

Sept. 1, 1964

R. J. PREST
APPARATUS FOR MANIPULATING RADIOACTIVE MATERIAL
TO AND FROM A STORAGE CHAMBER

3,147,383

Filed May 16, 1962

3 Sheets-Sheet 1

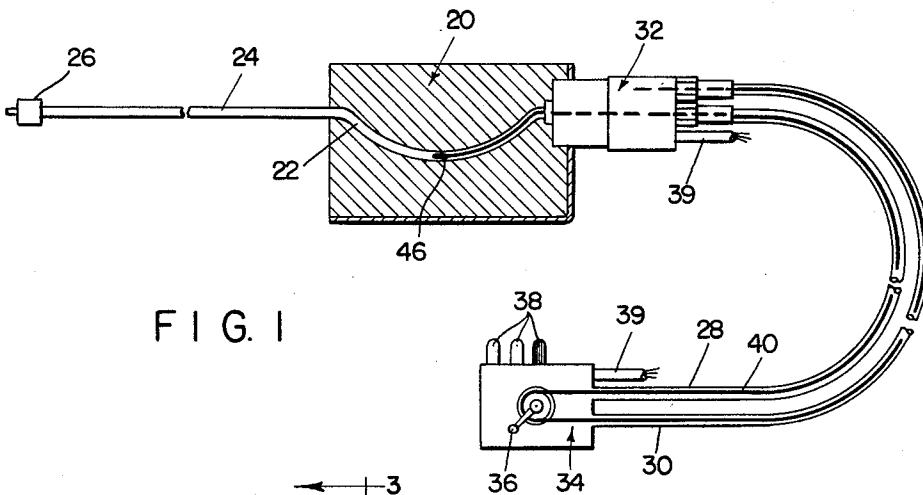


FIG. 1

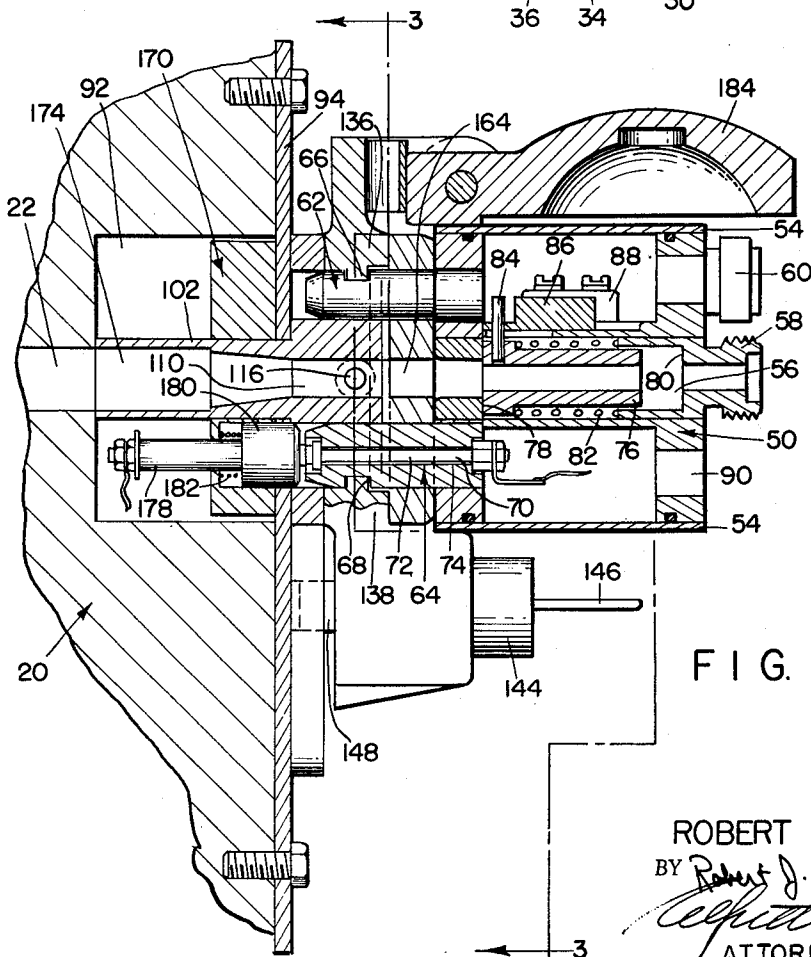


FIG. 2

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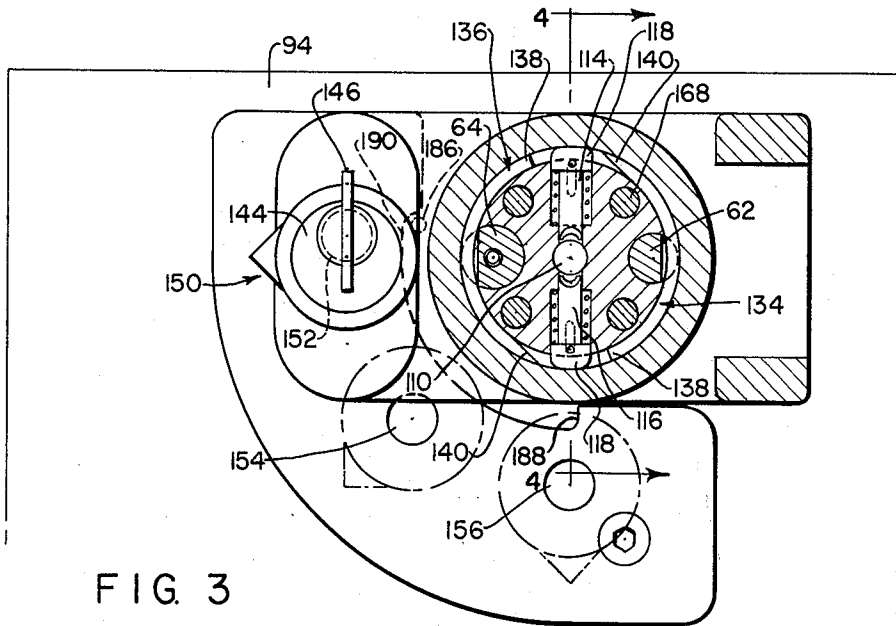


