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(54) GANTRY FOR COMPUTED TOMOGRAPHY

(71) We, GENERAL ELECTRIC COMPANY, a corporation organized and existing under the laws of the State of New York, United States of America, of 1 River Road, Schenectady 12305, State of New York, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to apparatus for performing computed tomography.

In one method of computed tomography, a patient is supported for being translated along a longitudinal axis which is usually horizontally disposed. The axis coincides with the center of rotation of a rotatable base which has an x-ray source on one side of the center of rotation and a multiple array of x-ray detectors on the other side. A fan-shaped x-ray beam, that is thin in the longitudinal direction, is projected through the patient as the base rotates so that the detectors may develop signals indicative of x-ray transmission characteristics along a plurality of paths through a subject undergoing examination. Analog signals representative of x-ray attenuation by all of the volume elements in a layer of the body at various rotational angles are then converted to digital signals which are used by a computer to produce signals which may be used for controlling a cathode ray tube to display a reconstructed image of the layer. Further background information on computed tomography is obtainable in an article entitled "Image Reconstruction From Projections" by Gordon et al; Scientific American, October 1975, Vol. 233, No. 4. A prior gantry appears in U.S. Pat. No.

3,922,522.

Another prior method of performing computed tomography involves jointly translating an x-ray source on one side of the body and a detector on the other side of the body across a body layer repeatedly and rotating the source and detector through a small angle for each translation.

In both of the foregoing examples, the x-ray beam is projected through a thin layer of the body so that the reconstructed layer is essentially perpendicular to the longitudinal axis along which the patient is translated to obtain views of successive layers. On some occasions, however, unique diagnostic information can only be obtained by viewing a slice or layer through the body which is tilted through a small vertical angle and is not perpendicular to the horizontal or longitudinal axis along which the patient is translated.

The present invention provides a tilting gantry for tomography comprising: frame means including a pair of generally L-shaped members spaced apart from each other in the transverse direction, each of said members comprising an upstanding leg portion and an angularly related base portion, each of said base portions having a lower edge which is curved convexly downwardly, a downwardly convex curved track fastened to each of said base portions, the radii of curvature of each of said tracks passing through a virtual transversely extending axis which is above said tracks, a stand fixed adjacent each of said tracks, first and second sets of rollers supported on respective stands for rotation and said tracks being supported on said sets of rollers, respectively, for translating thereon along a curved path about said virtual transverse axis, support means spann-

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ing between and connected with said up-  
standing portions of said L-shaped members,  
pulley means journaled in said support  
means and rotatable about a longitudinally  
5 directed axis which intersets and is perpendi-  
cular to said virtual transverse axis, said  
pulley means being open within its circum-  
ference for permitting an examination sub-  
ject to be translated along said longitudinal  
10 axis, a rotatable base fastened to said pulley  
means for rotation therewith, radiation  
source and radiation detector means  
mounted to said rotatable base on opposite  
sides of said longitudinal axis for orbiting  
15 about said axis when said base is rotated,  
means for driving said pulley means rota-  
tionally, and means for moving said tracks  
on said rollers to effect tilting of said L-  
shaped members.

20 The terms x-ray and x-ray source are used  
herein for the sake of brevity and conveni-  
ence but these terms should be construed  
as embracing gamma radiation and gamma  
sources and other penetrating radiation and  
25 sources as well. The apparatus just outlined  
is called a computed tomography gantry.

The gantry is tiltable to enable taking  
angular slices or views of body layers in  
connection with a computed tomography  
30 procedure.

As with all x-ray apparatus, the gantry  
described herein for use with computed x-ray  
tomography is expected to require mainte-  
nance of the x-ray tube and the detector  
35 which might require that these heavy objects  
be removed from the rotating base. Usually  
there is no hoist available in the x-ray room  
in which the apparatus is installed for sup-  
porting the component when it is being  
40 loosened nor for handling it until it can be  
placed on a cart nor in a joist available for  
handling the components mentioned or oth-  
ers during reinstallation.

A brake may be provided comprising a  
45 block which is mounted on a shaft for  
eccentric rotation thereon. The shaft pro-  
vides another eccentric within the eccentric  
and it is mounted for rotation on the stand.  
Rotation of the shaft sets the size of the gap  
50 between a friction block and the track so  
movement of the block is minimal to effect  
braking. The shaft is locked against rotation  
when the gap is set. The block normally  
presses against the track under the influences  
55 of a spring. The brake block is released with  
a solenoid which overcomes the spring force  
such that if electric power to the solenoid  
should fail the brake will be applied auto-  
matically.

60 In order that the invention may be clearly  
understood, a preferred embodiment thereof  
will now be described by way of example  
only with reference to the accompanying  
drawings, in which:—

65 FIGURE 1 is a perspective view of a

computed tomography gantry, with its deco-  
rative shrouds removed, and an associated  
patient supporting table;

FIGURE 2 is an exploded view of the  
gantry in the preceding figure; 70

FIGURE 3 is a front elevation of the  
gantry in FIGURE 2 wherein the rotatable  
base is assembled to the rocking frame and  
showing the frame for supporting the deco-  
75 rative shrouds and a hoist jib adjacent the  
mechanism;

FIGURE 4 is a right side elevation of the  
apparatus shown in FIGURE 3 with some  
parts being shown fragmentarily;

FIGURE 5 is a side elevation of a brake 80  
cooperating with a rocking member;

FIGURE 6 is a side elevation of the  
rotatable base with parts broken away and  
other parts shown in sections to illustrate the  
bearing with which the rotatable base is 85  
journaled to the rocking frame;

FIGURE 7 is an enlargement of a frag-  
ment of the bearing structure with some parts  
being shown in sections;

FIGURE 8 is a side view, with parts 90  
broken away, of the lower portion of the  
rocking base;

FIGURE 9 is a front view of the floor  
support and drive mechanism for the rocking  
base, with parts omitted for the sake of 95  
facilitating description;

FIGURE 10 is a rear view of the gantry  
with some parts omitted;

FIGURE 11 is a side view of the gantry  
similar to FIGURE 4 but with some parts 100  
omitted; and

FIGURE 12 is a section of the brake taken  
along a line corresponding with 12—12 in  
FIGURE 5.

