July 1, 1958 A. J. KIZAUR 2,841,717

X-RAY APPARATUS

Original Filed Nov. 16, 1951 3 Sheets-Sheet 1

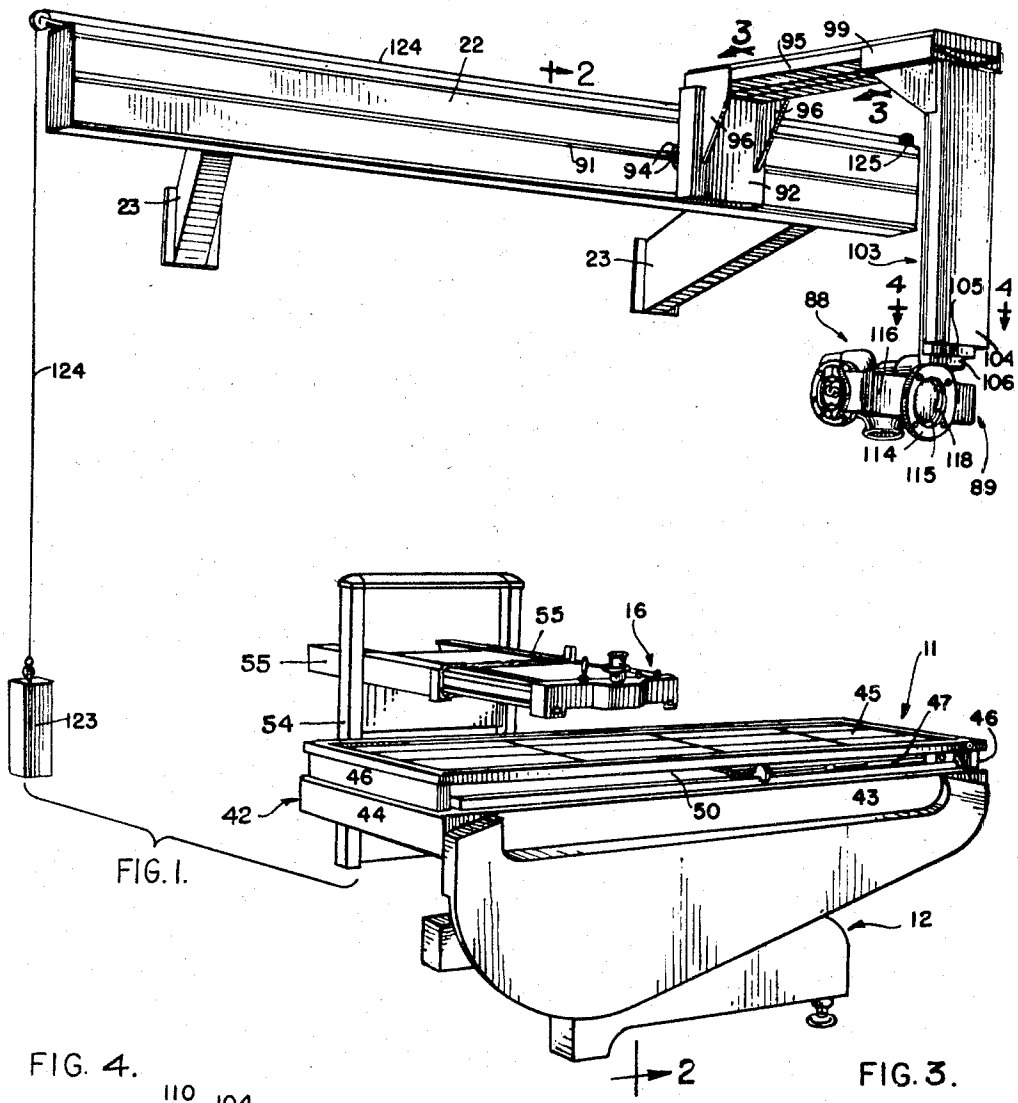


FIG. 1.

FIG. 4.

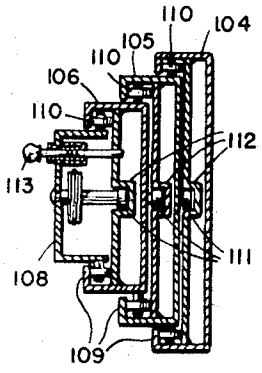
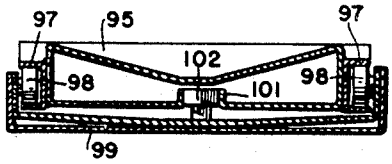


FIG. 3.



