

[54] **ROTARY SUPPORT FOR RADIATION TREATMENT APPARATUS**

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[57] **ABSTRACT**

A neutron radiation treatment apparatus having a high voltage generator, a neutron generator and a collimator. The neutron generator is supplied with power from the high voltage generator. The collimator forms a beam of useful rays suitable for radiation treatment. The high voltage generator, the neutron generator and the collimator are rigidly connected together and are fastened to a rotatably mounted support plate. The high voltage generator and the neutron generator are disposed on one side of the support plate. The collimator is disposed on the other side of the support plate.

10 Claims, 2 Drawing Figures

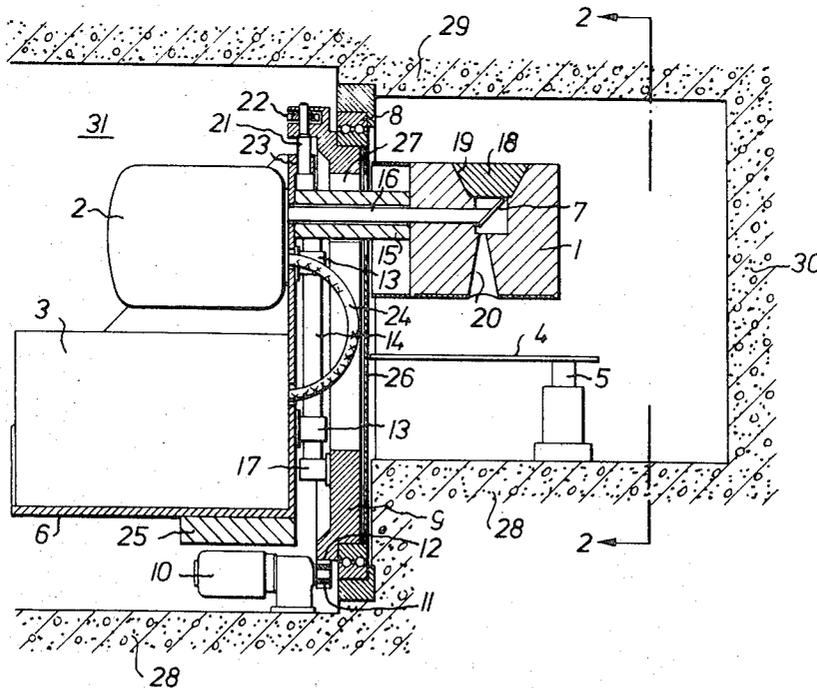


FIG. 1

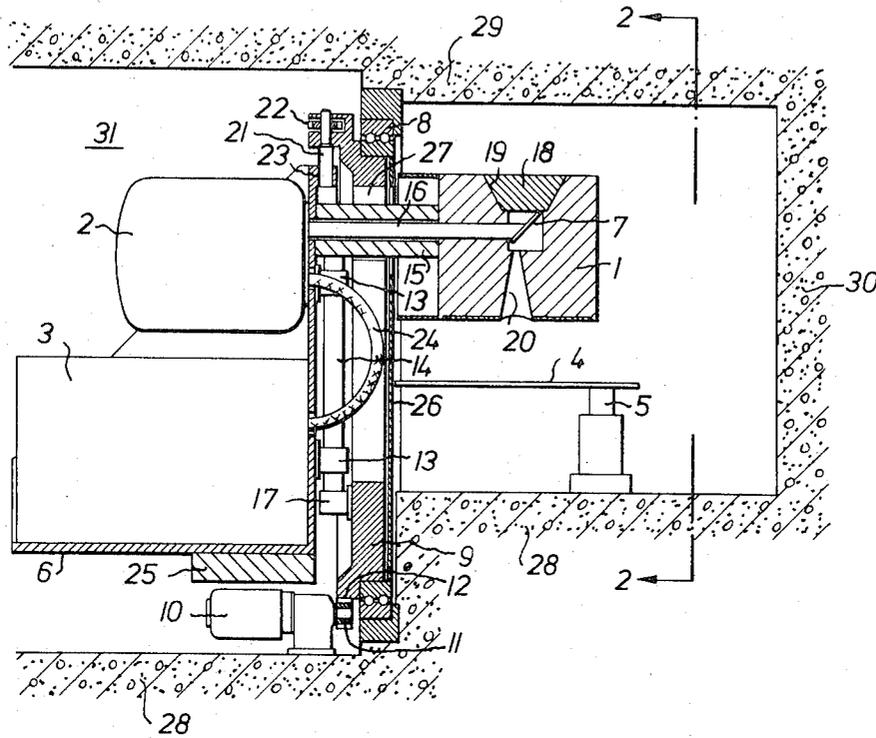
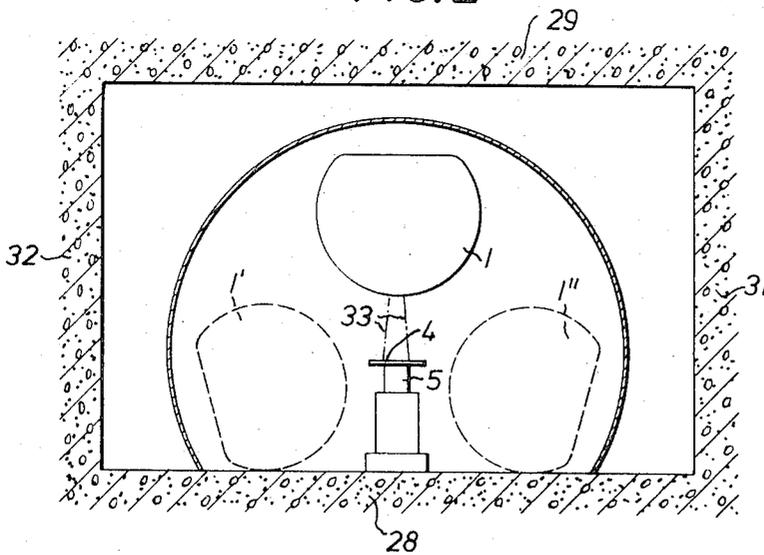


