Nov. 17, 1953 D. T. SCAG ET AL 2,659,827
ORIENTING AND SCANNING SUPPORT FOR BETATRONS
Filed May 19, 1951 2 Sheets-Sheet 1

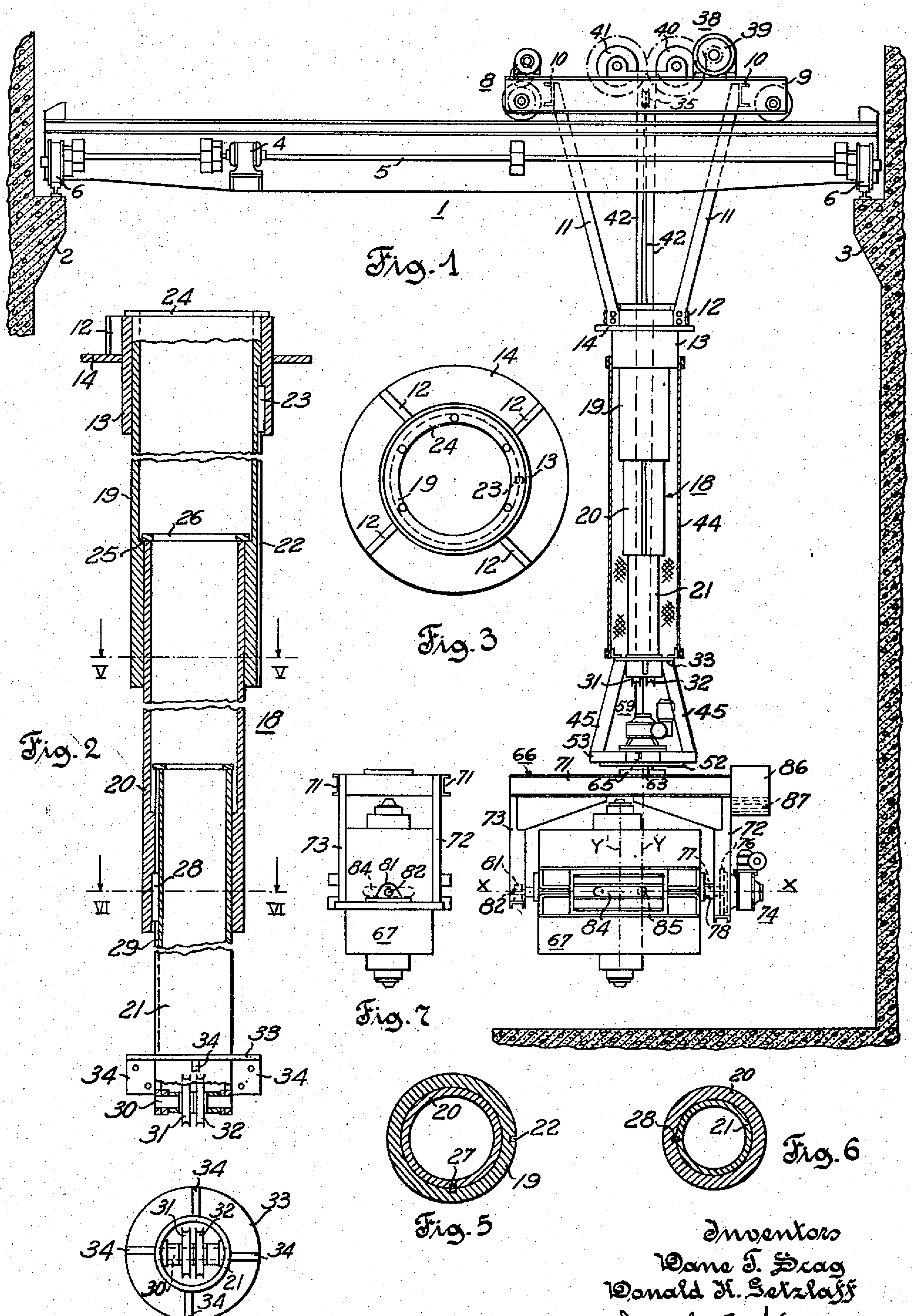

Fig. 1
Fig. 2
Fig. 3
Fig. 4
Fig. 5
Fig. 6
Fig. 7

Inventors
Dane T. Scag
Donald H. Getzlaff
by Joseph E. Kerwin
Attorney

Nov. 17, 1953 D. T. SCAG ET AL 2,659,827

ORIENTING AND SCANNING SUPPORT FOR BETATRONS

Filed May 19, 1951 2 Sheets-Sheet 2

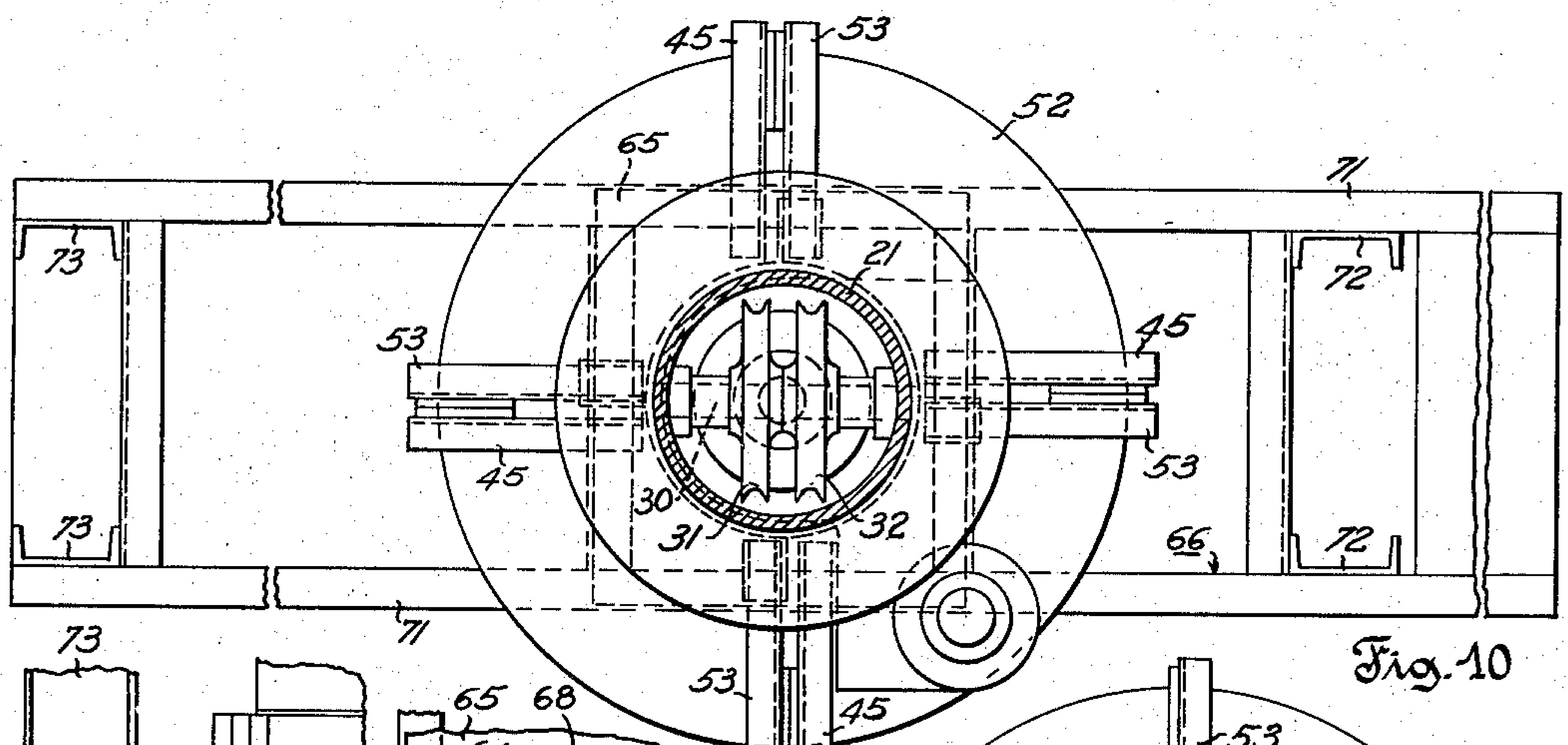

Fig. 10

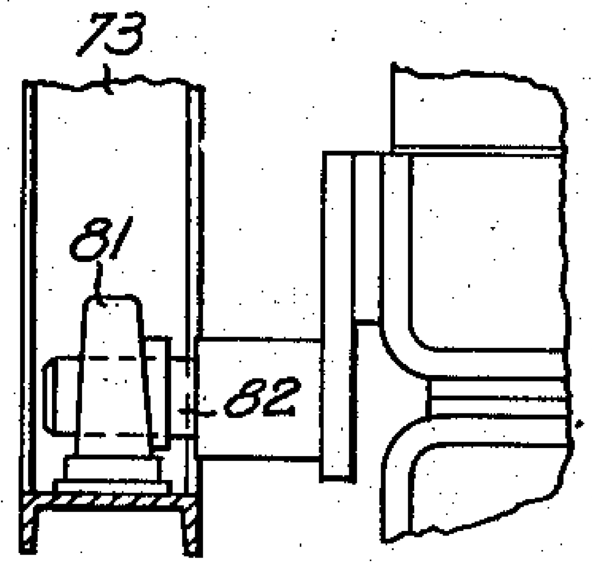

Fig. 8a

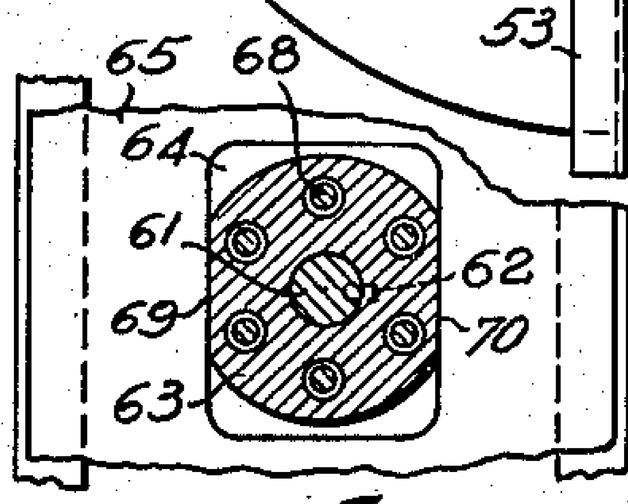

Fig. 12

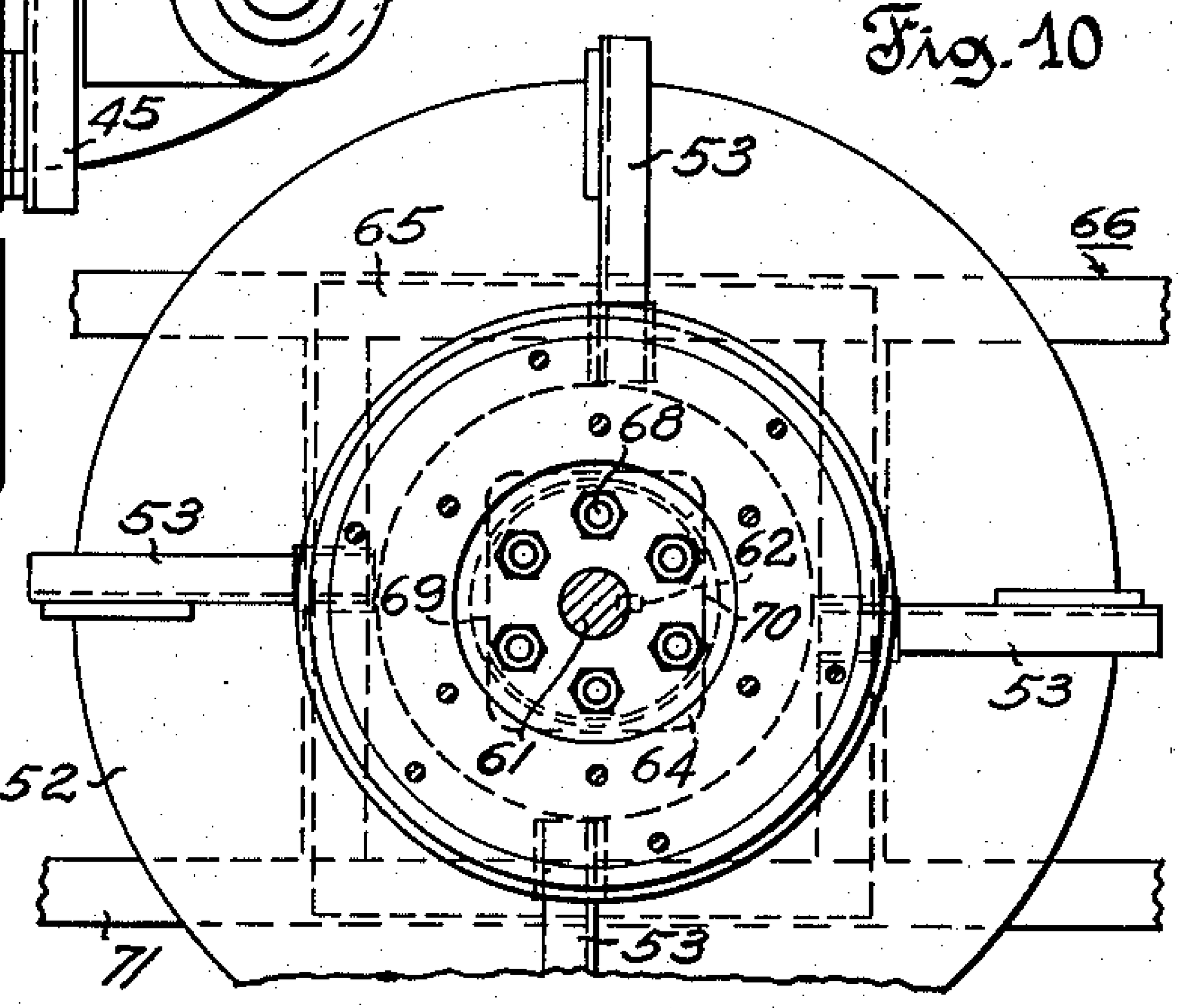

Fig. 11

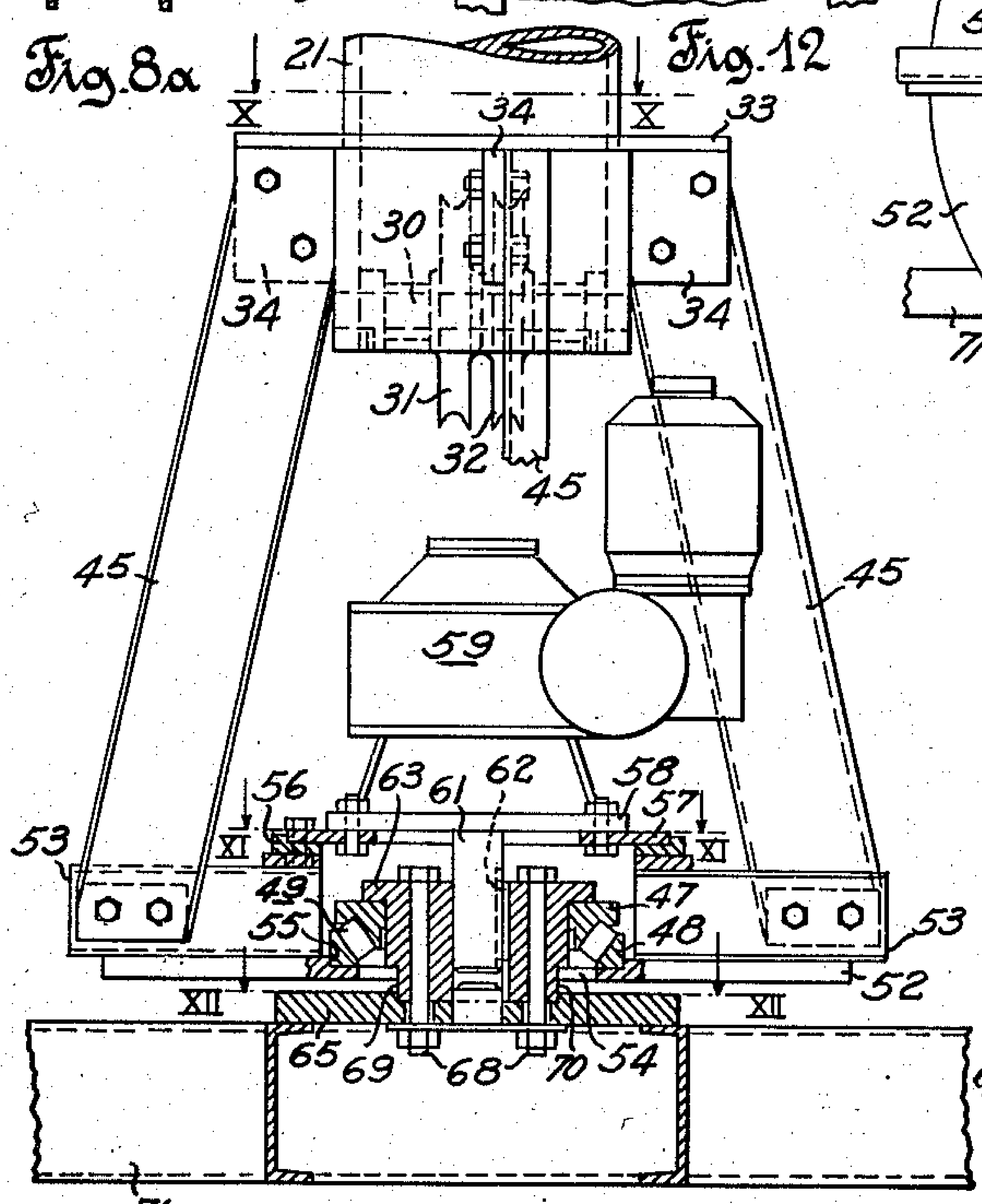

Fig. 9

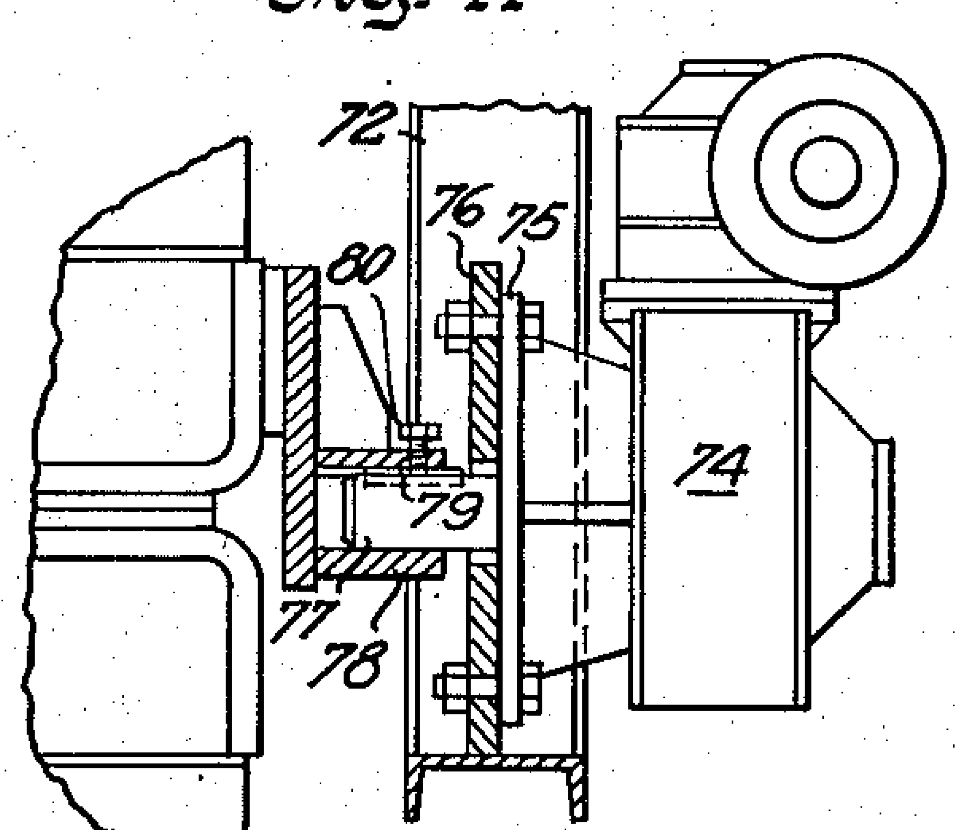

Fig. 8

Inventors
Dane T. Scag
Donald H. Getzlaff
by Joseph E. Kerwin
Attorney

Patented Nov. 17, 1953

2,659,827

UNITED STATES PATENT OFFICE

2,659,827

ORIENTING AND SCANNING SUPPORT FOR BETATRONS

