

[54] **MOBILE X-RAY UNIT**

[75] Inventor: **Anthony J. Foderaro**, Middleburg Heights, Ohio

[73] Assignee: **Picker Corporation**, Cleveland, Ohio

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[51] Int. Cl. **G03b 41/16**

[58] Field of Search..... **250/65 R, 91, 92, 52**

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Primary Examiner—James W. Lawrence

Assistant Examiner—C. E. Church

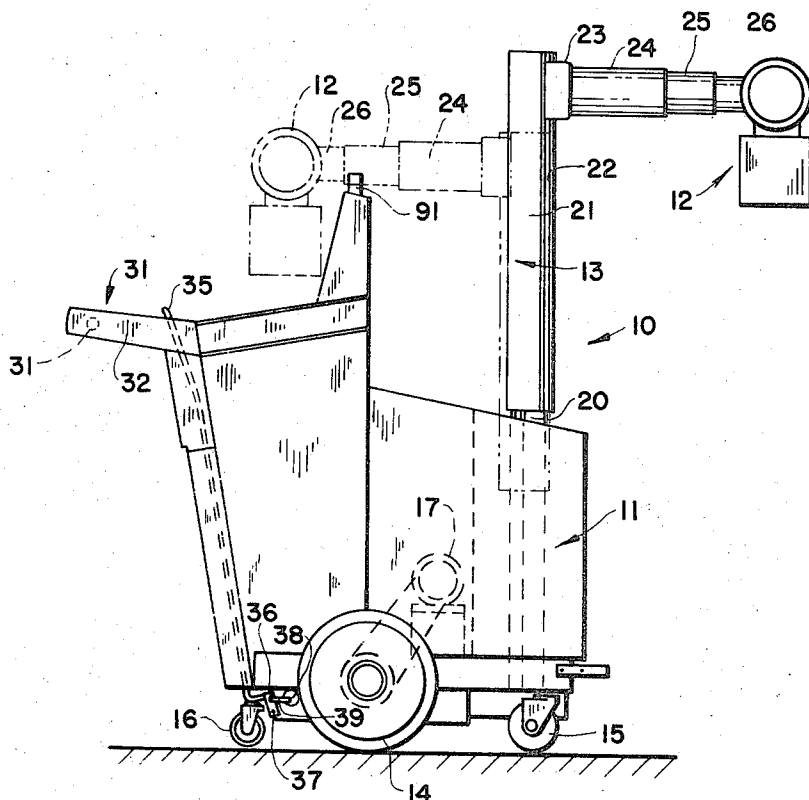
Attorney, Agent, or Firm—Watts, Hoffmann, Fisher & Heinke Co.

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ABSTRACT

A power driven mobile X-ray unit having greatly improved maneuverability through the provision of an X-ray source nestable for transit and a drive control handle which gives the operator the feel of pushing or pulling the unit during transit. The handle comprises a horizontally disposed gripping bar, movable horizontally forwardly and rearwardly of a neutral position. The handle is biased toward the neutral position where the drive means is deactivated and serves to break the unit from moving. Increased pressure on the handle causes the unit to move at a higher speed. A limit switch is provided to prevent the operation of the power drive at any other than the slowest speed when the X-ray tube is in a position other than its storage position. A novel telescoping mast supports the X-ray tube.

