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XR 3,848,137

# United State

Ellis

[11] 3,848,137

[45] Nov. 12, 1974

[54] **HANDLING OF RADIO-ACTIVE SOURCES**

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[73] Assignee: **Sidney Geoffrey Young,** London, England

[22] Filed: **Apr. 9, 1973**

[21] Appl. No.: **348,896**

[52] **U.S. Cl.** ..... **250/497,** 250/506

[51] **Int. Cl.** ..... **G21f 5/00**

[58] **Field of Search** ..... 250/506, 507, 505, 515, 250/493, 496, 497, 498; 176/30, 37

[56] **References Cited**

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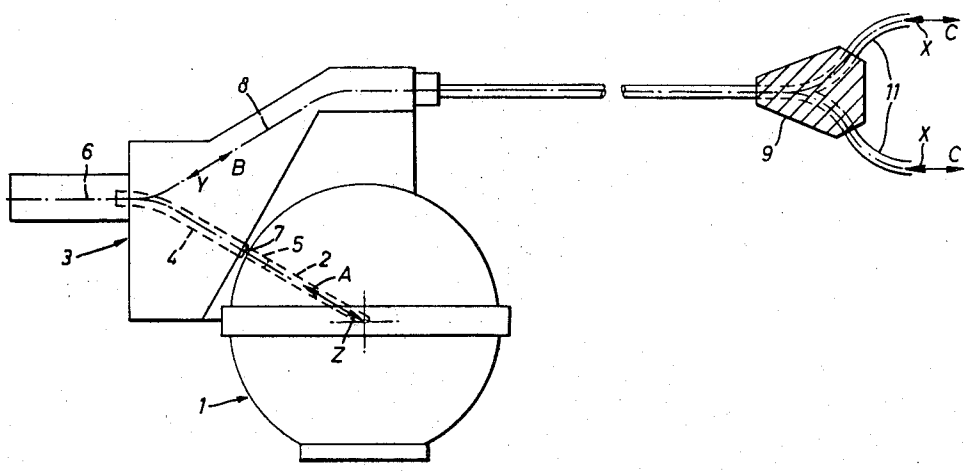
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*Assistant Examiner*—Davis L. Willis
*Attorney, Agent, or Firm*—Perry Carvellas, Esq.

[57] **ABSTRACT**

An isotope capsule carried at the end of a radio-active source holder is handled by retracting the source holder from one position into a curved passage of a guide member through an inlet at one end of the passage, turning the guide member through an angle of less than 360° about the central axis of the other end of the passage, and then ejected through the inlet into a different position. Manipulating apparatus for withdrawing and inserting the radio-active source holder from and to a hole in a shielded transport container for the source holder and for transferring the source holder to and from a location beyond the container comprises a curved tube adapted to receive the source holder and mounted for rotation about the central axis of one of its ends so that the other end can be selectively brought into alignment with the hole in the container or with at least one guide path for the source holder externally of the container, and an operating mechanism for effecting rotation of the curved tube only in response to movement of the source holder through the operating mechanism under the influence of a remotely driven control cable attached to the source holder.