Dane T. Scag, Milwaukee, and Donald K. Getzlaff, Wauwatosa, Wis., assignors to Allis-Chalmers Manufacturing Company, Milwaukee, Wis.

Application May 19, 1951, Serial No. 227,132

7 Claims. (Cl. 250—91)

1

This invention relates to X-ray devices, and in particular, to supporting and orienting structure for radiography by scanning with betatrons.

The development of betatrons capable of accelerating electrons to twenty-five million electron volts to produce relatively high energy X-rays has made the utilization of these electron accelerators of considerable importance in radiography. Massive steel parts can now be X-ray inspected with the betatron relatively quickly and very accurately. The X-rays produced by the betatrons, being highly penetrating, have resulted in the industrial application of radiography to types and sizes of apparatus not heretofore possible. In some instances of industrial radiography the apparatus irradiated will be small and may be brought entirely within the cone of the X-ray beam, making it possible to utilize a stationary target directed to a moving production line on to a single casting or forging. However, for application where castings or forgings are large, the cone of high energy X-rays will not be sufficiently wide to irradiate the entire apparatus, for as the energy of X-rays becomes higher the angle of divergence of the cone becomes less, and the angle of divergence of a twenty-five million electron volt betatron is only about nine degrees. Where the object to be irradiated is large and bulky, it is desirable to provide an orienting mechanism for the betatron unit to move the X-ray source while keeping the object stationary. The orienting support of the betatron should provide for movement about vertical and horizontal axes as well as provide for raising or lowering of the betatron while leaving complete freedom of floor space beneath and around the unit.

To obtain entirely free floor space beneath and around the betatron unit it is necessary that the unit be suspended from an overhead assembly. However, overhead supporting structures of the prior art, when used for raising or lowering and orienting a betatron, have disadvantages making the use of the betatron inefficient. For example, such overhead supporting structures for a twenty-five million electron volt betatron and its suspension assembly must support a weight of approximately seven tons hanging twenty to twenty-five feet from the overhead bridge structure. This relatively large weight hanging that far from the overhead bridge structure is a considerable pendulum so that exact positioning of the target of the betatron becomes almost impossible with suspension of the prior art. An eighth or a sixteenth of an inch displacement

2

of the focal spot of the betatron cannot be tolerated as the focal spot of the betatron is no larger than 0.010 inch high and 0.005 inch wide.

