

(21) Application No 8027025

(22) Date of filing
19 Aug 1980

(30) Priority data

(31) 67605

(32) 20 Aug 1979

(33) United States of America
(US)

(43) Application published
18 Mar 1981

(51) INT CL³ A61B 6/00

(52) Domestic classification
H5R 11 12 7 8B

(56) Documents cited
GB 1169475

(58) Field of search
H5R

(71) Applicant
John Kevin Grady
South Great Road
Lincoln
Massachusetts
USA 01773

(72) Inventor
John Kevin Grady

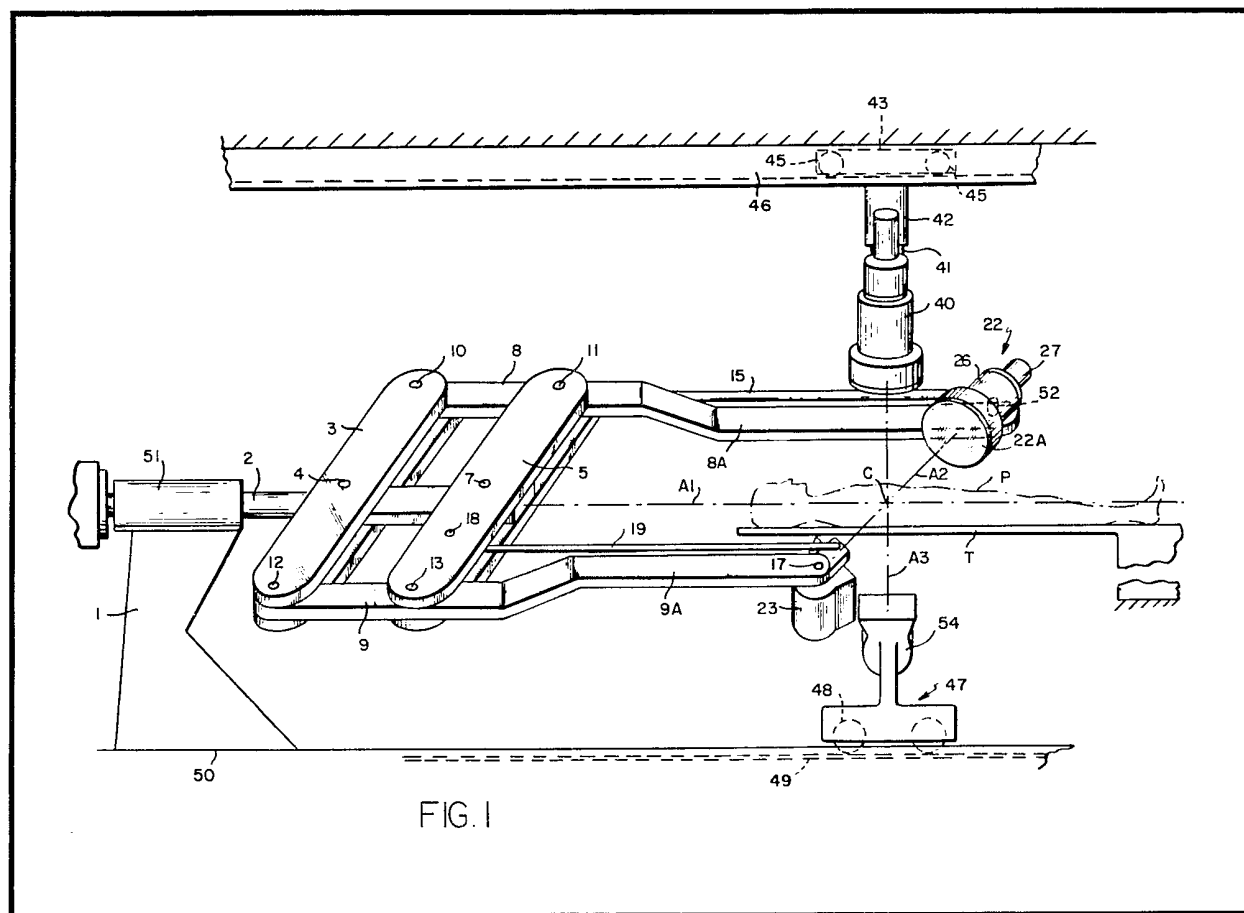
(74) Agents

Brookes & Martin
High Holborn House
52/54 High Holborn
London WC1V 6SE

(54) Radiological examination system

(57) A radiological examination system employs two X-ray tubes (23, 54) which have associated receptors in the form of image intensifiers (22, 40). The tubes (23, 54) emit radiation to their receptors (22, 40) along radiation axes (A3, A2) which coincide at an isocenter. One of the tubes (54) and its receptors (40) are relatively reciprocable and the other of the tubes (23) is movable with its receptor (22) along points which trace the loci of a sphere and about a rotational axis (A1). The first-mentioned tube and

