This invention relates to apparatus for housing radioactive material and more particularly to heads for medical therapy which heads utilize nuclear energy as the energy source.

In recent years much ray energy therapy treatment, particularly of cancer, has been performed with apparatus which utilize radioactive isotopes as energy sources. One such apparatus is described in detail in the United States Patent No. 2,844,736 issued July 22, 1959, to Johns and McKay, and entitled “Collimator for High Energy X-Ray Beam.” In the device of that patent a radioactive source material is stored near the center of the head. The material is moved from the storage position to a position adjacent a window, which is pervious to ray energy for the therapeutic treatment to be made. The emitted energy is emitted in a beam through the use of a shielding adjustable collimator.

In other devices shielding cones have been used. Usually these cones are removably connected to a head. A cone of appropriate size and shape is selected for each treatment of a patient. An adjustable collimator is a mechanism which is quite convenient for most treatments because it is permanently connected to a head and may be adjusted to change the shape of the beam. However, a collimator has certain disadvantages for certain selective types of therapy, primarily because the adjustable structure results in a bulkier structure with the attendant problems where width imposes a space limitation.

A collimator is particularly a disadvantage in therapy such as treatment of the head and/or neck. Therefore, where it is desirable to place the source quite close to the patient and where width is a limitation, cones are used. It has been the practice to use one machine for a collimator and another with interchangeable cones. With this invention the same machine uses both a collimator and interchangeable cones.

Although this invention was developed primarily for medical use, it is also equally applicable to many industrial uses where it has been practiced to use the X-ray field, including industrial radiography and irradiation.

With the present invention control of beam size, ease of operation and versatility of use of such a head are greatly enhanced. These advantages are obtained by providing a radiant energy head with a plurality of ray energy pervious windows in the form of apertures and a novel arrangement for selective positioning of a radioactive source adjacent each such window. At least one window has a coating collimator and at least one window has coating interchangeable cones.

Therefore, one of the principal objects of this invention is to provide a multiple windowed head for storage and control of radioactive materials.

Another object of this invention is to provide a device which will allow selective positioning of radioactive material in a stored position or positioned to emit radiation from one of a plurality of windows.

Another object of this invention is to provide a medical therapy head which has two exposure ray energy windows and contains a quantity of radioactive material which may be selectively positioned, one at a time, adjacent the windows. The head also includes a provision for shielded storage of radioactive material.

A further object of the invention is to provide a ray energy head made in accordance with the foregoing objects in which a collimator is secured to the head in alignment with one window, and cones are removably securable to the head in alignment with the other of the windows.

Other objects and a fuller understanding of the invention may be had by referring to the following description and claims taken in conjunction with the accompanying drawing in which:

FIGURE 1 is a sectional view of the apparatus; and,

FIGURE 2 is a sectional view of a portion of the apparatus as seen along the plane designated by line 2—2 of FIGURE 1.

Referring now to the drawing, a yoke 5 which may be supported by a suitable stand, not shown, supports a head shown generally at 8. The head is trunnionned at 9 for rotation relative to the yoke 5.

The head 8 includes a somewhat tear-drop shaped housing 10. The housing 10 has an internal chamber 11 which is generally circular in cross section. A first and larger ray energy window aperture 12 extends transversely through the wall of the housing 10. A second and smaller ray energy window aperture 13 extends through the opposite wall of the housing 10. The windows 12, 13 are in axial alignment with one another and circumferentially spaced 180°.

A suitable collimator 18 and interchangeable cones 19 are secured to the housing 10 for control of beam size.

In the preferred and disclosed embodiment and as best seen in FIGURES 1, the collimator 19 is adjustable for controlling the size of the beam of radiation which may be obtained through the large aperture 12. The illustrated cone 19 is for controlling the beam of radiation which may be obtained through the smaller aperture 13. The illustrated cones are for treatment of a head or neck where short source to target distances are required.

Selective positioning radioactive material at either aperture, or safely shielding it at the center of the housing, is accomplished in a new and unique manner.

A segment of a ring-gear 14 is carried by the housing 10 and has a plurality of teeth which extend into the internal chamber 11. The teeth are radially disposed and substantially normal to the axis of the chamber. In the preferred and disclosed embodiment the teeth 15 are located circumferentially over a distance of about 200°. A non-secured, large, cylindrical shield wheel 20 is disposed in the chamber 11 and substantially fills such chamber. The shield wheel 20 is rotatable about its axis 23. The axis 23 is coincident with the axis of the internal chamber 11. The shield wheel 20 has an internal cavity 21 which is generally cylindrical in shape. The internal cavity is positioned eccentrically in the member 20 and extends from the axis 23 to an elongated opening 22 in outer periphery 24 of the inner member 20.