FIG. 3

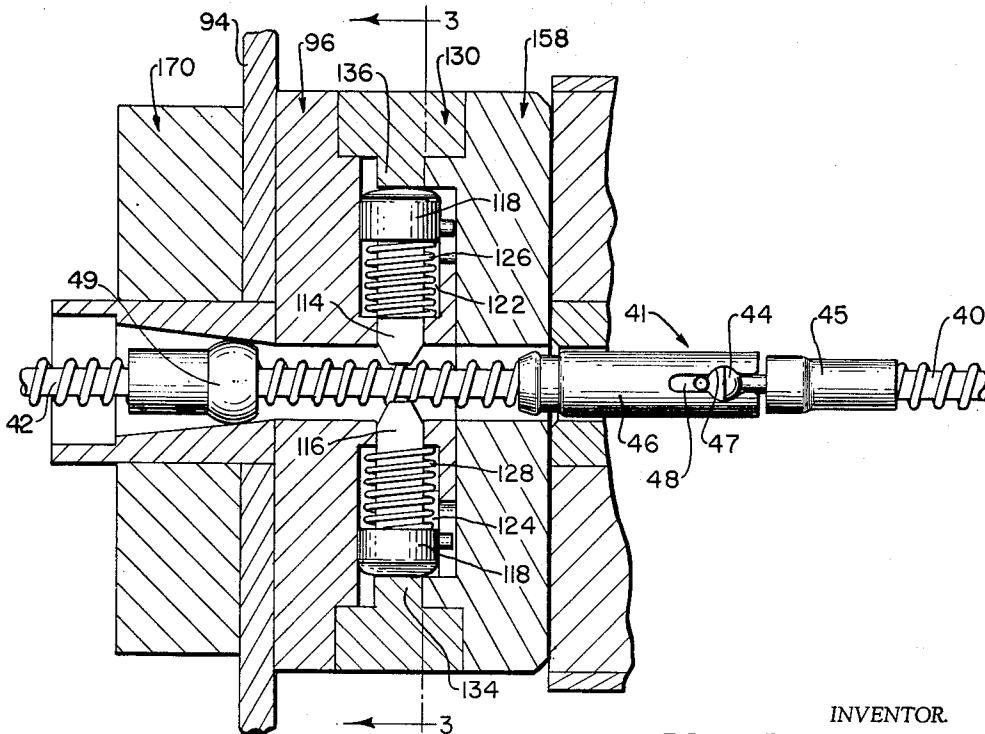


FIG. 4

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APPARATUS FOR MANIPULATING RADIOACTIVE MATERIAL TO AND FROM A STORAGE CHAMBER

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The present invention relates to radiography and more particularly to devices for manipulating radioactive materials.

Present practices in radiography employ a storage body made of radiation-shielding material, such as lead, having a bore therein in which a radioactive source, usually a capsule of radioactive material, may be stored. Means are provided for moving the capsule between storage and a location in a radiographic exposure device or snout. Typically, as shown in detail in U.S. Patent No. 2,916,628 issued December 8, 1959, to R. J. Prest, such means take the form of a flexible conduit coupled to the bore of the storage body, an elongated flexible element such as wire rope or cable coupled to the capsule, and means such as a reel for moving the cable so as to propel the capsule through the conduit between the two extreme positions at the snout and the storage body. This construction allows for manipulation of the capsule between its extreme positions by an operator stationed at a point remote from the path of the capsule.

In radiographic applications, for example on ship-board, the cramped quarters and complex construction of the ship necessitate snaking the control cables of the manipulating device through congested spaces. Where the control cables are not readily and safely detachable from the source and the storage body, it is necessary to attempt extension of the cables and their conduit by passing the bulky reel through those spaces, a difficult and sometimes impossible procedure.

The present invention, therefore, has as a principal object, the provision of novel means for coupling and uncoupling manipulating devices from shielding bodies. More particularly, objects of the present invention are to provide means whereby control cable and associated conduit can be easily and quickly coupled and uncoupled respectively to a radioactive capsule and to the storage body in which the capsule is encased; to provide such a means which cannot be uncoupled without authority; to provide means thus described whereby exposure of the capsule cannot be made without authority; to provide such a means which cannot be inadvertently uncoupled when the source is not in its storage position within the storage body; and to provide such a means which can be uncoupled only when the source is in said storage position.

These and other objects of the present invention will in part be obvious and will in part appear hereinafter. Since certain changes may be made in the above apparatus without departing from the scope of the invention herein involved, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted in an illustrative and not in a limiting sense.