its receptor (54, 40) move along tracks aligned parallel to the rotational axis (A1). During use, a patient (P) being examined is disposed upon a table located in a fixed plane defining the rotational axis (A1) and through the use of the system, oblique biplanar examination is possible without moving the patient.



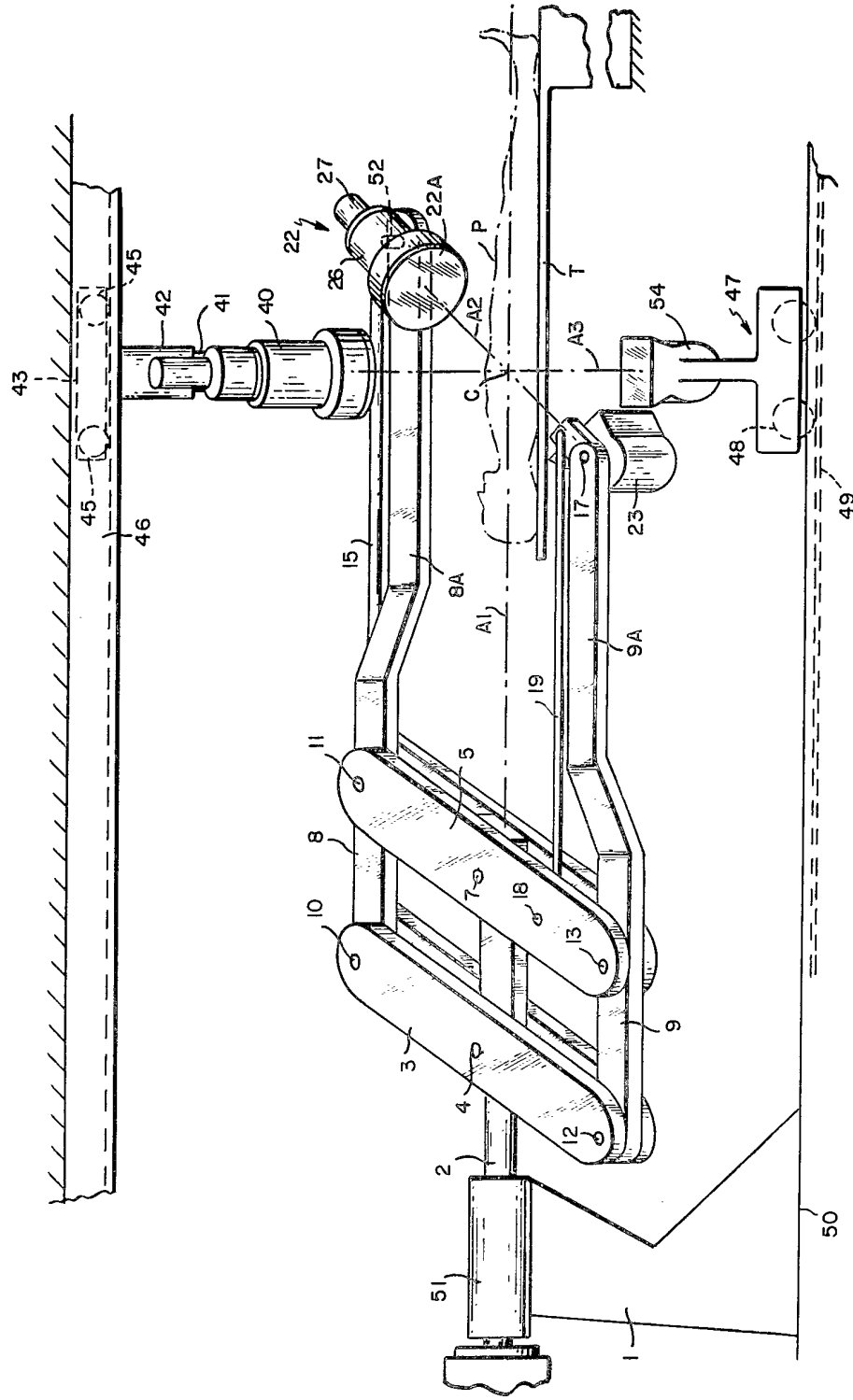


FIG. 1

SPECIFICATION

Radiological examination system

5 The present invention relates in general to radiological examination systems and more particularly to such a system which can radiologically examine a patient or other subject with penetrating radiation from an X-ray tube or some other radioactive source through two planes without moving the patient.