In addition to the problem of preventing movement of the target of the betatron due to external impact, shock or vibration the utilization of such units for scanning radiography has other disadvantages. The betatron has essentially a three-legged transformer core structure in which the accelerating field for the electrons encircles the center leg of the core with the X-ray target between the center leg and one of the outer legs. As a result of such a core structure the focal spot of the X-rays or target is offset from the geometrical center of the betatron, which is closer to its center of gravity. Rotation of betatron about its vertical axis through its geometrical center results in movement of the focal spot of X-ray on an arc instead of rotation on a fixed point. Therefore, if the betatron is used for scanning, the target will move with respect to the object being scanned and the radiograph will be blurred and impossible to interpret.

It is an object of this invention to provide a magnetic induction accelerator of the betatron type for radiography by scanning;

Another object of this invention is to provide an orienting mechanism for betatrons;

Another object of this invention is to provide adjustable overhead supporting structure for high energy X-ray accelerators;

Another object of this invention is to provide overhead supporting structure for raising and lowering high energy X-ray accelerators which can be used for radiography by scanning;

Another object of this invention is to provide high energy X-ray accelerators in which the focal spot of X-rays can be precisely adjusted to the axes of rotation of the accelerator;

Still another object of this invention is to provide adjustable overhead supporting structure for high energy X-ray accelerators in which the weight of the supporting structure and the accelerator can be adjusted so that the axes of movement of the structure extend through the focal spot of X-rays in the accelerator;

Still another object of this invention is to provide rotation of high energy electron or X-ray betatrons about a vertical axis through the focal spot of X-rays in the betatron with the center of gravity of the betatron and supporting structure adjusted to the axis of rotation.

Objects and advantages other than those above set forth will be apparent in the following description when read in connection with the accompanying drawing in which:

Fig. 1 is a view in front elevation of a betatron magnetic electron accelerator supported from an overhead crane;

Fig. 2 is an enlarged view partly in section of an intermediate portion of the overhead support of the betatron illustrated in Fig. 1;

Fig. 3 is a plan view of the upper portion of the support portion illustrated in Fig. 2;

Fig. 4 is a bottom view of the support portion shown in Fig 2;

Fig. 5 is a view in section of the support taken along line V—V of Fig. 2;

Fig. 6 is a view in section of the support taken along line VI—VI of Fig. 2;

Fig. 7 is a side elevation of the betatron and yoke support shown in Fig. 1;

Fig. 8 is an enlarged view partly in section of the motor driven right hand trunnion of the betatron illustrated in Fig. 1;

Fig. 8*a* is an enlarged view partly in section of the bearing support for the left hand trunnion of the betatron shown in Fig. 1;

Fig. 9 is an enlarged view in elevation partly in section of the motor driven rotating mechanism for the suspension yoke assembly shown in Fig. 1;

Fig. 10 is a sectional view of the rotating mechanism of the suspension yoke assembly taken along line X—X of Fig. 9; and

Figs. 11 and 12, are sectioned views taken along lines XI—XI and XII—XII, respectively, of Fig. 9.

The betatron high energy X-ray accelerator illustrated in the drawings is suspended from a traveling crane **1** which is movable along the runways **2**, **3** of the side walls of the building in which the betatron type is installed. The crane is moved by a motor driven means including the motor **4**, a drive shaft **5**, and the driving wheels **6**. The crane is of conventional construction and includes a pair of parallel bridge members or girders on which is a motor operated trolley **8**. The bed of the trolley includes horizontal channel members **9**, **10** to which are attached by suitable means, preferably by bolting, four hanging channel support arms **11**. These support arms extend downward from the trolley between the two bridge members of the traveling crane, and the lower ends of the support arms are bolted to ears **12** of a stub tube **13** so that the stub tube **13** is fixed with respect to the trolley **8**.

A flange **14** extends outward from the stub tube and is attached thereto by suitable means such as by welding. The ears **12** are attached to the tube and to the upper surface of the flange **14**. There are four ears **12** extending out from the stub tube in a generally radial direction with an angle of approximately 90° between the adjacent ears.

A telescopic tube support designated generally as **18** is shown in Figs. 1 and 2 as including the stub tube **13** and three other tubes **19**, **20**, **21**, but the number of tubes included in the support may be varied.

The construction and assembly of the overhead tube support provides means to very accurately maintain the focal spot or source of X-rays on a predetermined vertical axis while allowing the betatron and, of course, its focal spot of X-rays, to move along that axis as is desired or to be held at any position along that axis. The keyed, close fitting tubes **13**, **19**, **20**, **21** when combined with the actuating means comprising an electric motor controlled winch for raising or lowering the tubes in the manner to be described and also combined with the precise adjusting means for the position and weight of the betatron and its support assembly, provides a completely new orienting and support means for high energy accelerators which are to be employed in industrial radiography.

The intermediate tubes **19**, **20** are similar in construction and differ only in diameter. A straight keyway is cut parallel to the longitudinal axis of these tubes on their outer surfaces. The keyway **22** of tube **19** receives the key **23** of stub tube **13**. The tube **19** has a sliding fit in stub tube **13**, and the inner surface of the stub tube is made of suitable bearing material such as babbitt. The upper edge of tube **19** has an overhanging ring **24** bolted thereto. The ring abuts against the upper edge of the stub tube when tube **19** is in the lowered position, preventing the sliding tube **19** from falling out of stub tube **13**. The lower portion of tube **19** has a reduced internal diameter providing a shoulder **25** against which an overhanging ring **26** of tube **20** abuts thereby preventing tube **20** from sliding out of tube **19**. The lower portion of tube **19** has a key **27** as shown in Fig. 5 which extends into a keyway in the outer surface of the tube **20**.

The key **28** of tube **20** slides in the keyway **29** of the bottom tube **21**. The tubes are assembled so that the keys or keyways of adjacent tubes are displaced by an angle of 90°.

The lower end of the bottom tube **21** supports a shaft **30**, transverse the tube for freely rotating sheaves **31**, **32**. The lower end of the bottom tube **21** is provided with a flange **33** extending outwardly normal to the outer surface of the tube. The flange **33** is similar to the flange **14** which is attached to the stub tube **13**. Also the lower end of the bottom tube **21** has four substantially radially extending ears **34** which are attached by suitable means to the tube **21** and the bottom surface of the flange **33**.

