Jan. 15, 1963 R. L. GUENTNER ETAL 3,073,960

TELETHERAPY DEVICE

Filed July 14, 1958

2 Sheets-Sheet 1

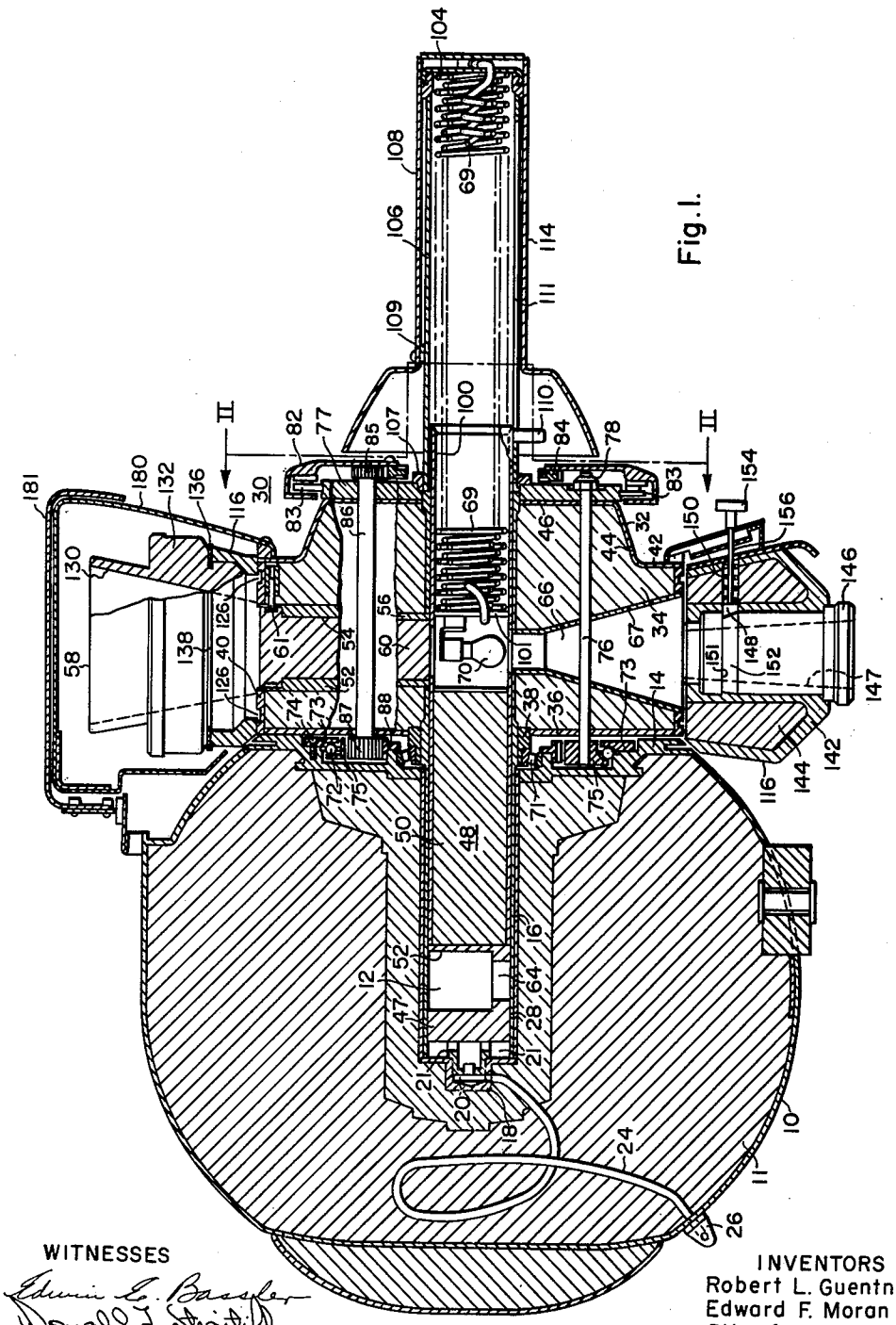

Fig. 1.