10 In certain radiological examination systems it has become desirable to examine two planes of the subject and preferably to examine these planes simultaneously. In patients with coronary artery disease, for instance, oblique views of the right and left anterior ventricle are considered optimal for assessment of regional wall motion. With most of the equipment presently used, the patient is strapped to a cradle and a radiological examination on one plane is made and then the patient is tilted on the cradle to provide for examination in the second plane. Such examinations have not always been desirable because the procedure of tilting the patient to take biplanar views can be traumatic.

25 Certain radiological equipment now in use allows the subject to remain fixed while the radiation beam is inclined through different angular paths about the subject. Generally an X-ray source tube is mounted on a framework which moves the tube through various angular positions with respect to the plane of a film holder and is parallel to a fixed plane. Such equipment is suitable for tomography in which a single film is exposed continuously from various angles. The variation in the X-ray beam incidence on the fixed plane of the film produces the variation of the distance from the X-ray source to different parts of the film other than the plane being X-rayed, thereby causing portions of the subject outside the selected plane through the subject parallel to the film to be distorted by different magnifications and radiation intensities.

30 In U.S. specification 3,892,967 equipment is described which permits scanning of a subject with penetrating radiation from various angles throughout a solid angle while maintaining the alignment of the source of radiation and the radiation receptor on a radiation axis which is common to their respective axes. Such scanning also maintains the radiation source and the receptor at a constant distance from the subject. While the equipment described in the above-mentioned patent specification is most efficient for examining a subject on a single plane and around the long axis, it has been found that two views can be provided if a second radiation source and receptor (aligned on a common axis) are focused upon the isocenter.

65 In accordance with the present invention, a radiological system for biplanar examination of

a subject or patient comprises a radiological examining apparatus or device that includes a radiation source and a radiation receptor that focus upon a common axis. The radiological examining device is rotatable about a central axis and the common radiation axis passes through the central axis at an isocenter. The system also includes a second radiological examining device or apparatus including a radiation source and a radiation receptor that focus upon a second common axis. The second common radiation axis, which at least is alignable to pass through the isocenter, extends at an angle, preferably a substantial angle, to the first common axis. Preferably, means is provided to align both the first and second common radiation axes at said isocenter.

70 A system in accordance with the present invention can be constructed so that the second radiation source can be moved along the common axis to provide enlarged views and further can be easily removed from alignment with the isocenter to provide easy access to the patient during treatment. With such a system biplanar examination can be conducted without moving the patient or the examining table upon which he is placed.

85 In the preferred embodiment, the radiological examining apparatus is movable on upper and lower slides that are disposed parallel to each other on the floor and ceiling respectively of an examining room. These units of the apparatus are movable along lines parallel to the central axis around which the radiological examining device can rotate, so that the second common axis can be moved into coincidence with the isocenter. Quite advantageously, the radiation source of the radiological examining apparatus is disposed on a common radiation axis with the radiation receptor, and can be reciprocated on this axis to take views of different magnifications while maintaining a focus in one place on the subject being examined. The units which form the radiological examining device are movable in loci defining a spheroidal shape around the isocenter being examined, thereby providing many possible different views of the isocenter.

115 The invention may be understood more readily, and various other features of the invention may become apparent, from consideration of the following description.

120 An embodiment of the invention will now be described, by way of example only, with reference to the accompanying drawings, wherein:—
Figure 1 is a side elevational view of the radiological examining system constructed in accordance with the present invention and illustrating the positioning of a patient relative to the radiological examining device that has been disposed approximately 30° from the horizontal and at approximately right angles to the common axis of the radiological examining

apparatus. Both portions of the system are focusing upon an isocenter located on a long axis of the patient: and

Figure 2 is an end view of the system

5 shown in Fig. 1.