**7 Claims, 11 Drawing Figures**



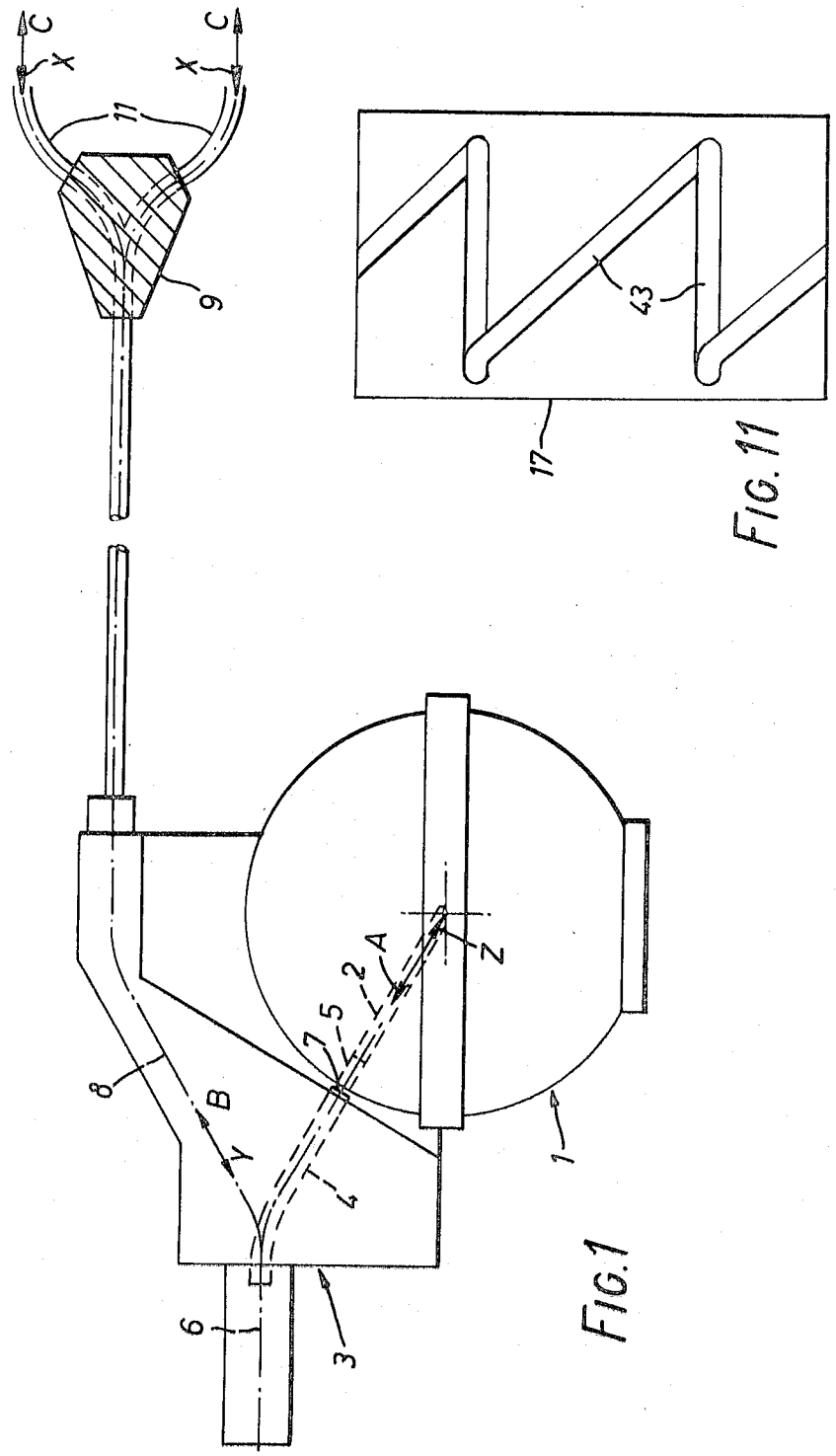



FIG. 11

FIG. 1