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X-RAY APPARATUS

Original Filed Nov. 16, 1951 3 Sheets-Sheet 2

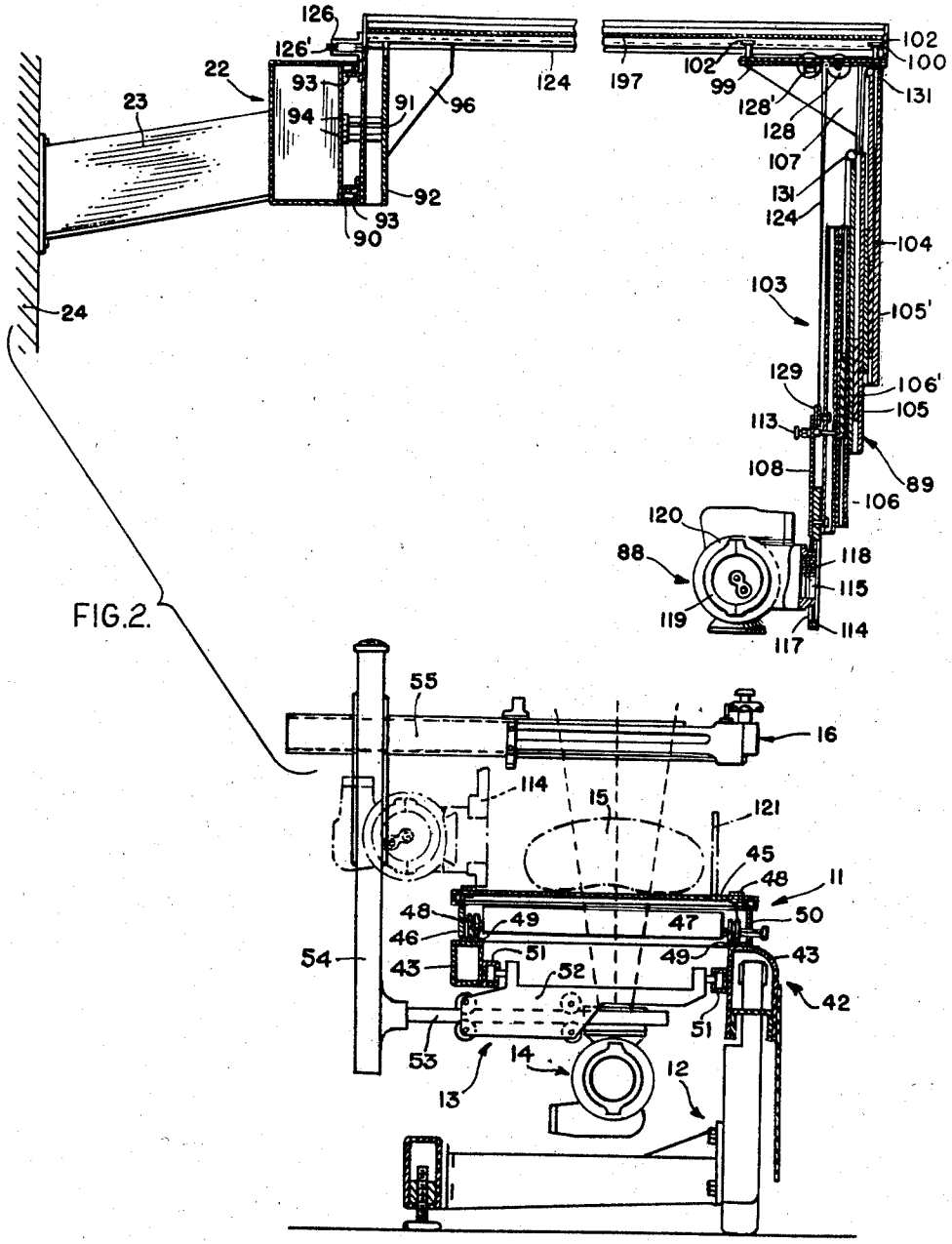

FIG.2.

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X-RAY APPARATUS

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FIG. 6.

