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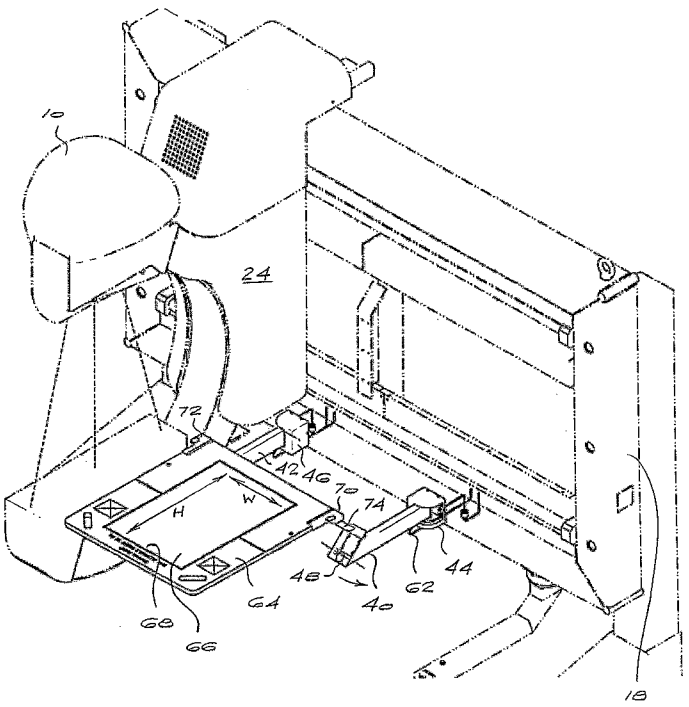
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(54) **Title:** AUXILIARY POSITIONING APPARATUS FOR USE WITH LINEAR SCANNING X-RAY SYSTEM



(57) **Abstract:** Auxiliary positioning apparatus is provided for use with a linear scanning X-ray system of the kind having a radiation source for generating an imaging beam, a detector responsive to the imaging beam to generate an output signal, and a drive arranged to move at least one of the radiation source and the detector relative to a subject in a scanning direction. In the X-ray system, a drive control system controls the operation of the drive, and at least one sensor is provided, having an output to which the drive control system is responsive to limit the scanning travel of the X-ray system. The auxiliary positioning apparatus includes an X-ray translucent panel or screen defining a scanning area of reduced size compared to a maximum scanning area of the linear scanning X-ray system, and a location arrangement to locate the positioning member relative to the radiation source and the detector in at least one predetermined position. When the screen is so located, the sensor is operated, and the drive control system responds to the sensor output to limit travel of the radiation source and/or the detector so as to scan a subject or portion of a subject within the scanning area defined by the screen. This allows the X-ray system to be used in conventional radiography applications as well as for whole-body scanning.

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AUXILIARY POSITIONING APPARATUS FOR USE WITH LINEAR SCANNING X-RAY SYSTEM

BACKGROUND OF THE INVENTION

This invention relates to auxiliary positioning apparatus for use with a linear scanning X-ray system.

Linear scanning X-ray systems are known which comprise a radiation source mounted at one end of a C-shaped arm for generating an imaging beam, a detector at an opposed end of the C-arm responsive to the imaging beam to generate an output signal, and a drive arranged to move at least one of the radiation source and the detector relative to a subject in a scanning direction. Such systems are typically used for the acquisition of whole-body images of a patient or other subject, as described in US patent no. 6,921,200.

For example, such apparatus can be used provide fast X-ray images of injured patients. Once a patient has been stabilized, he or she can conveniently be placed on a trolley or gurney, placed in position, scanned, and wheeled out for further treatment, with the resulting radiograph appearing on the diagnostic screen virtually instantaneously. Due to the low X-ray dose administered by the apparatus, the risk of radiation exposure to staff and patients is reduced.

The application of radiographic imaging apparatus. Two basic types of imagining apparatus for human and animal diagnosis are known. The first uses an x-ray source which illuminates the whole of the area under examination. For human application, this is often referred to as full field or whole body examination, the latter when the whole body is to be examined. The second is a scanning x-ray system, for which the x-ray source and the detector are moved relative to the subject under examination,

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in order to generate a composite image of the subject. Such a system is disclosed in International patent application no. WO 00/53093.

Generally, linear scanning X-ray systems of the above kind are not ideal for producing conventional radiographs of selected portions of a patient's body, in conventional general purpose radiography applications.

SUMMARY OF THE INVENTION

According to a first aspect of the invention there is provided auxiliary positioning apparatus for use with a linear scanning X-ray system of the kind comprising a radiation source for generating an imaging beam, a detector responsive to the imaging beam to generate an output signal, a drive arranged to move at least one of the radiation source and the detector relative to a subject in a scanning direction, a drive control system arranged to control the operation of the drive, and at least one sensor having an output to which the drive control system is responsive to modify movement of the radiation source and/or the detector, the auxiliary positioning apparatus comprising:

a positioning member defining a scanning area of reduced size compared to a maximum scanning area of the linear scanning X-ray system; and

location means arranged to locate the positioning member relative to the radiation source and the detector in at least one predetermined position and to operate the sensor when the positioning member is so located, the drive control system responding to the sensor output to limit travel of the radiation source and/or the detector so as to scan a subject or portion of a subject within the scanning area defined by the positioning member.

The positioning member is preferably a planar screen or panel of X-ray transparent or translucent material.

The planar screen is preferably supported by a frame of X-ray opaque material.

The screen may be rectangular, with a height corresponding to a predetermined scan width of the linear scanning X-ray system.

Preferably, the screen has a width less than the maximum travel of the radiation source and/or the detector.

In a preferred embodiment, the ratio of the width of the screen to the maximum travel of the radiation source and/or the detector is less than 1 to 4.