WITNESSES

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2 Sheets-Sheet 2

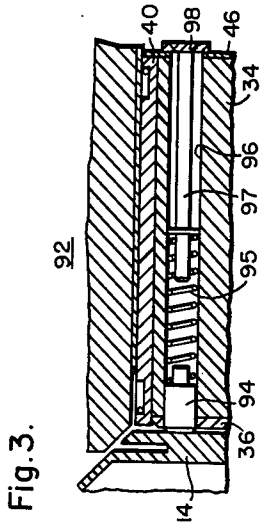

Fig. 3.

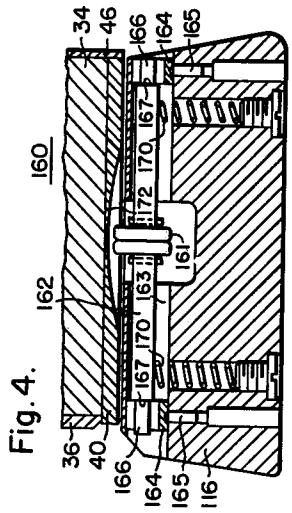

Fig. 4.

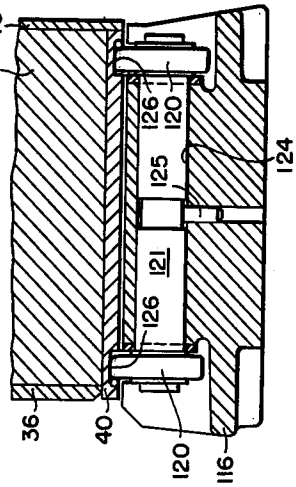

Fig. 5.

