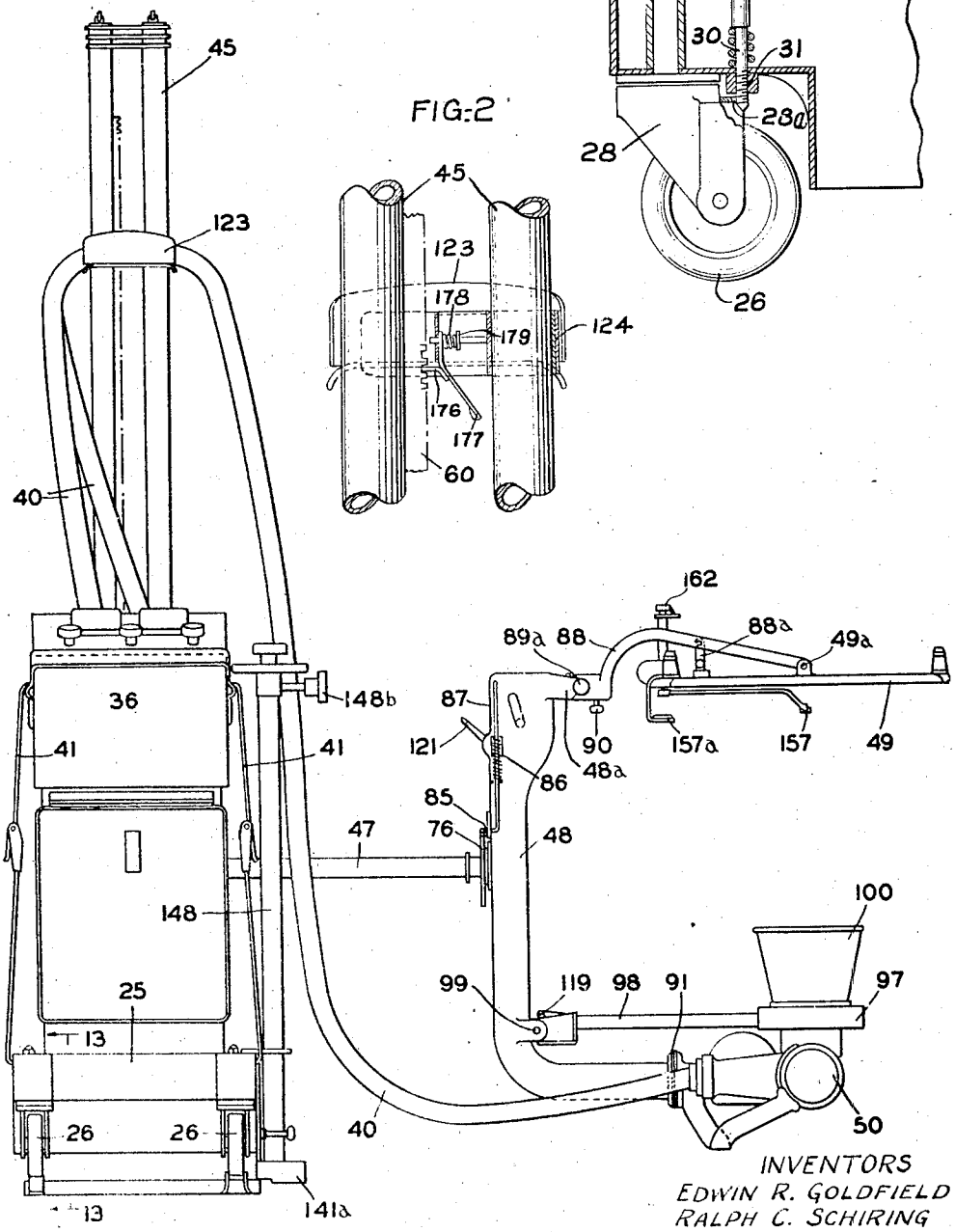
Feb. 13, 1945. E. R. GOLDFIELD ET AL 2,369,453