The general features of apparatus for 105  
obtaining x-ray attenuation data for com-  
puted tomography will be outlined in refer-  
ence to FIGURES 1 and 2. In FIGURE 1, a  
table for supporting a patient undergoing  
tomographic examination is generally desig- 110  
nated by the reference numeral 10. The table  
has a top 11 on which a patient may be  
supported in a recumbent position with the  
head at the end marked 12 and the feet at the  
end marked 13. Top 11 is translatable 115  
lengthwise which, in this discussion, is called  
the longitudinal direction. Top 11 is adapted  
for being translated longitudinally so that it  
extends in cantilever fashion from table 10  
for the purpose of disposing successive longi- 120  
tudinally adjacent layers of a patient's body  
in the path of a scanning x-ray beam. The  
mechanism for advancing and retracting the  
patient longitudinally is within the housing  
of table 10 and is not shown in detail since it 125  
forms no part of the present invention.

Table top 11, when fully extended, obtains  
additional support from a rear table 14 so  
that substantially the entire length of a  
patient may be disposed in the scanning 130

beam if desired.

X-ray scanning and obtaining x-ray attenuation data on a multiple of small volume elements in the body is carried out with components of a gantry which is generally designated by the reference numeral 15.

The principle elements of the gantry may be seen clearly in the FIGURE 2 exploded view. The gantry comprises a floor base plate 20 with a pair of substantially identical upstanding plates 21 and 22 mounted at opposite ends. Plates 21 and 22 are equipped with rollers which will be described in detail later. The rollers support a tiltable frame comprising curved rocker tracks or segments 23 and 24. Tracks 23 and 24 are fastened to L-shaped members which are part of the tilting frame. One of the members is substantially completely visible in FIGURE 2 and is seen to be a unitary member comprised of a generally horizontally extending base portion 25 and an upstanding leg portion 26. Typically, leg portion 26 is an edgewise disposed plate which has a laterally extending flat plate 27 fastened to it. Plate 27 and its counterpart on the other upstanding leg 28 are both fastened to a circular bearing or mounting plate 29 of the rocking frame. Thus, it will be evident that circular mounting plate 29, which is part of the tilting frame, may be rocked on rockers 23 and 24 to dispose the plane of plate 29 vertically if desired or at angles on opposite sides of vertical. The frame does not rock in the manner in which the rockers of a chair would rock on a flat floor. In such case the centre of curvature of the rockers translates. In the present design, the curved rocker tracks, cooperating with the rollers, results in the rocker tracks translating along a curved path having radii extending back to a virtual axis of rotation which does not translate even though the frame supported on the rockers tilts.

Plate 29 of the tiltable frame is provided with a large ring bearing structure 30 to which rotatable base 31 is mounted. The center of rotation of rotatable base 31 and bearing structure 30 is marked 32 and the axis of rotation, herein called the longitudinal axis, is shown as a dashed line and is marked 33. Axis 33 is also commonly called the azimuth axis. A transverse horizontal line 32' extending through point 32 constitutes a virtual axis about which support plate 29 and bearing 30 which it carries tilt through opposite vertical angles on rockers 23 and 24. In a commercial embodiment, the plane of circular plate 29 is adapted to be tilted rearwardly or cranially and forwardly or caudally about said transverse virtual axis through angles of minus and plus 15 degrees relative to vertical. This means that longitudinal axis 33 may be tilted upwardly or downwardly through a corresponding acute

angle.

Rotating base 31 is mounted to bearing structure 30 for rotation thereon about longitudinal axis 33. In general terms, rotating base 31 has a frame comprised of side members 35 and 36, a top cross member 37 and a bottom cross member 38. An x-ray tube casing 39 is mounted to cross member 37 by means of a bracket assembly 40 which permits lateral and longitudinal position adjustment of the x-ray tube casing for causing the central ray of the x-ray beam emanating from the x-ray source to pass through the longitudinal rotational axis 33.

Mounted to the output side of x-ray source 39 is a collimator device 41 which, in this particular design, collimates the x-ray beam into a thin fan-shaped beam which originates from a substantially point source on the target of an x-ray tube in casing 39. In a commercial embodiment, by way of example, the longitudinal thickness of the x-ray beam is about 1cm and a slice or layer of corresponding thickness in the body is penetrated by the beam for each scan.

An x-ray detector and data acquisition assembly 42 is mounted to rotatable base 31. This assembly comprises a plate 43 whose corners are fastened to plates 44 and 45 which extend from the base. The detector portion has a curved x-ray input window 46 behind which there is an array of adjacent detector cells, not visible, which each produce output signals corresponding with the intensity of the plurality of rays that radiate from the x-ray source and penetrate contiguous series of volume elements in a body layer that is disposed along longitudinal axis 33 during x-ray examination of a body. The discrete plurality of analog signals, representative of x-ray attenuation by small volume elements in the body, are processed in a data acquisition system within an enclosure 47 after which the analog signals are converted to digital signals which are used by a computer, not shown, to execute the image reconstruction algorithm. A suitable detector is shown in our copending U.K. patent application No. 36624/77 (Serial No. 1588538).

In further reference to FIGURE 2, rotatable base 31 has four forwardly extending posts or spacers 48—51 to which a pair of flat bars 52 and 53 are mounted. A disc 54 having a central hole surrounded by a cylindrical tube 55 is carried by bars 52 and 53 and serves as the rear wall of a cylindrical chamber 55, see FIGURE 1, in which electric cables are wrapped that are used to make electrical connections with the x-ray tube 30 and data acquisition system 42.