FIG. 1 is a schematic view, partly in section and partly in fragment of a radiographic apparatus employing the principles of present invention;

FIG. 2 is an elevational partly cross-sectional view of elements of an embodiment of the present invention showing the connector parts in mated relation;

FIG. 3 is cross-sectional view of the embodiment of FIG. 2 taken along the line 3-3 of the latter;

FIG. 4 is an enlarged cross-sectional view of a portion

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of the embodiment of FIG. 3 taken along the line 4-4 of the latter, including a cable coupling device in locked position therein; and

FIG. 5 is a view of elements of the present invention in exploded perspective, partly broken away.

Generally the present invention contemplates the provision of novel means for releasably coupling manipulating apparatus to a radioactive-shielding body. The manipulating apparatus preferably includes known flexible, elongated propelling means, such as wire cable, movable through a flexible conduit by rotation of an actuating device, for instance, a manually operable reel. The manipulating apparatus of the present invention, however, includes a first connector device through which the wire cable cannot be drawn and therefore constitutes a first terminus for cable movement. The first connector device includes a portion of a signal system, preferably electrical, for providing information indicative of the positioning of the radioactive source with respect to the snout and the bore of the storage body. The invention also includes a second connector device adapted to mate with the first connector device. The second connector device includes means for releasably and positively coupling the first connector device in fixed relation thereto; means for releasably retaining the radioactive source in fixed position, for instance, in the storage body; manually operable means for actuating the other parts of the second connector device and being selectively and alternately movable between a first position at which movement of the radioactive source is unimpeded and the connector devices are positively coupled, a second position at which the connector devices are still positively coupled but the source is fixedly retained, for instance, in a safe position in the storage body, and a third position at which the source is retained in a fixed position, but the connector devices are uncouplable.

The present invention further comprises a third connector device for coupling and uncoupling the cable and the source, the third connector device preferably including means for actuating the signal system, and means engageable by a portion of the second connector device for retaining the source in its safe position. In order to assure that the second connector device is maintained in any of its aforesaid positions, the invention includes a locking device, preferably key actuated, for preventing movement of the manually operable means of the second connector device without authorization or through accident.

Referring now to FIG. 1, there is shown schematically radiographic apparatus incorporating an embodiment of the present invention. The apparatus includes a storage or shielding body 20 having a tortuous bore or tube 22 therein. Tube 22 has two openings at different locations of the surface of the storage body, and to one of these openings there is coupled a hollow flexible conduit 24 leading to radiographic exposure device such as snout 26. The apparatus of FIG. 1 also includes manipulating means which include a pair of flexible hollow conduits 28 and 30, the former being coupled at one end by the releasable coupling means of the present invention, shown generally at 32, coaxially with the other opening of tube 22. The other end of conduit 28 is connected to manipulating unit 34 which, for the sake of simplicity in description, is shown as including both a motive means or reel and safety indicating means.

The reel of unit 34 is adapted for manual operation by crank 36. The safety indicating means includes means such as lamps 38 for giving visual warnings. Means, such as electrical cable 39 are provided for conveying electrical signals for display on lamps 38. Cable 39, shown only in fragment, has one end connected to unit 34 and its other end attached to coupling means 32.

The safety indicating means also includes other associated parts (not shown) such as a current source for activating the lamps, energy storing means, switch means located in the snout, and other switch means described hereinafter located in element 32.

Flexible conduit 30 also leads from coupling means 32 to unit 34. An elongated flexible propelling means, such as cable 40, is contained in conduits 28 and 30, the former providing storage means for the blind end portion of the cable. The other end of the cable is attached through releasable coupling 41 to cable or wire leader 42; the latter in turn is connected to radioactive capsule 43. An intermediate portion of this cable is in engagement with the reel of unit 34 so as to be movable therewith.

As thus described the apparatus of FIG. 1, with the exception of coupling means 32 as hereinafter described, is well known in the art and is particularly shown and described in detail in the aforesaid U.S. Patent No. 2,916,628.

Coupling 41 (shown in detail in FIG. 4) is in the form of a ball-and-socket type of joint, and comprises ball 44 mounted on and extending from an end of cylindrical shank 45, the other end of the latter being firmly attached as by crimping to said other end of cable 40. Both the shank and ball are preferably dimensioned so that their diameters are approximately the same as the diameter of cable 40. Coupling 41 also includes socket 46 formed as a hollow, cylindrical element having an internal diameter slightly larger than the diameter of ball 44 and an external diameter substantially greater than that of the shank. Socket 46 has a keyhole aperture 47 in one side thereof communicating with an end of the socket which is constricted to less than the diameter of ball 44. A portion of aperture 47 is dimensioned to permit ball 44 to be inserted therethrough into the interior of the socket and thereafter positioned so that the ball is retained in the socket by the constricted end whilst shank 45 is adjacent the constricted end approximately coaxial therewith. The other end of socket 46 is firmly attached to leader 42. The socket includes spring-loaded slide 48 which is preferably axially movable along the socket interior and is biased to force ball 44 against the constricted end and to occlude at least a section of aperture 47 when the ball is thus forced. Spaced a predetermined distance along leader 42 from the socket is a stop element such as solid stop ball 49 firmly attached to the leader.