12 Claims, 11 Drawing Figures



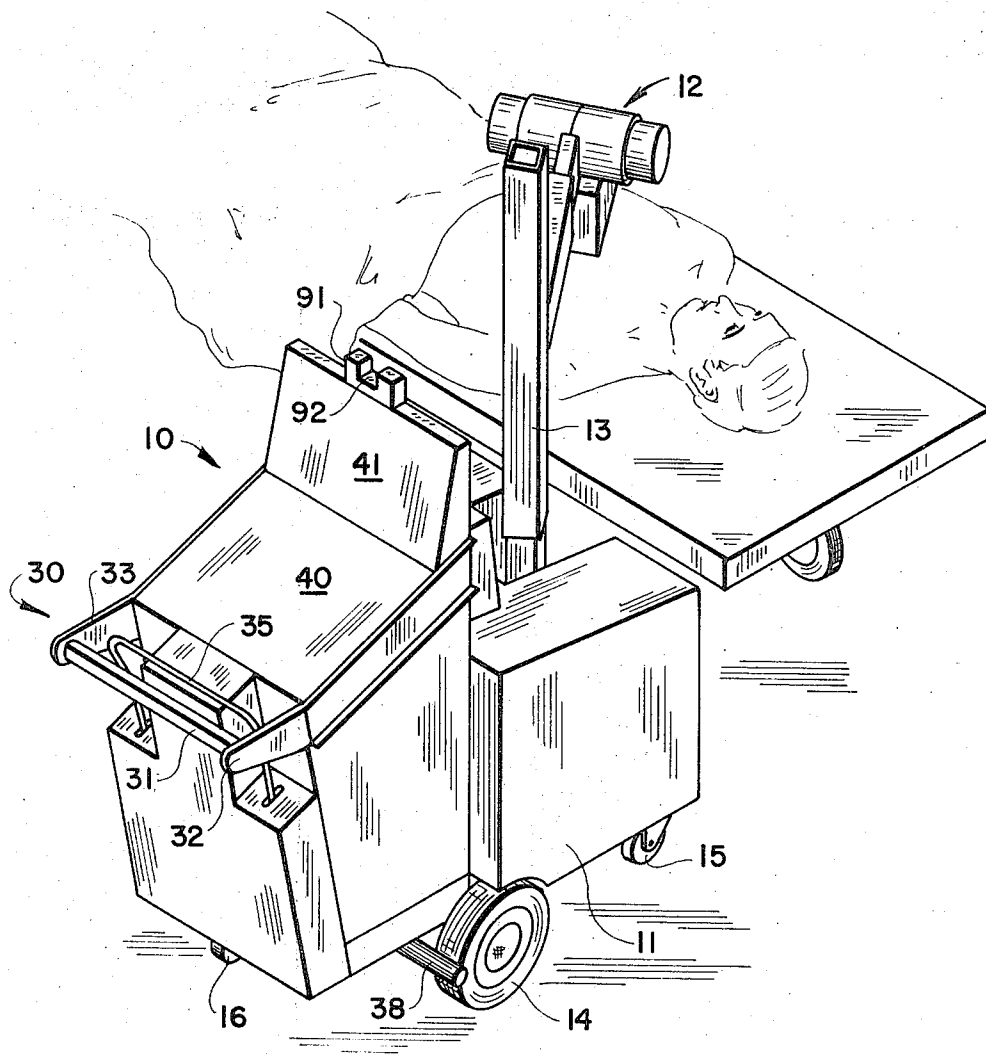
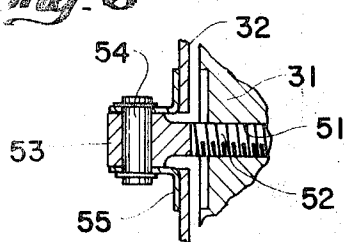
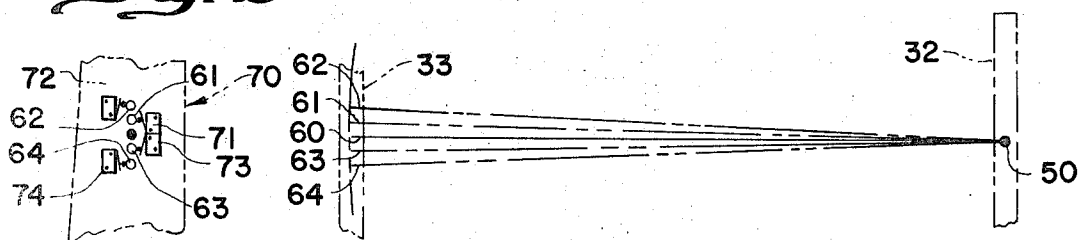
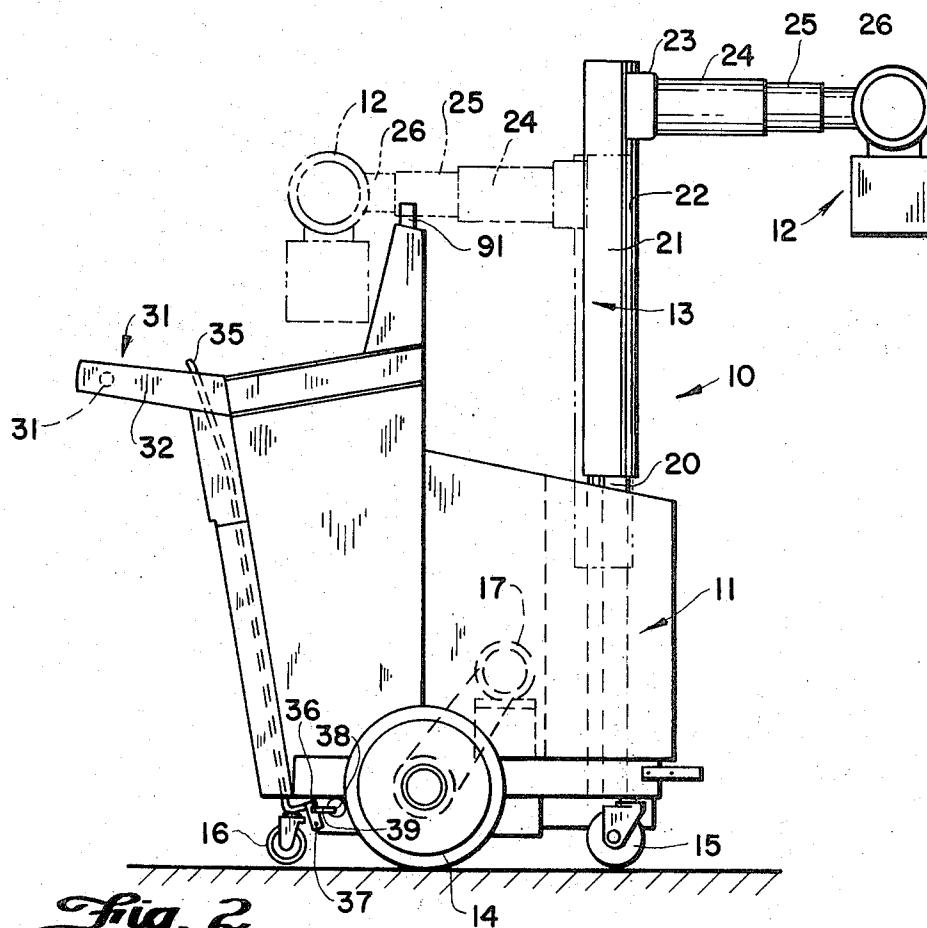