The location means may comprise at least one locating member shaped to engage a locating formation associated with the linear scanning X-ray system and to cause the sensor to provide a corresponding output when so engaged.

Preferably, the location means comprises a pair of pins fixed to the planar screen.

Further according to the invention there is provided X-ray apparatus adapted for use with the auxiliary positioning apparatus defined above, the X-ray apparatus comprising a radiation source for generating an imaging beam, a detector responsive to the imaging beam to generate an output signal, a drive arranged to move at least one of the radiation source and the detector relative to a subject in a scanning direction, a drive control system arranged to control the operation of the drive, and at least one sensor having an output to which the drive control system is responsive to modify movement of the radiation source and/or the detector when the presence of the positioning member is detected by

the sensor, the drive control system responding to the sensor output to limit travel of the radiation source and/or the detector so as to scan a subject or portion of a subject within the scanning area defined by the positioning member.

Said at least one sensor may be located in a locating formation for the positioning member attached to a frame supporting the drive of the X-ray apparatus.

The locating formation may be formed in an arm extending transversely from the frame of the X-ray apparatus, said at least one sensor being located in or adjacent the locating formation and arranged to detect insertion of a locating member of the positioning member.

The locating formation is preferably arranged to receive the locating member of the positioning member in at least two different orientations, with said at least one sensor being arranged to detect the orientation of the positioning member and to provide a corresponding output to the drive control system, the drive control system being responsive to the sensor output to orient the X-ray source and the detector to correspond to the detected orientation of the positioning member.

In a preferred embodiment, the locating formation defines at least two locating bores, the locating member of the positioning member comprising complemental locating pins, and said at least one sensor comprising respective microswitches arranged to detect the presence of the locating pins in one or the other of the locating bores.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a is a pictorial view of linear scanning X-ray apparatus of the general kind suitable for use with auxiliary positioning apparatus according to the invention;

Figure 2 is a pictorial view of a radiological installation incorporating the linear scanning X-ray apparatus shown in Figure 1;

Figure 3 is an end elevation of the apparatus of Figure 1 showing a scanning arm thereof rotated through 90 degrees relative to its position in Figure 1;

Figure 4 is an end elevation of linear scanning X-ray apparatus similar to that shown in Figures 1 to 3, adapted for use with auxiliary positioning apparatus according to the invention, with a scanning arm thereof in a position corresponding to that of the apparatus in Figure 3 and auxiliary positioning apparatus according to the invention

Figure 5 is a similar view to that of Figure 4 in which the scanning arm is rotated through 90 degrees and the auxiliary positioning apparatus is located for horizontal imaging;

Figure 6 is a pictorial view of the apparatus corresponding to Figure 5;

Figure 7 is a sectional side view of a locating device of the apparatus of Figures 3 to 6; and

Figure 8 is a view similar to that of Figure 7 showing locating pins of the auxiliary positioning apparatus inserted in the locating device.

DESCRIPTION OF PREFERRED EMBODIMENTS

Figures 1 to 3 show three different views of known linear scanning X-ray imaging apparatus. The apparatus comprises a head 10 containing an X-ray source 12 which emits a narrow, fanned beam of X-rays towards a detector arrangement 14. The X-ray source 12 and the detector 14 are supported at opposite ends of a curved arm 16 which is generally semicircular or C-shaped. A frame 18 mounted on a wall 8 or another fixed structure defines a pair of rails 20 with which a motorized drive mechanism 22 engages to drive the arm linearly back and forth in a first, axial direction of movement, or scanning direction. In addition, the drive mechanism comprises a housing 24 in which the arm 16 is movable by the drive mechanism in order to cause the X-ray source and the detector to rotate about an axis parallel with the first direction of movement of the mechanism.

A typical application of the imaging apparatus of the invention is in a radiological installation, such as that illustrated in Figure 2. The imaging apparatus is shown located in a corner of a room which may be a resuscitation area or trauma room of a hospital, for example. Alternatively, the apparatus may be located in a radiological department of a hospital or elsewhere.

Located adjacent to the imaging apparatus is a local positioning console 26, by means of which an operator can set up the required viewing parameters (for example, the angle of the arm 16, start and stop positions, and the width of the area to be X-rayed). A main operator console 28 is provided behind a screen 30 which is used by the operator to set up the required radiographic procedure. The imaging apparatus is operated to perform a scan of a subject 32 supported on a specialized trolley or gurney 34 and an image of the radiograph is displayed on a screen at the console 28, in order to allow the operator to judge whether a successful image has been acquired.

One or more high quality monitors 36 are provided for diagnostic viewing and are located so that attending clinical staff can study the radiographs being acquired. In addition, a console 38 is provided which forms part of a standard Radiological Information System which permits picture viewing and archiving.

The arrangement of Figure 2 is designed for use in the resuscitation room of a trauma unit, in order to provide fast X-ray images of injured patients. Once a patient has been stabilized, he or she can conveniently be placed in position, scanned, and wheeled out for further treatment, with the resulting radiograph appearing on the diagnostic screen virtually instantaneously. Due to the low X-ray dose administered by the apparatus, the risk of radiation exposure to staff and patients is reduced.

Apparatus of the kind described above is well known to those skilled in the art, and is described in detail in US Patent no. 6,921,200, for example.

Referring now to Figures 4 to 8 of the drawings, linear scanning X-ray apparatus is shown that has been modified for use with auxiliary positioning apparatus according to the invention. In Figures 4 to 6, the modified linear scanning X-ray apparatus is substantially similar to that shown in Figures 1 to 3, and corresponding parts are numbered accordingly.

The modified apparatus includes a pair of arms 40 and 42 that are mounted pivotably relative to the frame 18 at the lower edge of the frame, on respective mountings 44 and 46. The arms can be moved between an extended position, as shown in Figures 4 to 6, in which they extend transversely outwardly from the lower edge of the frame 18, through 90 degrees to a stowed position adjacent the lower edge of the frame (as indicated by the arrow in Figure 6). The mountings 44 and 46 include a locking or locating mechanism to hold the arms rigidly but releasably in their extended positions in use.