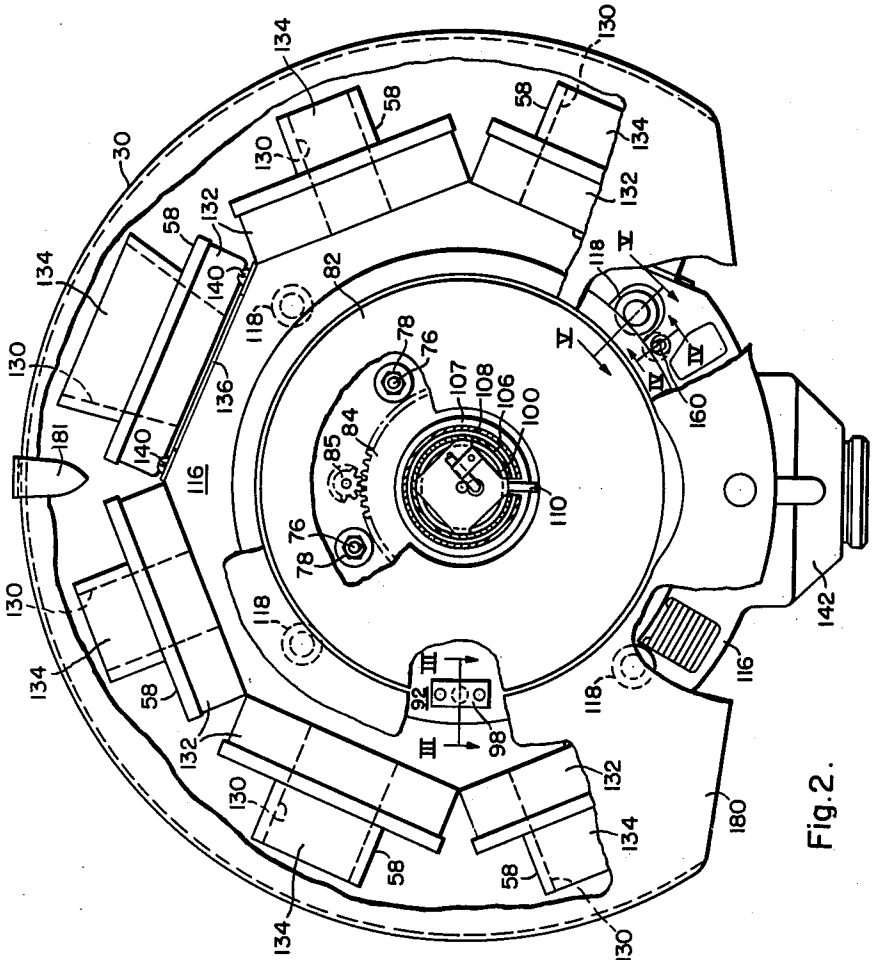

Fig. 2.

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TELETHERAPY DEVICE

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This invention relates to shielded teletherapy devices for holding a source of radioactive material and directing a beam of radiant energy therefrom for the treatment of disease; and more particularly to such source holder devices as provide for regulation in the size and pattern of the radiation beam to suit different areas of exposure of patients undergoing treatment.

Certain prior art source holder devices of the above general type have employed adjustable field collimators in the form of heavy interleaved sliding blocks for shielding material which may be operated like a diaphragm to control the extent of opening of a beam emergence aperture. Such collimators are inherently expensive and limited as to beam shape. Another prior art source holder device employs various-sized heavy-walled hollow beam collimator members, or cones, which are handled manually for substitute mounting on the device. This particular cone-substitution arrangement, while enabling selection of both beam size and pattern, involves considerable work and effort on the part of operating personnel since each of the cones which must be handled may weigh as much as fifty pounds and an exchange of cones to a different size is usually necessary before each treatment.

In view of the foregoing remarks, it becomes a prime object of the present invention to provide an improved radioactive source material holder of the type which enables regulation of the size and pattern of the radiation beam in a simple and facile manner.

Another object of the present invention resides in the provision of an improved radioactive source material holder which carries a plurality of cones of radiation absorbing material arranged to be rendered effective selectively for regulation of the size and/or pattern of the radiation beam.

Another object of the present invention resides in the provision of a radioactive source material holder having a plurality of radially disposed cones arranged for rotary movement in unison about a central source station to bring selected ones of such cones into registry with a beam emergence aperture originating at such source station.

Another object of the present invention resides in the provision of a radioactive source material holder having means defining a central guideway along which the source material may be moved from a non-operative position at a repose station to an operative position at the central source station within the cone assemblage.

Another object of the present invention resides in the provision of a radioactive source material holder having a radial cone assemblage provided with manually-operable means to effect rotary movement of such assemblage for accurate orientation of the radiation beam emergence aperture and maintenance of a selected position.

Other objects and advantages of the invention will become apparent from the following detailed description of such invention when taken in connection with the accompanying drawing, in which:

FIGURE 1 is a side sectional view, several components being in outline, of the source material holder embodying the invention;

FIG. 2 is a front view, substantially in outline and partly in section, of the source material holder taken along the line II—II in FIG. 1, with portions cut away to expose certain components;

FIG. 3 is a fragmentary sectional view, taken along the line III—III in FIG. 2, showing details of a friction assemblage employed in the source material holder;

FIG. 4 is a fragmentary sectional view, taken along the line IV—IV in FIG. 2, showing details of a detent structure employed in the source material holder; and

FIG. 5 is a fragmentary sectional view, taken along the line V—V in FIG. 2, showing details of a roller structure employed in the source material holder.

The source holder embodying the invention is primarily, though not necessarily, intended for employment with a cobalt-60 source, and to provide adequate shielding with minimum bulk includes a generally spherically shaped hollow metal container 10 filled with lead 11 in which is centrally located a source capsule 12 when in a non-operative position at a repose station. One end of the container 10 is blunt and enclosed by a substantially disc-shaped front wall 14 to which is attached a cylinder member 16 extending inwardly of container 10 centrally of wall 14. An end member 18, attached to the innermost end of the cylinder member 16, is provided with a fluid pressure port 20 to enable ingress and egress of fluid under pressure to and from a pressure chamber 21 via a conduit 24 and external fitting 26 for actuation of the source capsule 12 in manner as will be set forth in detail hereinafter.