The manner in which the rotatable base 31 is journaled for rotation on circular support plate 29 of the tilting frame will now be discussed in reference to FIGURES 6 and 7 130

primarily. Note in FIGURE 6 that the frame of base 31 comprised of side members 35 and 36 and top and bottom members 37 and 38 is fastened to an apertured plate 60 which is also visible on rotatable base 31 in FIGURES 2 and 7. The frame comprised of members 35—38 supports x-ray tube casing 37, collimator 41 and the detector and data acquisition system assembly 42. In FIGURE 7 it is evident that plate 60, to which the frame members 35—39 are fastened, is also fastened to the rim 61 of a pulley 62 which has external teeth 63 for being engaged by an internally toothed closed loop drive belt 64. In FIGURE 7, the mounting ring 29 which, as may be seen in FIGURES 1 and 2, is supported from the upright legs 26 and 28 of the curved tracks or rockers, has a counterbore into which the outer race 65 of a ball bearing 66 is pressed. The inner race 67 of the ball bearing is pressed into a counterbore in the rim of pulley 62. Plate 60 of the rotatable base is fastened to the rim of pulley 62 with circumferentially spaced machine screws such as the one marked 68 and there is an intervening ring 69 between plate 60 and the pulley rim which retains the inner race 67 of the bearing in the rim. Another ring 70 is fastened to support ring 29 with circumferentially arranged machine screws such as the one marked 71 which clamp the outer race 65 of the bearing to ring 29. There is a gap 72 between retaining rings 69 and 70. Hence, plate 60 and pulley 62 are essentially unitary and rotatable in circular plate 29 which is supported for rocking as was mentioned earlier. Thus, the x-ray tube casing 39 and data acquisition system 47 being mounted on plate 60 will orbit an examination body disposed along axis 33 when pulley 62 is driven rotationally. Note that pulley 62 is provided with a beveled ring flange 73 which is secured to the rim of the pulley 62 with machine screws 74. Flange 73 serves to prevent the belt 64 from sliding axially off of pulley 62.

Note also in FIGURE 7 that a bearing 66 is used which has v-shaped grooves 75 in the inner and outer races 65 and 67. This type of bearing is especially efficient in maintaining alignment between the inner and outer races when the bearing is subjected to a cantilever load as is the case here where heavy components such as the x-ray tube casing 37, data acquisition system 47 and the supporting frame comprised of members 35—38 are mounted to ring 60 which is, in turn, carried exclusively on the inner race 67 of the bearing.

Note in FIGURE 6 that a spring biased detent 76 is provided for selectively interlocking pulley 62 with circular support plate 29. A locking device 77 is also associated with the detent for holding it out of engagement with circular plate 29. The detent is

normally disengaged so that the pulley may be driven by belt 64 but the detent may be engaged when it is desired to interlock the pulley and circular plate 29 such as during shipping the machine, or when the belt 64 is removed, or when normal balancing of the rotatable base would be upset by removal of one of the parts that is supported on the base.

Referring to FIGURE 6, the rotatable base 31 which carries the x-ray tube casing 39 and data acquisition assembly 47 is rotated in circular plate 29 with belt 64. The belt is driven with a pulley 78 which is fastened to the shaft of a speed reducer 79. The motor 80 for driving the speed reducer has been omitted from FIGURE 6 but its shaft 81 is shown in that figure. The drive assembly is visible in FIGURE 10 which is a rear view of the gantry. In this view it may be seen that motor 80 and speed reducer 79 are mounted on a vertically disposed base plate 82. Base 82 is supported at one end in a cantilever fashion with some vertically yieldable support members 83 which are shown schematically and are mounted to the upstanding leg portion 26 of one of the rocking supports. Base 82 has a pair of idler pulleys 84 and 85 mounted for rotation on it. These pulleys serve to maintain belt 64 in contact with most of the periphery of pulley 62. Base plate 82 is urged to rotate counterclockwise about its end support 83 under the influence of some springs 86 which are shown schematically. The tendency for the base plate to swing down results in the tension on the belt 64 being maintained and the arrangement also introduces some resiliency into the drive so the vibration will not be felt when it is started and stopped suddenly. The mounting is such that if the belt 64 should break, base 82 will remain supported in cantilever fashion.

Motor 80 is reversible. It is controlled to drive rotatable frame 31 and the x-ray tube and detector which it carries from 0° to 360° and from 360° back to 0°.

A more detailed discussion of how the gantry is adapted for enabling the x-ray scanner to be rocked cranially and caudally to enable obtaining a view of a slice of the body which is at a small vertical angle relative to horizontal will now be discussed in greater detail in reference to FIGURES 2, 3, 4 and 8—11.

As stated earlier, circular plate 29 is part of a tiltable frame in which the bearing for rotating base 31 is mounted. The frame is comprised of a pair of members which are designated generally by the reference numerals 26 and 28. One of the members, 28, will be described in detail. Refer to FIGURE 4. Member 28 is generally L-shaped and has an upstanding leg portion 90 to which a flange 91 is welded. Flange 91 is used for fastening the upstanding leg of member 28 to circular plate 29 such as with machine bolts 92 and

93. The member has a substantially horizontally extending base portion 94 which has a straight top edge 95 and a curved bottom edge 96. The curved rocker segment or track 24 is bolted to the side of base 94. As can be seen in FIGURE 9, in particular, track 24 has a v-shaped lower edge. This v-shaped edge runs in a pair of rollers 98 and 99 which each have a v-groove in their periphery. Rollers 98 and 99 are journaled on stud shafts such as 100 which are held by means of nuts to upstanding plate 22 which is supported from base 20. As can be seen in FIGURE 8, there are some cylindrical blocks 101 and 102 fastened to the inside of upstanding plate 22 and these blocks almost touch the curved upper edge 103 of rocker segment 87. Their primary purpose is to assume that track 24 cannot pull out of grooved rollers 98 and 99 under any circumstances. Upstanding plate 22 has a web 104 welded to it and to base plate 20 to stiffen plate 22 and assure that it does not tend to flex outwardly. The upstanding plate 21 on the opposite side is similarly stiffened with a web 105, see FIGURE 3. Plate 22 must be very rigid since any flexure would result in the center of rotation 32 of the rotatable frame 31 shifting which would be detrimental to getting reproducible x-ray attenuation data incidental to having the x-ray tube and detector orbit around a patient who is coincident with axis 32.

Since plate 22 is rigid and since the track 24 cannot shift laterally because of its v-shaped lower edge running in a v-groove of rollers 98 and 99, a vertical plane through the v-grooves constitutes a reference plane for all lateral adjustments which must be made to establish axis 32 at a fixed point relative to the patient support table. The curvature of track 24 is such that the center from which it is generated is on a transversely extending line which intersects longitudinal axis 32. Thus, the transverse axis is essentially a virtual axis for a curve along which the rocker translates. The point of intersection of the virtual transverse axis of the tracks and the longitudinal axis 32 remains fixed in space even though the mechanism is tilted on the tracks.