At the outer end of each arm 40, 42 is a box-shaped head or locating formation 48 having an inclined outer face 50 in which is formed first and second bores 52 and 54. (See Figures 7 and 8.) The bores are parallel to one another and extend through the locating formation 48. The bores are sized to receive a locating pin of an auxiliary radiographic positioning screen as described below.

The arms 40 and 42 are constructed of robust rectangular section steel tubing, while the locating formations 48 are fabricated from steel plate. It will be appreciated that other materials could be used for these components, provided that they offer suitable strength.

Located within a central cavity 56 in the locating formation 48 are first and second sensors in the form of microswitches 58 and 60. The terminals of the microswitches are connected to respective conductors of cables 62 that are fed via the interiors of the respective arms 40 and 42 to control circuits of the scanning apparatus. The microswitches have respective actuators 78 and 78 which protrude slightly into the bores 52 and 54 via respective cross-bores 80 and 82.

An embodiment of auxiliary positioning apparatus of the invention is shown in Figures 4 to 6 and is seen to comprise a rectangular outer frame 64 which supports a rectangular X-ray translucent panel or screen 66. In the prototype apparatus, the outer frame 64 and the inner panel or screen 66 were formed from the same material, as an integral unit, but it will be understood that the frame and screen could be formed separately and of different materials. For example, in some cases it might be desirable to form the frame from an X-ray opaque material.

The panel 66 defines a scanning area which is substantially smaller in area than the maximum scanning area that the X-ray apparatus can normally cover. The height H of the panel (see Figure 6) and thus of the scanning area is defined by the standard width of coverage of the X-ray apparatus,

but the width W of the panel and thus of the scanning area is much less than the full length of the travel of the C-arm of the apparatus in the scanning direction. For example, the ratio of width of the panel to the full travel of the linear scanning X-ray machine is typically less than 1 to 4. A bold white rectangular border 68 defines the outer edges of the panel 66. In the prototype apparatus, the panel had dimensions of approximately 670 mm high by 436 mm wide.

At two opposed corners of one end of the frame 64, a pair of sturdy brackets or hinges 70 and 72 of mild steel are fixed to the frame. Each bracket has a pin 74 extending from it at an angle of 135 degrees to the plane of the panel 66, as seen most clearly in Figure 8.

The pins 74 are sized to fit snugly into the bores 52 and 54 in the locating formations 48 at the ends of the arms 40 and 42. It will be seen that the pins 74 can be inserted either into the respective bores 54 with the panel 66 oriented horizontally as shown in Figures 5 and 6 (and corresponding to the detail of Figure 8) or into the respective bores 52 with the panel oriented upright, as shown in Figure 4.

With the panel 66 located as shown in Figures 5 and 6, the microswitches 60 in the locating formations 48 are operated. The switch contacts are connected via the cables 62 to the control electronics of the linear drive of the X-ray apparatus, and operation of these switches serves as an input to the control electronics, indicating that the auxiliary positioning apparatus is in the illustrated position. The control logic causes the C-arm to rotate to the illustrated position, with the head 10 uppermost and the detector 14 lowermost. A limb of a patient, for example a hand or arm, can be placed on the panel 66 within the border 68 to be X-rayed. When the X-ray apparatus is operated, the control logic regulates the operation of the X-ray source 12 so that when a scan is carried out, the source is only active when its fan beam X-ray output traverses the scanning area defined by the panel 66. Thus a conventional type of radiograph can be obtained, over a limited area corresponding to that of conventional non-scanning radiography

apparatus, using the adapted scanning X-ray apparatus and the auxiliary positioning apparatus.

When the pins 74 are inserted into the lower bores 52 with the panel 66 upright, as shown in Figure 4, the microswitches 58 are operated, indicating to the control logic of the X-ray apparatus that the C-arm must rotate to the position shown in Figure 4. In this position, with the head 10 remote from the frame 18 and the detector 14 adjacent the frame. In this position the apparatus is suitable, for example, for an upright chest X-ray of a patient. The patient is preferably seated on a height-adjustable stool or chair against the panel, between the panel and the head 10 of the apparatus, and moved relative to the upright panel so that the portion of the patient's body to be X-rayed is correctly positioned within the border 68 of the panel 66.

It will be appreciated that many different types of radiographs can be obtained using the described apparatus, and the examples given above are not intended to be exhaustive.

The described auxiliary positioning apparatus, together with the described modifications to the linear scanning X-ray apparatus, allow the apparatus to detect automatically the orientation of the positioning apparatus and to orient the C-arm carrying the X-ray source and detector accordingly. The use of the described positioning apparatus also causes the X-ray apparatus to adjust and limit the extent of its movement in the scanning direction to correspond to the width W of the panel 66 of the positioning apparatus, thus automatically causing the X-ray apparatus to capture a radiograph of a relatively small area corresponding to that of conventional radiography apparatus. This increases the versatility of the scanning X-ray apparatus and makes it unnecessary, for many purposes, to provide conventional X-ray apparatus in addition to the scanning X-ray apparatus.

CLAIMS

1. Auxiliary positioning apparatus for use with a linear scanning X-ray system of the kind comprising a radiation source for generating an imaging beam, a detector responsive to the imaging beam to generate an output signal, a drive arranged to move at least one of the radiation source and the detector relative to a subject in a scanning direction, a drive control system arranged to control the operation of the drive, and at least one sensor having an output to which the drive control system is responsive to modify movement of the radiation source and/or the detector, the auxiliary positioning apparatus comprising:

   a positioning member defining a scanning area of reduced size compared to a maximum scanning area of the linear scanning X-ray system; and

   location means arranged to locate the positioning member relative to the radiation source and the detector in at least one predetermined position and to operate the sensor when the positioning member is so located, the drive control system responding to the sensor output to limit travel of the radiation source and/or the detector so as to scan a subject or portion of a subject within the scanning area defined by the positioning member.