X-RAY GENERATING MEANS

Original Filed April 2, 1941 4 Sheets-Sheet 1



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X-RAY GENERATING MEANS

Original Filed April 2, 1941 4 Sheets-Sheet 2

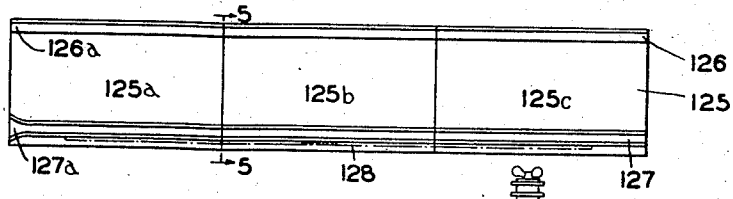


FIG.-4

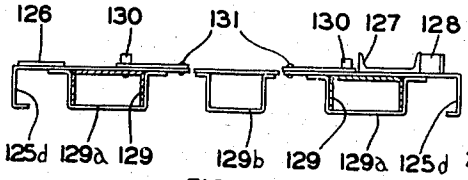


FIG.-5

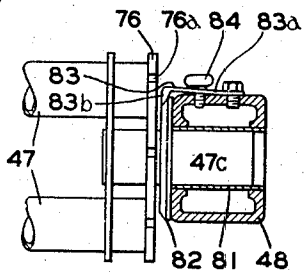


FIG.-3A

FIG.-3

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X-RAY GENERATING MEANS

Original Filed April 2, 1941 4 Sheets-Sheet 3

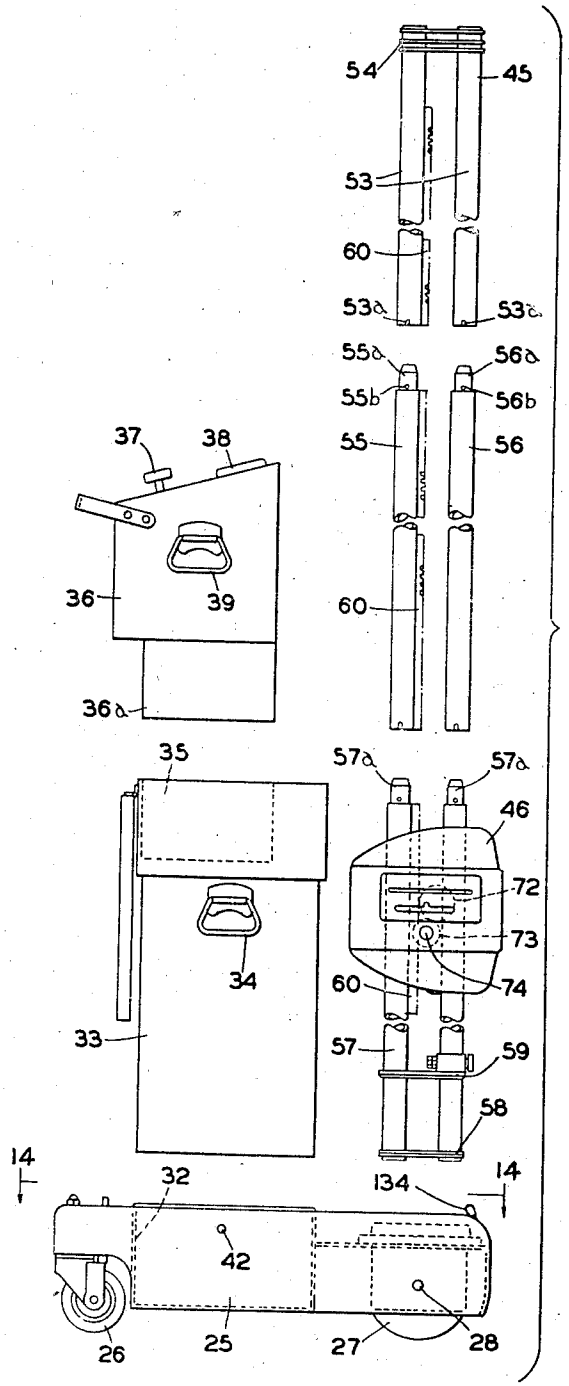


FIG.-6

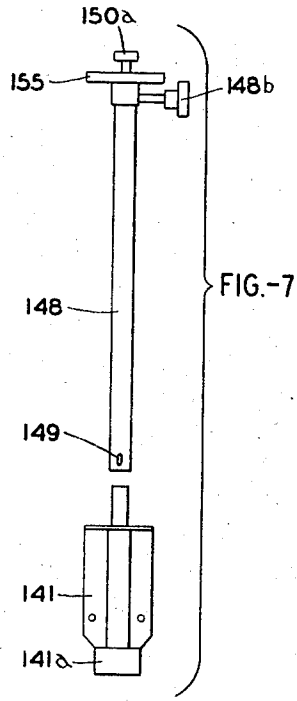


FIG.-7

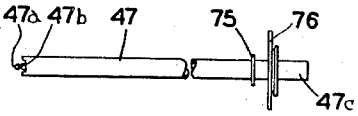


FIG.-8

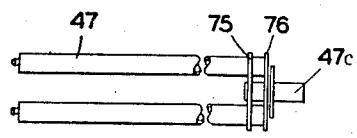


FIG.-8A

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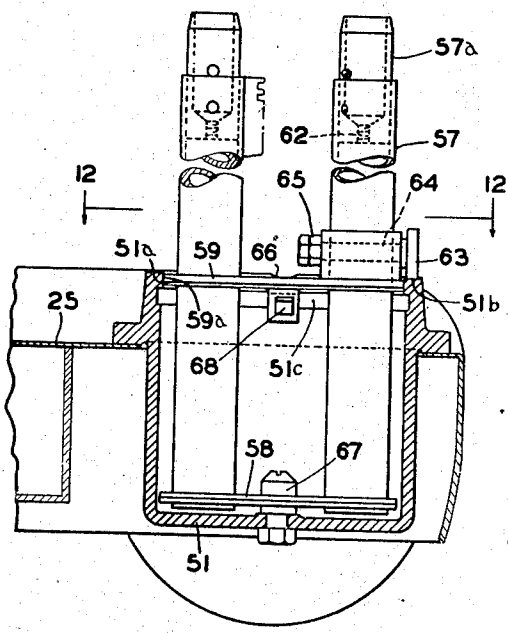


FIG.-11

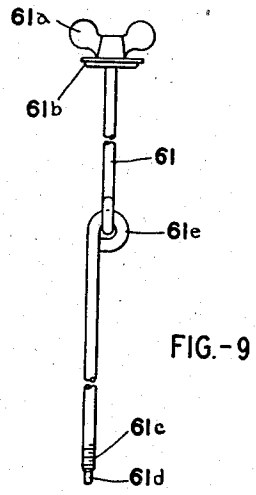


FIG.-9

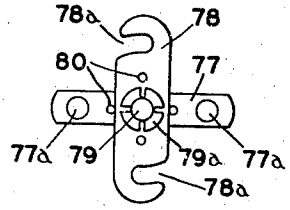


FIG.-10

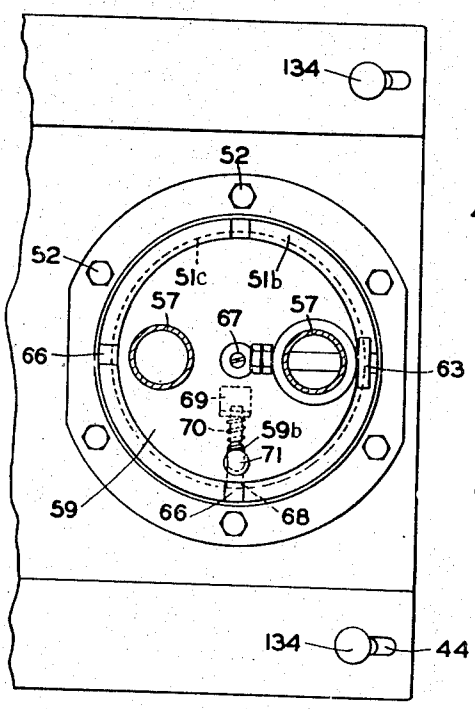


FIG.-12