Each of the rockers 26 and 28 is driven. As can be seen particularly well in FIGURE 8, the drive mechanism on the side of the tilting frame having rocker 28 comprises a chain 106 which is fastened at its opposite ends 107 and 108 to the curved bottom edge 96 of the rocker base 94. The chain is engaged by a drive sprocket 109 on a shaft 110. A plate 111 is journaled on shaft 110. This plate carries an idler sprocket 112 and there is another idler sprocket 113 carried by a bracket 115. Idler sprockets 112 and 113 maintain chain 103 in contact with almost all of the length of the curved lower edge 96 of rocker portion

94. Plate 111 is adjustable angularly with a turnbuckle assembly 114 which enables the chain 106 to be tensioned by swinging sprocket 112 in one direction or the other as required. Bracket 115 is also adjustable with a jack screw 116.

Fastened to the opposite ends of curved rocker track 24 are a pair of stops 118 and 119 which strike cylindrical blocks 101 and 102 to prevent the rocker tracks from going too far in either direction. As indicated earlier, in this example, the amount of forward or rearward tilt from vertical is about 15° but more or less tilt may be desired in some cases. In reality, the plane of the fan-shaped x-ray beam tilts to a vertical angle corresponding with that of the rocker frame measured from a vertical plane extending through the virtual axis of tilting and the plane of a slice in the body from which x-ray attenuation data is being taken.

The opposite support leg 26 also has a curved track 23 fastened to its side. This track may be seen in section in FIGURE 10 and it is also apparent in the left bottom region of FIGURE 3. This track runs on a pair of flat periphery rollers such as the one marked 121 in FIGURE 10. Since the curved bottom edge of curved track 23 is flat as compared with the bottom edge of rocker 24 on the other side which is v-shaped, rocker 23 may shift axially on rollers 121 so that there need be no concern about alignment of this track and its rollers since, as was explained earlier, the reference line for rotational center 32 is the vertical plane which is coincident with the tip of the v-shaped rocker edge. The lower curved edge of L-shaped leg 26 of the tilting frame also has a chain, similar to chain 106, for tilting it. The sprockets 122 and 123 for driving this chain are visible in FIGURE 9 where the drive motor 124 is also depicted. The drive motor shaft is connected to a drive shaft 125 with a coupling 126. This coupling is made in sections 127 and 128 which are relatively rotatable to permit phasing of each of the chain drives so that tilting occurs without distortion of the frame. Drive shaft 125 is supported in pillow blocks 129 and 130 as can be seen particularly well in FIGURE 10.

The leg assemblies 26 and 28 constituting parts of the tilting frame, as can be seen in FIGURE 3, are tied together with a cross brace 131 which also connects through a bracket 132 to ring 29. There is another cross member 133 for further stiffening the assembly.

In the illustrated preferred embodiment, the curved tracks 23 and 24 are on the tilting frame and the rollers supporting them are on the stationary stands 21 and 22. However, those skilled in the art will appreciate that the rollers could be on the tilting frame and the tracks could be on the stands 21 and 22.

Either way the tilting motion of the frame would occur along a curved path about a virtual transverse axis.

5 The tilting frame is provided with unique  
brakes one of which is generally designated  
by the reference numeral 136 and which will  
now be described primarily in reference to  
FIGURES 4, 5 and 12. In FIGURE 5, it is  
10 evident that the brake comprises a rectangular  
metal block which serves as a brake shoe  
137. The shoe has a lower curved face 138  
which is adapted to frictionally engage the  
upper curved surface of track 24. The brake  
15 is actuated with a lever 139. A solenoid  
operator 140 is used to disengage the brake.  
A rod 141 extends from the armature of the  
solenoid and terminates in a clevis 142 which  
pivotaly connects with lever 139 by means of  
20 a pin 143. When solenoid 140 is energized,  
lever 139 is urged to the angular position in  
which it is shown such that friction surface  
138 of brake shoe 137 is in spaced relationship  
with track 24 so no braking action occurs.  
25 When solenoid 140 is deenergized, lever 139  
is urged clockwise through a small angle by  
a coil spring 144 which has one of its ends  
connected to lever 139 and the other of its  
ends attached to a bracket 145. This bracket  
30 is held by means of screws 146 to the  
upstanding roller support plate member 22.  
Unless solenoid 140 is energized, spring 144  
will cause the lower surface 138 of brake shoe  
137 to frictionally engage track 24.

35 Brake shoe 137 is actuated with an eccentric  
device comprised of a cylinder 147 which is  
rotatable in a bushing or bearing 148. Bushing  
148 is fixed in brake shoe 137. Offset from  
the center of cylinder 147 is another bushing  
40 149 which is fixed in the cylinder. Another  
shaft 150 is rotatable in bushing 149. Shaft  
150 has an integral axial shaft extension 151  
whose center is eccentric to the center of shaft  
150. Shaft extension 151 has an end portion 152  
45 which is square in cross section to facilitate  
engaging it with a wrench to effect rotation of  
cylindrical shaft 150. As is evident in FIGURE  
12, shaft extension 151 has a threaded portion 153  
immediately adjacent square end portion 152. A  
50 nut 154 is turned onto threads 153 for supporting  
shaft 150 and its extension 151 in upstanding  
plate or stand 22. When shaft 150 is rotated  
about the axis of shaft extension 151 by engaging  
square end portion 152 with a wrench, shaft  
55 portion 150 is caused to swing eccentrically  
and, hence, raise or lower brake shoe 137.  
This enables setting the gap 155 between brake  
surface 138 and the top of rocker track 24  
small so that brake shoe 137 needs to travel  
60 only a small distance to frictionally engage  
and disengage with track 24. When the brake  
shoe has been adjusted, nut 154 is tightened  
so that there will be no rotation of shaft  
extension 151 in upstanding plate 22.  
65 Lever 139 is fastened to cylinder 147 so that

when the lever is rotated through a small  
angle as described above, the cylinder will  
turn on shaft 150, which is eccentric to  
cylinder 147, to thereby move shoe 137  
70 downwardly to frictionally engage the shoe  
with the top of track 24. The cylinders or  
shafts are retained in shoe 137 with a thin  
strap 156 which is secured with screws 157 to  
shoe 137. A collar 158 spaces shaft 150 from  
75 plate 22 so there is clearance for the lever 139  
to swing. A stop pin 159 limits the distance  
through which lever 139 can swing under the  
influence of spring 144.