A hollow cylinder member 28 is rotatably mounted in cylinder member 16 to act as a cylindrical guideway for directing movement of the source capsule 12 from its repose position in which it is shown in FIG. 1 to an operative position hereinafter defined, and to define the hub of a novel radiation emergence portion 30 of the source holder.

The radiation emergence portion 30 includes a substantially cylindrical metal shell 32 filled with lead 34, the central portion of shell 32 being defined by an extension of the cylindrical member 28 which is attached to such shell by means such as welds (not shown). An end of the shell 32 adjacent to front wall 14 of container 10 is defined by an annular end wall 36 and bearing race support member 38 encircling member 28, each component being attached suitably one with the other to provide a fluid tight container adapted for holding the lead 34 when introduced initially in its molten state. The periphery of the shell 32 is defined by an elongated ring member 40, and the outer end of such shell is defined by a portion including an annular flange 42 attached at its outer periphery to ring member 40, an integral frustro-conical portion 44 and annular end wall 46 attached at its inner periphery to cylinder member 28.

The source capsule 12 is carried in an end portion 47 of an elongated piston member 48, such end being of steel, for example, and the remainder being filled with lead 50. End portion 47 of piston 48 is provided with a cylindrical socket 52 adapted for registry, in a displaced position of piston 48, with an aperture 54 defined by a sleeve member 56 associated with portion 30 and extending radially outward from corresponding apertures in cylinder member 28 at its inner end and in ring member 40 at its outer end. Registry of socket 52 with sleeve member 56 enables the source capsule 12 to be inserted and removed into and from such socket via aperture 54 either by way of the interior of one of a plurality of removable lead cones 58, to be described subsequently, or directly by way of the sleeve member 56 with the respective cone 58 removed. A lead plug 60, removably secured by a set screw 61, normally fills the aperture 54 subsequent to insertion of the source capsule 12 into socket 52. An emergence port 64 opens from the socket 52 radially of piston member 48 for registry with a tapered radiation emergence aperture 66 formed by a

hollow member 67 extending radially from cylinder member 28 and sleeve member 40 for emergence of radiation from capsule 12 to the exterior of the source holder when the piston member 48 is fluid pressure actuated to attain such registry.

A return spring assemblage 69 is arranged to return the piston assemblage 48 to the repose position in which it is shown in FIG. 1 with source capsule completely shielded. In such repose position, a source of visible light in the form of a bulb 70 is brought into registry with the emergence aperture 66 to provide for focusing such aperture by visible light with the target area of a patient to undergo teletherapy.

To enable the emergence portion 30 and piston member 48 to be turned about the axis of such piston member for selective orientation of the radiation emergence aperture 66 while at the same time relieving the hollow cylinder member 28 of the load of such portion and providing a relatively frictionless rotary connection, a tapered roller bearing assemblage 71 is interposed radialwise between bearing race support member 38 and a portion of wall 14 of container 10, and a ball type thrust bearing assemblage 72 extends radialwise in interposition between wall 14 and such portion 30. An outer raceway 73 of assemblage 72 is removably secured by screws 74 to wall 14, and the inner raceway 75 of assemblage 72 is attached to a plurality of bolts 76 which extend through portion 30, including an annular end member 77 attached to end wall 46 of such portion 30. By means of nuts 78, the portion 30 is removably attached to container 10 through the medium of the bolts 76 and thrust bearing assemblage 72.