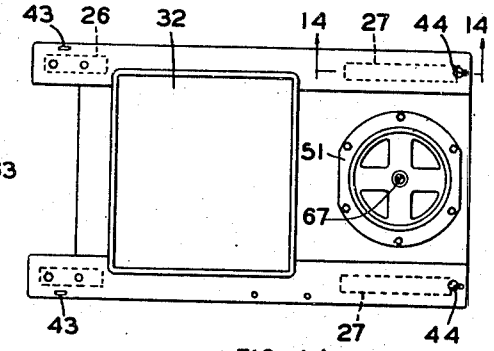


FIG.-14

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UNITED STATES PATENT OFFICE

2,369,453

X-RAY GENERATING MEANS

Edwin R. Goldfield, Ralph C. Schiring, and Robert J. Stava, University Heights, Ohio, assignors to Picker X-Ray Corporation Waite Manufacturing Division, Inc., Cleveland, Ohio, a corporation of Ohio

Original application April 2, 1941, Serial No. 386,390. Divided and this application July 18, 1942, Serial No. 451,415

7 Claims. (Cl. 250—92)

This invention relates to improvements in X-ray apparatus and particularly to improvements in a mobile unit adapted to be moved about on a supporting surface and useful for both horizontal and vertical fluoroscopy and for horizontal radiography. Our invention also contemplates the incorporation in this unit, if desired, of equipment for localizing foreign bodies, that is to say, for determining the position of a foreign body in a patient.