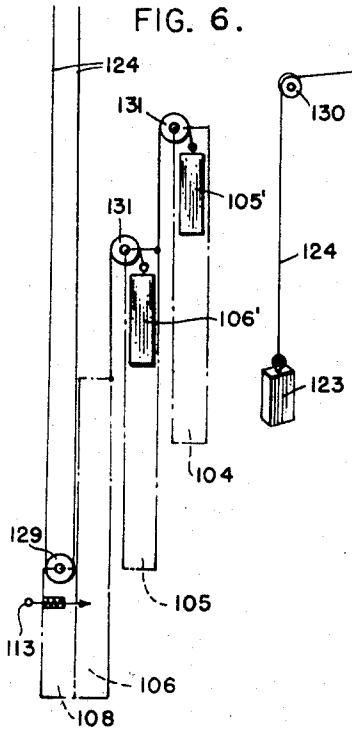


FIG. 5.

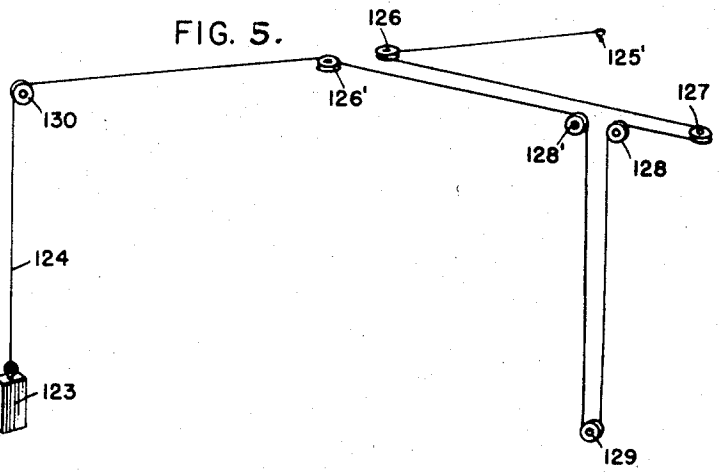
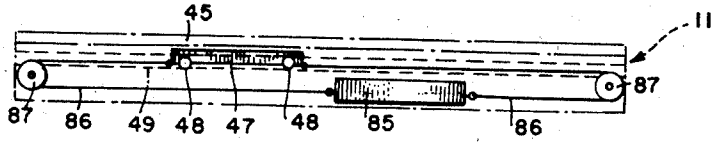


FIG. 7.



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United States Patent Office 2,841,717 Patented July 1, 1958

2,841,717

X-RAY APPARATUS

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Original application November 16, 1951, Serial No. 256,801. Divided and this application August 19, 1952, Serial No. 305,105

5 Claims. (Cl. 250—91)

The present invention relates in general to X-ray apparatus particularly adapted for use in connection with the X-ray examination, treatment and picturing of objects, especially the bodies of human patients, the invention having more particular reference to a universally adjustable support structure for mounting an X-ray tube or other ray source in desired position with respect to a table of the sort adapted for supporting human and other bodies in position for X-ray examination, photography, and treatment of the so supported bodies, the present invention comprising subject matter divided from a co-pending application for United States Letters Patent, Serial No. 256,801, filed November 16, 1951, on the invention of Arthur J. Kizaur, in X-Ray Apparatus.

In the making of X-ray pictures or radiographs of human bodies, as well as in the fluoroscopic examination of patients, the body of the patient is supported in position between a suitable source of X-rays and an X-ray sensitive viewing screen, for fluoroscopic examination or an X-ray sensitive film, in making X-ray pictures. It is also highly desirable, in some circumstances, to be able rapidly to change the inclination at which the object being pictured or examined is supported; and to provide for the picturing of the examination object, or a desired portion thereof, as quickly as possible after the desired picture subject matter shall have been determined by fluoroscopic examination. It is therefore desirable to provide a table structure, in conjunction with auxiliary equipment including X-ray generating tubes, X-ray sensitive fluoroscopic viewing screens, and X-ray sensitive film carriers, for supporting the body of a patient in position for X-ray examination, picturing, and treatment; and to provide for the rapid adjustment of the examination or picture subject, as well as the auxiliary equipment, to desired examining or picturing positions.