Referring to FIGURE 10, one may see  
80 that the gantry is provided with means for  
lifting the tracks 24 and 23 from the rollers  
such as 99 and 121, respectively, on which  
the tracks are supported. The lifting means  
are also effective to prevent the L-shaped  
85 frame members 26 and 28 from rocking on  
the rollers. As can be seen in FIGURE 10,  
the lifting and locking means comprise a pair  
of angle brackets 161 and 162. Bracket 161 is  
fixed to upstanding plate 22. Bracket 162 is  
90 fixed to L-shaped member 28. As shown, there  
is a space between brackets 161 and 162 and  
the track 24 is resting on v-grooved rollers  
99. The respective brackets have holes 163  
and 164 which are aligned with each other.  
95 When it is desired to lift track 24, for  
example, from its rollers 98 and 99 and to  
lock L-shaped member 28 to upstanding plate  
22, a bolt 165 is inserted through holes 163  
and 164. A nut, not shown, is then tightened  
100 onto bolt 165 in which case the bolt acts  
like a jack and lifts L-shaped member 28  
and everything that is attached to it. The  
other side of the apparatus is provided with  
a similar pair of angle brackets 166 and 167  
105 through which a bolt 168 is inserted for  
effecting jacking as previously described.  
The jacking or lifting devices are used when  
the machine is being shipped to prevent  
inadvertent tilting of the frame and to avoid  
110 having to rely exclusively on brake 137 to  
prevent tilting.

Another important feature of the new  
gantry is a built-in jib on which a hoist, not  
shown, may be mounted for handling the x-  
ray tube casing 39 or the data acquisition  
115 unit 42 if these devices or any other devices  
must be removed from rotating base 31 in  
connection with maintenance and repair  
procedures. The jib may be seen best in  
FIGURE 3 which shows the gantry as it  
120 appears from the front. In this figure a frame  
is mounted to the L-shaped members 26 and  
28. The frame comprises side members 170  
and 171 and a top member 172. Panels, not  
shown, for concealing the mechanism are  
125 mounted to this frame. The frame has an  
upper internal cross member 173 and a lower  
laterally extending member 174. The jib for  
the hoist constitutes a column, which in this  
case is a metal tube 175. Tube 175 has a 130 .

flange or collar 176 at its bottom end. A shaft 177 extends below the collar into a corresponding opening in cross member 174, thus enabling rotation of column 175 about its axis. The column is also journaled at 177 in cross member 173. The column is also journaled at 177 in cross member 173. The column has another load bearing flange 178 and an extension 179. A horizontally extending arm 180 is fastened to extension 179 by a pair of gusset plates such as 181. Plate 181 may be suitably welded to extension 179 and arm 180. Although the cross section of arm 180 is not visible, it is essentially a channel whose sides are bent inwardly to define a slot that is coextensive with the length of the arm 180. The channel is for accommodating a roller carriage, not shown, to which a sling may be attached for engaging with x-ray tube casing 39 or data acquisition assembly 46, for example, when it is desired to remove or reinstall these heavy components. In such cases, rotating base 31 may be rotated until whatever component is to be engaged is under arm 180 at which time it may be engaged with a sling. The device may then be moved clear of the gantry by swinging arm 180 about the axis of column 175.

In FIGURE 4 the cylindrical shell 15 for enclosing the cables is visible in profile. This shell, as can be seen in FIGURE 4 and in FIGURES 1 and 3, has a central opening 185 through which the patient undergoing examination may be passed by translation of patient supporting table 11. In FIGURE 4 the rotational axis for the rotating base 31 which carries the x-ray tube casing 39, collimator 41 and the data acquisition system 46 is marked 32 as it is in FIGURE 1. The horizontal axis 32', as indicated earlier, is the axis from which the curvatures of tracks 23 and 24 are generated. The fan-shaped x-ray beam emerging from collimator 41 passes through intersecting axes 32 and 32'. Thus, axis 32' constitutes a virtual axis for tilting or inclining rotatable base 31. There is no shift of the x-ray beam relative to axis 32' when the frame is tilted by rocking of L-shaped segments 26 and 28. Thus, the slice or layer of interest to which horizontal axis 32 is always perpendicular when the frame is upright or tilted can always be determined precisely.

The present computed tomography gantry is also the subject of our copending patent applications Nos. 7007/78 (Serial No. 1597647), 7008/78 and 7009/78 (Serial Nos. 1597648, 1597649).

WHAT WE CLAIM IS:—

1. A tilting gantry for tomography comprising:  
 frame means including a pair of generally L-shaped members spaced apart from each other in the transverse direction, each of said

members comprising an upstanding leg portion and an angularly related base portion, each of said base portions having a lower edge which is curved convexly downwardly, a downwardly convex curved track fastened to each of said base portions, the radii of curvature of each of said tracks passing through a virtual transversely extending axis which is above said tracks,

a stand fixed adjacent each of said tracks, first and second sets of rollers supported on respective stands for rotation and said tracks being supported on said sets of rollers, respectively, for translating thereon along a curved path about said virtual transverse axis,

support means spanning between and connected with said upstanding portions of said L-shaped members,

pulley means journaled in said support means and rotatable about a longitudinally directed axis which intersects and is perpendicular to said virtual transverse axis, said pulley means being open within its circumference for permitting an examination subject to be translated along said longitudinal axis,

a rotatable base fastened to said pulley means for rotation therewith,

radiation source and radiation detector means mounted to said rotatable base on opposite sides of said longitudinal axis for orbiting about said axis when said base is rotated,

means for driving said pulley means rotationally, and

means for moving said tracks on said rollers to effect tilting of said L-shaped members.

2. Apparatus as claimed in claim 1, wherein said means for moving said tracks comprises a chain having its ends fastened to said downwardly convex lower edge of the base portion of said L-shaped member,

a pair of idler sprockets immediately adjacent said lower edge and a drive sprocket spaced from said edge, the rotation axis of said sprockets being in parallel with each other and with said virtual axis, a portion of said chain looping around said drive sprocket and between and in contact with said drive sprocket to thereby maintain said chain in contact with said lower edge, and motor means for driving said drive sprocket.