Fig. 1

INVENTOR
ANTHONY J. FODERARO

BY

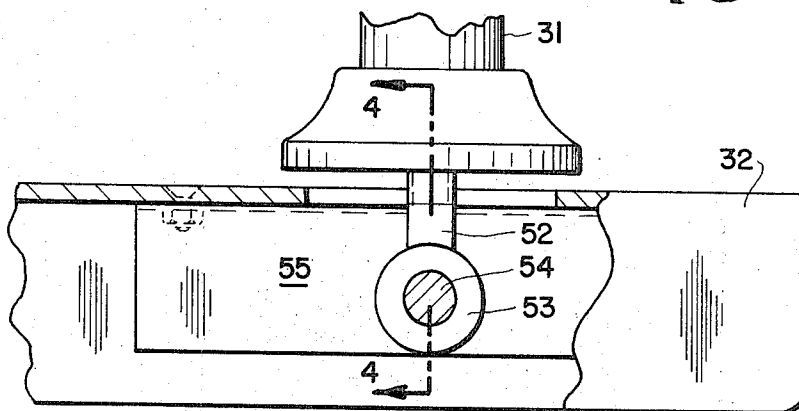
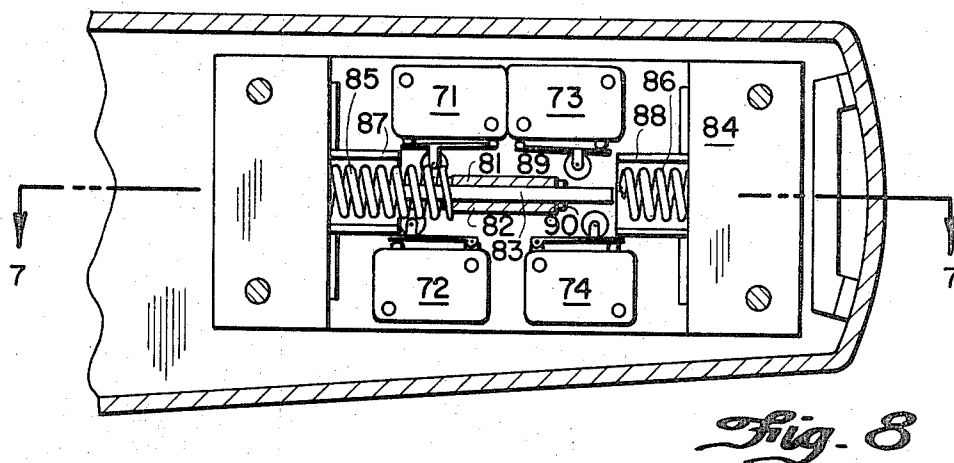
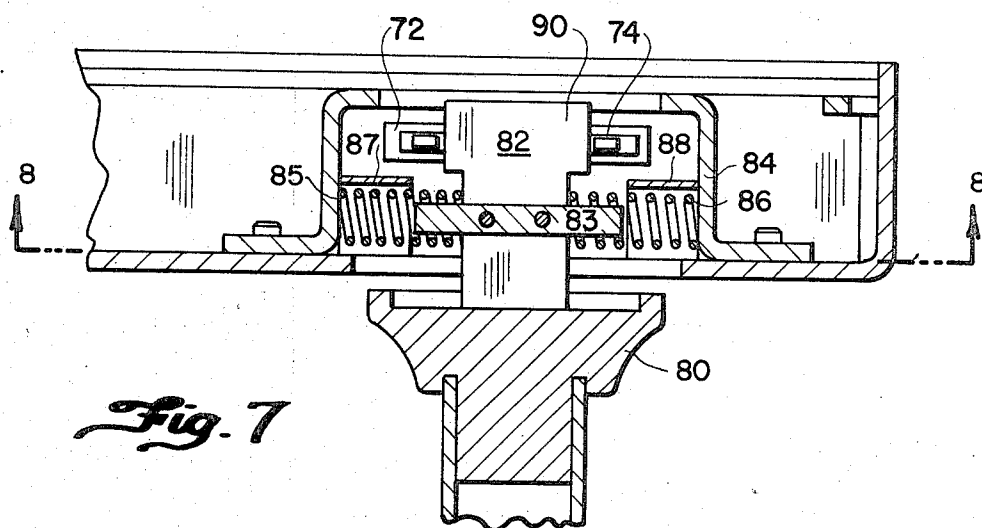
Katts, Hoffmann, Fisher & Weink
ATTORNEYS