As indicated in United States Letters Patent No. 1,599,696, of September 14, 1926, on the invention of Julius B. Wantz; No. 1,874,582, of August 30, 1932, on the invention of Albert C. Nelson; No. 2,038,327, of April 21, 1936, on the invention of Julius B. Wantz; No. 2,315,786, of April 6, 1943, on the invention of Julius J. Grobe; and No. 2,568,236, of September 18, 1951, on an invention of Arthur J. Kizaur, it has heretofore been the practice to provide tilting tables for receiving and supporting the object to be examined, pictured, or treated, such tables carrying auxiliary equipment including X-ray generating tubes, fluoroscopic screens, and sensitive film carriers on and adjustable with respect to the tiltably supported table structure. In the operation of such equipment, the table may be first adjusted to support the examination subject in desired position. The examination screen, or picturing film, and the X-ray source may then be adjusted to desired position on the opposite sides of the subject. After completion of such adjustments, the subject may be pictured or fluoroscopically examined by actuating the ray source to cast a shadow picture of the subject upon the screen or film. In structures requiring rapid adjustment, on occasion, it is desirable to provide X-ray generating tube mountings, of minimum weight, not only in the interests of rapid adjustment but to minimize the physical effort required upon the part of the operator of the equipment in placing the various adjustable parts thereof rapidly in desired positions of adjustment. In that connection, it should be understood that the operator of heretofore available equipment is usually required manually to adjust the X-ray generating tube on its support, such operations in prior equipment requiring considerable physical effort on the part of the operator of the equipment.

The present invention represents a new approach toward the provision of X-ray equipment wherein adjustment of the apparatus may be accomplished extremely rapidly and substantially without effort upon the part of the operator of the equipment.

An important object of the present invention is to provide novel light weight and counterbalanced means for supporting an X-ray generator tube or other ray source in operative position, said means being universally adjustable to permit the supported tube to be disposed in any desired position and at any desired inclination with respect to an object to be examined or pictured; a further object being to provide a tube support embodying a plurality of telescopically arranged members, each successively counterbalanced upon the next adjacent member and all counterbalanced on a suitable support stand for the purpose of supporting the ray source in fashion allowing for the substantially effortless manipulation thereof.

Another important object is to provide a support structure of the sort mentioned, wherein the supported ray source may be horizontally adjusted, in mutually normal directions, as laterally and longitudinally of an associated table structure, and may also be adjusted in a vertical direction, so that the source may be readily located in any desired relative position within the adjustment limits of the support structure.

The foregoing and numerous other important objects, advantages, and inherent functions of the invention will become apparent as the same is more fully understood from the following description, which, taken in connection with the accompanying drawings, discloses a preferred embodiment of the invention.

Referring to the drawings:

Fig. 1 is a perspective view showing X-ray apparatus embodying the present invention;

Figs. 2, 3 and 4 are sectional views respectively taken substantially along the lines 2—2, 3—3, and 4—4 in Fig. 1; and

Figs. 5, 6 and 7 are schematic views illustrating the manner of counterbalancing the several adjustable components of the apparatus.

To illustrate the invention, the drawings show X-ray apparatus including a table structure for supporting human bodies in position for X-ray examination and therapy, or for the making of X-ray pictures of the supported body. If desired, the table structure may be tiltably supported in any suitable or preferred fashion for adjustment to any desired inclination, so that a supported body thereon may be disposed at will in horizontal or in any position tilted from horizontal in either direction, including vertical position in either direction.

To these ends, the apparatus may comprise a table structure 11, and suitable support means 12 for carrying the table structure at a desired elevation above the floor or support base on which the table is mounted when

in use, the means 12 preferably providing for the tiltable adjustment of the table structure to any desired angularity with respect to the support base or floor.

Frame means 13 may be provided for movement longitudinally of the table structure 11, such frame means carrying a ray source, such as an X-ray generating tube, enclosed in a suitable casing 14 in position beneath the table structure 11 to direct a beam of rays upwardly through the table structure and a body 15 disposed thereon in position for examination or therapy, or to be pictured. The frame means 13 also provides for the support thereon of a frame structure 16 adapted to carry ray sensitive fluorescent screen means, or X-ray sensitive film material, in position above the table structure 11, to allow for the fluoroscopic examination or the radiographic picturing of the supported body when irradiated with X-rays from the ray source in the casing 14. It will be seen that the ray source in the casing 14 and the frame means 16 may be moved simultaneously and in fixed relative position longitudinally of the table structure 11, thereby allowing for radiography or fluoroscopy of the subject body 15 in any selected zone, longitudinally of the table structure, merely by moving the frame means 13 to an appropriately adjusted position longitudinally of the table structure.