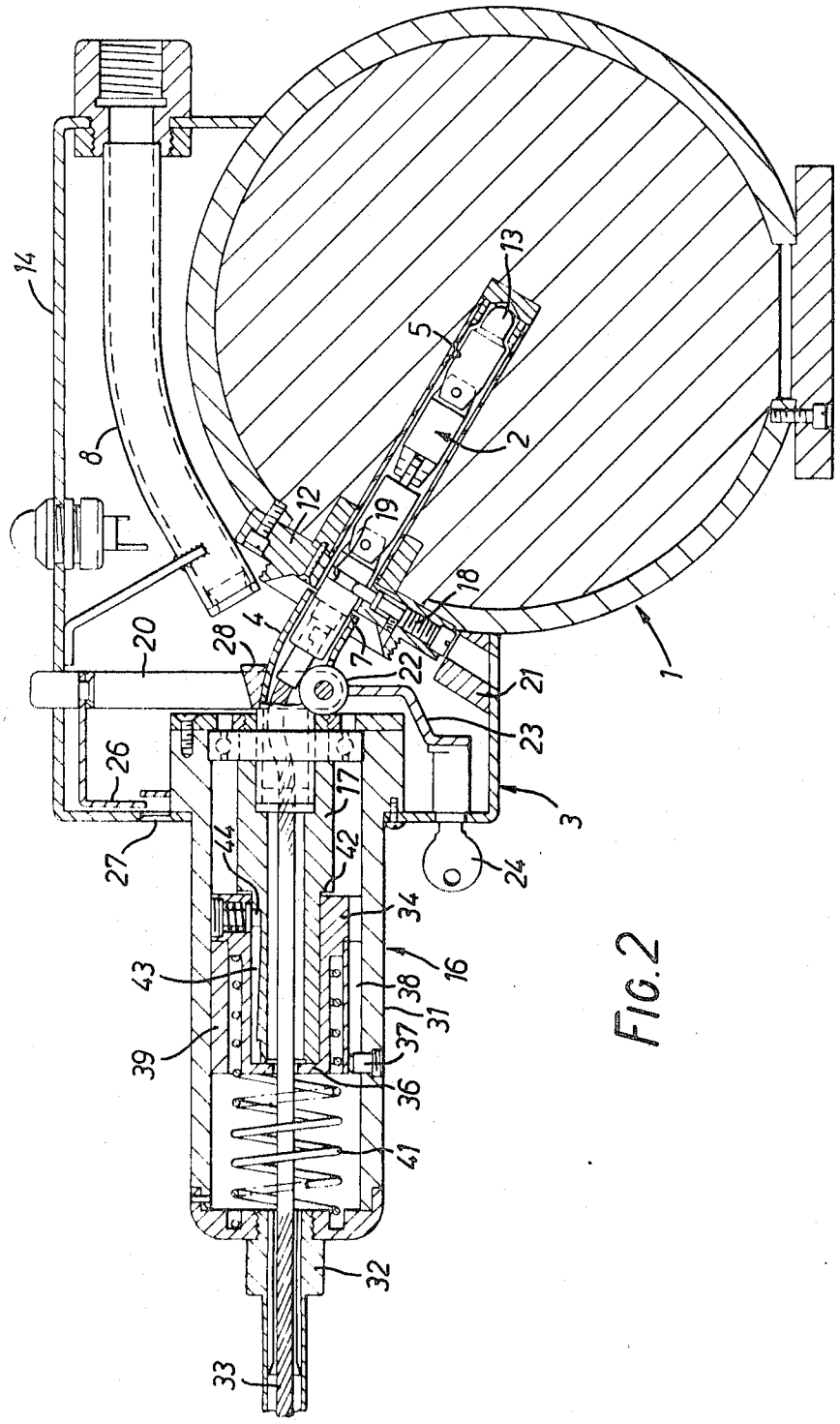

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FIG. 2