FIG. 2



ROTARY SUPPORT FOR RADIATION TREATMENT APPARATUS

BACKGROUND OF THE INVENTION

The present invention relates to a neutron radiation treatment apparatus for stationary field and/or pendulum and/or rotational field radiation. The invention more particularly relates to a radiation treatment apparatus which includes a high voltage generator, a neutron generator supplied by the high voltage generator and a collimator which forms a beam of useful rays suited for the intended purpose. The radiation treatment apparatus is particularly suitable as a neutron therapy apparatus.

In such a neutron therapy apparatus problems exist particularly when the radiation apparatus is to be used not only for stationary field but also for pendulum or rotational field radiation. While in such cases known X-ray, gamma or electron beam radiation apparatuses operate by rotating a radiation source about a treatment area with the patient being stationary, similar neutron therapy apparatuses will not operate satisfactorily because the cable which is required for supplying a neutron generator with electrical energy and which carries high voltages is not sufficiently flexible and, in practice, may be only slightly stressed by bending or torsion forces. The neutron therapy apparatus composed of the neutron generator and the collimator must thus not perform any large movements relative to the high voltage generator.

In order to overcome this difficulty a radiation apparatus for neutron therapy with stationary field and/or rotational field radiation has been proposed in which the rotational field radiation is effected by means of a center portion of a collimator which contains a beam aperture and which is pivoted together with a treatment table about a stationary radiation source. However, this previously proposed radiation apparatus requires considerable expenditures, is relatively complex and is uncomfortable for a patient because of the necessary movement of the treatment table.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide in a neutron radiation treatment apparatus a neutron source which may be moved about a patient or the like without subjecting a high voltage input cable to undesirable stresses.

It is another object of the present invention to provide a neutron radiation treatment apparatus a neutron generator and a high voltage generator which may be moved relative to a patient or the like so that the neutron generator and high voltage generator remain fixed relative to each other.

It is a further object of the present invention to provide a neutron therapy apparatus for stationary field as well as rotational field radiation in which a treatment table is stationary and a neutron source is moved about a patient or the like without subjecting an associated high voltage cable to undesirable stresses.

These and other objects of the present invention are accomplished in a neutron treatment apparatus which includes a high voltage generator, a neutron generator and a collimator. The high voltage generator supplies power to the neutron generator. The collimator forms a beam of useful rays suitable for radiation treatment. The high voltage generator, the neutron generator and

the collimator are rigidly connected together and are fastened to a rotatably mounted supporting plate. The neutron generator and the high voltage generator are fastened to one side of the supporting plate. The collimator is fastened to the other side of the supporting plate.

The advantage of the solution of the present invention is that by combining of a high voltage generator, a neutron generator and a collimator into a rigid unit which can be rotated about a stationary treatment table there is obtained an extremely compact design with relatively little space requirement and simultaneously a required high voltage cable leading from the high voltage generator to the neutron generator can be easily attached and moved relative to the treatment table without the danger of undesirable mechanical stresses. This permits rotational radiation with angles of rotation of $n \times 360^\circ$ without any difficulty. Since one side of a supporting plate holds the high voltage generator and the neutron generator and the other side of the supporting plate holds the approximately equally as heavy collimator, the resulting weight distribution is very favorable so that finally only slight moments need be absorbed by the bearings of the rotatably mounted supporting plate. Compared to the known neutron radiation apparatus the treatment table in accordance with the present invention can remain stationary during neutron radiation treatment even in the case of rotational field radiation.