The table structure 11 may conveniently comprise a rectangular frame 42 embodying a pair of spaced apart, longitudinally extending members 43 rigidly interconnected in spaced relationship by transverse bracing and spacing members 44 forming the opposite ends of the rectangular frame 42. The table frame 42, of course, may carry a table top panel 45 secured to the frame in any suitable or preferred fashion, as on mounting members 46 at the ends and along one side of the frame, whereby to support the panel in position overlying the top of the frame. Immediately beneath the top panel, the frame 42 may provide a mounting for a cassette and diaphragm carriage 47, the same being provided with bearing wheels 48 in position to ride upon suitable tracks 49 on and extending longitudinally of the side frame members 43, so that the carriage 47 may be shifted to any desired position longitudinally of the frame 42 beneath the top panel 45.

In this connection, it will be noted that the panel 45, at its forward longitudinal edge, is spaced above the frame member 43 to form a slot-like opening 50, through which access to the cassette carriage may be had, the function of the cassette carriage being to removably receive and support a case or cassette adapted to receive, in light tight fashion, X-ray sensitive material. In this connection, the film containing cassette may be introduced edgewise into mounted position in the carriage 47 through the slot-like opening 50. When in mounted position in the carriage, the cassette enclosed X-ray sensitive film may be adjusted longitudinally of the table structure to any desired position for exposure to X-rays through an object to be pictured.

The cassette and diaphragm carriage 47, as shown in Fig. 7, may be and preferably is counterbalanced against a weight 85 of suitable mass, said weight being movable on suitable roller trackways formed in the table frame structure 42, the opposite ends of the counterweight 85 being connected with the opposite ends of the carriage 47, as by means of cables 86 guided on pulleys 87 mounted in the table frame structure 42 at the opposite ends thereof. The foregoing arrangement, of course, is to support the carriage 47 in adjusted position and to facilitate adjustment of the carriage longitudinally of the table frame when the same is in position inclined with respect to horizontal.

The frame means 13 may be formed and arranged and supported on the table structure in the manner shown in United States Letters Patent No. 2,567,566, of September 11, 1951, and No. 2,588,124, of March 4, 1952, on the inventions of Arthur J. Kizaur in X-Ray Apparatus. To this end, the table frame 42 may be provided with tracks 51 on the side members 43 beneath the tracks 49 for mounting the frame structure 13 for movement longitudinally of the table frame.

In this connection, the structure 13 may comprise a carriage frame 52 formed with rollers adapted to ride the tracks 51 between the opposite ends of the table frame. This carriage frame is preferably counterbalanced on the table frame by connection of the carriage frame with pulley guided cables connected with a counterbalance weight, in the manner heretofore described in connection with the cassette and diaphragm carriage 47 and its counterweight 85 and connecting cables 86 guided on the pulleys 87. Means, of course, may be provided for anchoring the carriage frame 52 in any desired longitudinally adjusted position on the table frame.

Supported on the frame 52, for movement thereon in a direction transversely of the table structure, is a subframe 53 having portions extending outwardly of and beneath the side of the table frame, preferably opposite from the slot 50, said sub-frame 53 carrying an upstanding support portion 54, extending alongside of the table frame and upwardly of the table top panel 45. A preferably counterbalanced frame, embodying a pair of spaced channel members 55, may be supported for adjustment on the upstanding frame portion 54, said channel members being supported on the frame portion 54 in spaced, parallel and facing relationship in position to receive and support the opposite side edges of the frame structure 16, the same preferably comprising serialographic apparatus of the sort shown in United States Letters Patent No. 2,552,858, of May 15, 1951, on the invention of R. J. Mueller and Ivan Burgeson.

Such equipment embodies a fluorescent screen and a shiftable ray sensitive film cassette carriage, whereby either the fluorescent screen or a cassette, carrying material sensitive to X-rays, may be disposed in position above the table top for X-ray excitation by rays emanating from the ray source 14 beneath the table. As described in said United States Patent No. 2,552,858, the frame structure 16 may be adjusted in the guiding and supporting channels 55 to a projected position presenting the fluorescent screen in vertical alinement with an X-ray beam emanating from the source 14. The frame structure 16 may also be disposed in retracted or inactive position, within and between the members 55, in which position the frame 16 is withdrawn from above the table top to leave the same unobstructed above a body 15 supported thereon. The frame supporting channel members 55 may be rigidly interconnected to provide a frame vertically adjustable on the support frame portions 54 to allow the serialographic mechanism 16 to be disposed in any desired spacement with respect to the top panel 45 of the table structure.