To enable accurate and facile rotary movement of the beam emergence portion 30, relative to container 10, a handwheel 82 is provided which is rotatably supported on the outer periphery of end member 77 through the medium of rollers 83 and is connected to container 10 through a gear train. The gear train includes a large ring gear 84 attached to handwheel 82, an engaging small gear 85 attached to one end of a rotatable shaft 86 journaled in end member 77 and extending through lead 34 and end wall 36, a gear 87 attached to the opposite end of shaft 86, and a gear 88 attached to the front wall 14 of container 10. An idler gear, not shown, may be suitably arranged in such gear train where it is desired to change the directionality relationship between rotary movement of shell 32 and that of the handwheel 82. It will be apparent by reference to FIG. 2, that turning movement of shaft 86 around its own axis through the medium of handwheel 82 and gears 84, 85 will cause gear 87 to roll around gear 88 and carry such shaft 86 and shell 32 with it, thereby turning the emergence aperture 66 about the axis of the piston member 48 which will also be turned correspondingly during the turning of cylindrical member 28 in which it is disposed.

To assure that the emergence portion 30 may not accidentally be moved from a selected rotary position relative to container 10, a friction assemblage 92, FIG. 3, is provided. The friction assemblage 92 includes a shoe member 94 urged by a spring 95 into sliding frictional engagement with the end face of front wall 14 of the container 10. Shoe member 94 and the spring 95 are disposed within a bore 96 extending in an axialwise direction through the metal shell 32 and the lead 34 with which it is filled. A removable spring seat member 97 extends into the bore 96 for compressive engagement with the spring 95, and a removable securing member 98 is attached to spring seat 97 and mounted on the outer face of end wall 46 of the shell 32 for access to the bore 96 and the components disposed therein.

The spring assemblage 69 extends into the end of a hollow extended portion 100 of piston member 48 and into contact at its one end with an interior wall 101 of the piston member. The opposite end of the spring assemblage is in thrust engagement with an end wall 104 of a cylindrical spring container 106 which is attached at a flanged end 107 to the end member 77. A cover 108, attached at 109 to spring container 106, encases same and covers a substantial front portion of the handwheel 82 primarily to enhance the appearance of the source holder.

A tab 110, attached to the end of the hollow extended portion 100 of piston member 48, extends radially outward therefrom through a longitudinal slot 111 in spring container 106. During rotary movement of the emergence portion 30 by manipulation of the handwheel 82 for orientation of the radiation emergence aperture, the spring container 106 attached to end member 77 will turn in unison with the shell 32, and through contact of a side wall of the slot 111 with the tab 110, turning of the piston member 48 in unison with portion 30 for proper registry of emergence ports 64 and 66 in unison with portion 30 will be assured. In addition, an elongated slot 114 in registry with slot 111 is formed in the cover 108 for accommodation of the tab 110 during fluid pressure actuation of the piston member 48 to enable the tab 110 to project outwardly therefrom to serve as indication that the source capsule 12 is in its operative position at the radiation emergence aperture 66. Upon return of the piston member 48 to its repose position in which it is shown in FIG. 1, the tab 110 will become disposed within cover 108 to indicate that the source capsule 12 is disposed in its fully shielded inoperative position.

The spring assemblage 69, in addition to its normal piston-returning function, represents a fail-safe arrangement to assure return of the piston member 48 automatically, should pressure of fluid in the source (not shown) supplying chamber 21 become depleted accidentally at a time when the piston member 48 was positioned for registry of source capsule 12 with the emergence aperture 66.

In accord with a prime feature of the invention, an emergence portion 30 is provided with a mounting ring 116 encircling shell 32 and mounted for rotary movement on the periphery of ring member 40 through the medium of a plurality of circumferentially spaced-apart roller assemblages 118, FIGS. 2 and 5, each of which includes, FIG. 5, a pair of rollers 120 rotatably mounted on a shaft 121 disposed in a bore 124 and locked by a set screw 125. Tracks in the form of grooves 126 are formed in the periphery of ring member 40 to guide the rollers 120 and retain the mounting ring 116 on such member.