2. Auxiliary positioning apparatus according to claim 1 wherein the positioning member is a planar screen of X-ray transparent or translucent material.

3. Auxiliary positioning apparatus according to claim 2 wherein the planar screen is supported by a frame of X-ray opaque material.

4. Auxiliary positioning apparatus according to claim 2 or claim 3 wherein the screen is rectangular, and has a height corresponding to a predetermined scan width of the linear scanning X-ray system.

5. Auxiliary positioning apparatus according to claim 4 wherein the screen has a width less than the maximum travel of the radiation source and/or the detector.

6. Auxiliary positioning apparatus according to claim 5 wherein the ratio of the width of the screen to the maximum travel of the radiation source and/or the detector is less than 1 to 4.

7. Auxiliary positioning apparatus according to any one of claims 2 to 6 wherein the location means comprises at least one locating member shaped to engage a locating formation associated with the linear scanning X-ray system and to cause the sensor to provide a corresponding output when so engaged.

8. Auxiliary positioning apparatus according to claim 7 wherein the location means comprises a pair of pins fixed to the planar screen.

9. X-ray apparatus adapted for use with the auxiliary positioning apparatus of any one of claims 1 to 8, the X-ray apparatus comprising a radiation source for generating an imaging beam, a detector responsive to the imaging beam to generate an output signal, a drive arranged to move at least one of the radiation source and the detector relative to a subject in a scanning direction, a drive control system arranged to control the operation of the drive, and at least one sensor having an output to which the drive control system is responsive to modify movement of the radiation source and/or the detector when the presence of the positioning member is detected by the sensor, the drive control system responding to the sensor output to limit travel of the radiation source and/or the detector so as

to scan a subject or portion of a subject within the scanning area defined by the positioning member.

10. X-ray apparatus according to claim 9 wherein said at least one sensor is located in a locating formation for the positioning member attached to a frame supporting the drive of the X-ray apparatus.

11. X-ray apparatus according to claim 10 wherein the locating formation is formed in an arm extending transversely from the frame of the X-ray apparatus, said at least one sensor being located in or adjacent the locating formation and arranged to detect insertion of a locating member of the positioning member.

12. X-ray apparatus according to claim 11 wherein the locating formation is arranged to receive the locating member of the positioning member in at least two different orientations, with said at least one sensor being arranged to detect the orientation of the positioning member and to provide a corresponding output to the drive control system, the drive control system being responsive to the sensor output to orient the X-ray source and the detector to correspond to the detected orientation of the positioning member.

13. X-ray apparatus according to claim 12 wherein the locating formation defines at least two locating bores, the locating member of the positioning member comprising complemental locating pins, and said at least one sensor comprising respective microswitches arranged to detect the presence of the locating pins in one or the other of the locating bores.