3. Apparatus as claimed in claim 1 or claim 2, additionally including hoist means mounted to said frame means, said hoist means being constructed and arranged for enabling means which are mounted to said rotatable base to be coupled with and supported by said hoist means.

4. Apparatus as claimed in claim 3, wherein said hoist means comprises:  
 a generally vertically disposed jib column

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- mounted to said frame means at a side thereof, said column being mounted for rotation about its axis, and
- an arm extending radially and generally horizontally from said column, said arm being swingable with said column over and away from the orbital path of said x-ray source and said detector means.
5. Apparatus as claimed in any one of claims 1—4, additionally including
- brake means operable to hold said frame means to a selected angle of tilt, said brake means comprising:
- a brake shoe body having a surface for being disposed in proximity with said track and for being moved into frictional engagement with said track,
- a first cylindrical shaft journaled for rotation in said body,
- a second cylindrical shaft journaled for rotation in said first shaft with the axis of the second shaft in parallel with the axis of said first shaft,
- an extension shaft projecting axially from said second shaft and the axis of said extension shaft being eccentric with respect to the axis of said second shaft, said extension having means for enabling said extension to be engaged and rotated,
- stationary means having an aperture through which said shaft extension projects to expose said means which enable rotation, rotation of said extension causing said second shaft to rotate eccentrically to thereby set the spacing between said brake shoe surface and said track,
- means for clamping said shaft extension against rotation when said spacing has been set, and
- means for selectively rotating said first cylindrical shaft through small opposite angles to thereby engage and disengage said shoe with said track.

J. A. BLEACH & CO.,  
Agent for the Applicants.

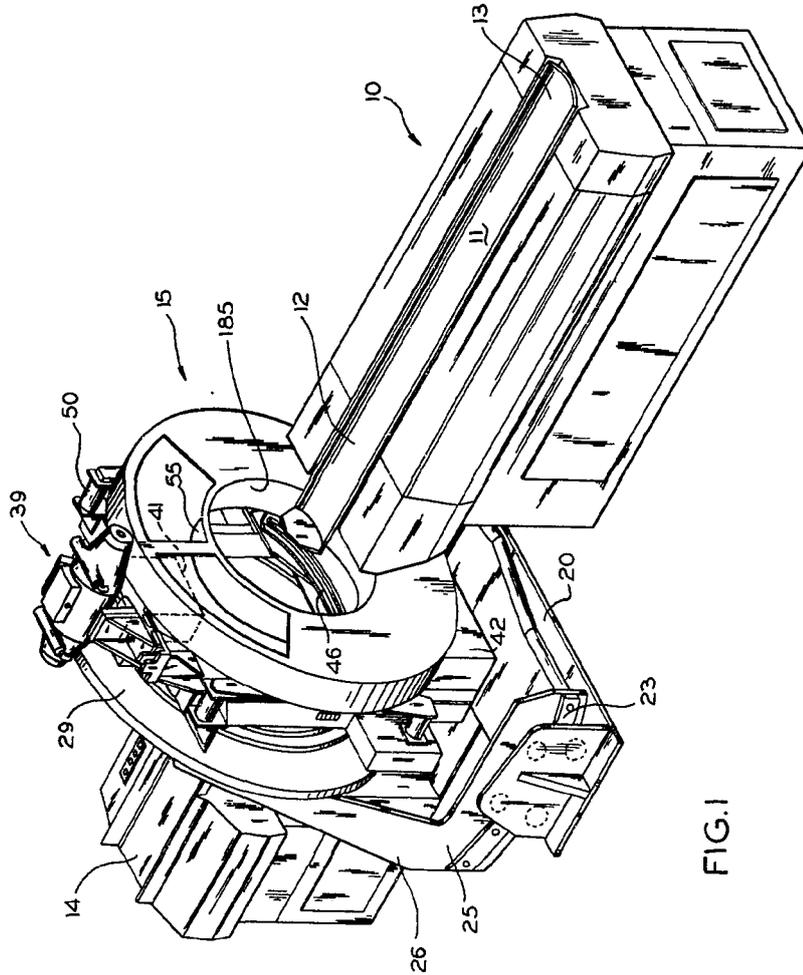
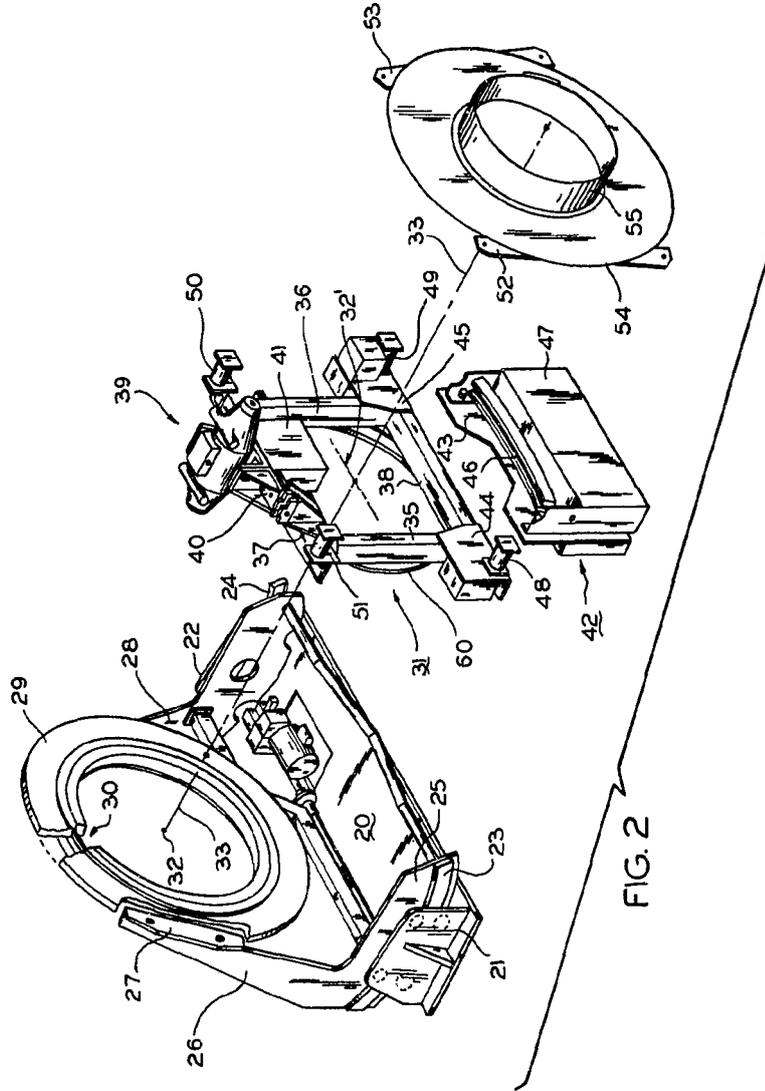