According to a preferred embodiment of the present invention, a high voltage generator, a neutron generator and a collimator are arranged on a support plate which is displaceably, radially mounted on the supporting plate. To hold the displaceably, radially mounted support on the supporting plate, a columnar guide is provided. It is a preferred feature of the present invention to provide a spindle which is supported by the supporting plate and which is parallel to the columnar guide to engage in a threaded bushing at the displaceably, radially mounted support. A drive for the spindle may also be provided.

The thus realized radial adjustability of the radiation source results in the advantage that even with rotational radiation the distance between a patient or the like and the radiation source can be easily varied. This also provides for infinite variability of the radiation field at the locus of radiation for the rotational field radiation since the radiation fields which can be produced with different sizes of aperture inserts available for the collimator in that the radiation distance can be adapted to the respective location of the nidus in the patient in an optimum manner.

To compensate moments about the axis of rotation of the supporting plate, the radially mounted support is preferably adapted to hold counterweights.

A further feature of the present invention is that the collimator is connected with the neutron generator by means of a connecting tube brought through an opening in the supporting plate, the length of the connecting tube being such that no tilting moment can result in the bearing plane of the supporting plate from the weights of the collimator, the neutron generator and the high voltage generator. A tooth ring is preferably provided at the outer periphery of the supporting plate to rotate the supporting plate, a pinion drive engaging thereinto.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a partially cross-sectional elevational view of a neutron radiation treatment apparatus incorporating the present invention.

FIG. 2 is a cross-sectional view of the neutron radiation apparatus shown in FIG. 1 taken along line 2—2 of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 1, an exemplary embodiment of a neutron radiation treatment apparatus incorporating the present invention includes a collimator 1, a neutron generator 2 and a high voltage generator 3, all being arranged on a support 6 and rigidly connected together. The support 6 is displaceably, radially mounted on and is held by a supporting plate 9 which is mounted in a ball bearing 8 and is driven by means of a drive 10 and a pinion 11 which engages in a toothed ring 12 provided at the outer periphery of the supporting plate 9.

A patient supporting treatment table 4 is held on a base 5 and is adjustable in a conventional manner, vertically as well as horizontally. The treatment table 4 is disposed below the collimator 1 which is rigidly connected with the support 6 via a connecting tube 15. A radiation tube 16 is disposed within the connecting tube 15 and a target 7 is disposed on the end of the radiation tube 16 which is opposite the neutron generator 2. On the target 7, for example a tritium target, deuterium ions which were accelerated within the neutron generator 2 impinge and produce neutrons according to the nuclear reaction ${}^3_1\text{T} (d,n) {}^4_2\text{He}$ whose energy is substantially 14 million electron volts. The neutron radiation emanating from the target 7 disposed in a central cavity of collimator 1 is shielded due to the multilayer construction of the collimator 1 except for a useful beam exiting from a conical aperture 20 which is directed toward a patient or the like lying on the treatment table 4.

Different aperture inserts (not shown) of different sizes may be inserted into the aperture 20 to vary the radiation field.

In order to be able to unmount the target 7 which is disposed in the interior of collimator 1, for example for the purpose of exchange, the collimator 1 is provided with an opening 19 which can be closed by means of a shielding block 18.

The support 6 on which the high voltage generator 3, the neutron generator 2 and the collimator 1 are disposed is radially displaceable on the supporting plate 9 by means of a columnar guide arrangement consisting of, for example, two parallel columns 14 which are fastened to the supporting plate 9 and guide sleeves 13 fastened to the support 6. The support 6 can be displaced with respect to the supporting plate 9 with the aid of a spindle 21 which engages in a threaded bushing 23 associated with the support 6, a pinion 22 fastened to a shaft of the spindle 21 being driven by a drive (not shown). A high voltage cable 24 leads from the high voltage generator 3 to the neutron generator 2, and a cover 26 is fastened to the inner ring of the ball bearing 8.

Since, according to the present invention, the arrangement of the high voltage generator 3, the neutron generator 2 and the collimator 1 is so selected that the collimator 1 is disposed on the one side of the support-

ing plate 9 and the high voltage generator 3 as well as the neutron generator 2 are disposed on the other side of the supporting plate 9, tilting moments acting in the plane of the ball bearing 8 can be readily compensated.