In their most extended position the telescoping tubes have considerable surface contact. As shown in Fig. 2 the lower portions of every tube in which one other of the tubes slides has a considerable length, providing a long surface contact between tubes so that the tube assembly cannot be deformed laterally.

The telescopic tubes are raised and lowered by winch means **38** on the motor operated trolley **8**. The winch **38** includes a motor **39** and two drums **40**, **41** on which a cable **42** winds. The cable extends from the drum **40**, down the inside of the tube support **18**, over one of the sheaves **32**, then up around an idler pulley **35**, then down again through the tube support **18**, over the sheave **31**, and up the tube support to the drum **41**.

The tubes are shown in their extended position in Fig. 2. When they are raised, the motor operated winch first raises the bottom tube **21** inside of tube **20** until the flange **33** abuts against the bottom edge of the tube **20**, then tube **20** slides inside of tube **19** until the flange **33** abuts against the bottom of tube **19**. Continued operation of the winch to raise the tube support causes tube **19** to slide inside of stub tube **13** until the flange **33** abuts against the bottom of the stub tube **13**. In the fully raised position the telescoped tubes extend upwardly from the stub tube **13** between the two bridge members of the traveling crane.

The electric motor operated winch and sheave provides a precise control of the telescoping tube support. By means of the motor control and which the tubes can be very slowly moved or stopped at any height for long periods of time without any slippage.

The outside surfaces of the sliding tubes can be kept clean by surrounding the tubes with a collapsible fabric bag 44 attached to the lower end of the stub tube and to the flange 33 on the lower end of the bottom tube. The collapsible bag may include some means such as a spiral spring support (not shown) to prevent the bag from collapsing against the outer surfaces of the tubes. The tubes being positioned directly over the betatron, provide a chimney for the air heated by the betatron, whereby an upward draft tends to prevent dirt from settling on the inside of the tubes. Also the bearing portions on the insides of the tubes on which other of the tubes slide are always fully engaged or in contact with the outside of an inner tube, so that the inside sliding bearing surfaces are never exposed.

Attached to the bottom tube 21 is a rotating mechanism and support assembly for the betatron 67. This rotating mechanism and support assembly can be very precisely positioned so that the betatron always rotates about and/or moves along the vertical axis of the tubes. In this instance, the rotating mechanism is attached to four channel supports 45.

The ears 34 at the lower end of the bottom tube 21 have bolted thereto the four channel supports 45 which extend downward from the bottom tube. A circular base plate 52 is attached to the lower end of the channel supports. A preferred arrangement for attaching the base plate to the lower end of the channel supports is illustrated in Fig. 9 in which four substantially radially extending channels 53 are fixed to the upper surface of the base plate 52 by a suitable means such as welding, and are bolted to the lower end of the channel supports 45.

The base plate 52 has a circular opening 54 at its center and an annular recess 55 concentric with the opening in the upper surface portion of the base plate. The lower race 48 of a spherical thrust bearing 49 is fixed to the base plate and held in the annular recess 55. Preferably the base plate is shrunk fit to the lower race 48 of the bearing. A spacer ring 56 having a step shaped cross section is attached to the upper surfaces of the channels 53 and a reducer plate 57 is bolted to the ring 56. A motor drive assembly is attached to the reducer plate. The flange 58 of the motor assembly 59 is supported by and bolted to the reducer plate 58.

The drive shaft 61 of the motor assembly 59 has a spline 62 and is keyed to the bearing centering plug 63. The upper race 47 of the thrust bearing 49 is fitted to the centering plug 63. The centering plug is rotated by the motor assembly drive shaft and is fitted to a cross plate 65, and the cross plate 65 is fixed to the suspension yoke assembly 66 so that the motor assembly, the centering plug, the spherical thrust bearing and the cross plate of the yoke assembly provide a motor driven rotating mechanism for the betatron 67 which is attached to the yoke assembly.

While the centering plug 63 is bolted to the cross plate of the yoke assembly, it is preferable that the bolts 68 do not have to transmit the torque for rotating the betatron and yoke assembly. Therefore, instead of making the bottom of the centering plug circular it is provided with two flat sides, 69, 70 which tightly fit into a generally rectangular recess 64 in the cross plate 65, whereby the load of rotating the betatron and yoke assembly is carried by the flat sides of the centering plug which abut against flat sides of the rectangular recess in the cross plate.

An adjustment of the position of the focal spot or target of the betatron can be obtained by adjustably connecting the centering plug to the cross plate. This can be done by making the lengthwise dimension of the recess in the cross plate longer than the corresponding dimension of the bottom of the centering plug and by providing a clearance fit for the bolts 68 in the holes in the cross plate as shown in Fig. 12. By this means the cross plate can be adjustably positioned with respect to the centering plug whereby the entire betatron can be adjusted to a position on the common axis Y of the drive shaft 61 and the tube support, and the betatron when rotated by the shaft 61 will have a rotating beam with X-rays issuing from a single point.

The suspension yoke assembly 66 comprises a U-shaped support in which the betatron 67 can be rotated about its horizontal axis. The horizontal member 71 of the yoke assembly is made up of channel members and cross supports to have the rectangular shape as shown in Fig. 10. The cross plate 65 is attached to the upper surface of the horizontal member 71 not in the center thereof but in a position offset from the center (Fig. 1) so that the center of the recess in the cross plate can be aligned exactly above the focal spot of the betatron. The depending arms 72, 73 of the yoke assembly support a motor driven trunnion which carries the betatron in a horizontal position as shown in Fig. 1.