This equipment, comprising the film and screen supporting frame 16, being supported on the frames 52, 53 and 55, may not only be adjusted toward and away from the table top panel 45, but, together with the ray source 14, may also be adjusted laterally and longitudinally of the table. The equipment may be disposed at either end of the table when not in use, in order to leave unobstructed the remaining area above or in front of the top panel 45.

For use in conjunction with a tiltable table structure of the sort described, the present invention contemplates improved carriage means 89 for supporting an X-ray source 88 in universally adjustable position, above the table structure, to direct X-rays through the table top 45 and onto cassette enclosed ray sensitive material mounted in the carriage 47 beneath or behind the table top, to thus provide for the making of radiographic pictures of a body supported on the table top. Since the table is adapted to be positioned at any desired inclination, it is desirable to provide for supporting the X-ray source 88 in any required position and at any required

inclination within the adjustable range of the source supporting mechanism. Accordingly, the present invention contemplates apparatus **89** for supporting the ray source **88** for universal adjustment within the range of the support apparatus; and also support apparatus which may be adjustably moved rapidly and with minimum physical effort.

To these ends, the carriage means **89** may be mounted and supported on a beam structure **22** which may be carried on mounting arms or brackets **23**, anchored as on a supporting wall **24**, which may comprise a part of the building in which the X-ray apparatus of the present invention is installed for use. Of course, the beam structure, by means of suitable brackets, may be mounted or suspended from the roof structure of a room in which the equipment is installed for use, rather than on a wall. The beam structure provides roller trackways **90** and **91** extending longitudinally of the beam between the opposite ends thereof, the beam being preferably disposed in position extending in the longitudinal direction of the table structure **11**.

The trackways **90** may comprise angle irons suitably fastened, as by welding, to and along the upper and lower edges of the beam structure **22**. The trackway **91** may comprise a rib or flange suitably fastened, as by welding, to and along the beam structure **22** medially between the trackways **90**. The support structure **89** is carried on a frame, including a hollow, preferably formed sheet metal box portion **92**, provided with rollers **93** in position to engage and ride in and along the trackways **90**, and rollers **94** adapted to engage and ride along the opposite sides of the rib-like track **91**. In addition to its portion **92**, the support frame comprises a cantilever beam **95**, of preferably formed sheet metal construction, said beam **95** being integrated, as by welding, at one end thereof, with the frame portion **92**, corner bracing plates **96**, which may be welded to the frame portions **92** and **95**, being preferably employed to provide a rigid frame structure.

The beam **95** is formed with roller trackways **97**, as at its opposite side edges, for the reception of rollers **98** mounted on a carriage **99**, whereby the carriage is supported on the beam **95** for movement longitudinally thereof, the beam being preferably provided with an end stop **100** for limiting carriage movement thereon in a direction away from the frame portion **92**. The beam **95** may also be provided on its under side with a medial longitudinal slot forming a trackway **101** for the reception of a roller **102** carried by the trackway.

Mounted on and dependent from the carriage **99** is a telescopically extensible framework **103** for supporting the X-ray source **88** on the carriage **99**, said framework comprising a series of similar interfitting and relatively movable channel members **104**, **105** and **106**. The channel member **104**, at one end, is integrally united, as by welding, with the carriage **99**, the carriage **99** and dependent channel member **104** being braced and rigidified, as by means of corner bracing plates **107**, which may be integrated, as by welding, to the opposite sides of the carriage and the dependent channel member **104**. The dependent channel member **104** supports the next adjacent channel member **105**, which in turn supports the channel member **106**. The channel member **106** in turn supports a frame **108** upon which the X-ray source **88** is mounted.