Referring now particularly to FIG. 5 there will be seen an exploded perspective view of the parts of coupling means 32 which includes a pair of mating connectors, male connector 50 and female connector 52. In the form shown, particularly in detail in FIG. 2, male connector 50 comprises a substantially cylindrical body 54 having or supporting therein an axial bore 56 through which cable 40 is movable. One end of bore 56 is adapted to be axially connected with conduit 28 as by attachment means, for instance threaded, hollow, cylindrical cable adapter 58. Means, such as blind-cable adapter 60, similar to adapter 58, is also provided adjacent the latter for attaching the male connector and the appropriate end of conduit 30. Disposed adjacent the other end of bore 56 are means releasably engageable with female connector 52. Such means preferably comprises a pair of elongated cylindrical lock pins 62 and 64 of different cross-sectional diameter, mounted on connector 50 so as to extend substantially parallel with the longitudinal axis of the latter from points on opposite sides of such other end of bore 56. Lock pins 62 and 64 are provided respectively with depressed areas or transverse grooves 66 and 68. Preferably, one pin such as 62 is located approximately co-axially with blind cable adapter 60 and comprises a solid element rigidly mounted on connector 50. The other lock pin, 64, is also rigidly mounted on connector 50, but preferably has a hollow cylindrical axial passage 70. Disposed within the latter is an elon-

gated, electrically conducting, contact element 72, one end of which extends into the interior of connector 50, and the other end of which is slightly recessed within the adjacent end of pin 64. Means, such as insulating material 74, are provided between the length of contact element 72 and the walls of passage 70 for preventing electrical short circuits between the pin and contact element. Because of the interior structure within pin 64, the latter has the greater cross-sectional diameter of the two lock pins.

Male connector 50 also includes switch means forming a portion of the safety indicating means heretofore described. The switch means incorporated within connector 50 preferably is of the type described in the aforesaid Patent No. 2,916,628 in that it preferably comprises a hollow cylindrical switch bushing 76 disposed interiorly of bore 56, and movable axially along between stops 78 and 80. Stop 78 is located in bore 56 adjacent the connector end bearing pins 62 and 64, while stop 80 is located adjacent the other end of the bore bearing cable adapter 58. Bushing 76 is normally biased by resilient means such as spring 82 into engagement with stop 78. Mounted on bushing 76 is a first switch contact linkage such as pin 84 extending outwardly of bushing 76 substantially normal to the longitudinal axis of the latter. Mounted exteriorly of connector 50 is a second switch contact linkage such as slide 86 in engagement with pin 84. Slide 86 in turn is connected to microswitch 88. Pin 84 and slide 86 are so positioned that when bushing 76 is biased into engagement with stop 78, the contacts of microswitch 88 are open, and when bushing 76 is moved toward stop 80, the microswitch contacts are closed. A hole 90 is provided in connector 50 preferably on the same face thereof bearing adapters 58 and 60, through which electrical cable 39 is connected in circuit to microswitch 88 and to contact element 72. The interior of bushing 76 is so dimensioned and shaped as to allow free passage of cable 40 and shank 45 therethrough but restricted enough to be engageable with and thus prevent passage of socket 46 therethrough.

Referring again to FIGS. 2 and 5, there are also shown the elements of female connector 52. The latter is adapted to fit within, for instance well 92 in storage body 20, well 92 being a substantially cylindrical hole in storage body 20 coaxial with one end of tube 22. As means for attached connector 52 to storage body 20 there is provided, for example, mounting plate 94 which can be bolted or otherwise affixed to the storage body about the well. As means for locking pins 62 and 64 when in mated relationship with connector 52, and for releasably arresting cable 40 in a predetermined position, there are provided retaining means such as lock body 96. Connector 52 also comprises guide means providing mating channels for pins 62 and 64. These mating channels are in part formed of holes 98 and 100 in the lock body. In the form shown the latter is shaped as four adjoining cylindrical sections 102, 104, 106 and 108 of different radii, disposed along a common axis, and having a common tubular bore 110 through which cable 40 is movable. Lock body 96 is preferably mounted exteriorly of storage body 20 upon mounting plate 94 with cylindrical section 102, the section of the smallest radius, extending through plate 94 such that bore 110 is in register with tube 22. Holes 98 and 100 are formed with their longitudinal axis extending through sections 104, 106 and 108 substantially parallel with and on diametrically opposed sides of bore 110, being spaced from bore 110 such that each hole intersects the surface of cylindrical section 104 (the section of next larger radius) thereby forming a pair of peripheral slots 112 and 113 parallel in the axis of the bore.

Cable arresting means movable in and out of engagement with cable 40 or leader 42 for locking or unlocking either of the latter, as the case may be, are provided in the form of a pair of cable lock pins 114 and 116. Each lock pin is a substantially cylindrical element having an

enlarged portion or flange 118 adjacent one end thereof and a cable engaging surface, such as teeth 120, at the other end thereof. Cylindrical section 104 also includes a pair of holes 122 and 124 extending from the outer cylindrical surface thereof radially into bore 110 preferably from diametrically opposed directions and displaced angularly about the axis of the lock body from guide channels 98 and 100. The opening of each of holes 122 and 124 into bore 110 is preferably dimensioned so that only the body of a respective lock pin 114 and 116 can fit there-through. The two lock pins are respectively disposed in holes 122 and 124 and are biased, as by springs 126 and 128 respectively, for movement within holes 122 and 124 away from bore 110. Each lock pin is so dimensioned longitudinally that when in normal position the top of its associated flange extends outwardly from the outer cylindrical surface of section 104 while the toothed end of the pin is either flush with or withdrawn slightly from the wall of bore 110.