A geared small, cylindrical source wheel 30 is positioned in the internal cavity 21 of the shield wheel 20. The source wheel 30 is about half the diameter of the shield wheel 20. Thus, the source wheel 30 has an axis 33 which is coincident with the axis of the cavity and located about half the distance between the axis 23 and the shield wheel outer periphery 24. The source wheel 30 is rotatable on its own axis 33 and orbitable about the axis 23 of the shield wheel 20. The source wheel 30 has a space 32 near its outer surface to carry a source or "slug" of radioactive material 36.

A ring gear 31 connected to it. The ring gear 31 has a plurality of teeth 34 located circumferentially 360°. The teeth 34 are shaped and positioned to mesh with the teeth 15 of the ring gear segment 14. The ring gear 31 has half the diameter of the segment 14 and therefore the same number of teeth.
over its entire 360° circumferential span as the ring gear segment 14 has over 180° span. A drive shaft 40 is provided which is drivingly connected to the shield wheel 20 to be able to drive it to rotate about its axis 23. A motor, shown schematically at M, is mounted on the housing 10 and is drivingly connected to the drive shaft 40.

**Operation**

Operation of the device can best be understood by tracing the movement of each of the parts as the shield wheel 20 is rotated. Referring now to FIGURE 1, radioactive material 36 in the space 32 is shown aligned with the large window 12. In such a position, ray energy from the radioactive material 36 passes through the large window 12, and then through the collimator 13, emerging as a collimated beam. To change the device to an "off" or "safe" position, the shield wheel 20 is rotated in a counterclockwise direction as seen in FIGURE 1. As the shield wheel rotates in a counterclockwise direction on its axis 23, the axis of the internal cavity 21 orbits counterclockwise about the axis 23. Since the source wheel 50 is confined to the cavity 21, the axis 33 of the source wheel 30 must orbit with the axis of the internal cavity 21 of the shield wheel 20. Hence, the source wheel 30 will orbit counterclockwise about the axis 23 of the shield wheel 20. The interaction of the teeth 13 of the segment of a ring gear 14 and the teeth 34 of the inner ring gear 31 will cause the source wheel 30 to also rotate counterclockwise about its own axis 33. Since the ring gear 31 has the same number of teeth over 360° as the ring gear 14 has over 180°, when the shield wheel 20 has been rotated on its axis 90°, the source wheel 30 will have rotated 90° about its own axis 33 and simultaneously orbited 90° about the axis 23 of shield wheel 20. The combination effect of the orbiting and rotating of the source wheel 20 is to move the radioactive material along the diameter of the outer housing 10 extending from the first aperture 12 to the second aperture 13. Rotation of the shield wheel 20 through 90° will shift the source space 32 to a location on the axis 23 of the shield wheel 20. Thus, the effective thickness of shielding for the radioactive material 36 when in the off position is the distance from the axis 23 of the shield wheel 20 to outside of the housing 10. The housing 10, the shield wheel 20, and the source wheel 30 all combine to provide complete and uniform shielding surrounding the source.

If the rotation of the shield wheel 20 is continued in the counterclockwise direction, the source wheel 30 will continue to orbit about the axis 23 of the shield wheel 20. Also, the source wheel 30 will continue to rotate upon its own axis 33. If the rotation of the shield wheel 20 is continued in a counterclockwise direction, as seen in FIGURE 1, 90° from the off position, the source wheel 30 will again rotate 90° on its own axis 33 and orbit 90° about the axis 23 of the shield wheel 20; and thus the source 36 will be moved along the diameter of the housing until it is aligned with the opening 22 and the smaller aperture 13. The position of the cavity 21 in this position is shown in phantom in FIGURE 1.

While the invention has been described with detail, it will be seen that it essentially comprises a therapy head in which the radioactive material may be selectively positioned one at a time at either a large or small aperture or at an off position. The selection is obtained by mounting a smaller circular source member in an eccentrically located circular cavity in a larger circular member of about double the diameter of the smaller, and providing a mechanical means to position the smaller member to rotate as it orbits due to rotation of the larger.

Although the invention has been described in its preferred form with a certain degree of particularity, it is understood that the present disclosure of the preferred form has been made only by way of example and that the numerous changes in the details of construction and the combination and arrangement of parts may be resorted to without departing from the spirit and the scope of the invention as hereinafter claimed.

What is claimed is:

1. In a ray energy device having a support and a windowed head trunnioned on the support, the combination of, a shield wheel journaled in the head, a source wheel journaled in the shield wheel and having an axis spaced from and parallel to the axis of the shield wheel, said source wheel including a space to carry a radioactive source, gear means interconnecting the head and the source wheel, and drive means connected to one of the wheels to rotate the shield wheel relative to the head and simultaneously cause the source wheel to rotate in the opposite direction whereby to position the source wheel.

