34** housing **118.** Thus, solenoid **184** moves arms **176** and **178** through the first small angle and the arms are moved through the larger angle manually by means of operating lever **206.** When arm **176** turns through a maximum angle as shown in phantom lines in FIG. **7,** pointed bolt **188** carried thereby engages in a slot **222** in a collar **224** which allows the user to detect the point at which the X-ray tube is aligned vertically. This provides an alignment of the X-ray tube by feel only and may be overcome by exerting additional rotational force on the X-ray tube.

In FIG. **8** it will be evident that when arms **176** and **178** are driven clockwise by opertion of manual handle **206,** a plunger or sliding bearing **208** will cause clamping collar supporting shaft **170** to be driven axially to thereby uncouple the coupling bar **50** and yoke **128.** This is so because levers **176** and **178** pivot about point **182** such as to drive plunger **208** axially by virtue of the pivot connection that is co-axial with cap screws **210** and **212** which are in spacers **214** and **216,** respectively. The spacers are mounted on a sleeve **218** which is stationary and serves as a pivot support for levers **176** and **178.** These levers have a slot **224** on which they slide to compensate for radius changes around their pivot **182** as can be seen in FIG. **7.** The plunger **208** may slide without interference by virtue of outer shaft **132** having an axial slot **220** therein which allows tubular shaft **132** to rotate about its axis through a total angle of over 70°. When shaft **132** is rotated, of course, it will cause its co-axial extension shaft **132** to rotate

and thereby rotate or angulate the X-ray tube. On the other hand, when the shaft extension **126** is unlocked by means which are not visible in the forward end of tube arm housing in FIG. **7**, the X-ray tube will be free to rotate, turning the yoke **128** with it.

Details of the coupling bar **50** are shown in FIG. **10**. The lower end of the coupling bar is provided with an adaptor or coupling element **232**. The coupling member is provided with an axial bore **234** which engages with pointed pin **60** on the crank arm of the fulcrum mechanism as can be seen in FIG. **3** where the coupling bar **50** is in active position for use in connection with either tomography or angular radiography. To park and store the coupling bar **50** as has been implied earlier, it is driven out of the X-ray tube driving yoke **128**. The bar is then detached from crank arm **58** and deposited on a storage or parking pin **48** as shown in FIG. **3** where the coupling bar in storage position is represented by phantom lines. **9**

The coupling member **232** at the lower end of the bar cooperates with a socket **58** which is integral with fulcrum crank arm **56** as can be seen in FIG. **12**.

FIG. **10** shows how the tubular coupling bar **50** may be joined by welding along a line **234** to coupling adapter **232**. The adapter has a key or latch **236** which is mounted on a pivot **238** for movement in a radial slot **240**. A spring **242** biases latch **236** radially outwardly and a stop pin **244** limits the travel of the latch.

The cross section of adapter **232** is generally circular but it has a flat area **246** on one side as can be seen in FIGS. **10** and **11**. Adapter **232** is sized to fit through a hole **248** in socket **58** of FIG. **12** such that latch key **236** aligns with and enters a key slot **250** while pointed pin **60** enters axially bore **234** of adapter **232**. Key slot **250** compels fulcrum bar **50** to be aligned in such a way that the serrations on the fulcrum bar are engageable by the clamping member which was discussed above. When adapter **232** is plunged into socket hole **248**, the flat region with its axially overhanging portion is engaged by a flat spring member **252** so that withdrawal of adapter **232** is prevented and so that the coupling bar has the capability of transmitting an axial force as well as a rotational force to crank arm **56**.

To detach coupling bar **50** and its end adapter **232** from socket member **58**, latch **236** is pressed radially inwardly to release it from key slot **250** and the entire coupling bar is turned about its own axis to bring a circular portion of the adapter periphery in contact with flat spring **252**. This permits adapter **232** to be withdrawn or slid over the surface of flat spring **252** for detachment of the coupling bar from the socketed lever **56**. If the coupling bar is then released from the tube rotational yoke, it can be swung over and aligned with parking pin **48** and plunged down onto the parking pin as indicated in FIG. **3**. As explained earlier, with this situation existing, column **36** can nevertheless be rotated, carrying the coupling bar with it while the latter is in storage position.

To return the coupling bar to active position, the operator merely lifts it off of storage pin **48** and deposits it on pin **60** of crank arm **56**. Then by actuating manual lever **206** the coupling bar may be driven into the tube rotational yoke **128** as it appears in FIG **7**.

Although a preferred embodiment of the invention for handling, activating, deactivating and storing a tomographic coupling bar has been described in considerable detail, such description is intended to be illustrative rather than limiting, for the invention may be variously embodied and is to be limited only by interpretation of the claims which follow.

We claim:

1. In diagnostic X-ray apparatus adapted for tomography and angular radiography and other procedures, said apparatus comprising an X-ray permeable patient supporting top, a film cassette supporting carriage movable on one side of the top, an X-ray tube means supported on the other side of the top for moving relative thereto, shaft means supporting said tube means for angulation relative to the top at least in connection with tomography and angular radiography procedures, the improvement comprising:

a. a movable element for providing a laterally projecting fulcrum axis,

b. link means attached to said carriage and swingable about said fulcrum axis,

c. coupling bar means constructed and arranged for selectively engaging said link means to said X-ray tube shaft means so that said relative movement of said X-ray tube means will angulate said X-ray tube means rotationally about its shaft means axis and turn said link means and coupling bar means about said fulcrum axis,

d. engagement means operative to selectively engage said coupling bar means with said X-ray tube shaft means in a first manner to effect a positive non-sliding connection between said tube shaft means and coupling bar means, and in a second manner to effect a sliding connection therebetween and said engagement means being operative in a third manner to effect complete disengagement between said coupling bar means and shaft means, and

e. means for operating said engagement means.