Our invention also contemplates the construction and arrangement of the parts of the mobile unit and the construction whereby the different parts may be disassembled and packed into a small space so that the device is capable of use as a field unit by the army with a maximum of usefulness and requiring the minimum of space.

Other objects and advantages of the present invention will appear from the accompanying description and drawings and the essential features will be set forth in the claims.

This application is a division of our copending application, Ser. No. 386,390, filed April 2, 1941. Our copending application Ser. No. 451,416, filed July 18, 1942, disclosing the same device, contains claims to certain features not claimed herein.

In the drawings,

Fig. 1 is an end elevation of our improved apparatus;

Fig. 2 is a sectional view taken along the line 2—2 of Fig. 3;

Fig. 3 is a side elevational view of the apparatus of Fig. 1;

Fig. 3A is an enlarged fragmental sectional view taken along the line 3A—3A of Fig. 3;

Fig. 4 is a top plan view of a base floor or track along which the apparatus may be moved;

Fig. 5 is an enlarged transverse sectional view taken along the line 5—5 of Fig. 4;

Fig. 6 is an exploded view of the apparatus of Fig. 3;

Fig. 7 is an exploded view of a portion of the foreign body localizer attachment of Figs. 1 and 3;

Fig. 8 is a view of a cross arm in a position disassembled from its associated parts of Fig. 6;

Fig. 8A is a top plan view of the cross arm of Fig. 8;

Fig. 9 is a view of the folding draw bolts which secure the vertical mast sections together;

Fig. 10 is a view of an end plate associated with the cross arm of Figs. 8 and 8A;

Fig. 11 is an enlarged vertical sectional view through the lower section of the vertical mast;

Fig. 12 is a transverse sectional view taken along the line 12—12 of Fig. 11;

Fig. 13 is an enlarged fragmental sectional view taken along the line 13—13 of Fig. 1; and

Fig. 14 is a top plan view of the base carriage taken approximately from the position of the line 14—14 of Fig. 6.

The mobile unit here disclosed may be provided with the track of Figs. 4 and 5 where the unit is to be used in the field where a separate floor or track must be provided. It is useful however without such extra track, in which case the unit may be moved about on the floor of a hospital or other room and such use of the unit is contemplated. The unit therefore is mounted upon a base carriage 25 which as shown in the various views is built up of sheet metal parts preferably welded together to give a generally rectangular carriage supported at one end by the two swiveling casters 26 and at the other end by the two wheels 27 which are supported upon axles 28 suitably mounted in the carriage 25. Preferably all of the wheels have rubber tires. The caster wheels 26 as best seen in Fig. 13 are mounted on forks 28 which are carried by suitable studs 29 in the carriage 25. The wheels are on ball bearings and the casters preferably also have ball bearing mountings. Preferably means is provided for fixing the casters in position so that the wheels 26 are parallel to the wheels 27 to insure movement of carriage 25 in a straight line when that is desired. To this end each fork 28 is provided with a notch 28a into which a bolt 30 may be inserted when desired to fix the casters against turning. This bolt 30 has threaded engagement at 31 with a portion of the carriage 25 and extends above the top of the carriage where the bolt has a knurled end 30a for its manipulation.

The carriage is provided with a square well 32 into which fits the bottom of a transformer case 33. This case houses the usual high tension transformer adapted to receive current at sixty cycles and low voltage from any field generator equipment when used under army field conditions or from any other suitable source when used under hospital conditions. The transformer of course will step up the current to the high voltage requirements for X-ray work. The transformer casing is preferably provided with a handle 34 on each side so that it may be more easily lifted. In the upper portion of the transformer casing is a recess 35 adapted to receive the lower end 36a of the control box 36. This box houses any usual standard control circuits for X-ray equipment including control knobs 37 and meters 38 so that the equipment may be set for the proper operating conditions as is well understood in this art.