Each of the lead cones 58 or beam collimator members has a beam emergence aperture 130, FIG. 2, extending axially therethrough, the several apertures of the various cones being of different sizes and/or shapes to define radiation beams suitable to the various treatment areas. Each cone 58 includes preferably a base portion 132 of standard outside dimensions and an extension portion 134 of shape and size respective to the particular aperture 130. The base 132 of each cone 58 includes a socket portion which fits in accommodating receptacles at circumferentially spaced-apart intervals around the mounting ring 116 and is locked in place by such as a split locking ring 136, FIGS. 1 and 2, fitted in a groove 138 in base 132, FIG. 2, and secured to ring 116 by screws 140, FIG. 2. The locking ring 136 is shown in FIG. 2 with respect to only one of the cones 58, however, it may be presumed that each of the cones 58 will be similarly secured to the mounting ring 116. It should be pointed out that the number of cones 58 carried by the mounting ring 116 is sufficiently great to satisfy the larger sized treatment areas encountered during employment of the source holder and the mounting of these cones may be considered to be permanent.

According to other important features of the invention, the mounting ring 116 is provided with a heavily-shielded integrally-formed cone portion 142 which is filled with lead 144 and is adapted to receive a relatively lightweight insert member 146 of radiation absorbing material, such as lead or bronze, having an aperture 147 to define the radiation beam where treatment areas reside in and

around a patient's throat, or neck, for example, and it is desirable to have available a relatively great number of smaller beam sizes and shapes. For this reason, a tapered latch member **148** is provided which is biased by a spring **150** into locking engagement with an annular shoulder **151** at the edge of a tapered groove **152** formed in the outer periphery of each of the insert members to be employed in cone portion **142**. During insertion of an insert member **146**, the latch member **148** will be displaced by the leading portion of member **146** until registry with groove **152** is attained, whereupon locking becomes automatic. To effect retraction of latch member **148** for removal of the insert member **146**, a pull may be exerted on a circular handle **154** which is attached to such latch member **148** via a rod **156**. Since the shielding is done primarily by the lead-filled portion **142**, the insert members **146** may be of relatively lightweight construction to reduce the burden involved in frequent exchange during respective employment of the device. The lead-filled portion **142**, is tapered or conical-shaped at its projecting end to enable it to easily be extended between such portions of a patient's anatomy as the head and shoulders in close proximity to treatment areas on the throat or neck with assurance that other areas will be exposed to a minimum amount of stray radiation.

Rotation of the cone assemblage to bring selected ones of the cones **58** or portion **142** into registry with the beam emergence aperture **66** is done manually by grasping, for example, one or the other of such cones and exerting a turning effort thereagainst. Detent means **160**, FIG. 4, is employed to define and yieldably lock the cone assemblage in positions with respect to ring member **40** corresponding to the registered position of selected ones of the cones **58**, including portion **142** of mounting ring **116**. Such detent means **160** includes a roller assemblage **161** mounted equidistant opposite ends of a rotatable shaft **162** which is contained with radial clearance in a cylindrical opening **163** in mounting ring **116**. Slotted retainer elements **164**, locked by set screws **165** accommodate reduced end portions **166** of the shaft **162** to permit turning of shaft **162** while serving to guide transverse movement of such shaft **160** and roller assemblage **161** and while cooperating with annular shoulders **167** on such shaft to prevent its escape from the opening **163**. The roller assemblage **161** is urged in the direction of the outer surface of ring member **40** to be in constant contact therewith, by a pair of compression springs **170** disposed in the mounting ring **116** and acting on the shaft **162**. A plurality of circumferentially spaced-apart recesses **172**, one of which is shown in FIG. 4, are formed in the outer periphery of ring member **40** for cooperation, one at a time, with the roller assemblage **161** which is urged thereinto when either a cone **58** or the portion **142** is brought into registry with the beam emergence aperture **66**. Each recess **172** is shaped to cooperate with the roller assemblage **161** for accurate definition and yieldable retention of the selected cone in its operative position in alignment with the beam emergence aperture **66**, while permitting such roller assemblage to ride up and out of such recess for enabling rotary movement of the cone assemblage when making cone selections.