The female connector of the invention also comprises manually operable means for actuating the cable arresting means and for locking pins 62 and 64 within the mating channels. In the form shown, the manually operable means comprises a selector lever body 130. Lever body 130 is shaped as a substantially flat rectangular element having cylindrical aperture 132 substantially centrally thereof, the aperture being circularly dimensioned to fit snugly but rotatably about the cylindrical exterior of lock body section 106 (having a radius of greater than the radius of section 104 and less than the radius of the largest section 108). Disposed within the internal periphery of aperture 132 are a pair of cam surfaces 134 and 136, each located on opposite interior walls of the aperture. Each cam surface is in the form of a curved ramp having a high end 138 and a low end 140, the latter being substantially at the level of the interior wall of aperture 132, while the former is raised a substantial distance therefrom. In the form shown, each cam surface extends over approximately 60° of the aperture periphery, the greater part of which is subtended by the high end of the cam in the form of a plateau, while the sloping portion of the cam surface is less than 30°. The cams and aperture are so dimensioned that a circle concentric with aperture 122 and tangent to high ends 138 will have a radius just slightly larger than the radius of cylindrical section 104 of lock body 96 thereby allowing the cams to rotate with lever body 130 about section 104. Disposed to one side of aperture 132 on lever body 130 is a cylinder-type lock 144 of known construction adapted to be operated by key 146, the lock cylinder being the usual bolt 148 spring biased for movement away from pig 20.

Disposed immediately adjacent lever body 130 is sector plate 150 preferably mounted on mounting plate 94. Sector plate 150 has therein a plurality of holes 152, 154 and 156 dimensioned to accept bolt 148. The holes are spaced along the arcuate path of rotation of bolt 138 at intervals, for instance of 45°.

As means for holding selector lever body 130 in rotatable relationship with respect to lock body 96 and mounting plate 94 adjacent sector plate 150 there is provided lock body retainer cover 158. The latter includes therein another portion of the guide means providing mating channels in the form of cylindrical holes 160 and 162. There is also provided in the retainer cover a central aperture or bore 164. Retainer cover 158 preferably is shaped as a cylindrical disc in which holes 160 and 162 and bore 164 are so disposed that they can be registered respectively with holes 98 and 100 and bore 110 of lock body 96.

When assembled to form connector 52, lock body 96 and lock body retainer cover 158 are aligned with their respective bores coaxial and with selector lever body 130 rotatably mounted therebetween. In order to hold these three elements in this relation in which holes 98 and 100 are aligned respectively with holes 162 and 164, connector 52 also includes fastening means such as bolts 166

(only one shown as in FIG. 5) adapted to be inserted through appropriate holes 168 provided in both retainer cover 158 and lock body 96. In the form shown, there are four holes 168 equiangularly spaced about the respective bores of each of the retainer cover and lock body, and a corresponding number of bolts are provided. It will be seen that three elements of female connector 52 (the lock body, the selector lever and the retainer cover) are intended to be mounted on mounting plate 94 exteriorly of body 20. In order to hold the three elements, when bolted together, on mounting plate 94 the latter also includes bolt holes (not shown) through which the bolts extend, and there is provided a back-up plate 170 having a plurality of tapped holes 172 corresponding in number and position to bolts 166 extending through said three elements. When the bolts are properly emplaced, the ends thereof preferably extend through the bolt holes in plate 94 and into threaded engagement in holes 172 of back-up plate 170. The latter is, of course, then located on the other side of mounting plate 94 from the lock body. Back-up plate 170 also includes another aperture or switch channel 176 extending therethrough and so located as to be aligned with hole 98 in the lock body when bolts 166 are threaded into holes 170.

Plate 170 includes central bore 176 therein located to be coaxial with both tube 22 and with the bores of lock body 96 and cover 158 when plate 170 is bolted to the latter elements. Bore 176 is shaped as a transition, i.e. tapered such that the end adjacent lock body 96 is of the same diameter as bore 110 while the end adjacent the opening of tube 22 is of the same diameter as the latter. In the preferred embodiment, dimensions are selected such that tube 22 is of greater diameter than stop ball 49, the latter in turn being of greater diameter than bore 110. Back-up plate 170 also includes another aperture or switch channel 176 extending therethrough and so located as to be aligned with hole 98 in the lock body when bolts 166 are threaded into holes 170.

It will also be seen that the lock pin guide channels provided by the alignment of hole 98 with hole 160, and by the alignment of hole 102 with hole 162 are slightly different in diameters. This insures that lock pins 62 and 64 are not interchangeably insertable, but can only be placed into the guide channels in a predetermined relationship, the two lock pins being of correspondingly different diameters as hereinbefore described. In order to provide electrical contact with the contact element in pin 64 hole 98 extends completely through lock body 96 to communicate with switch channel 176 in back-up plate 170; on the other hand, hole 100 is a blind hole, no electrical through-connection being necessary.

Mounted in each channel 176 is switching means comprising a cylindrical elongated contact element 178 formed of electrically conductive material. Element 178 is mounted adjacent one end thereof in hollow cylindrical switch bushing 180, and electrically insulated therefrom. The bushing and element in turn are slideably movable along their common longitudinal axis within switch channel 176. Resilient means, such as spring 182, are provided for biasing contact element 178 and bushing 180 for movement into the guide channel provided by aligned holes 98 and 160. The other end of element 178 extends toward body 20 and is intended to be electrically coupled with switch means in the snout.

Also mounted on lever body 130 is a pivoted door or cover 184, spring biased toward a position wherein the cover extends substantially perpendicularly to lever body 130. Cover 184 is movable between the latter position and a position at which it covers the exterior face of retainer cover 158, thereby constituting means for protecting the guide channels from the introduction of foreign objects therein.