In the drawings, similar numerical designations connote similar elements. Referring to the drawings, a patient P is disposed in a fixed position on a radiation-transparent table T. The patient P is shown with his heart located at an isocenter C which is the intersection of an axis of rotation A1 of the radiological examining device and a common radiation axis A2 between an X-ray tube 23 and a radiation image intensifier 22 and a common radiation axis A3 between an X-ray tube 54 and a radiation image intensifier 40. When filming the ventricle of the heart located at isocenter C, the axis A3 can be perpendicular to axis A2 which, in turn, can be perpendicular to axis A1. When providing cardiac angiography, the heart can be examined by tilting the X-ray tube 23 through 360° of angle around central axis A1 of the system which is aligned with the long axis of the patient. The common axis A2 can also be rotated 90° about a secondary axis perpendicular to the central axis A2 about the isocenter C, that is a solid angle defined from the head to the foot. Simultaneously, the radiological apparatus 40, 41 is focused upon the isocenter C thereby allowing oblique biplane filming of the same point.

The system for providing these types of X-rays comprises a heavy base 1 anchored to the floor 50 of the examining room, the base 1 having a central rotor shaft 2 journaled in rotor bearing 51. A first transverse member 3 extending at a right angle to the rotor shaft 2 is pivotally attached to the rotor shaft at 4. A second transverse member 5 parallel to the first transverse member 3 is pivotally supported at the distal end of the rotor shaft 2 at 7. Upper and lower support arms 8 and 9 are pivotally connected by bearing pins 10, 11, 12 and 13 to form an angularly adjustable parallelogram (3, 5, 8, 9) whose sides are of a fixed length between the pivotal connections, that is the distance between pin 10 and 12 is the same as the distance between pins 11 and 13 and the distance between pins 10 and 11 is the same as the distance between 12 and 13. Upper and lower support arms 8 and 9 have extensions 8A and 9A from the parallelogram for a distance sufficient to allow the table T and the patient P to be located close to the transverse member 5. At the distal ends of the extensions 8A and 9A are two pivots 52 and 17 for the image intensifier 22 and the X-ray tube 23. The pivot points 12, 13 and 17 are in a straight line parallel to the central axis A1 and spaced the same distance from the central axis as a line through pivot points 10, 11 and 52. One end of a first link 15 is pivotally attached to the

second transverse member 5 and the other end is pivotally attached to the image intensifier 22 at 53. Similarly one end of a second link 19 is pivotally attached to a pivot point 18 in a second transverse member 5 and pivot point 20 of X-ray tube 23. The distances between points 17 and 20 and points 52 and 53 are equal, as are the distances between points 18 and 13 and point 11 and the unshown point attaching link 15 to second transverse member 5. In this way movement of a first transverse member 3 around point 4 will cause X-ray tube 23 and image intensifier 22 to move simultaneously in equal angles respectively around points 17 and 52. Simultaneously, equal angular movement of X-ray tube 23 and image intensifier 22 maintains these two units on a common axis, as the equipment is angulated over the long axis A1 of the patient around the isocenter C.

The image intensifier 22 includes a fluorescent imaging plate 22A which stimulates image intensifier stages to produce an optical image of required brightness. The intensified image enters a beam splitting image distributor 26 of known design and transmits the image to an image recorder 27, such as a television camera. The camera 27, the image distributor 26 and the intensifier 22A are on a common axis which is coincident with the radiation axis A2.

It has been found that for certain angiographic examinations the X-ray tube 23 and the image intensifier 22 can be moved through loci which can define a spheroidal shape around the isocenter C while simultaneously focusing upon the same isocenter from a different angle. Such examinations are particularly valuable in estimating the ventricular volumes. This oblique biplanar examination is provided, without moving the patient, by including a radiological examining apparatus in the radiological examining system. The apparatus includes an X-ray tube 54 and an image intensifier 40. The image intensifier and X-ray tube are constructed in a manner similar to equipment used in the radiological examining device described previously.

The radiological intensifier 40 is affixed to a support piston 41 that is slidably held by a cylinder 42. The support piston 41 is positioned perpendicular to the central axis A1 and can be raised or lowered through counter weights (not shown) so as to place the intensifier 40 on the common axis A3 with X-ray 54. X-ray intensifier 40 is also slidably retained on support piston 41 so that it can be reciprocated along common axis A3 to vary the focus (as shown in position 40*) and provide enlargements of the area of the organ being X-rayed. The cylinder 42 is attached to a carrier 43 that has wheels 45 mounted within channels 46, each of which is preferably disposed parallel to central axis 46. X-ray tube 54 is

tion receptor having a second common radiation axis disposed at an angle to the first common radiation axis, and means for aligning at least the second common radiation
5 axis with the isocenter..