FIG. 1



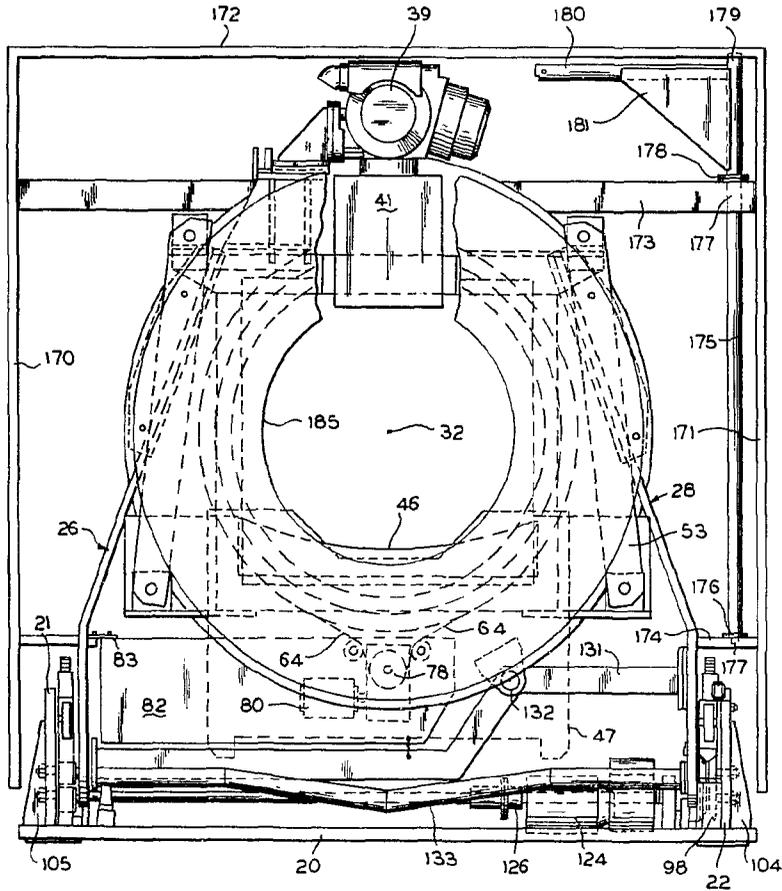


FIG. 3

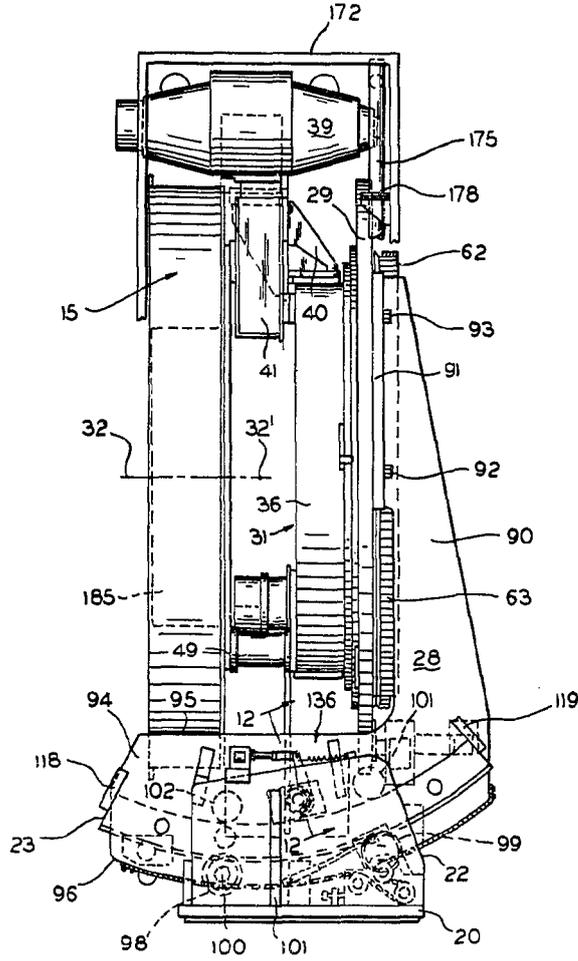


FIG. 4

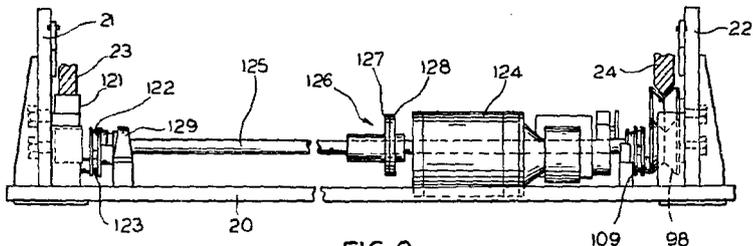
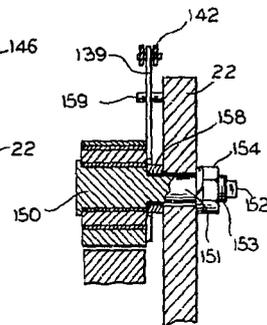
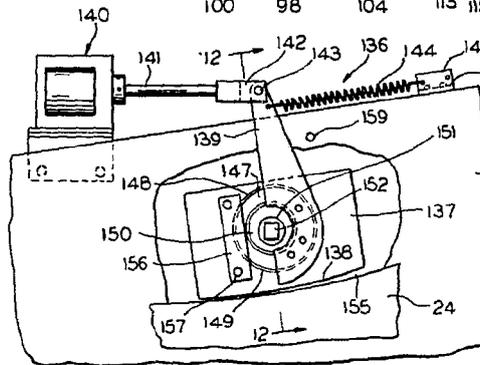
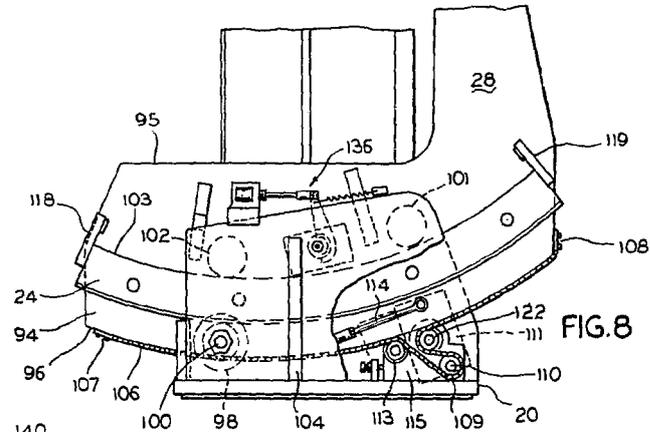