INVENTOR.
ANTHONY J. FODERARO

BY

Watts, Hoffmann, Fisher & Heimke
ATTORNEYS



INVENTOR.
ANTHONY J. FODERARO

BY

Watts, Hoffmann, Fisher & Heinke
ATTORNEYS

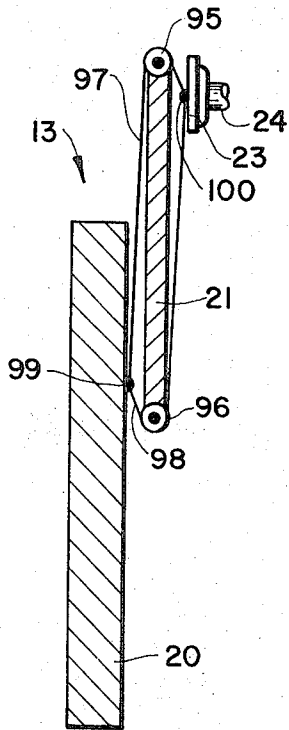


Fig. 9

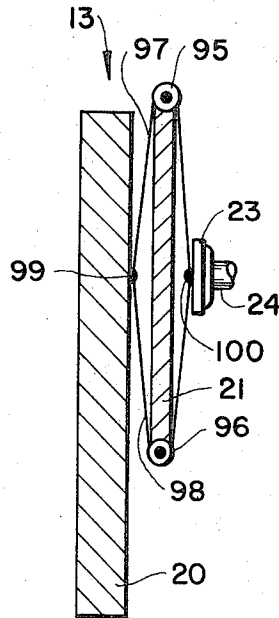


Fig. 10

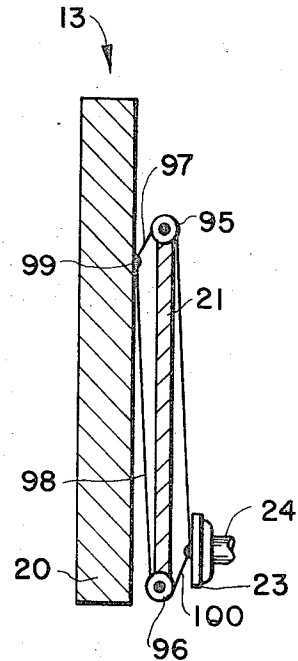


Fig. 11

INVENTOR
ANTHONY J. FODERARO

BY

Watts, Hoffmann, Fisher & Heinke
ATTORNEYS

MOBILE X-RAY UNIT

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to a mobile X-ray unit, and more particularly to a power driven mobile X-ray unit having a reversible multiple speed drive.

2. Prior Art

Mobile X-ray units which can be taken into a patient's hospital room for radiographic procedures are increasingly in demand. Such mobile units obviate the need to move the patient to a remote X-ray room for relatively simple procedures and thus serve both to facilitate patient convenience and comfort and to avoid the expense of moving the patient.

As the demand for and usage of mobile units has increased, larger and larger units have evolved. To a certain extent, all mobile X-ray units are awkward to move, especially the larger units. The problem of maneuverability is compounded by the need for cantilevering the X-ray tube to extend substantially forward of the unit in order that it may be positioned over, beneath or to one side of a bed-ridden patient.

Due to the weight of the mobile units and the fact that many X-ray technicians are women, these units are often provided with power drive systems. While power drive systems have therefore been used in mobile X-ray units, the control systems provided with such units have not given the operator the feel of "pushing" or "pulling" the unit. Prior power drive systems have also failed to provide a simple, inexpensive and reliable power control system.

In addition, most power driven mobile units are difficult to maneuver through doorways and around obstacles. In many instances the range of X-ray tube movement available for diagnostic studies has been sacrificed to improve maneuverability and to provide low profiles which will pass through doorways.

SUMMARY OF THE INVENTION

The present invention provides a mobile X-ray unit with a variable speed, reversible drive having an improved and simplified speed control and an X-ray tube movable to a protected nested storage position for transit. The invention also provides a novel telescoping mast which permits a large range of vertical X-ray tube movement while also providing a low storage position profile for passage through doorways or the like.