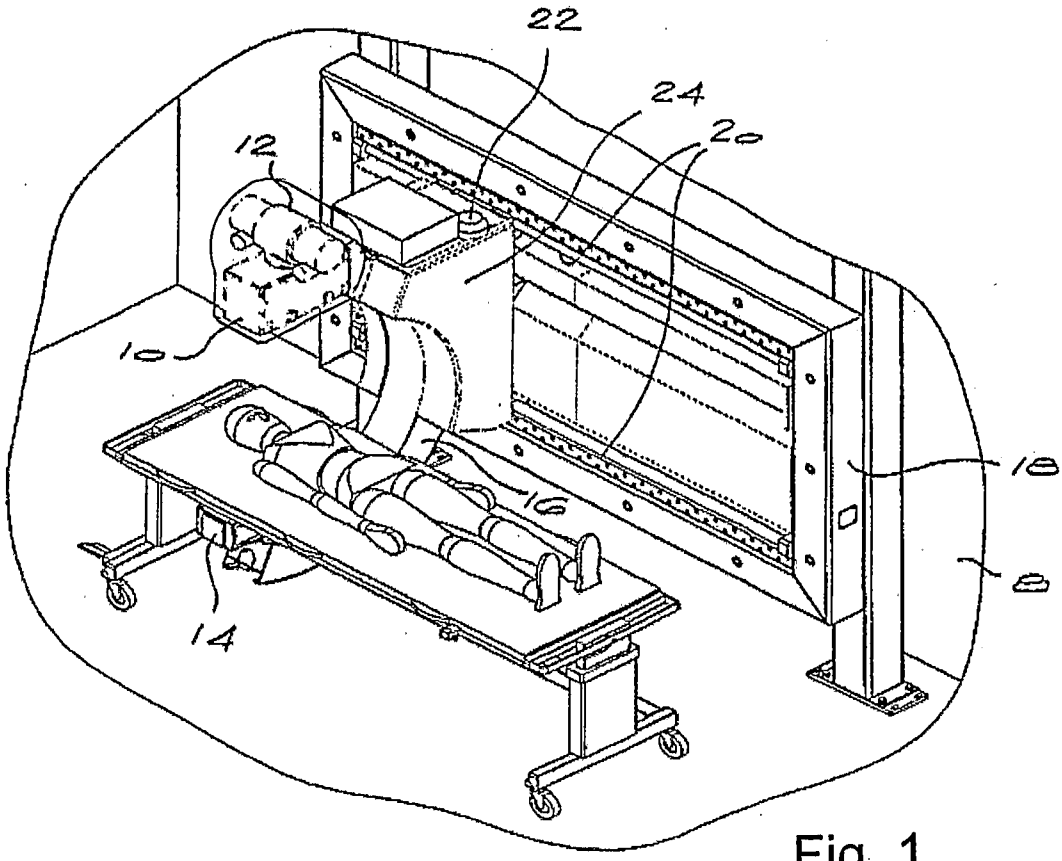


Fig. 1

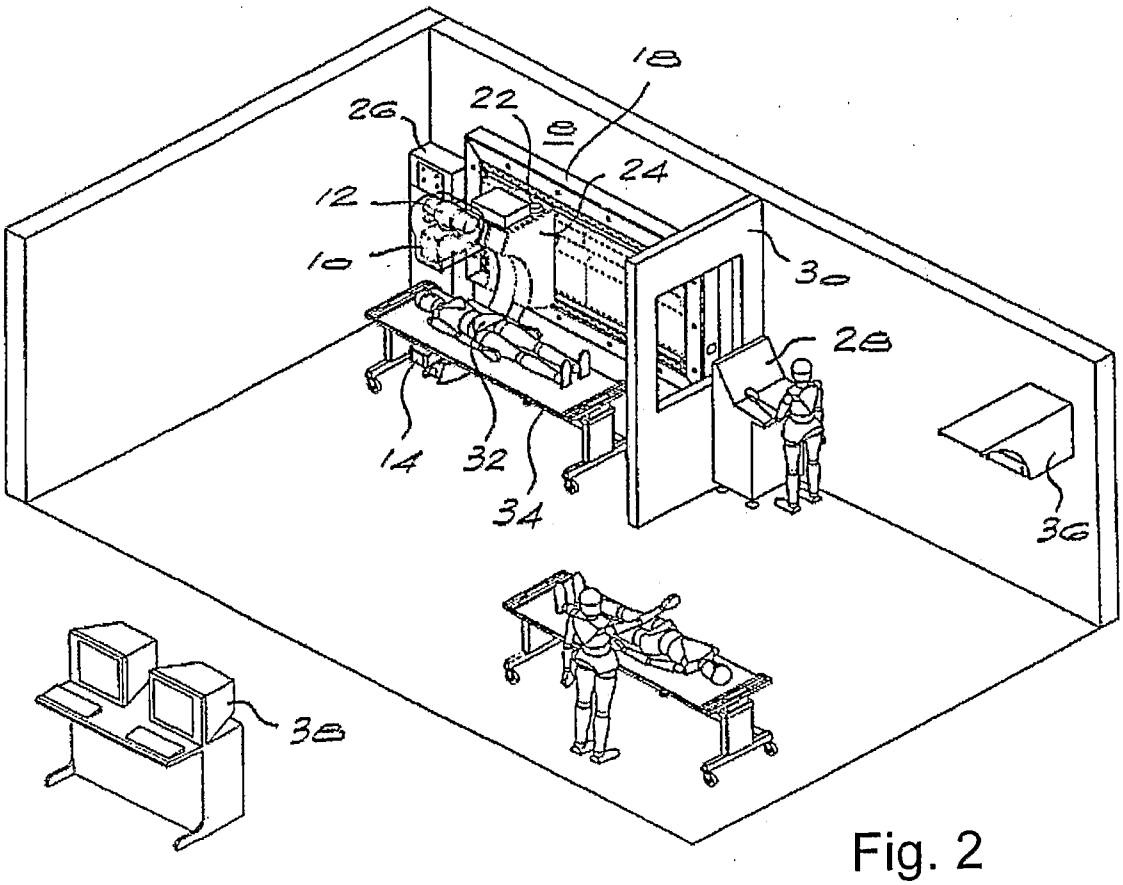


Fig. 2

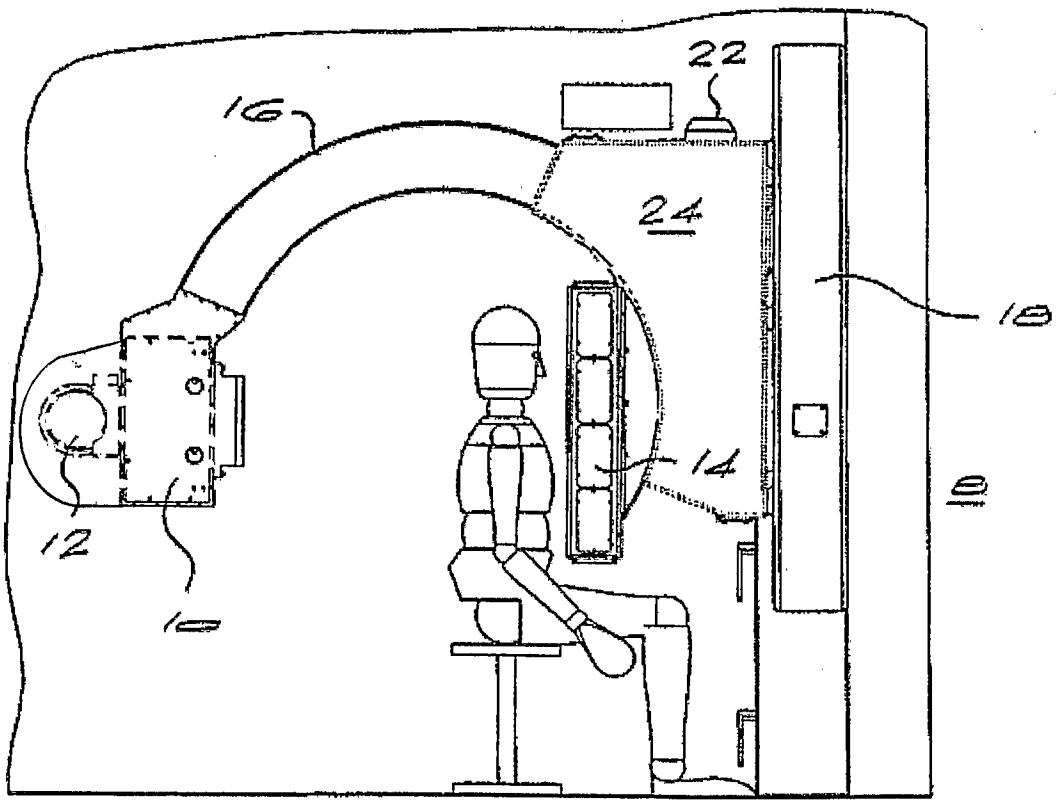