The control box is preferably provided with a handle 39 on each side for its manipulation. Suitable connections (not shown) are provided at the rear bottom portion, that is to say the right-hand side of the control box as viewed in Fig. 6, for the attachment of the supply wires from the generator set or other source of current and for the attachment of a hand timer if desired, a foot control switch and other auxiliary equipment. Also a connection (not shown) is provided between the control circuits in box 36 and the transformer in the casing 33. All connections of separable wire connections differ in size, shape or arrangement so that proper connections are always assured. Shockproof cables 40 are connected between the upper rear portion of the transformer in casing 33 and the X-ray tube to be later described. The disassembled position of the base carriage, the transformer casing and the control box is shown in Fig. 6 and the assembled position of these parts is shown in Figs. 1 and 3. As best viewed in Figs. 1 and 3, these parts are held in assembled relationship by means of retaining rods 41, one at each side of the unit, attached between the handle 39 at the top and a suitable opening 42 in the base carriage. Each rod has an over-center toggle securing device 41*a* so as to hold the parts firmly in position. When the unit is disassembled for packing in the field kit each of the rods is fastened to the top of the base carriage, one on each side thereof, between the points 43 and 44 shown in Fig. 14.

A vertical mast 45 is provided at one end of the base carriage upon which is mounted a vertically movable arm supporting carriage 46. This carriage 46 in turn supports the horizontal cross arm 47 upon the end of which is mounted a C-bracket 48 which carries the fluoroscopic screen 49 and the X-ray tube 50. The mast 45 is mounted for rotation in a well casting 51 (Figs. 11 and 14) which is secured by bolts 52 to the base carriage 25. For purposes of disassembling and packing the mast, it is built in a plurality of separable tubular sections. The upper section comprises a pair of parallel tubes 53 tied together at the top by tie bars 54. The middle section is composed of the separate tubular members 55 and 56 and the bottom section is composed of parallel tubular members 57 tied together at the lower end by tie bars 58 and intermediate the ends mounted in a bearing disk 59. The left-hand tubes 53, 55 and 57 of Fig. 6 have secured rigidly to one side thereof rack members 60 which coact with mechanism in the cross arm supporting carriage 46 for the raising and lowering of that carriage. These rack members are very carefully located on their respective tubes so that when the mast is assembled the rack members are in accurate alinement. The separable connections between the various tubular members of the mast comprise sleeve projections 55*a* and 56*a* accurately finished with very small tolerances to fit in the respective coacting lower ends of the tubular members 53. Positioning means comprises the small pins 55*b* and 56*b*, respectively, which enter into notches 53*a* when the parts are assembled. In a similar fashion the sleeve projections 57*a* on the lower mast section fit into the lower ends of the tubes 55 and 56. The mast is held together as a whole by means of folding draw bolts 61 best illustrated in Fig. 9. Each of these bolts carries a wing nut 61*a* at the upper end and a centering washer 61*b*. The lower section of the bolt is threaded as at 61*c* and carries a guide extension 61*d*. It will be noted from Fig. 11 that each of the tubular members 57 is provided with a centrally located threaded portion 62 located in a cup-shape depression below the sleeve projection 57*a*. When the bolt 61 is extended downwardly through the hollow tubular mast sections the cup-shape recess guides the end 61*d* of the bolt into the threaded opening 62, after which turning of the nut 61*a* causes the thread 61*c* to engage the threads at 62 so as to tightly draw the mast sections together. Each bolt 61 is provided with a foldable joint as at 61*e* so that the bolts may be packed in the field kit. The length of the upper, central and lower sections of the mast when disassembled as shown in Fig. 6 are of approximately the same length as the longer dimension of the base carriage 25 so that these parts will all fit in the same chest.

The details of the mounting of the mast 45 in the base casting 51 are best seen in Figs. 11 and 12. This base casting has an annular perpendicular bearing surface at 51*a* adapted to coact with the corresponding annular surface 59*a* of the disk 59. One of the tubular sections 57 carries a bearing roller 63 on a shaft 64 which extends through the tube and is secured by a nut 65. The roller 63 is so positioned that it bears upon the upper horizontal annular face 51*b* of the casting 51. Preferably this casting has slightly milled out hollow spots 66 located at four points 90° apart so that the mast may be more or less definitely located in each of four oriented positions with the cross arm 47 extending either forward or rearward parallel to the longer dimension of the base carriage 25 or in position extending laterally to either side of the carriage 25. It will be noted that the roller 63 is on that side of the mast beyond which the arm 47 extends to support the weight of the bracket 48, the screen 49 and the tube 50. This considerable weight at one side of the carriage would not be firmly supported in the absence of the roller 63 and it would be difficult to rotate the mast and its supporting weight withouft the bearing roller. To steady the mast for true rotative movement, the bottom tie bars 58 are provided with a centrally located opening into which enters a stud 67 which as shown in Fig. 11 is bolted to the central bottom portion of the casting 51. The positions of the bearing surfaces on the disk 59 are accurately located with reference to the stud 67 and all of the coacting bearing surfaces including the central aperture in the bars 58 are held to very small tolerances so that the mast is very firmly supported in erected position.