In accordance with one feature of the present invention, a speed control is provided which includes a substantially horizontally disposed gripping bar movable in either the forward or reverse directions according to the direction in which it is desired to move the unit. The gripping bar is biased to a neutral position by a biasing means which exerts an increased biasing force the farther the bar is moved from the neutral position. Movement of the unit at a higher speed requires the exertion of more force on the gripping bar, whereby the operator has the feel of pushing or pulling the unit.

In accordance with another feature of the present invention, the X-ray tube is supported on a novel rotatably mounted mast which telescopes to a minimal height for transit and permits the tube to be pivoted from its forwardly extending operative position to a rearwardly extending protective nested position for transit.

In accordance with still another feature of the present invention, a safety means may be provided which requires that the X-ray tube be moved to the protective nested position before the unit can be moved at any other than its slowest speed.

Accordingly, it is the principal object of this invention to provide a mobile X-ray unit which is simple and easy to operate and which affords a maximum of protection to the X-ray tube during transit.

Other objects and a fuller understanding of the invention may be had by referring to the following description and claims in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of the mobile X-ray unit with the X-ray tube shown in a forwardly extending operative position above a patient;

FIG. 2 is an elevational view of the mobile X-ray unit with the X-ray tube shown by solid lines in the operative position, and by phantom lines in the protective nested position;

FIG. 3 is an enlarged plan view partially in cross section of one end portion of the horizontally disposed gripping bar which controls the movement of the unit;

FIG. 4 is a sectional elevational view showing the gripping bar end portion of FIG. 3;

FIG. 5 is a schematic motion diagram depicting the movement of the horizontal gripping bar about its neutral position;

FIG. 6 is a schematic diagram illustrating the control arrangement which is responsive to the movement of the gripping bar to drive the unit;

FIG. 7 is an enlarged sectional plan view of the other end portion of the horizontally disposed gripping bar;

FIG. 8 is a sectional view as seen from the plane indicated by the line 8-8 in FIG. 7;

FIG. 9 is a schematic illustration of a cable and pulley system interconnecting sections of the telescopic mast, the mast being shown in its uppermost extended position;

FIG. 10 is a schematic illustration similar to FIG. 9 with the mast shown retracted to the nested or storage height; and

FIG. 11 is a schematic illustration similar to FIGS. 9 and 10 with the mast shown retracted to its lowermost position.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1, a mobile X-ray unit is indicated generally at 10. The mobile unit 10 includes a base indicated generally by the numeral 11. A source of X-rays in the form of an X-ray tube assembly 12 is provided. The tube assembly 12 is supported above the base 11 by a telescopic mast 13.

The base 11 is supported by a pair of centrally disposed drive wheels 14, a pair of forwardly disposed support wheels 15, and a rearwardly disposed balance wheel 16. A source of rotary motion comprising a reversible battery operated motor 17, shown in dotted lines in FIG. 2, is connected to the drive wheels 14 to selectively move the unit 10 in forward or reverse directions.

The telescopic mast 13 includes a rotatably mounted, vertically extending base section 20 and a movable mast section 21 which is telescoped over the base. The

mast section 21 is adapted to move vertically relative to the base section 20. A track 22 is formed along the forward side of the mast section 21. A horizontally extending X-ray tube assembly carriage 23 is mounted on the track 22 for vertical movement relative to the mast section 21. The movable mast section 21 and the carriage 23 are provided with a counterbalance (not shown) to facilitate their movement. A telescopic column composed of sections 24, 25, 26 connects the tube assembly 12 to the carriage 23. A suitable telescopic column is described in U.S. Pat. No. RE 24,982 to R. C. Schiring entitled "Tubular Telescopic Column."

As was previously mentioned, the vertical base section 20 is pivotally mounted relative to the base 11. By this arrangement, the X-ray tube assembly may be moved from the operative position shown by solid lines in FIG. 2 to the protected nested or storage position shown in phantom in FIG. 2. When the X-ray tube assembly is moved to the nested position, it is afforded an increased degree of protection for transit. Moreover, movement of the X-ray tube assembly to the nested position substantially decreases the effective length dimension of the unit and concentrates the weight by moving the center of gravity rearwardly making the unit easier to maneuver. In addition, when the X-ray tube is in its nested or storage position, the telescopic mast is partially collapsed to a height which will pass through doorways conveniently.

A handle assembly 30 extends rearwardly from the base 11 at a convenient height to be grasped by an operator. The handle assembly 30 includes a substantially horizontally disposed gripping bar 31 extending between a pair of side bar supports 32, 33. As will be explained in greater detail, the gripping bar 33 is movable forwardly and rearwardly to control the movement of the unit 10.