The right arm 72 of the yoke is shown enlarged in Fig. 8 and carries the motor and reduction gear box 74 with the flange 75 of the motor assembly bolted to a plate 76 which is welded to the arm 72. The plate 76 has a central aperture through which a drive shaft 77 of the motor assembly extends. The right hand side of the betatron has a collar 78 with a key 79. The drive shaft 77 is splined and fits into the collar 78 so as to serve as the right hand trunnion of the betatron with the key 79 sliding into the spline of the drive shaft. The collar may be locked axially to the drive shaft by suitable means, one being illustrated as a set screw 80. The englarged view of Fig. 8*a* illustrates the mounting of the betatron on its left hand trunnion 82. The arm 73 carries a bearing 81 in which the trunnion 82 attached to the betatron assembly turns.

The trunnion 82 is long enough to allow it to be moved axially with respect to the bearing 81. Also the collar 78 is made to have axial clearance with respect to the drive shaft 77 so it can be moved axially of that shaft. Thus, a horizontal or lateral adjustment of the position of the betatron may be made to exactly position the X-ray target or focal spot 85 of the betatron on the vertical axis Y without moving the motor driven trunnion or yoke support. This provides another means for adjusting the position of the focal spot of the betatron. While the adjustment which can be made by the centering plug 63 is transverse the common axis X of the trunnions and the betatron, the other adjustment which affects the betatron only, provides for horizontally moving the position of the betatron along the axis of the trunnions at 90° to the direction of the adjustment made by means of the centering plug. In addition to these adjustments, there is another mode of adjusting the position of the target, and that is to rotate the accelerating tube 84 about its own axis, thereby moving the target 85 on an arc without moving the betatron or its supporting assembly so that the target may be located on the trunnion axis X.

Both the motor assemblies 59 and 74 include adjustable speed motors and gear reduction means to provide for slowly turning the betatron about a vertical axis Y and a horizontal axis X, respectively. The X-ray target 85 can be exactly positioned so that it coincides with the intersection of these vertical and horizontal axes. By means of the overhead support 18 the position of the X-ray target is maintained on the vertical axis Y whether the betatron be held in one position along that axis or moved along that axis.

The weight of the betatron normally is not balanced with respect to the X-ray target 85. The center of gravity of the betatron is substantially at its geometrical center at the intersection of the horizontal axis X and the vertical axis Y'. However, the target is horizontally offset from the vertical axis Y' to a position on the vertical axis Y between the center leg and outer leg of the betatron core. The weight of this type accelerator is approximately four and one-half tons without the yoke assembly, and since the above described structure provides means by which the X-ray target of the betatron can be exactly positioned on axes of rotation, this results in the betatron being rotated about a vertical axis which does not pass through the center of gravity of the betatron. There is included in the illustrated structure a means for adjusting the weight of the yoke assembly and betatron so that the center of gravity of the betatron and its yoke assembly is on the vertical axis Y through the X-ray target, which is also the longitudinal axis of the overhead support.

In this instance, the means for adjusting the center of gravity comprises the container 86 which is attached to the right leg 72 of the yoke assembly. Steel plates 87 are inserted into the container 86 until the center of gravity of the betatron and yoke assembly is vertically aligned with the X-ray target. The adjusted center of gravity will then be aligned also with the axis of rotation of the motor driven rotating mechanism which turns the yoke assembly and betatron. The balance of the yoke assembly and betatron about the vertical axis through the X-ray target is partially accomplished by the weight of the motor assembly of the trunnion and the final adjustment is made exact by adding the weights to the container. With the entire suspension assembly balanced the rotation of the betatron about a vertical axis through the X-ray target will not cause the rotating mechanism to bind and the raising or lowering of the betatron will not bind the supporting tubes.

Although but one embodiment of the present invention has been illustrated and described, it will be apparent to those skilled in the art that various changes and modifications may be made therein without departing from the spirit of the invention or from the scope of the appended claims.

It is claimed and desired to secure by Letters Patent:

1. A scanning X-ray device comprising a betatron, a pair of trunnions having a horizontal axis of symmetry attached to said betatron, a yoke assembly having arms extending downwardly forming a support for said trunnions providing for rotation of said betatron about said trunnion axis, support means for said betatron, means connecting said yoke assembly to said support means including a motor operated means for rotating said yoke assembly with said betatron about a vertical axis, a motor operated means for rotating said betatron about said trunnion axis, and means for positioning the X-ray focal point of said betatron on said vertical axis comprising a first adjusting means providing for movement of said betatron relatively to said yoke assembly in a direction parallel to said trunnion axis and a second adjusting means providing for movement of said yoke assembly relatively to said connecting means in a horizontal direction normal to said trunnion axis.

2. A scanning X-ray device comprising a betatron, a trunnion having a horizontal axis of symmetry attached to said betatron, a yoke assembly having an arm extending downwardly forming a support for said trunnion providing for rotation of said betatron about said trunnion axis, support means for said betatron, means connecting said yoke assembly to said support means including a first motor operated means for rotating said yoke assembly with said betatron about a vertical axis, a second motor operated means for rotating said betatron about said trunnion axis, and means for positioning the X-ray focal point of said betatron on said vertical axis including first and second adjusting means, said first adjusting means comprising a first member of said trunnion mounted on said betatron and a second member of said trunnion connected to said second motor operated means, said members being movable with respect to each other in a direction parallel to said trunnion axis, and means to fix the position of said members with respect to each other, said second adjusting means comprising a first element attached to said yoke assembly having a recess with opposite sides thereof having parallel straight portions extending in a horizontal direction 90° to said trunnion axis, a second element connected to said first motor operated means having opposite parallel sides abutting said sides of said recess, said second element being movable in said recess parallel to said sides and having a fixed position with respect to said vertical axis whereby the relative movement of said elements adjusts the X-ray focal point, and means to clamp said elements together.

3. A scanning X-ray device comprising a betatron, a pair of trunnions having a horizontal axis of symmetry attached to said betatron, a yoke assembly having arms extending downwardly forming a support for said trunnions providing for rotation of said betatron about said trunnion axis, overhead support means for said yoke assembly including a plurality of telescoping tubes having a common vertical axis of symmetry, means for retracting and for extending said tubes, means connecting said yoke assembly to said tubes including a motor operated means for rotating said yoke assembly with said betatron about said vertical axis, a motor operated means for rotating said betatron about said trunnion axis, and means for positioning the X-ray focal point of said betatron on said vertical axis comprising a first adjusting means providing for movement of said betatron relatively to said yoke assembly in a direction parallel to said trunnion axis, and a second adjusting means providing for movement of said yoke assembly relatively to said connecting means in a horizontal direction normal to said trunnion axis.