It will be apparent to those skilled in the art that with minor modification the male connector can be adapted for mounting on the storage body, while the female con-

sector, in turn, is connected to the conduits and cables leading to the control unit. In the device disclosed, lock pin 64 has both a mechanical and electrical function. It is equally feasible to employ but single lock pin, for instance, of triangular cross-section, in place of two lock pins and combining both the mechanical and electrical functions.

Alternatively, in place of pins 62 and 64 a greater plurality of lock pins can be provided, for instance three, two of which provide the mechanical functions and one of which is employed for its electrical function.

It will be assumed for purposes of description of the operation of the invention that capsule 43 is initially in body 20 in "safe" position wherein leader 42 extends from the capsule such that socket 46 extends just sufficiently from female connector 52 as to be couplable to ball 44 attached to cable 40 and extending out of bore 56 of male connector 50 thereon. This "safe" position can be established by setting the length of leader 42 and locating stop ball 49 so that the latter is arrested in the tapes of bore 176 when the capsule and socket are correctly positioned.

When male connector 50 is not coupled to female connector 52, it will be seen that spring 182 biases bushing 180 into the guide channel provided by holes 98 and 160. When bushing 180 so extends into the guide channel, lever body 130 is in its "disconnect" position from which it cannot be rotated because high end 138 of cam surface 134 is obstructed by the presence of bushing 180 in the guide channel.

To operate the device, the operator manually swings cover 184 to its open position exposing the internal face of retainer cover 158. Coupling 41 is manually made by inserting ball 44 into aperture 47, thus connecting cable 40 and lead 42 to one another. The operator inserts lock pins 62 and 64 respectively into holes 162 and 160. By virtue of difference in diameter of the latter two holes and the size of the pins, there can be no confusion as to which pin fits which hole.

As pin 64 moves axially into hole 160, the contact of element 72 with element 176 forms an electrical connection. The contact of the latter two elements and the pressure exerted by the operator inserting pin 64 also causes bushing 180 to slide out of hole 98, compressing spring 182 which firmly holds the contact elements in engagement. Bushing 180 is now no longer in the path of movement of cam 134, and the lever body is kept, if at all, in its "disconnect position" by lock 144 only.

The operator need merely insert key 146 in lock 144 to release bolt 148 from engagement with hole 156. It will be seen that when the lever body is in its "disconnect" position, the position of cams 135 and 136 are such that high ends 138 thereof are in engagement with flanges 118 of lock pins 114 and 116, forcing the latter against the bias of springs 126 and 128 respectively toward and into bore 110. Thus, in the "disconnect" position, teeth 120 of both lock pins 114 and 116 extend into bore 110, positively retaining leader 42 from movement by engagement therewith as shown particularly in FIG. 4. The lock body 130 is now rotatable in a clockwise direction being restrained from movement in the opposite direction by virtue of the engagement of pin 186 with stop portion 188 of sector plate 150. As lock body 130 is rotated clockwise through 45°, cams 134 and 136 are respectively moved about the periphery of section 104 of lock body 96, and high end 138 of the cam surfaces move transversely of slots 112 and 113. But, male connector 50, when fully seated with respect to the female connector, has grooves 66 and 68 respectively of pins 62 and 64, located at slots 113 and 112. Thus, the movement of high end 138 across slots 113 and 112 is also into a position in engagement with grooves 66 and 68. The positioning of the cam surfaces in grooves 66 and 68 therefore effectively serves to lock pins 62 and 64 posi-

tively with respect to the guide channels so that the pins cannot be withdrawn.

The rotation of lock body 130 through 45° from its "disconnect" position therefore finds the lock body at a "lock" position wherein pins 62 and 64 are positively retained in holes 198 by virtue of engagement of cam surfaces 134 and 136 with grooves 68 and 66, while lock pins 114 and 116 are still cammed by cam surfaces 136 and 134 so as to extend into bore 110 and engage leader 44. The lock body can be fixed in this "lock" position by manually forcing bolt 148 into engagement with hole 154 in the sector plate. In this position connectors 52 and 52 cannot be withdrawn nor can capsule 46 be moved.

Lever body 130, upon release of bolt 148 from hole 154, can either be moved counterclockwise toward its "disconnect" position, or clockwise another 45° toward an "operate" position, the latter being shown in FIG. 3. Lever body 130 cannot be moved clockwise past the "operate" position because of the engagement of pin 186 with another stop portion 190 of sector plate 150. At the "operate" position, bolt 148 is in alignment with hole 152 on the sector plate. At the "operate" position, bolt 148 is in alignment with hole 152 on the sector plate and the lever body may be locked in this position by manually forcing the bolt into engagement with hole 152.

As lever body 130 is rotated from its "lock" position to its "operate" position, low ends 140 of cam surfaces 134 and 136 are moved into alignment with lock pins 114 and 116 permitting the latter pins to move along holes 122 and 124 under the bias of their respective springs outwardly from bore 110 and release leader 42. However, the cam surfaces still remain engaged in grooves 66 and 68. Thus, in the "operate" position, the two connectors are still positively locked to one another but the release of leader 42 now permits movement of capsule 43 out of tube 22 into conduit 24 toward snout 26. As is well known in the art, when capsule 43 arrives at snout 26, capsule 43 or an attachment to the leader such as stop ball 49 closes a microswitch and an electrical signal is then sent back through the engaged contact elements 178 and 70 to unit 34 so that the positioning of the capsule is indicated on one of lamps 38. A radiographic exposure may now be made.