The channel members **104**, **105** and **106** each comprise elongated elements of formed sheet metal construction providing internal facing trackways **109** at and along the opposite edges of the members, the members **105** and **106** being each sized for sliding reception, respectively, on the members **104** and **105** within the spaced trackways thereof, the frame member **108** being formed for sliding reception on the member **106** between the trackways **109** thereof. The members **105**, **106** and **108** are provided with rollers **110**, at the opposite sides thereof, in position to rollingly engage each in the trackways of

the next adjacent member. In addition, each of the members **105**, **106** and **108** may be provided with centrally disposed roller means **111** adapted, respectively, to ride in trackways **112** formed longitudinally and medially in the next adjacent member of the extensible frame structure **103**. A spring pressed latch pin **113** may be provided on the member **108** in order to latch the same on the member **106**, by engagement of the latch pin **113** in a perforation or socket formed in the member **106**, in order to determine the limit of movement in one direction of the frame **108** on the channel member **106**.

The frame **108** preferably carries a dependent plate **114** having an opening **115**, in which is journalled a yoke **116** having a central portion journalled on the plate **114**, as by means of suitable, preferably roller bearings **117**. The central portion of the yoke **116** is formed with a central opening **118** in alinement with the opening **115** in the plate **114**. The yoke **116** also provides spaced end arms **119** forming bearings for turnably receiving the opposite ends of the support casing **120**, in which an X-ray tube forming the X-ray source **88** may be mounted.

It will be seen from the foregoing that the X-ray source **88** may be moved to any desired position longitudinally and transversely of the table top **45**, including positions substantially outwardly of the table top on opposite sides thereof, such transverse adjustment of the X-ray source with respect to the table **11** being accomplished by movement of the carriage means **99** on the beam **95**. Adjustment of the source longitudinally of the table is, of course, accomplished by movement of the carriage **92** along the beam structure **22**.

It will be seen, also, that the X-ray source may be moved toward and away from the carriage **99**, that is to say, away from and toward the table structure, within a wide range determined by the extensional and collapsible limits of the telescopic frame structure **103**. In addition, the X-ray source may be tilted and adjusted in any desired angular position about the rotary axis of the yoke **116**; and said source may also be adjusted tiltably to any desired angle about the turning axis defined by the yoke bearings **119**, including a position in which the X-ray beam is directed through the alined openings **115** and **118**. Such position is indicated in dotted lines in Fig. 2 of the drawings, wherein the ray source is disposed to direct an X-ray beam transversely through a body **15** on the table top, such position allowing for the making of a radiographic picture on X-ray sensitive material, enclosed in a cassette and held or otherwise supported in the picturing position, as indicated in dotted lines at **121** in Fig. 2.

In order to make manipulation and adjustment of the X-ray source **88** exceedingly easy and effortless, on the part of the operator of the equipment, the mass of the adjustable parts is counterbalanced against a weight **123** which may be conveniently suspended on one end of a cable **124**. The opposite end of the cable may be anchored, as at **125**, on a suitable mounting at an end of the beam structure **22**. From said mounting **125** the cable may extend around a guide pulley **126** on the frame **92**, thence around a guide pulley **127** on the beam **95** at the end thereof remote from the support frame **92**, the cable extending thence on a guide pulley **128** on the carriage **99**, around a guide pulley **129** on the X-ray source supporting frame **108**, around a guide pulley **128'** on the carriage **99**, adjacent the guide pulley **128**, thence around a guide pulley **126'** on the support frame **92**, adjacent the guide pulley **126**, and finally around a guide pulley **130** at the end of the beam **22** remote from the cable anchorage **125**, the entire system being illustrated schematically in Fig. 6 of the drawings.

It will be seen that the foregoing system will allow the mass of the X-ray source to be counterbalanced against the weight **123** at all times during longitudinal movement of the frame **92** on the beam **22**, the cable traveling freely around the rollers **126**, **126'**, **127**, **128**, **128'** and **129**,

during such longitudinal movement, and the counterbalance weight **123**, as well as the pulley **130**, remaining stationary. The structure also will remain counterbalanced for all adjusted positions of the carriage **99** longitudinally of the beam **95**, the cable traveling freely on the pulleys **128**, **128'** and **129**, the other pulleys **125**, **126**, **126'**, **127** and **130** remaining stationary, along with the counterweight **123**, during longitudinal movement of the carriage **99** on the beam **95**.

When the X-ray source **88** is adjusted vertically through the relative telescoping movement of the frame sections **104**, **105** and **106** and the source supporting frame **108**, the bite of the cable defined between the pulleys **128** and **128'** by the pulley **129** will either lengthen or shorten as the X-ray source is lowered or raised. During such adjustment of the elevation of the X-ray source, the cable **124** may travel on the pulleys **126'**, **128'**, **129** and **130**, the remaining pulleys **126**, **127** and **128** remaining stationary, and the weight falling or rising as the source **88** is raised or lowered.