2. The invention defined in claim **1** including:

a. coupling means at one end of said coupling bar means for coupling and uncoupling said bar means and link means, and

b. means for holding said coupling bar means in a storage position when said bar means is disconnected from said link means, said bar means being stabilized by said engagement means when said engagement means has been operated to disengage said coupling bar means completely from said shaft means.

3. The invention defined in claim **1** wherein:

a. said coupling bar means has serrations on a surface thereof and said engagement means includes an element having serrations, whereby to enhance the non-sliding connection between said engagement means and said coupling bar means when said engagement means is engaged in said first manner.

4. In diagnostic X-ray apparatus adapted for tomography and radiography and other procedures, said apparatus comprising an X-ray permeable top for supporting a patient, a film cassette supporting carriage movable on one side of said top, an X-ray tube means supported from an arm normally extending laterally over the table top and movable relative to said top, a stand adjacent said apparatus from which said arm extends and on which said arm is mounted for vertical movements, said stand being selectively rotatable about a vertical axis, shaft means journaled in said arm and supporting said X-ray tube means for angulation, the improvement comprising:

a. a movable element for providing a laterally projecting fulcrum axis,
b. link means attached to said film cassette supporting carriage and swingable about said fulcrum axis and extending radially from said axis,
c. crank arm means engaged with said link means and extending radially opposite of said link means from said fulcrum axis,
d. coupling bar means including means for detachably connecting an end thereof with said crank arm means,
e. first means connected to said X-ray tube shaft means for rotation therewith and being constructed and arranged for receiving said coupling bar means and for engaging said bar means to swing said bar means about said fulcrum axis under the influence of said X-ray tube arm being moved,
f. second means engageable with said coupling bar means, and
g. means for selectively operating said second means to alternately clamp said coupling bar means for non-sliding engagement with said first means, or unclamp said bar means for sliding engagement with said first means, or completely disengage said coupling bar means from said first means.

5. The invention defined in claim **4** including:
a. means mounted to said stand means for holding said coupling bar means in a storage position when it is simultaneously detached from said first means and said crank arm means.

6. The invention defined in claim **5** wherein:
a. said coupling bar means is swingable jointly with said stand means when said stand means is turned about its axis and said coupling bar is in storage position.

7. The invention defined in claim **4** wherein:
a. said means for detachably connecting said coupling bar means comprising:
1. an element projecting endwise of said coupling bar,
2. spring biased latch means pivotally mounted on said element,
3. socket means carried by said crank arm means, said socket means having a slot means for receiving said latch means to restrain said bar means against rotation,
4. said socket means including a spring member engageable with said element when inserted therein, and
5. said latch means being manually depressable clear of said slot means to permit rotation of said coupling bar to thereby disengage said spring member and permit withdrawal of said coupling bar from said crank arm means.

8. The invention defined in claim **4** wherein:
a. said first means comprises yoke means,
b. said second means comprises collar means and a second shaft means supporting said collar means for rotation coaxial with said X-ray tube shaft means, said collar means embracing said coupling bar means, and
c. means for shifting said second shaft means to effect said selective operation of said second means.

9. The invention defined in claim **4** wherein:
a. at least a portion of the length of said coupling bar means is provided with serration means, and
b. said second means has serration means for engaging said coupling bar means to enhance said non-sliding engagement when said coupling bar is clamped.

10. A diagnostic X-ray system including means for performing tomography, comprising:
a. X-ray permeable patient supporting panel means,
b. carriage means for supporting a film cassette on one side of said panel means, said carriage means being mounted for movement relative to said panel means in a parallel plane,
c. an element that is movable in a line substantially perpendicular to said panel means,
d. link means journaled for swinging on said element about an axis projecting laterally of said panel,
e. means for coupling said link means to said carriage means,
f. X-ray tube means movable relative to said panel means on the side opposite of said carriage means,
g. first shaft means normally extending laterally over said panel and supporting said X-ray tube means for angulation about the axis of said shaft means;
h. yoke means coupled with said shaft means,
i. tomographic coupling bar means constructed and arranged for connecting said yoke means to said link means whereby movement of said x-ray tube means will swing said link means and for being stored in proximity with said yoke and link means,
j. collar means surrounding said coupling bar means in the vicinity of said yoke means,
k. second shaft means for supporting said collar means for rotation and translation, respectively, coaxially with said first shaft means,
l. means for controlling said second shaft means and collar means in selected axial positions in the first of which said collar means urges said coupling bar means into non-sliding engagement with said yoke means, in the second of which said bar means is in sliding engagement with said yoke means and the third of which said bar means is clear of said yoke means,
m. said coupling bar means when disconnected from said link means being retained in said collar means when said collar means is in said third position whereby said coupling bar means may be stored in a plane adajcent the plane in which said coupling bar means swings when it is connected, and
n. means for holding said coupling bar means jointly with said collar means when said bar means is in storage.

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