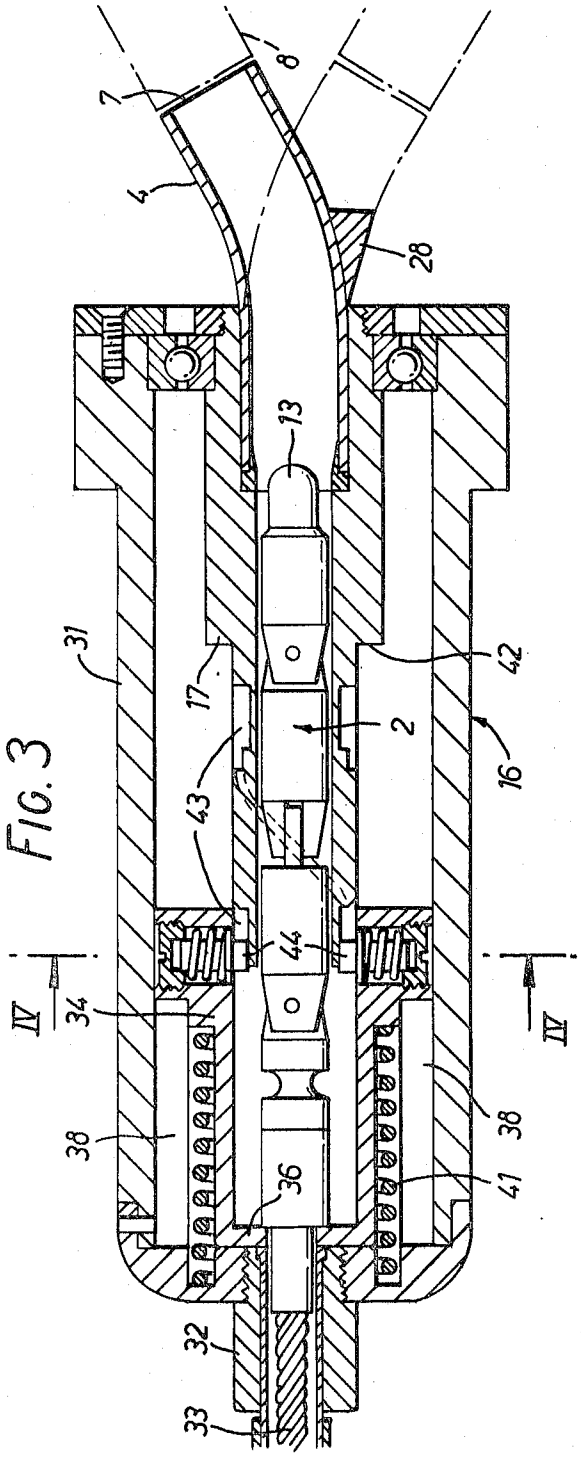



FIG. 3

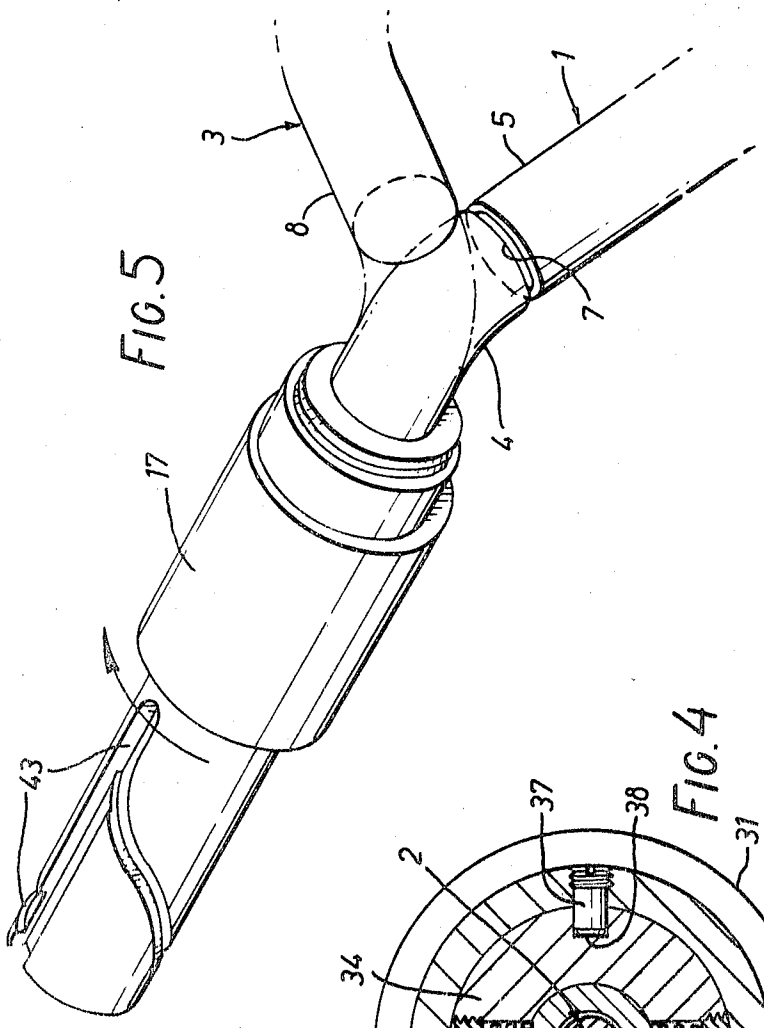



FIG. 5