In addition, the weight of the frames **105** and **106** may be counterbalanced, as shown in Fig. 7 of the drawings, by connecting the frame **105** with a counterweight **105'** operating in and longitudinally of the frame **104**, and by connecting the frame **106** with a counterweight **106'** operating in and longitudinally of the frame **105**, the frames **105** and **106** being respectively connected with their corresponding counterweights **105'** and **106'** by means of cables guided on pulleys **131**, respectively mounted on and at the upper ends of the members **104** and **105**.

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

The invention is hereby claimed as follows:

1. An adjustable support structure for a ray source comprising an elongated horizontally extending beam member, a carrier frame movable horizontally on and longitudinally of said beam member, a cantilever beam mounted on said carrier frame in position extending outwardly of said beam member, a carriage supported on and movable longitudinally of said cantilever beam, toward and away from said beam member, a series of telescopically interfitting frames each mounted on and adjustable longitudinally of the next adjacent frame of the series, one of said interfitting frames comprising a supported end frame of the series, the same being secured on said carriage in position depending therefrom, mounting means for mounting the ray source on another of said interfitting frames forming a supporting end frame of the series, and means for counterbalancing, on said beam member, the movable mass of said supported ray source, in all adjusted positions thereof laterally, longitudinally, and vertically with respect to said beam member.

2. An adjustable support structure for a ray source comprising an elongated horizontally extending beam member, a carrier frame movable horizontally on and longitudinally of said beam member, a cantilever beam mounted on said carrier frame in position extending outwardly of said beam member, a carriage supported on and movable longitudinally of said cantilever beam, toward and away from said beam member, a series of telescopically interfitting frames each mounted on and adjustable longitudinally of the next adjacent frame of the series, one of said interfitting frames comprising a supported end frame of the series, the same being secured on said carriage in position depending therefrom, mounting means for mounting the ray source on another of said interfitting frames forming a supporting end frame of the series, weight counterbalancing traction means, and a cable connected at one end on said beam member at an end thereof, the other end of the cable being connected with said traction means at the opposite end of said beam member, the intermediate portions of said cable being supported on guide rollers mounted on said carrier frame and said supporting end frame, whereby to counterbalance the movable mass of the supported ray source on said beam member.

3. An adjustable support structure for a ray source comprising an elongated horizontally extending beam member, a carrier frame movable horizontally on and longitudinally of said beam member, a cantilever beam mounted on said carrier frame in position extending outwardly of said beam member, a carriage supported on and movable longitudinally of said cantilever beam, toward and away from said beam member, a series of telescopically interfitting frames each mounted on and adjustable longitudinally of the next adjacent frame of the series, one of said interfitting frames comprising a supported end frame of the series, the same being secured on said carriage in position depending therefrom, mounting means for mounting the ray source on another of said interfitting frames forming a supporting end frame of the series, weight counterbalancing traction means, a cable connected at one end on said beam member at an end thereof, the other end of the cable being connected with said traction means at the opposite end of said beam member, the intermediate portions of said cable being supported on guide rollers mounted on said carrier frame and said supporting end frame, whereby to counterbalance the movable mass of the supported ray source on said beam member, and means for counterbalancing the movable mass of certain of said telescopically interfitting frames each upon the next adjacent frame of the series.

4. An adjustable support structure for a ray source comprising an elongated horizontally extending beam member, a carrier frame movable horizontally on and longitudinally of said beam member, a cantilever beam mounted on said carrier frame in position extending outwardly of said beam member, a carriage supported on and movable longitudinally of said cantilever beam, toward and away from said beam member, vertically adjustable means for mounting a ray source on said carriage at a desired elevation with respect to said beam member, and means for counterbalancing, on said beam member, the movable mass of said supported ray source, in all adjusted positions thereof laterally, longitudinally and vertically with respect to said beam member.

5. An adjustable support structure as set forth in claim 4, wherein said vertically adjustable means comprises a bracket suspended from and extending beneath said carriage, said bracket defining an opening, a support yoke formed with a corresponding opening, bearing means turnably securing said yoke on said bracket with said openings in alinement, and journal means on said yoke for turnably supporting the ray source thereon.

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