For holding the mast in assembled position within the base casting 51, a latch 68 is slidably supported beneath the disk 59 in a bracket 69. A spring 70 urges the latch radially outwardly. Through a slot 59*b* in the disk 59 extends a pin or handle 71 by which the latch may be manipulated. The nose of the latch is adapted to enter into an annular groove 51*c* in the inner wall of the casting 51 near the top thereof when the mast is assembled in the base.

Means is provided for moving the cross arm supporting carriage 46 vertically along the mast 45 and for holding this carriage in any position to which it is moved. This means comprises a gear 72 indicated in Fig. 6 which engages the rack member 60 and which in turn is operated by a pinion 73 which in turn is operated by a removable crank which may be inserted from either side of carriage 46 at point 74. In connection with the gear mechanism 72, 73 we provide the clutch mechanism disclosed and claimed in

Patent No. 2,123,528, granted July 12, 1938, to Edwin R. Goldfield and Caperton B. Horsley. As clearly described in the said patent the crank handle may be rotated freely to move the carriage 46 up and down but when manipulation of the crank handle ceases the built in clutch mechanism automatically locks the carriage in the position to which it has been moved.

The horizontal cross arm 47 comprises a pair of parallel tubular members rigidly connected together at one end by the tie bar 75 and the disk 76. This cross arm is supported on suitable rollers in the carriage 46 so that the arm is freely slidable in a horizontal direction. The cross arm 47 when disassembled as shown in Figs. 8 and 8A is of approximately the same length as the longer dimension of carriage 25 or the various sections of the mast so as to fit in the same chest with those parts. The ends of the tubular portions of the cross arm 47 opposite the tie bar 75 are normally rigidly connected together by means of an end plate assembly best seen in Fig. 10. This comprises two bars 77 and 78 pivotally connected together at 79. In the bar 77 are two openings 77*a* adapted to pass over the button projections 47*a* on the ends of the tubular members of the cross arm 47. The arms 78 have slotted openings 78*a* adapted to swing into position embracing the neck portions 47*b* which support the buttons 47*a* so as to secure the end plate assembly on the two tubular members of the cross arm 47. Extruded spots 80 on the arms 77 and 78 interengage with snap action to hold the end plate assembly in assembled position until the same is forcibly removed. It will be understood that with the end plate assembly removed the cross arm 47 is readily inserted through the carriage 46 after which the end plate assembly is secured in position to not only hold the connected ends of the cross arm 47 rigid but also to limit transverse movement of the cross arm 47.

The bracket 48 is removably mounted on the outer end of the cross arm 47 for rotation relative thereto. This construction is best seen in Figs. 1 and 3*a*. The cross arm 47 has a nose 47*c* extending beyond the disk 76 which enters a suitable bossed opening in the bracket 48. Preferably the opening is provided with a plain bearing 81 which embraces the nose 47*c*. Rigidly mounted on the nose and slightly spaced from the disk 76 is a truncated cone disk 82. Mounted on the bracket 48 is a stamping 83 having an arm 83*a* which is loosely bolted to the bracket. The stamping has a beveled nose 83*b* which engages behind the cone surface of the disk 82 so as to hold the bracket 48 rotatably on the nose 47*c* and to act additionally as a friction lock if desired. A wing nut 84 controls the position of the stamping 83. The disk 76 is provided with suitable notches 76*a* into which a locking dog 85 is adapted to enter. This dog is spring pressed toward engaging position and is mounted in a suitable guide 86 on the bracket 48. The dog is controlled by the handle 87. Preferably the outer face of the disk 76, that is, on the right-hand side as viewed in Fig. 1, is provided with a marking dial graduated in degrees so that the operator can determine the position of the main portion of bracket 48 relative to the horizontal or vertical when adjusting the position of bracket 48 rotatably about the nose 47*c*.

The mounting of the screen and X-ray tube on the bracket 48 and the mounting of this bracket on the cross arm 47 preferably follows the teaching of Patent No. 2,097,095, granted October 26, 1937, to Edwin R. Goldfield, Caperton B. Horsley and Ralph C. Schiring. Reference may be had to this patent for further description if necessary.

