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. 451,415, 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 an enlarged fragmental top plan view of a portion of the fluoroscope screen taken in substantially the position of the line 2—2 of Fig. 1;
Fig. 3 is a side elevational view of the apparatus of Fig. 1;
Fig. 4 is an enlarged fragmental sectional view taken along the line 3A—3A of Fig. 3;
Fig. 5 is a top plan view of a base floor or track along which the apparatus may be moved;
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 locator attachment of Figs. 1 and 3;
Fig. 8 is a view of the 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; while
Fig. 13 is a top plan view of the base carriage taken approximately from the position of the line 15—15 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 swivel 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 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 36 of the control box 38. 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 casting, the transformer casing, the motor and the control box is shown in Figs. 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 41a 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. 15.

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 45 in turn supports the horizontal cross arm 47 upon the end of which is mounted a C-bracket 48 which carries the fluorescent screens 49 and the X-ray tube 50. The mast 45 is mounted for rotation in a well casting 51 (Figs. 11 and 12) 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 the separate parallel members 57 tied together at the lower end by tie bars 58 and intermediate 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 connect with mechanism in the cross arm supporting carriage 45 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 alignment. The separable connections between the members of the mast comprise sleeve projections 55a and 56a accurately finished with very small clearances to fit in the respective coating lower ends of the tubular members 55 and 56. Positioning means comprises the small pins 55b and 56b, respectively, which enter into notches 53a when the parts are assembled. In a similar fashion the sleeve projections 56c 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. Both of these bolts carries a wing nut 62 on the upper end and a centering washer 64b. The lower section of the bolt is threaded as at 64c and carries a guide extension 64d. 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-shaped depression below the sleeve projection 57a. When the bolt 61 is extended downwardly through the hollow tubular mast sections the cup-shape recesses the end 61d of the bolt into the threaded opening 52, after which turning of the nut 61c causes the bolt 61 to expand 62 as to tightly draw the mast sections together. Each bolt 61 is provided with a foldable joint as at 61e 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. The wavy edges of the annular perpendicular bearing surface at 51a adapted to coat with the corresponding annular surface 59a of the disk 59. One of the tubular sections 51 carries a bearing roller 53 on a shaft 54 which extends through the tube and is secured by a nut 55. The roller 53 is so positioned that it bears upon the upper horizontal annular face 51b of the casting 51. Preferably this casting has slightly cut out hollow spots 66 located at four points 50 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 53 is on that side of the mast beyond which the arm 47 extends to support the cross arm 47. The bearing journals 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 53 and it would be difficult to rotate the mast and its supporting weight about 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 coating bearing surfaces on the disk 59 are accurately located with reference to the stud 67 and all of the coating 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 the 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 80 in the disk 59 extends a pin or hand lever 72 which the latch may be manually manipulated. The nose of the latch is adapted to enter into an annular groove 51c 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 45 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 revolving 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 74, 75 which the clutch mechanism disclosed and claimed in Patent No. 2,123,838, granted July 13, 1938, to Edwin R. Goldfield and Caperton B. Horak. As clearly shown, 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 mechanism comprises a pair of parallel tubular members rigidly connected together at one end by the tie bar 75 and the disk 59.
ers 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 as to fit in the same chest with those parts. The support 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 76a and 76b formed over on projections 76c on the ends of the tubular members of the cross arm 47. The arms 78 have slotted openings 78a adapted to swing into position embracing the neck portions 77b which support the buttons 47a 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 can be raised from 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 reversibly mounted on the outer end of the cross arm 47 for rotation relative thereto. This construction is best seen in Figs. 1 and 3A. The cross arm 47 has a nose 47c 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 47c. 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 83c which is loosely bolted to the bracket. The stamping has a beveled nose 83b which engages behind the cone surface of the disk 82 so as to hold the bracket 48 rotatably on the nose 47c 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 16a into which a locking dog 85 is adaptable. The notches are directed 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 47c.

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 E. Goldfield, Caperton B. Horsley and Ralph C. Schirling. Reference may be had to this patent for further description if necessary.

The fluoroscopic screen 49 is provided with a bracket 88 by which the screen is pivotally mounted at 95 on the bracket 48. This connection comprises a sleeve 89 on the bracket 88 which is clamped to a separable nose or projection by means of the wing nut 90 so that the parts may be disassembled at this point. The sleeve 89 may be clamped in position to hold the fluoroscopic screen horizontal when desired by means of a pin 89a which extends through sleeve 89, member 94, and bracket arm 48c of bracket 48, as best seen in Figs. 1 and 16. This is the position of the screen for foreign body localization. A latch 88a pivotally mounted on the frame of screen 49 may be hooked over a pin on bracket 88 to prevent tilting of the screen about pivot 88a.

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 47c and the X-ray tube 50 may be directly mounted on the nose 47c in rotatable fashion.

The high tension cables 45 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 that the cable supports in any adjusted position.

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 125a, 125b and 125c 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 run a flange track 127. These tracks may slope downwardly toward the floor at the points 126a and 127a 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 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.

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 14¼" 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 81. The assembly of the cross arm in the carriage 46 has already been described.
What we claim is:

1. 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 housing on said carriage, coacting bearing surfaces on said housing and mast, coacting latch and keeper parts, one of said parts on said housing and the other of said parts on said mast, and said parts in latching position preventing removal of said mast from said housing.

2. In X-ray apparatus, a base carriage, a vertical mast on said carriage for supporting an X-ray tube, said mast comprising a plurality of hollow tubular members assembled in vertical alignment, said members having interfitting parts at their adjoining ends providing a rigid mast when assembled, and bolt means extending through the hollow portions of said tubular members and having threaded engagement inside the end tubular member of said mast for holding the mast assembled.

3. In X-ray apparatus, a base carriage, a vertical mast on said carriage, said mast comprising two parallel tubular members, means connecting said tubular members near the top and bottom of said mast, a cross-arm at right angles to said mast, means mounting said arm on said mast for movement generally parallel to a plane passing through said tubular members, and an X-ray tube mounted on an end of said arm spaced from said mast, whereby said tubular members reinforce each other to support said arm and said X-ray tube.

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