For this purpose, it is only necessary to dimension the axial length of the connecting tube 15, which is brought through an opening 27 in the supporting plate 9, so that the moment resulting from the weight of the collimator 1 and its distance from the bearing plane of the supporting plate 9 is equal to the moment resulting from the weights of the neutron generator 2 and the high voltage generator 3 and their distances from the bearing plane of the supporting plate 9. An additional possibility for compensating moments is to provide receptacles for counterweights 25, generally designated by the numeral 25 in the support 6. With these counterweights 25 it would also be possible to realize and at least partial equalization of the moments resulting from the individual weights about the axis of rotation of the supporting plate 9.

The collimator 1, the neutron generator 2, the high voltage generator 3, and the treatment table 4, as well as the remaining parts of the neutron radiation treatment apparatus, are desirably housed within an enclosure defined by a floor 28, a ceiling 29, and end wall 30 and a pair of side walls 31 and 32, side wall 32 being shown in FIG. 2. The enclosure may desirably provide shielding and include a second end wall (not illustrated). As shown in FIG. 1, the base 5 is supported conventionally by an upstanding portion of the floor 28.

Referring to FIG. 2, the collimator 1 is shown, in solid lines, directly above the treatment table 4 which is supported on the base 5. A treatment beam, generally designated by the dashed lines 33, extends from the collimator 1, towards the treatment table 4. The side walls 31 and 32, the ceiling 29 and the floor 28 are shown.

The collimator 1, may be displaced along an arc of approximately 105° either to the left or to the right so as to occupy any position along the total arc of 210° ; the end positions of the collimator 1 being illustrated respectively, in phantom, at the numerals 1' and 4'.

In the illustrated embodiment of the present invention the neutron treatment apparatus is intended only for stationary field and pendulum radiation with an angle of rotation of approximately 210° ; it is, however, just as possible to design the radiation apparatus of the present invention for angles of rotation of $n \times 360^\circ$. In this case the base 5 of the treatment table 4 would merely have to be disposed outside of the range of the angle of rotation of the collimator 1, possibly by cantilevering the base 5 from the vertical wall 30 of the shielding walls (FIG. 1) and sufficient room would have to be made available available the collimator 1 to rotate.

The possibility of radial displacement of the unit consisting of the high voltage generator 3, the neutron generator 2 and the collimator 1 at the supporting plate 9 makes possible adjustment of the distance of the radiation source (target 7) from a patient or the like even for rotational field radiation so that, for example, in spite of the aperture inserts for the collimator 1 being available commercially only in graduated sizes, the radiation field can be continuously adjusted at the location of the radiation by changing the distance between the target 7 and the treatment table 4.

The current supply for the high voltage generator 3, in accordance with the present invention, produces no difficulties contrary to the high voltage input for the neutron generator 2, since a conventional low volt cable can be used which can be made to be relatively flexible. For an embodiment of the radiation apparatus for rotary field radiation, with angles of rotation of $n \times 360^\circ$, a conventional slip ring arrangement could be provided.

It will be understood that the above description of the present invention is susceptible to various modifications, changes and adaptations, and the same are intended to be comprehended within the means and range of equivalents of the appended claims.

We claim:

1. In a neutron radiation treatment apparatus composed of a high voltage generator, a neutron generator connected to be supplied by the high voltage generator, and a collimator arranged to form rays from the generator into a beam, the improvement wherein said high voltage generator, said neutron generator and said collimator are rigidly connected together and said apparatus comprises a rotatably mounted supporting plate said high voltage generator and said neutron generator being fastened on the side of said supporting plate and said collimator being fastened on the other side of said supporting plate, whereby stationary field, pendulum field and rotational field radiation may be effected selectively.

2. The apparatus as defined in claim 1 further comprising support means which is radially displaceably mounted on said supporting plate and on which said generators are disposed.

3. The apparatus as defined in claim 2 wherein said collimator is disposed on said support means.

4. The apparatus as defined in claim 2 further comprising columnar guide means holding said support means on said supporting plate.

5. The apparatus as defined in claim 4 further comprising a threaded bushing on said support means and spindle means, mounted on said supporting plate and disposed parallel to said columnar guide means, said spindle means engaging said threaded bushing.

6. The apparatus as defined in claim 5 further comprising drive means for driving said spindle means.

7. The apparatus as defined in claim 2 further comprising counterweight means attached to said support means.

8. The apparatus as defined in claim 1 wherein said supporting plate is provided with an opening and further comprising a connecting tube extending through said opening and via which said collimator is connected to said neutron generator, said tube having a length such as to prevent the occurrence of any tilting moment in the bearing plane of said supporting plate due to the weights of said collimator and generators.

9. The apparatus as defined in claim 1 further comprising toothed means at the outer periphery of said supporting plate, and a pinion drive means engaging said toothed means for rotating said supporting plate.

10. The apparatus as defined in claim 1 further comprising a treatment table arranged to be stationary and to support the treatment subject during treatment and disposed in the path of the beam from said collimator.

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