When it is desired to stop the exposure and restore the capsule to its safe position within storage body 20, the operator need only rotate crank 36 moving cable 40 and withdrawing capsule 43 from the snout and into the storage body. Just before capsule 43 arrives in "safe" position in the storage body, socket 46 engages bushing 76. Continued withdrawal of cable 40 forces socket 46 and bushing 76 against the bias of spring 82, moving bushing 76 toward stop 80. This movement of bushing 76 is transmitted through pin 84 and slide 86 to trip microswitch 88, and an electrical signal is sent through cable 39 to unit 34. The signal is then displayed at another of lights 38, indicating that capsule 43 is in its "safe" position. Of course when bushing 76 has engaged stop 80 the motion of cable 40 moving capsule 46 away from snout 26 is completely arrested. In the event that ball 44 should break away from its connection into socket 46 shank 45 is so dimensioned that it will push through bushing 76 and will not actuate the microswitch. Hence, if the joint of socket 46 and ball 44 breaks while the capsule is not in its safe position, no false signal of "safe" will be indicated.

If the operator does not wish to use capsule 43, and desires to prevent any further use thereof without authority, he need only unlock lever body 130 so that the latter may be rotated counterclockwise to its "lock" or "disconnect" positions. If it is intended to employ capsule 43 shortly thereafter, the operator can move lever body 130 into its "lock" position, and force bolt 148 into engagement with hole 154. By doing so, the use of the apparatus is denied to those without a key, manipulation of

crank 36 cannot move cable 40 because lock pins 114 and 116 have been cammed back into engagement with leader 42, and, connectors 50 and 52 are positively locked to one another preventing removal of control cables.

If it is desired to remove entirely the manipulating means comprising conduits 28 and 30, cable 40, unit 34 and male connector 50 from the unit, for instance for use with another storage body having an appropriate female connector, the operator need only rotate lever body 130 to its "disconnect" position and remove male connector 50. The latter is, at this position, no longer held to the female connector because cam surfaces 134 and 136 have been rotated by the lever body out of engagement with grooves 66 and 68.

It will be apparent that when connectors 50 and 52 are in mated relation and cable 40 is coupled to leader 42, even though lever body 130 is in its disconnect position, there will be difficulty in uncoupling connectors 50 and 52 unless lock pins 114 and 116 are in engagement with the leader. In the event that the capsule is at some other location than its safe position, lock pins 114 and 116 will in such cases be in engagement not with the leader but with the cable; separation of the leader from the cable cannot then be accomplished inasmuch as the cable coupling is hidden within the pig or in the conduit to the snout. However, the position of the capsule still cannot be disturbed; a complete separation of the connectors and the cable can only be effected when the capsule is in its safe position wherein lock pins 114 and 116 can engage leader 42.

Since certain changes may be made in the above apparatus without departing from the scope of the invention herein involved, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted in an illustrative and not in a limiting manner.

What is claimed is:

1. In apparatus for manipulating radioactive material including a unit for storing a radioactive capsule, an exposure snout to which said capsule is movable, and manipulating means including flexible cable for moving said capsule between said unit and said snout, coupling means for connecting said manipulating means to said capsule and said unit, said coupling means comprising in combination: a pair of mating connectors defining respective passageways adapted to have said cable movable therethrough, one of said connectors being adapted for fixed mounting on said storage unit; and means for locking and unlocking said connectors in mated relation and for retaining said capsule in a fixed position at least when said connectors are unlocked and for releasing said capsule for movement with said cable only when said connectors are locked.

2. In apparatus for manipulating radioactive material including a storage unit for a radioactive capsule, an exposure snout to which said capsule is movable, and manipulating means including flexible cable for moving said capsule between said unit and said snout, coupling means comprising in combination: a pair of mating connectors, one of said connectors including actuating means movable into any one of three positions when said connectors are mated; means responsive to said actuating means when the latter is in the first of said positions for positively locking both said connectors in mated relation and for providing an unobstructed path for movement of said cable through said connectors; means responsive to said actuating means when the latter is in the second of said positions for positively locking both said connectors in mated relation and for retaining said capsule at a predetermined position; and means responsive to said actuating means when the latter is in the third of said positions for unlocking said connectors from one another and for retaining said capsule at a predetermined position.

3. In apparatus for manipulating radioactive material

including a unit for storing a radioactive capsule, an exposure snout to which said capsule is movable, and manipulating means including flexible cable means for moving said capsule between said unit and said snout, coupling means for connecting said manipulating means to said capsule and said unit, said coupling means comprising in combination: a male and female connector adapted to mate with one another, said female connector including actuating means movable into any one of three positions when said connectors are mated; first means forming a portion of said female connector and responsive to said actuating means when the latter is in first and second of said positions for so engaging a portion of said male connector that said connectors are positively locked in mated relation; said first means being responsive to said actuating means when the latter is in the third of said positions for unlocking said connectors from one another; and second means forming a portion of said female connector and responsive to said actuating means when the latter is in said second and third positions for retaining said capsule in a predetermined position, said second means being responsive to said actuating means when the latter is in said first position for releasing said capsule so that the latter is freely movable.