Additional refinements of the source holder include the provision of a cover **180** which is carried by the mounting ring assemblage to rotate therewith during orientation of the beam emergence aperture **66** and enclose from view the inactive ones of the cones **58** or portion **142** as the case may be. To enable projection of portion **142**, in particular, and selected ones of the cones **58**, in general, the cover **180** is reduced in its radialwise dimension and open peripherally at the beam emergence station. A pointer **181**, attached to the container **10**, extends in front of the cover **180** to cooperate with indicating marks, not shown, to indicate the rotary position of the emergence aperture **66** with respect to such container.

Since numerous changes may be made in the above-described construction, and different embodiments of the invention may be made without departing from the spirit and scope thereof, it is intended that all matter contained in the foregoing description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

We claim as our invention:

1. A radioactive source holder comprising a rotatable shielded means having a radioactive-source-accommodating cavity for containing a source capsule and a radially-extending radiation emergence aperture for registry with said cavity, and a plurality of various sized and shaped collimator members encircling said shielded means and rotatable thereabout for selective radially-aligned registry with the radially-outermost end of said emergence aperture.

2. In a radioactive source holder, the combination of a rotatable generally cylindrical shielded member having a central radioactive source accommodating opening and radiation emergence aperture extending radially outward therefrom to the exterior of such member, and a plurality of circumferentially arranged collimator members mounted on said shielded member for movement circumferentially therearound to attain selected radially-aligned registry with the radially-outermost end of said radiation emergence aperture.

3. A radioactive source holder comprising first shielded means for containing a radioactive source capsule at a repose station and defining a shielded guideway along which said source capsule may be moved from such repose station, second shielded means defining an opening in registry with said guideway for receiving the radioactive source capsule and having a radiation emergence aperture extending radially outward from said opening, said second shielded means being mounted on said first shielded means for rotary movement about the axis of said opening to enable selective positioning of said radiation emergence aperture at different radial positions, and an assemblage of circumferentially arranged collimator members mounted in encirclement of said second shielded means and movable relative thereto for selective radially-aligned registry with said radiation emergence aperture.

4. A radioactive source holder comprising first shielded means for containing a radioactive source capsule at a repose station and defining a shielded guideway along which said source capsule may be moved from such repose station, second shielded means defining an opening in registry with said guideway for receiving the radioactive source capsule and having a radiation emergence aperture extending radially outward from said opening, said second shielded means being mounted on said first shielded means for rotary movement about the axis of said opening to enable selective positioning of said radiation emergence aperture at different radial positions, an assemblage of circumferentially arranged collimator members mounted in encirclement of said second shielded means and movable therearound for selective radially-aligned registry with said radiation emergence aperture, and detent means for defining stop positions of said assemblage coincident to attainment of registered positions of said collimator members with said radiation emergence aperture.

5. A radioactive source holder comprising first shielded means for containing a radioactive source capsule at a repose station and defining a shielded guideway along which said source capsule may be moved from such repose station, second shielded means defining an opening in registry with said guideway for receiving the radioactive source capsule and having a radiation emergence aperture extending radially outward from said opening, said second shielded means being mounted on said first shielded means for rotary movement about the axis of said opening to enable selective positioning of said radiation emergence aperture at different radial positions, manually operable means for effecting said rotary move-

ment, and an assemblage of circumferentially arranged collimator members mounted in encirclement of said second shielded means and movable relative thereto thereabout for selective radially-aligned registry with said radiation emergence aperture.

6. In a radioactive source holder, the combination of a rotatable generally cylindrical shielded member having a central radioactive source accommodating opening and radiation emergence aperture extending radially outward therefrom to the exterior of such member, a circular collimator assemblage mounted on said shielded member for movement circumferentially therearound, said collimator assemblage including a plurality of circumferentially arranged lead cones fixed thereto for selective radially-aligned registry with said radiation emergence aperture to define different radiation beams emerging from said holder, and at least one shielded socket interposed circumferential-wise between said cones for accommodating a removable lead insert member to define a beam size smaller than those provided by said cones.

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