The X-ray tube 50 is of standard construction and is removably secured at the point 91 to an arm of the bracket 48 by a connection which is in all respects similar to that shown in Figs. 3A and the parts have the same dimensions so that if desired the bracket 48 may be removed from the nose 47*c* and the X-ray tube 50 may be directly mounted on the nose 47*c* in rotatable fashion.

The high tension cables 40 as previously mentioned are connected between the transformer 33 and the X-ray tube 50. The excess length of these cables is supported in two cable supports 123 mounted on opposite sides of the cable support slide 124 which is movable up and down the mast 45. A spring catch on the slide 124 engages the rack 60 so as to hold the cable supports in any adjusted position. This construction is best seen in Fig. 2 wherein the dog 176 is rigidly secured to an arm 177 which is loosely mounted in the cable support slide 124 so that the dog engages the rack 60. A spring 178 on a pin 179 yieldingly urges the dog into engagement with the rack. The end of arm 177 overlies a portion of carriage 46 so that as the carriage is cranked upwardly the dog 176 is automatically released and the cable support slide 124 moves up the mast 45 in advance of carriage 46.

The base carriage 25 as previously mentioned may be provided with a track 125 (Figs. 4 and 5) when some separate additional surface is necessary to support the carriage or when the unit is used as a foreign body localizer. This track is preferably provided in a plurality of sections, the dimensions of which permit them to be placed in the same sized chest which accommodates the carriage 25, the various sections of the mast and other parts previously described. In other words the longer dimension of each of the sections 125*a*, 125*b* and 125*c* is approximately the same as the longer dimension of the carriage 25 and the width is not any greater than that of the carriage. Along one side of the track sections is secured a flat, plain track surface 126. Along the opposite sides of the sections runs a flange track 127. These tracks may slope downwardly toward the floor at the points 126*a* and 127*a* so as to facilitate the movement of the carriage 25 on and off the track. It will be understood that the track sections are secured to their respective floor sections and are broken at approximately the same points although the breaks in the track proper and the supporting base may be slightly overlapped if desired. Along the outside of track 127 are secured sections of a rack 128 which is adapted to coact with the foreign body localizer as described in the above-mentioned parent application. Preferably as shown in Fig. 5, the base track sections 125 have turned down flanged edges as at 125*d* so that the general shape of the base track sections is of channel form providing space underneath. In this space are slidably mounted channel-shape connecting members 129 which are slidably retained beneath one or the other of the sections 125*a*, *b*, *c*, when the parts are packed in the field kit, but which may be pulled out to extend in connecting position, one set between the sections 125*a* and 125*b* and the other set between the sections 125*b* and 125*c*. These

slidable connectors are held in position by spring pressed pins 130, the spring arms of which are riveted to the base track sections at the points 131. The supports for connecting members 129 comprise upwardly facing channel members 129a secured to the under surface of the track sections and embracing the members 129. Preferably another upwardly facing channel member 129b is secured along the center of each track section so that the edge flanges 125d and the channel members 129a and 129b present a fairly large surface to mud or soft ground upon which the equipment may rest in the field. Obviously also the members 129a protect the connecting members 129 from dirt and the like.

It is believed that the operation of the apparatus shown thus far will be readily understood. With the apparatus completely assembled, a foot control switch (not shown) may be connected into suitable plugs in the control box 36 and a hand timer may be connected there also if desired. With main line current then connected to the generator as previously mentioned, the equipment is ready for use. With the parts in the full line position of Figs. 1 and 3, the device may be used for horizontal fluoroscopy. With the bracket 48 rotated 90° from the full line position of Fig. 3 and raised by means of carriage 46 to the dot-dash position of Fig. 3, the equipment may be used for vertical fluoroscopy. In this position of the parts it will be noted that the screen 40 is directly in front of an operator standing alongside of the control box 36 with the control knobs 37 and the meters 38 directly at the left-hand of the operator so that he may readily control the equipment with his left hand while manipulating the screen and other equipment with his right hand. With the parts in the position of Fig. 1 it will be noted that the lower offset arm of bracket 48 extends sufficiently below the cross arm 47 that the tube 50 may be lowered practically to the floor or other supporting surface upon which the carriage 25 rides. When the apparatus is to be used for horizontal radiography the carriage 46 is run up the mast 45, the bracket 48 is rotated 180° from the position shown in Fig. 1 and the screen 49 is either removed or turned about a suitable pivot until it is out of the way. With this position of the parts the tube 50 may be placed high above the patient because the offset of bracket 48 relative to arm 47 gives this additional height above the top of the mast 45. If it is desired to traverse the equipment lengthwise of the body of a patient the casters 26 may be locked by the bolts 30 and the equipment may be moved in a line parallel to the length of the patient's body. At the same time the transverse movement made possible by the cross arm 47 permits traversing of the equipment in a direction at right angles to the patient's body.