2. The device of claim 1 wherein the diameter of the shield wheel is about two times the diameter of the source wheel.

3. In a ray energy device having a support and a head trunnioned on the support, the combination of, the head having a pair of radiation pervious windows, a shield wheel journaled in the head, a source wheel journaled in the shield wheel and having an axis spaced from and parallel to the axis of the shield wheel, said source wheel including a space to carry radioactive source material, gear means interconnecting the head and the source wheel, and drive means connected to one of the wheels to rotate the shield wheel relative to the head and simultaneously cause the source wheel to rotate in the opposite direction and orbit about the axis of the shield wheel, said source wheel having a storage position and first and second exposure positions adjacent the windows, and said source wheel being movable from the storage position to the first exposure position by rotation in one direction and to the other exposure position by rotation in the other direction.

4. A ray energy device having a support and a head trunnioned on the support, the head having an internal chamber and a plurality of apertures in communication with the chamber, shielding means including first and second internal members disposed in said chamber, one of said internal members having a radioactive source material space, said one member being rotatable and orbitable to position said space in any of said apertures at a time, said one member having a position wherein said space is shielded by the other member and itself, and means connected to said first member to cause said first member to orbit and rotate simultaneously and selectively from one position to another.

5. A ray energy device for selectively exposing and shielding radioactive material, comprising, a housing, said housing having an internal chamber, said housing having two apertures in communication with said chamber, said apertures being spaced circumferentially 180° and axially aligned, shielding means including a shield wheel and a source wheel disposed in said chamber, said source wheel carrying a quantity of radioactive material, said shield wheel being rotatable within said chamber, said source wheel being positioned in a cavity in said shield wheel and rotatable therein, said cavity having an opening in communication with said chamber, said cavity having an axis eccentric with respect to the axis of the shield wheel in which it is formed, said source wheel being orbitable about the axis of rotation of said shield wheel, said radioactive material having a first position wherein it is aligned with one of said apertures, a second position wherein it is aligned with the other said aperture, and a third position wherein the shielding means surrounds said radioactive material, and said source wheel being positioned in said cavity in said shield wheel by rotation of said shield wheel.

6. A ray energy device for selectively exposing and shielding radioactive material, comprising, a head, said head having a generally cylindrical interior chamber, said head having first and second apertures in communication with said chamber, said apertures being spaced 180° from
each other and axially aligned, said head including a segment of a first ring gear with teeth projecting into said chamber, said teeth extending circumferentially at least 180°, a shielding wheel rotatably positioned in said chamber, said shield wheel substantially filling said chamber, said shield wheel having an internal cavity eccentrically disposed and running generally parallel to its axis, said cavity extending from the axis of the shield wheel to its outer periphery and terminating at an elongated opening, a source wheel rotatably disposed in said cavity, said source wheel being generally cylindrically shaped, a second ring gear circumferentially said source wheel, said first and second ring gears being meshed, said second ring gear having the same number of teeth around 360° as the first ring gear has around 180°, said source wheel being orbital about the axis of rotation of the shield wheel, said source wheel having a radioactive source material space near its surface, said source material space being selectively positionable adjacent said first and second apertures and adjacent the portion of the cavity aligned along the axis of the shield wheel one at a time by rotation of the shield wheel.

7. The device of claim 4 wherein said one member may be rotated and orbited from the storage position to either one of the aperture positions and return, and wherein the one member passes through the storage position when rotated and orbited from one aperture position to the other.

8. In a mechanism for selectively emitting a radiant energy beam the combination of, a head member including an internal chamber and at least one communicating beam transmitting aperture, a shield wheel journaling in the head member and disposed within the chamber, a source member carried by the shield wheel and journaling thereon for relative rotation, at least a segment of an internal gear connected to one of the members, another gear connected to the other of the members and meshing with the internal gear, said source member including means to carry a quantity of radioactive material, and means to rotate the shield wheel and source member relative to the head and thereby cause the gears to cause relative rotation of the shield wheel and source member to shift the material carrying means from a storage position to an exposure position aligned with the aperture and to return the material to the storage position.

9. The device of claim 8 wherein the internal gear is carried by the head member.

References Cited in the file of this patent

UNITED STATES PATENTS

<table>
<thead>
<tr>
<th>Patent Number</th>
<th>Invention</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,058,826</td>
<td>Reece</td>
<td>Oct. 27, 1939</td>
</tr>
<tr>
<td>2,477,648</td>
<td>Piggot</td>
<td>Aug. 2, 1949</td>
</tr>
<tr>
<td>2,844,736</td>
<td>Johns et al.</td>
<td>July 22, 1958</td>
</tr>
<tr>
<td>2,866,905</td>
<td>Yeomans</td>
<td>Dec. 30, 1958</td>
</tr>
<tr>
<td>2,872,587</td>
<td>Stein</td>
<td>Feb. 3, 1959</td>
</tr>
<tr>
<td>2,950,394</td>
<td>Stava et al.</td>
<td>Aug. 23, 1960</td>
</tr>
</tbody>
</table>