A brake handle 35 is provided forwardly of the gripping bar 33 between the bar and the base 11. The brake handle 35 extends downwardly, as shown in dotted lines in FIG. 2, and connects to pivotally mounted levers 36. The levers 36 are pivoted about an axis 37. A wheel engaging rod 38 is supported from the levers 36 by means of linkages 39. A biasing means (not shown) biases the rod 38 into engagement with the drive wheels 14. This biasing is overcome by rearwardly moving the brake handle 35. By this arrangement, a "dead man" brake is provided which is normally effective to brake the unit 10 from movement, but which may be released by holding the brake handle 35 rearwardly.

Two console control panel surfaces 40, 41 are disposed forwardly of the gripping bar 31 and the brake handle 35. Suitable controls for the operation of the X-ray source 12 are positioned on the console surfaces 40, 41.

The horizontally disposed gripping bar 31 is pivotally mounted at one end relative to the side bar support, 32. As is seen in FIGS. 3 and 4, one end of the gripping bar 31 has a threaded aperture 51. An eye-bolt 52 is threaded into the aperture 51. The eye 53 of the eye bolt 52 journals a pivot pin 54. The pivot pin 54, in turn, journaled and supported by a U-shaped bracket 55 carried by the side bar support 32.

The movement of the gripping bar 31 is shown schematically in FIG. 5. The neutral position of the bar is illustrated by a dashed line 60. Slow-forward and fast-forward positions are illustrated respectively by the

dashed lines 61, 62. Slow-reverse and fast-reverse positions are illustrated by the dashed lines 63, 64.

A control mechanism 70 which is incorporated in the side bar 33 is shown schematically in FIG. 6. The control mechanism 70 comprises limit switches 71, 72, 73, 74 which correspond respectively to the mentioned slow-forward, fast-forward, slow-reverse and fast-reverse positions 61, 62, 63, 64. The switches 71, 72, 73, 74 are connected through suitable circuitry (not shown) to the reversible motor 17 and serve to control the direction and speed of rotation of the motor.

The details of the control mechanism 70 are more clearly shown in FIGS. 7 and 8. A flanged end bushing 80 is pressed onto the gripping bar 31. A pair of spaced plates 81, 82 are rigidly connecting to the flanged end bushing 80. An elongate bar 83 is carried between the spaced plates 81, 82. The bar 83 extends transversely of the plates 81 and 82 intermediate their ends.

A mounting bracket 84 is secured to the side bar 33. The switches 71, 72, 73, 74 are secured within a U-shaped channel formed in the mounting bracket 84. Biasing means in the form of a pair of compression springs 85, 86 engage opposite sides of the plates 81, 82 and the mounting bracket 84. A pair of circular channel segments 87, 88 are secured to the mounting bracket 84 and serve to maintain the springs 85, 86 in their operating positions with respect to the bracket 84. The elongate bar 83 projects into the springs 85, 86 to hold them in position.

The plates 81, 82 have enlarged outer end portions 89, 90, respectively, which serve to selectively actuate the switches 71, 72, 73, 74 depending on the position of the gripping bar 31. When the gripping bar is in the neutral position represented by the dashed line 60 of FIG. 5, none of the switches 71, 72, 73, 74 are actuated. As the gripping bar 31 is moved to the slow-forward position, the enlarged end portion 89 engages and actuates the limit switch 71, causing the motor 17 to be driven at a slow-forward speed. When the bar 31 is moved to the fast-forward position, the enlarged end portion 90 engages and actuates the limit switch 72, causing the motor to be driven at fast-forward speed. The switches 73, 74 similarly coact with the enlarged ends 89, 90 to initiate slow-reverse and fast-reverse speeds.

In accordance with one important feature of the present invention, the control mechanism 70 affords the operator the feel of pushing or pulling the unit. This "feel" of control is provided by the combination of the increased force needed to overcome the action of the springs 85, 86 in moving the gripping bar 31, and the corresponding increased speed of movement as is occasioned by actuation of the switches 71, 72, 73 and 74 respectively.

An automatic auxiliary braking means may also be actuated by moving the handle gripping bar 31. By way of example, suitable worm gear drive components (not shown) may be incorporated in the drive train of the mobile unit such that when the drive motor 17 is de-energized by moving the handle gripping bar 31 to the neutral position, the drive train itself serves to brake the unit.

In order to prevent the operation of the unit 10 at high speed while the X-ray tube assembly 12 is in its forwardly extending position, a safety means may be provided to disable the operation of the high speed switches 72, 74 when the X-ray source is moved from

the protective nested position. In this regard, a U-shaped rest 91 is provided atop the control console 41 as shown in FIGS. 1 and 2. A limit switch 92 projects into the U-shaped channel of the rest 91. When the X-ray tube assembly 12 is in the protective nested position, the limit switch 92 is engaged by the horizontally extending section 24. Appropriate circuitry, not shown, may be interconnected with the limit switches 72, 74, 92 to disable the operation of the switches 72, 74 when the X-ray source is moved from the nested storage position.