4. In apparatus for manipulating radioactive material including a storage unit for a radioactive capsule having a leader attached thereto, an exposure snout to which said capsule is movable, and manipulating means including flexible cable means for moving said capsule between said unit and said snout, coupling means for connecting said manipulating means to said leader and said unit, said coupling means comprising in combination: a pair of mating connectors; one of said connectors including actuating means rotatable between a first and third position through a second position when said connectors are mated; cam means being so rotatable with said actuating means as to be moved into locking engagement with a portion of the other of said connectors when said actuating means is in the first and second of said positions; said cam means being rotatable with said actuating means out of said locking engagement when said actuating means is rotated into said third position; and means so movable by said cam means as to engage a portion of one of said leader and said cable means and restrain said leader from movement when said actuating means is in said second and third position and to disengage said portion of one of said leader and cable means when said actuating means is in said first position.

5. In apparatus for manipulating radioactive material including a storage unit for a radioactive capsule, an exposure snout to which said capsule is movable, and manipulating means including flexible cable means for moving said capsule between said unit and said snout, coupling means for connecting said manipulating means to said capsule and said unit, said coupling means comprising in combination: a female connector having channel means therein; a male connector having part thereof adapted to mate with said channel means; said female connector including cam means rotatable, when said connectors are mated, into a first position wherein said part of said male connector and said cam means are in engagement for locking said connectors in mated relationship; said cam means being rotatable at least another position wherein said cam means is out of engagement with said part for allowing separation of said connectors; and locking means movable by said cam means into engagement with said cable means when said cam means is moved to said other position, and being biased out of said engagement when said cam means is in said first position.

6. Coupling means as defined in claim 5 wherein said cam means is rotatable to a third position wherein said cam means is in engagement with said part of said male connector and wherein said cam means is also in engagement with said locking means for positioning the latter against said bias into engagement with said cable means.

7. Coupling means as defined in claim 6 including

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means for selectively and releasably locking said cam means in any one of said positions.

8. Coupling means as defined in claim 5 wherein said part of said male connector includes a first insulated electrical contact element, and a second insulated electrical contact element is disposed in said channel means, said elements being engageable with one another for forming an electrical connection when said connectors are in mated relationship.

9. Coupling means as defined in claim 8 wherein said second contact element is so disposed in said channel means as to be in the path of movement of said cam means for obstructing the latter when said connectors are mated, said second contact element being displaceable from said path by engagement with said first contact element.

10. Coupling means as defined in claim 8 wherein said male connector includes electrical switching means actuable by a portion of said cable means when said capsule is in a predetermined position in said unit.

11. In apparatus for manipulating radioactive material including a storage unit for a radioactive capsule, an exposure snout to which said capsule is movable, and manipulating means including flexible cable means for moving said capsule between said unit and said snout, coupling means for connecting said manipulating means to said capsule and said unit, said coupling means comprising in combination: a female connector mounted on said unit, said female connector including an elongated bore adapted to have said cable means movable therethrough, a pair of guide channels disposed substantially parallel with and on respectively opposite sides of said bore, each of said guide channels having an opening in a side thereof, a pair of holes extending radially into said bore from opposite surfaces of said female connector, a pair of lock pins each disposed in one of said holes, and biased for movement away from said bore; a male connector having a pair of elongated elements adapted to fit said guide channels, each element having a slot therein so positioned that when said elements are fitted in said guide channels said slots are adjacent said openings; an actuating lever mounted on said female connector for rotation about said surfaces thereof, and including a pair of cam surfaces rotatable with said lever in and out of engagement with said lock pins for respectively moving the latter against said bias into engagement with said cable means, and for permitting said lock pins to move under said bias out of engagement with said cable means.

12. Coupling means as defined in claim 11 wherein said actuating lever is movable into any one of a plurality of positions, at one of said positions said cam surfaces being in engagement with said slots and out of engagement with said lock pins, at another of said positions said cam surfaces being out of engagement with said slots and in engagement with said lock pins.

13. Coupling means as defined in claim 12 wherein

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said plurality of positions includes a third position wherein said cam surfaces are in engagement with both said slots and said lock pins, and including key actuated lock means for positively and releasably locking said actuating lever in any of said positions.

14. In apparatus for manipulating radioactive material including a unit for storing a radioactive capsule in a double-ended bore therein, an exposure snout to which said capsule is movable from one end of said bore, and manipulating means including flexible cable movable in said bore for moving said capsule between said unit and said snout, coupling means for connecting said manipulating means to said capsule and said unit, said coupling means comprising, in combination, a pair of mating connectors defining respective passageways, one of said connectors being adapted for mounting on said unit with its passageway in register with the other end of said bore, the other of said connectors being adapted to have said cable disposed in its respective passageway; and means for locking and unlocking said connectors in mated relationship with their respective passageways in register, and for retaining said capsule in a fixed position at least when said connectors are unlocked and for releasing said capsule for movement with said cable only when said connectors are locked.

15. In apparatus for manipulating radioactive material including a unit for storing a radioactive capsule in a double-ended bore therein, an exposure snout to which said capsule is movable from one end of said bore, and manipulating means including flexible cable movable in said bore for moving said capsule between said unit and said snout, coupling means for connecting said manipulating means to said capsule and said unit, said coupling means comprising, in combination, a pair of mating connectors defining respective passageways, one of said connectors being adapted for mounting on said unit with its passageway in register with the other end of said bore, the other of said connectors being adapted to have said cable disposed in its respective passageway; and means for locking and unlocking said connectors in mated relationship with their respective passageways in register, said last named means including actuating means included as part of one of said connectors and being movable to a plurality of positions when said connectors are mated; means responsive to said actuating means when the latter is in one of said positions for retaining said capsule in a fixed position at least when said connectors are unlocked; and means responsive to said actuating means when the latter is in another of said positions for releasing said capsule for movement with said cable while positively locking said connectors in mated relationship.

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