Fig. 3

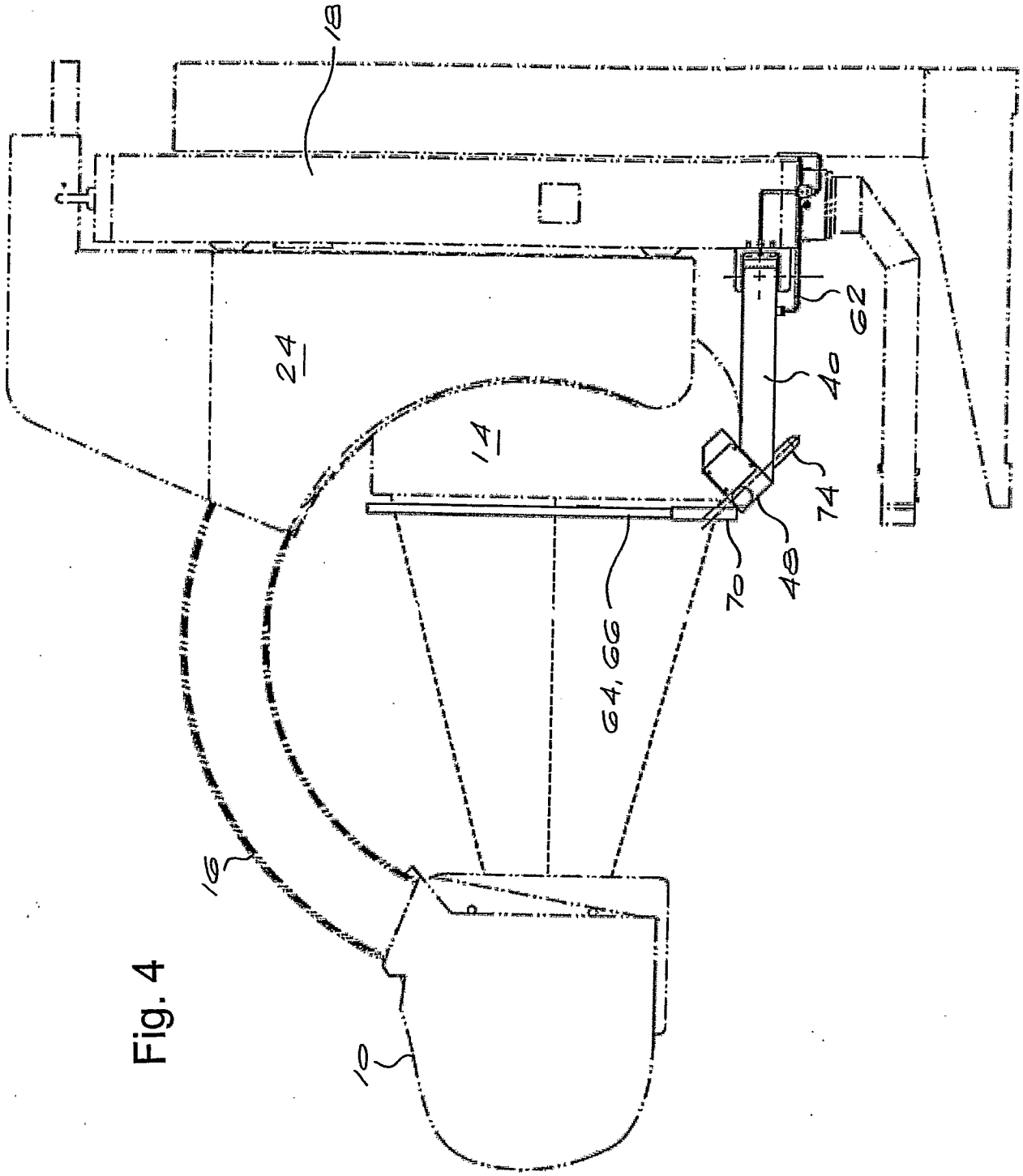


Fig. 4

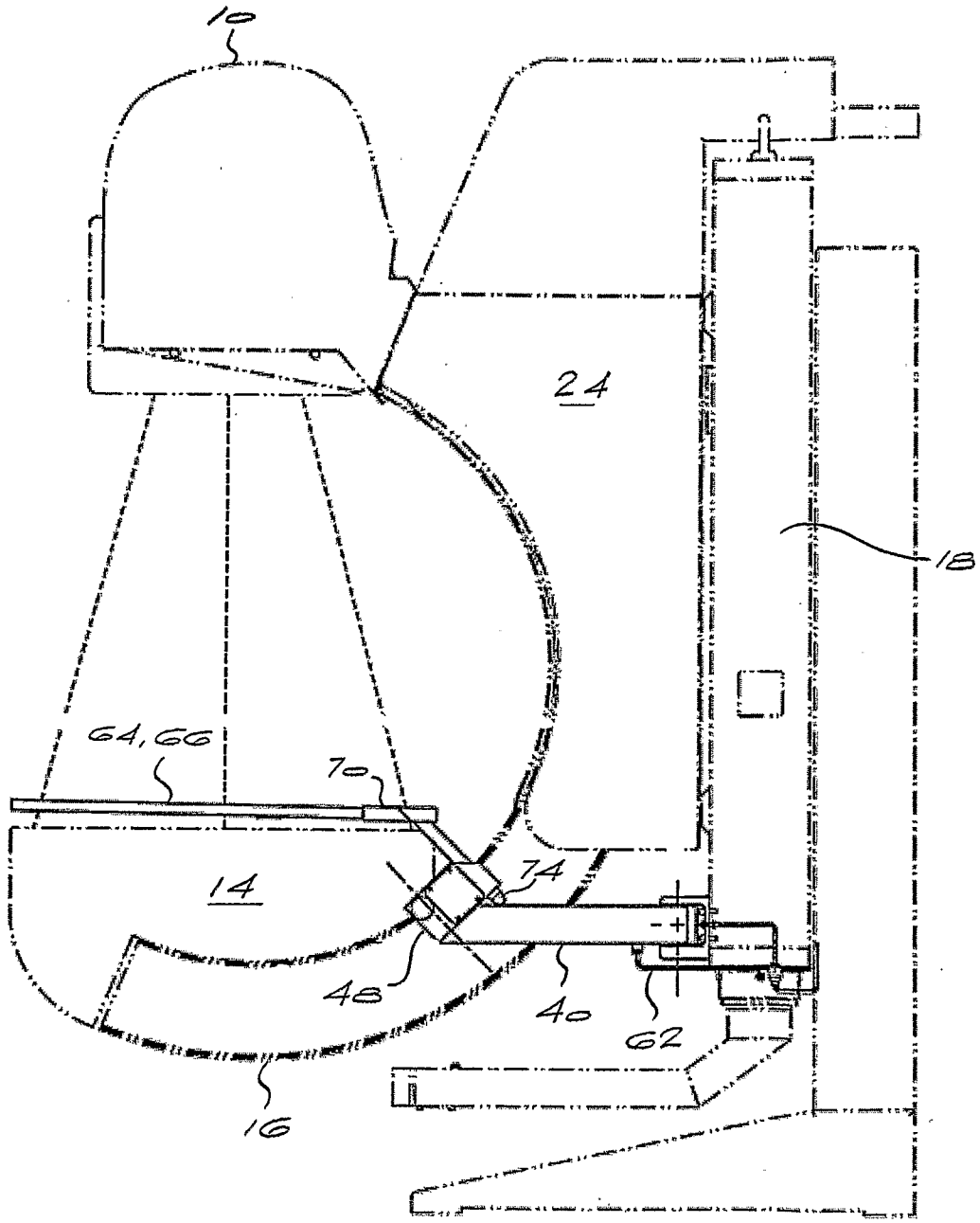


Fig. 5