13. A radiological examination system substantially as described with reference to, and as illustrated in, the accompanying drawings.

Printed for Her Majesty's Stationery Office
by Burgess & Son (Abingdon) Ltd —1981
Published at The Patent Office, 25 Southampton Buildings,
London WC2A 1AY, from which copies may be obtained.

disposed upon a table and stand 47 that is supported by wheels 48 which travel in tracks 49, each of which is parallel to the central axis A1. In use, the units of the radiological examining apparatus are moved on the two sets of tracks 46 and 49 so that the common axis A3 falls into alignment with the isocenter C. Preferably, stops are disposed on the tracks 46 and 49 so that the apparatus can be easily wheeled by the transverse members 3 and 5 to enable the technicians to work upon the patient.

In operation a patient is positioned on the table which is movable in horizontal and vertical planes. Such movement is provided by adjusting the elevation of the table or shifting it from side to side. In this way, the organ to be examined, for example the heart, is located at the isocenter of the system. To conduct the radiological examination of the heart, 50 cc of a radiopaque liquid is injected into a peripheral artery by way of a catheter. The X-ray system is then activated and films or videotape recordings are made of the dynamics of the heart motion. The records are then used for determination of the ventricular volume and valve action. Through the use of the present system, two views of the organ can be made with one injection of radiopaque liquid and the patient need not be tilted on the table to obtain the two views.

It is apparent that modifications and changes can be made to the embodiment of the present invention as described. For example, while a radiological device with a parallelogram construction that can move in loci defining a spheroidal shape around the isocenter has been described, a device can be adopted wherein the arms are fixedly attached to a vertical member or around the centerline and the source and receptor are rotatable in the vertical plane.

CLAIMS

1. A radiological system for biplanar examination of a subject comprising a radiological examining device including a first radiation source having an axis and a first radiation receptor having an axis, said first radiological examining device being rotatable around a central axis, the axis of said first radiation source being aligned with the axis of said first radiation receptor on a first common radiation axis, said first common radiation axis passing through said central axis at an isocenter; a radiological examining apparatus including a second radiation source having an axis and a second radiation source receptor having an axis, the axis of said second radiation source being aligned with the axis of said second radiation receptor on a second common radiation axis, said first common radiation axis being disposed at a substantial angle to said second common radiation axis; means to align said first common radiation axis and said

second common radiation axis at said isocenter.

2. A radiological examination system according to claim 1, wherein said radiological examining apparatus is movable away from said isocenter.

3. A radiological examination system according to claim 2, wherein said radiological examining apparatus is movable along lines that are parallel to the central axis.

4. A logical examination system according to claim 2, wherein the second radiation source and the second radiation receptor of said radiological examining apparatus are movable on upper and lower tracks disposed parallel to each other and parallel to said central axis, said upper track being disposed above said lower axis and said lower track being disposed below said central axis.

5. A radiological examination system according to claim 4, wherein said upper track is disposed on a ceiling of a room and said lower track is disposed on the floor of the room.

6. A radiological examination system according to claim 4 or 5, wherein stops are disposed on said upper and lower tracks, so that the axis of the second radiation source will align into coincidence with the axis of the second radiation receptor and perpendicular to said central axis.

7. A radiological examination system according to any one of claims 1 to 6, wherein said first common radiation axis is perpendicular to said second common radiation axis.

8. A radiological examination system according to any one of claims 1 to 7, wherein the length of said second common axis can be changed to modify the distance between the source and the receptor.

9. A radiological examination system according to any one of claims 1 to 8, wherein said second radiation receptor is reciprocal on the second common radiation axis.

10. A radiological examination system according to any one of claims 1 to 9, wherein said first radiation source and said first radiation receptor are movable in loci defining a spheroidal shape around said isocenter.

11. A radiological examination apparatus according to claim 1, wherein the second common radiation axis is fixed in a line through said isocenter and the first common radiation axis is disposable perpendicular to said second common radiation axis.

12. A radiological system for biplanar examination of a subject comprising a first radiological examining device including a first radiation source and a first radiation receptor having a first common radiation axis, the first radiological examining device being rotatable about a central axis passing through the first common radiation axis at an isocenter; a second radiological examining device including a