Referring to FIGS. 9-11, the structural arrangement of the telescopic mast 13 is shown schematically in greater detail. The mast section 21 is provided with a pair of pulleys 95, 96 adjacent its upper and lower ends, respectively. A pair of cables 97, 98 are reeved over the pulleys 95, 96 respectively. Each of the cables 97, 98 connects at one end with the mast base section 20 at a point 99. The other ends of the cables 97, 98 connect with the tube assembly carriage 23 at a point 100.

By this arrangement, when the carriage 23 is moved to its uppermost position, as shown in FIG. 9, a portion of the movable mast section 21 extends above the mast base section 20 to support the carriage 23. When the carriage 23 is moved to the storage or nested position height, as shown in FIG. 10, the upper end of the movable mast section 21 is lowered to substantially align with the upper end of the mast base section 20. When the carriage 23 is moved to its lowermost position, as shown in FIG. 11, the movable mast section 21 is also lowered to support the carriage 23. Hence, as will be apparent, the mast structure 13 provides a strong, rigid support for the X-ray tube which is capable of telescoping to a minimal height to facilitate transit of the unit 10.

Although the foregoing description is necessarily of a detailed character, in order that the invention may be set forth, it is to be understood that the specific terminology is not intended to be restrictive or confining, and that various rearrangements of parts and modifications of detail may be resorted to without departing from the scope or spirit of the invention as herein claimed.

What is claimed is:

1. A mobile X-ray unit comprising:
 - a. a base and frame structure;
 - b. a mast mounted on said structure;
 - c. a source of X-rays mounted on said mast and movable relative to said structure;
 - d. drive means for selectively moving the unit in forward and rearward directions including:
 - i. floor wheels supporting said structure;
 - ii. a source of rotary motion coupled to selected ones of said wheels and operable to rotate said selected wheels selectively in forward and reverse directions of rotation;
 - e. control means for selectively actuating said source of rotary motion to drive said selected wheels in forward and reverse directions of rotation, including:
 - i. a gripping bar disposed generally horizontally and transverse to a path of movement of the unit, accessible from rearwardly of said structure, and movable relative to said structure forwardly and rearwardly of a neutral position;
 - ii. biasing means biasing said gripping bar into said neutral position;

iii. position responsive means coupled to said source of rotary motion and responsive to forward and rearward movements of said gripping bar to actuate said source of rotary motion to rotate said selected wheels respectively in forward and rearward directions of rotation at a first speed when said gripping bar is moved a first distance from said neutral position, and at a second speed greater than said first speed when said gripping bar is moved a second distance from said neutral position greater than said first distance;

f. said mast and said structure cooperating to define a protective nested transport position for said source of X-rays; and

g. an electrical switch means responsive to the positioning of said source of X-rays relative to the nested position to prevent the operation of said drive means at any speed other than its slowest speed when said source of X-rays is moved from said nested position:

2. The mobile X-ray unit of claim 1 wherein said telescopic mast comprises:

- a. a base section pivotally mounted on said structure;
- b. a movable section movably mounted on said base section for translation relative to said base section;
- c. a carriage movably mounted on said movable section for translation relative to said base section; and,

d. cable and pulley means interconnecting said base section, said movable section and said carriage such that movement of said carriage relative to said base section is operative to effect concurrent movement of said movable section.

3. The mobile X-ray unit of claim 2 wherein said movable section telescopes over said base section and said carriage telescopes over said movable section.

4. The mobile X-ray unit of claim 3 wherein said movable section is shorter than said base section and is movable between a lowermost position surrounding the lower portion of said base section to an uppermost position wherein a portion of said movable section extends above said base section.

5. A mobile X-ray unit comprising:

- a. a base assembly;
- b. floor wheels supporting the base assembly for movement over a floor;
- c. a mast assembly mounted on the base assembly for relative movement, the mast assembly including an X-ray source mounted on a mast;
- d. a multiple speed and direction motor means mounted on the base assembly and drivingly connected to at least one of the floor wheels for selectively driving the one wheel selectively at relatively low and relatively high speeds;
- e. said mast assembly including operative and storage positions;
- f. disabling means carried by one of the assemblies and actuable by the other assembly when the mast assembly is in the storage position;
- g. said disabling means disabling high speed motor means operation when the mast assembly is in its operative position and enabling high speed motor means operation when the mast assembly is in its storage position;