4. A scanning X-ray device comprising a betatron, a trunnion having a horizontal axis of symmetry attached to said betatron, a yoke assembly having an arm extending downwardly forming a support for said trunnion providing for rotation of said betatron about said trunnion axis, overhead support means for said yoke assembly including a plurality of telescoping tubes having a common vertical axis of symmetry, means for retracting and for extending said tubes, means connecting said yoke assembly to said tubes including a first motor operated means for rotating said yoke assembly with said betatron about said vertical axis, a second motor operated means for rotating said betatron about said trunnion axis, and means for positioning the X-ray focal point of said betatron on said vertical axis including first and second adjusting means, said first adjusting means comprising a first member of said trunnion mounted on said betatron and a second member of said trunnion connected to said second motor operated means, said members being movable with respect to each other in a direction parallel to said trunnion axis, and means to fix the position of said members with respect to each other, said second adjusting means comprising a first element attached to said yoke assembly having a recess with opposite sides thereof having parallel straight portions extending in a horizontal direction 90° to said trunnion axis, a second element connected to said first motor operated means having opposite parallel sides abutting said sides of said recess, said second element being movable in said recess parallel to said sides and having a fixed position with respect to said vertical axis whereby the relative movement of said elements adjusts the X-ray focal point, and means to clamp said elements together.

5. A scanning X-ray device comprising a betatron, a trunnion having a horizontal axis of symmetry attached to said betatron, a yoke assembly having an arm extending downwardly forming a support for said trunnion providing for rotation of said betatron about said trunnion axis, overhead support means for said yoke assembly including a plurality of telescoping tubes having a common vertical axis of symmetry, means associated with said tubes to brace said tubes against lateral and angular movement, means for retracting and for extending said tubes, said tubes including a first motor operated means for rotating said yoke assembly with said betatron about said vertical axis, a second motor operated means for rotating said betatron about said trunnion axis, the joint center of gravity of said yoke assembly, said betatron and said second motor operated means being positioned away from said vertical axis, means for positioning the X-ray focal point of said betatron on said vertical axis including first and second adjusting means, said first adjusting means comprising a first member of said trunnion mounted on said betatron and a second member of said trunnion connected to said second motor operated means, said members being movable with respect to each other in a direction parallel to said trunnion axis, and means to fix the position of said members with respect to each other, said second adjusting means comprising a first element attached to said yoke assembly having a recess with opposite sides thereof having parallel straight portions extending in a horizontal direction 90° to said trunnion axis, a second element connected to said first motor operated means having opposite parallel sides abutting said sides of said recess, said second element being movable in said recess parallel to said sides and having a fixed position with respect to said vertical axis whereby the relative movement of said elements adjusts the X-ray focal point, means to clamp said elements together, and means including a counterweight attached to said yoke assembly for positioning the joint center of gravity of all the parts of said device moved by said first motor operated means on said vertical axis.

6. A scanning X-ray device comprising a betatron, a pair of trunnions having a horizontal axis of symmetry attached to said betatron, a yoke assembly having arms extending downwardly forming a support for said trunnions providing for rotation of said betatron about said trunnion axis, overhead support means for said yoke assembly including a plurality of telescoping tubes having a common vertical axis of symmetry, means associated with said tubes to brace said tubes against lateral and angular movement, means for retracting and for extending said tubes, means connecting said yoke assembly to said tubes including a motor operated means for rotating said yoke assembly with said betatron about said vertical axis, a motor operated means for rotating said betatron about said horizontal axis, and means for positioning the X-ray focal point of said betatron on said vertical axis including first and second adjusting means, said first adjusting means providing for movement of said betatron relatively to said yoke assembly in a direction parallel to said trunnion axis, said second adjusting means providing for movement of said yoke assembly relatively to said connecting means in a horizontal direction normal to said trunnion axis.

7. A scanning X-ray device comprising a betatron, a trunnion having a horizontal axis of symmetry attached to said betatron, a yoke assembly having an arm extending downwardly forming a support for said trunnion providing for rotation of said betatron about said trunnion axis, overhead support means for said yoke assembly including a plurality of telescoping tubes having a common vertical axis of symmetry, means associated with said tubes to brace said tubes against lateral and angular movement, means for retracting and for extending said tubes, means connecting said yoke assembly to said tubes including a first motor operated means for rotating said yoke assembly with said betatron about said vertical axis, a second motor operated means for rotating said betatron about said horizontal axis, and means for positioning the X-ray focal point of said betatron on said vertical axis including first and second adjusting means, said first adjusting means comprising a first member of said trunnion mounted on said betatron and a second member of said trunnion connected to said second motor operated means, said members being movable with respect to each other in a direction parallel to said axis, and means to fix the position of said members with respect to each other, said second adjusting means comprising a first element attached to said assembly having a recess with opposite sides thereof having parallel straight portions extending in a horizontal direction 90° to said trunnion axis, a second element connected to said first motor operated means having opposite parallel sides abutting said sides of said recess, said second element be-

ing movable in said recess parallel to said sides and having a fixed position with respect to said vertical axis whereby the relative movement of said elements adjusts the X-ray focal point, and means to clamp said elements together.

DANE T. SCAG.
DONALD K. GETZLAFF.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
Re. 13,813	Ariens	Oct. 27, 1914
1,630,181	Isherwood	May 24, 1927
2,394,070	Kerst	Feb. 5, 1946
2,548,489	Morrison	Apr. 10, 1951
2,553,378	Miller	May 15, 1951

FOREIGN PATENTS

Number	Country	Date
535,984	Germany	Oct. 17, 1931