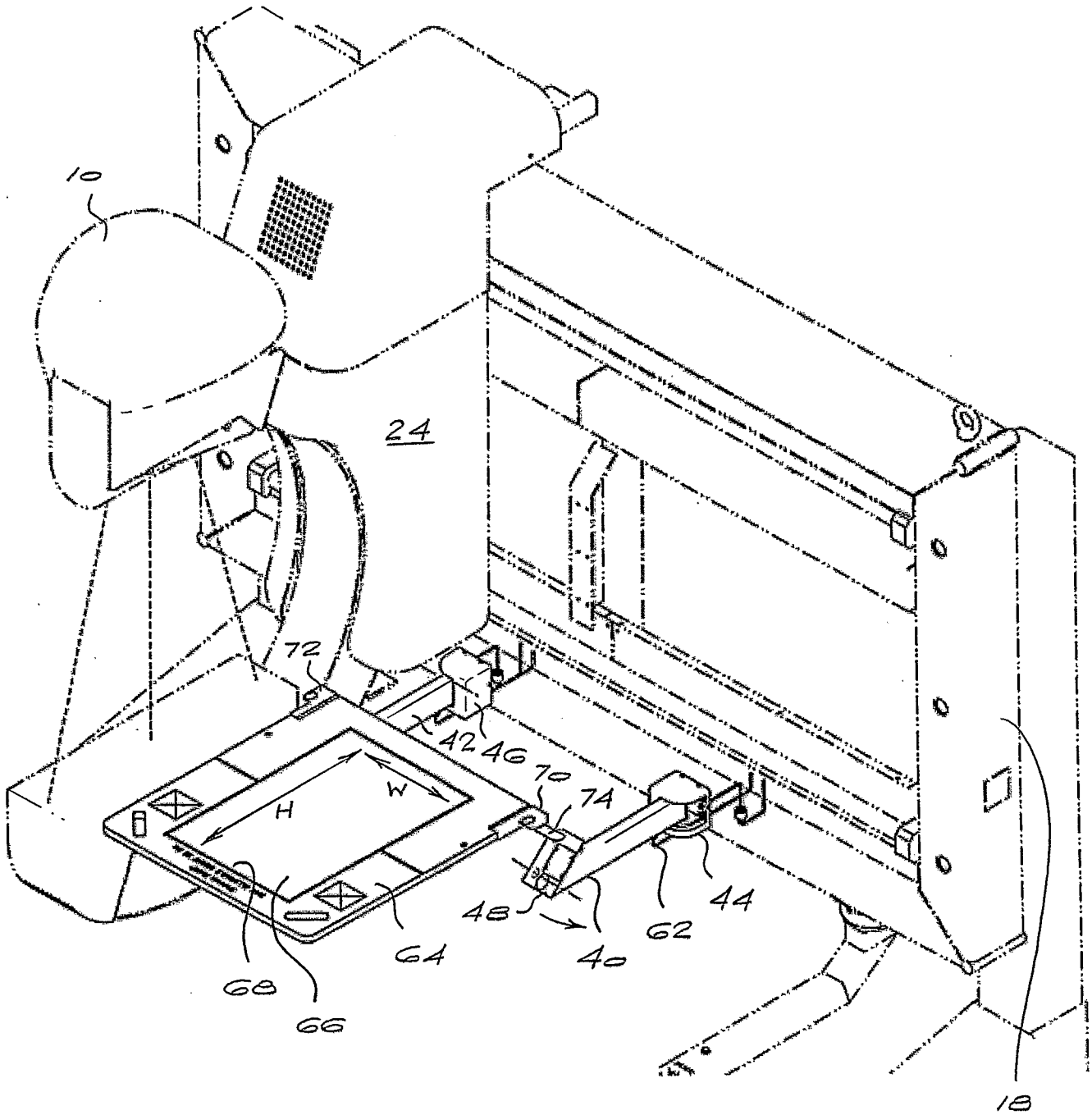


Fig. 6

Fig. 7

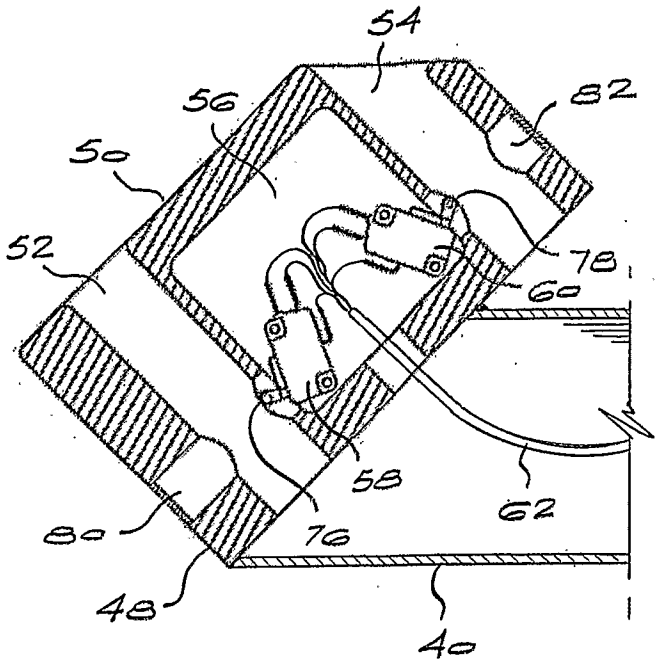
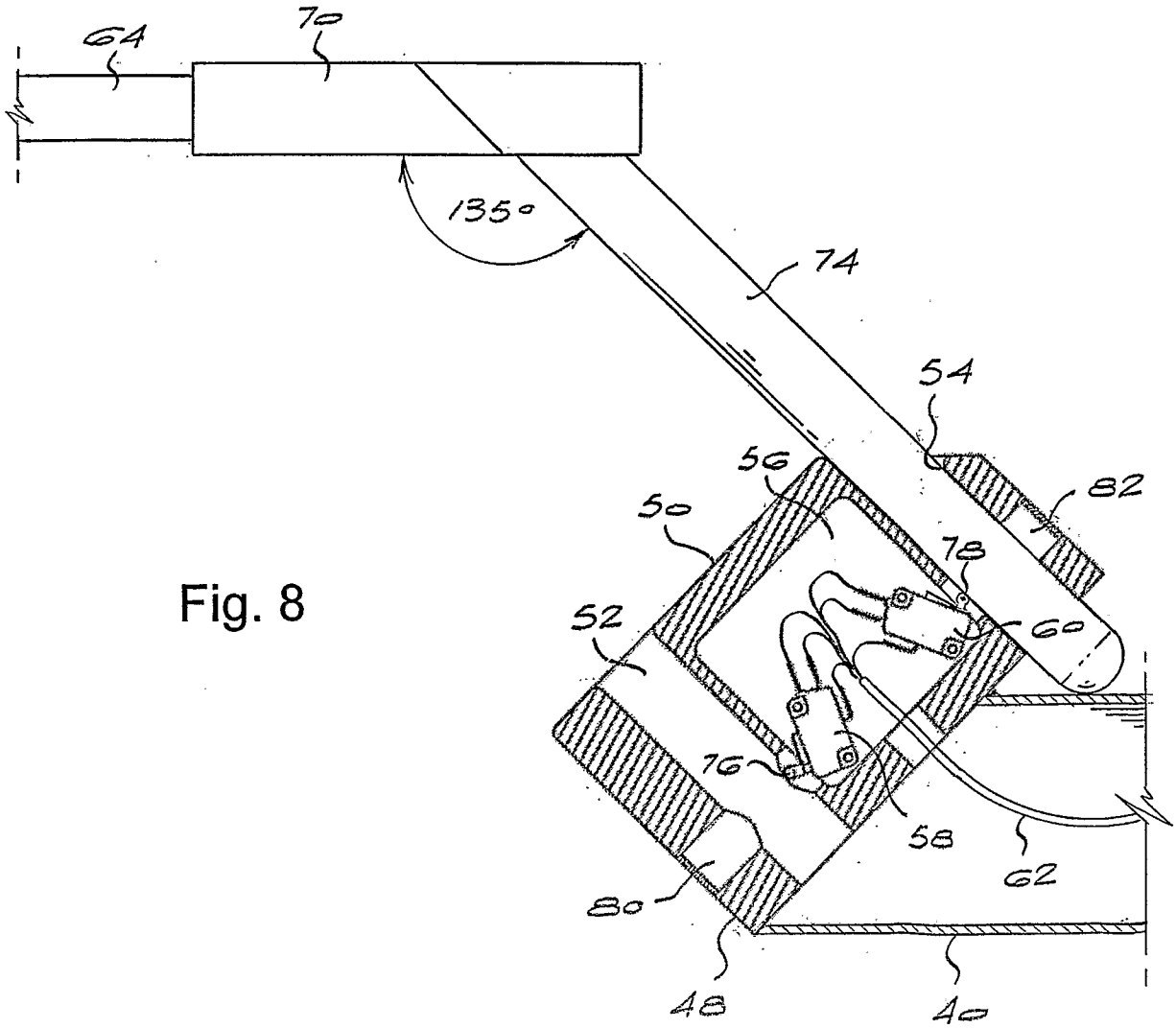

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Fig. 8


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