- h. a control handle accessible from rearwardly of said base assembly and movable in forward and reverse directions relative to said base assembly;
 - i. biasing means biasing said control handle in a neutral position;
 - j. position responsive means coupled to said motor means and responsive to forward and reverse movements of said control handle to actuate said motor means respectively in forward and reverse directions; and,
 - k. whereby forward movement of the mobile X-ray unit is effected by pushing on said control handle and rearward movement of the unit is effected by pulling on said control handle.
6. The mobile X-ray unit of claim 5 wherein said position responsive means is operative to actuate said motor means at a first speed when said control handle is moved a first distance from said neutral position, and is operative to actuate said motor means at a second speed greater than said first speed when said control handle is moved a second distance from said neutral position greater than said first distance.
7. The mobile X-ray unit of claim 6 wherein said biasing means is operative to exert an increased biasing force toward said neutral position the farther said control handle is moved from said neutral position, whereby an operator must exert a greater force on said control handle to actuate said drive means at said second speed than at said first speed.
8. A mobile X-ray unit comprising:
- a. a base and frame structure;
 - b. floor wheels supporting the structure for movement over a floor;
 - c. a mast mounted on the structure;
 - d. an X-ray source mounted on said mast and movable relative to the structure, said mast and said structure cooperating to define a protective transport position for said source of X-rays;
 - e. a control handle movably mounted rearwardly on said structure and disposed generally horizontally and transverse to a path of unit movement;
 - f. biasing means between the handle and structure and normally biasing said handle into a neutral position;
 - g. multiple speed and direction motor means mounted on the structure and drivingly connected to at least one of the wheels for selectively driving the wheel in forward and reverse directions;
 - h. a motor speed control device electrically connected to the motor and operatively connected to the handle when the handle is moved out of its neutral position;
 - i. the speed control device including low and high speed components;
 - j. said handle having low and high speed positions;
 - k. said handle being in the low speed position when pushed forwardly from its neutral position a certain distance and being in its high speed position when pushed forwardly further than said given distance;
 - l. said handle actuating the low speed component when in the low speed position and the high speed component when in the high speed position whereby the speed of forward movement of the unit is a function of the movement of the handle from its neutral position; and,
 - m. safety means coupled responsive to the positioning of said source to restrict the operation of said

- motor means to low speed operation when said source is out of its protective nested position.
9. A mobile X-ray unit comprising:
- a. a base and frame structure;
 - b. floor wheels supporting the structure for movement over a floor;
 - c. a mast mounted on the structure;
 - d. an X-ray source mounted on said mast and movable relative to the structure, said mast and said structure cooperate to define a protective transport position for said source of X-rays;
 - e. a control handle movably mounted rearwardly on said structure and disposed generally horizontally and transverse to a path of unit movement;
 - f. biasing means between the handle and structure and normally biasing said handle into a neutral position;
 - g. multiple speed and direction motor means mounted on the structure and drivingly connected to at least one of the wheels for selectively driving the wheel in forward and reverse directions;
 - h. a motor speed control device electrically connected to the motor and operatively connected to the handle when the handle is moved out of its neutral position;
 - i. the speed control device including low and high speed components;
 - j. said handle having low and high speed positions;
 - k. said handle being in the low speed position when pushed forwardly from its neutral position with a certain force and being in its high speed position when pushed forwardly with a force greater than said given force;
 - l. said handle actuating the low speed component when in the low speed position and the high speed component when in the high speed position whereby the speed of forward movement of the unit is a function of the force applied to the handle; and,
 - m. safety means coupled with the motor means and responsive to the positioning of said source to restrict the operation of said motor means to low speed operation when said source is out of its protective nested position.
10. A mobile X-ray unit comprising:
- a. a base assembly;
 - b. floor wheels supporting the base assembly for movement over a floor;
 - c. a mast assembly mounted on the base assembly for relative movement, the mast assembly including an X-ray source mounted on a mast;
 - d. a multiple speed and direction motor means mounted on the base assembly and drivingly connected to at least one of the floor wheels for driving the one wheel selectively at relatively low and relatively high speeds;
 - e. said mast assembly having operative and storage positions;
 - f. a control handle movable to different positions relative to the base assembly to selectively operate the motor means at said low and high speeds; and,
 - g. safety means carried by one of the assemblies and actuable by the other assembly when the mast assembly is in the storage position disabling high speed operation when the mast assembly is in its operative position and enabling high speed operation

tion when the mast assembly is in its storage position.

11. A mobile X-ray unit comprising:

- a. a base assembly;
- b. floor wheels supporting the base assembly for movement over a floor;
- c. a mast assembly mounted on the base assembly for relative movement, the mast assembly including an X-ray source mounted on a mast;
- d. a multiple speed and direction motor means mounted on the base assembly and drivingly connected to at least one of the floor wheels for selectively driving the one wheel selectively at relatively low and relatively high speeds;
- e. said mast assembly including operative and storage

positions;

- f. disabling means carried by one of the assemblies and actuatable by the other assembly when the mast assembly is in the storage position; and,
- g. said disabling means disabling high speed motor means operation when the mast assembly is in its operative position and enabling high speed motor means operation when the mast assembly is in its storage position.

12. The mobile X-ray unit of claim 11 wherein said disabling means comprises a limit switch carried by said base assembly and actuated by said mast assembly when said source of X-rays is in said storage position.

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