FIG. 5

FIG. 12

FIG. 9

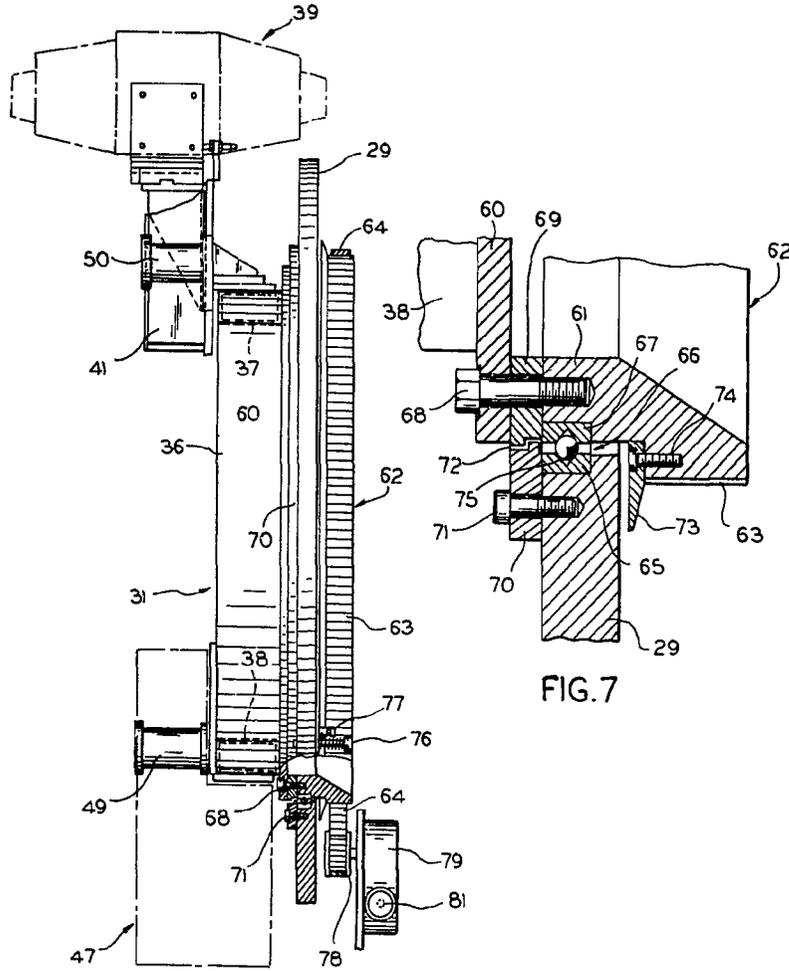


FIG. 6

FIG. 7

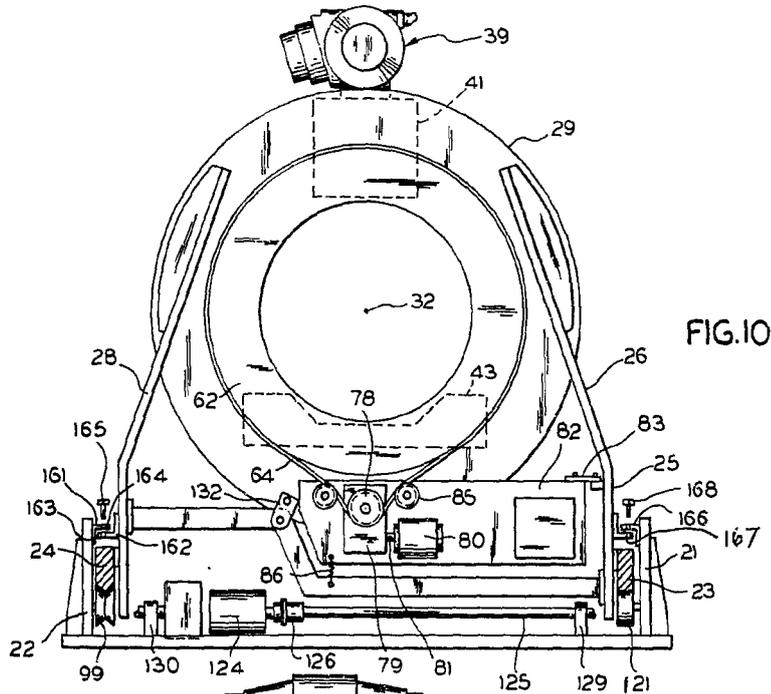


FIG. 10

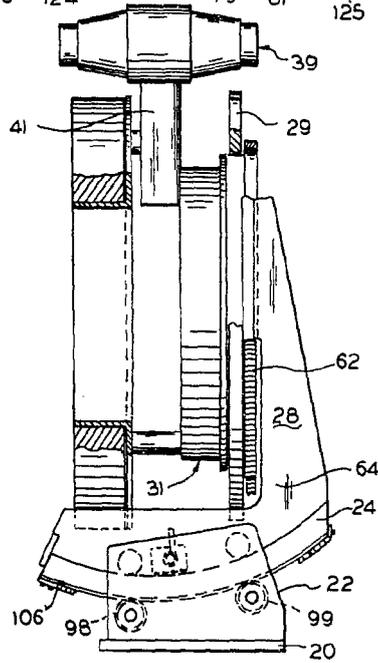


FIG. 11