A number of the parts which have just been described may be packed in a chest having inside dimensions of 16¼" width, 28" length and 14½" height. At the bottom of the chest may be packed the top mast section, the two center mast sections or tubular members and the folding draw bolts. In a layer just above this may be packed the carriage 25 and on the top layer of the chest may be packed the bottom mast section with the cross arm supporting carriage in position thereon, together with the cross arm itself, the cable supports and the radiation cone. In setting up this portion of the apparatus the lower section of the mast is easily assembled into its supporting casting after which the center and top mast sections are assembled and clamped together by means of the folding draw bolts 61. The assembly of the cross arm in the carriage 46 has already been described.

Another chest of the same size above mentioned may have the X-ray tube packed therein, together with the high tension shockproof cables, a tube motor cable and other small accessories.

The control box may be packed in a chest of the same size along with a main line cable for connecting the control box with the generator as previously mentioned, together with a foot switch and timer if desired, a lamp for the foreign body localizer, spare parts and other small accessory equipment.

In a fourth chest may be packed the fluoroscopic screen and the bracket 48 and the detachable parts of the foreign body localizer to be later described. Also the three track sections of Fig. 4 have approximately the same overall dimensions as the carriage 25 so that they may be placed in the same size chest as the other parts.

What we claim is:

1. X-ray apparatus comprising a low carriage movable on a supporting surface, a vertical mast on said carriage, an arm support movable along said mast down to the level of said carriage, an arm horizontally movable in said support, a bracket on said arm offset from said arm by an amount substantially equal to the height of said carriage above said surface, and an X-ray tube at the offset end of said bracket, whereby with said support at the bottom of said mast and with said bracket offset turned downwardly said tube may be placed substantially on said supporting surface.

2. In X-ray apparatus, a low base carriage movable on a supporting surface, there being a recess in the upper face of said carriage, a transformer seated in said recess, there being a second recess in the upper face of said transformer, a control box seated in said second recess, and detachable tension means holding said control box and transformer in position on said carriage.

3. In X-ray apparatus, a base carriage, a vertical mast for supporting an X-ray tube, and a separable connection between the lower end of said mast and said carriage mounting said mast for rotation about a vertical axis, said connection comprising a bearing in line with said axis, an annular bearing above said first bearing and concentric with said axis, a horizontal bearing surface on said carriage, and a roller on said mast engaging said horizontal bearing surface.

4. The combination of claim 3 including an X-ray tube mounted on said mast and laterally offset at one side of said mast, and said roller being located at the same side of said mast.

5. In X-ray apparatus, a base carriage, wheel means at each end supporting said carriage, one of said wheel means having caster mounting means, a vertical mast on said carriage, an arm support movable along said mast, an arm horizontally movable in said support, an X-ray tube on said arm, and means for fixing the position of said caster mounting means to hold both of said wheel means parallel, whereby said wheel means support said carriage and tube for straight line movement in one direction and said arm supports said tube for transverse movement in another direction.

6. In apparatus of the class described, a carriage movable along a horizontal surface, a verti-

cal mast on said carriage, a second carriage movable vertically on said mast, an X-ray tube supported by said second carriage, electricity supply equipment on said first named carriage, cable means between said equipment and said tube, a support for said cable means movable vertically on said mast, a latch for holding said cable support in adjusted position on said mast, and means for releasing said latch by upward movement of said second carriage.

7. In X-ray apparatus, a base carriage, a vertical mast on said carriage for supporting an X-ray tube, said mast comprising two parallel tubes, each tube having a plurality of members adapted to be assembled in vertical alinement, said members having interfitting parts at their adjoining ends providing a rigid mast when assembled, a vertically movable carriage mounted on said mast, a horizontally movable arm slidable in said last-named carriage, an X-ray tube on said arm, rack portions on the several members of one of said parallel tubes, said interfitting parts being arranged to aline said rack portions when said members are assembled, and a gear rotatably mounted on said last-named carriage and coacting with said rack to raise and lower said last-named carriage as said gear is rotated.

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