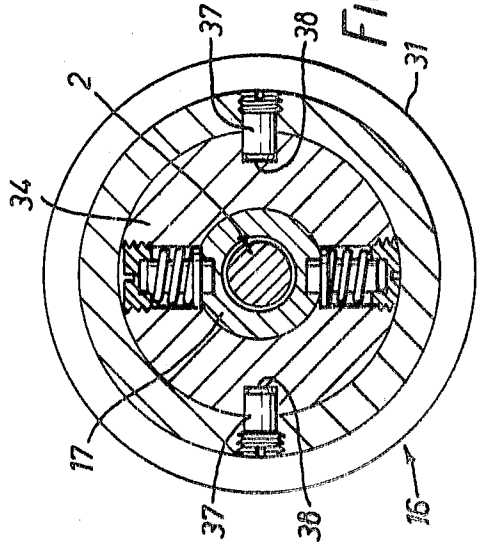



FIG. 4

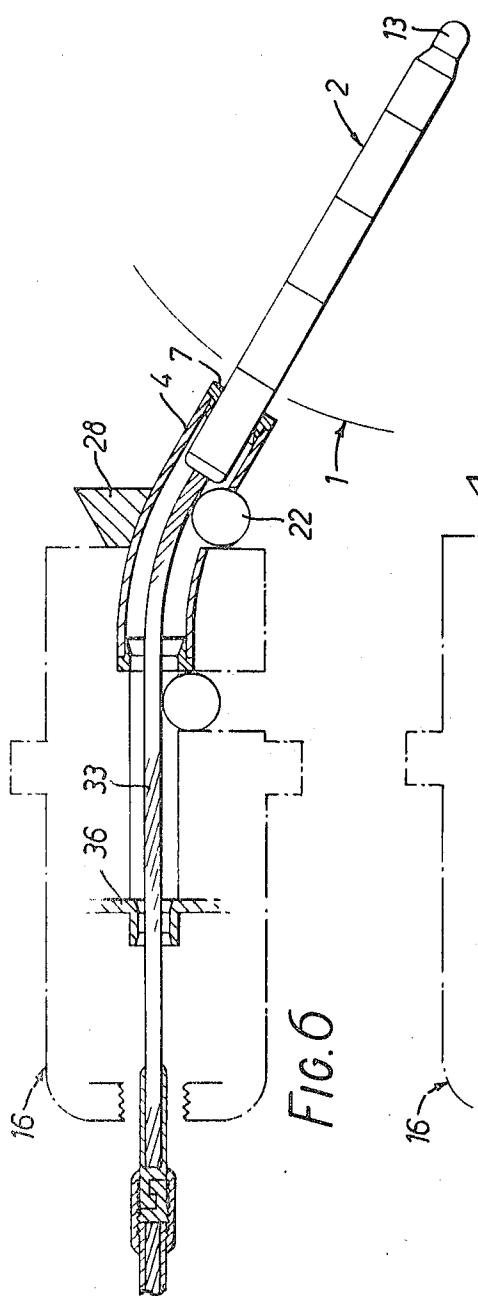



FIG. 6

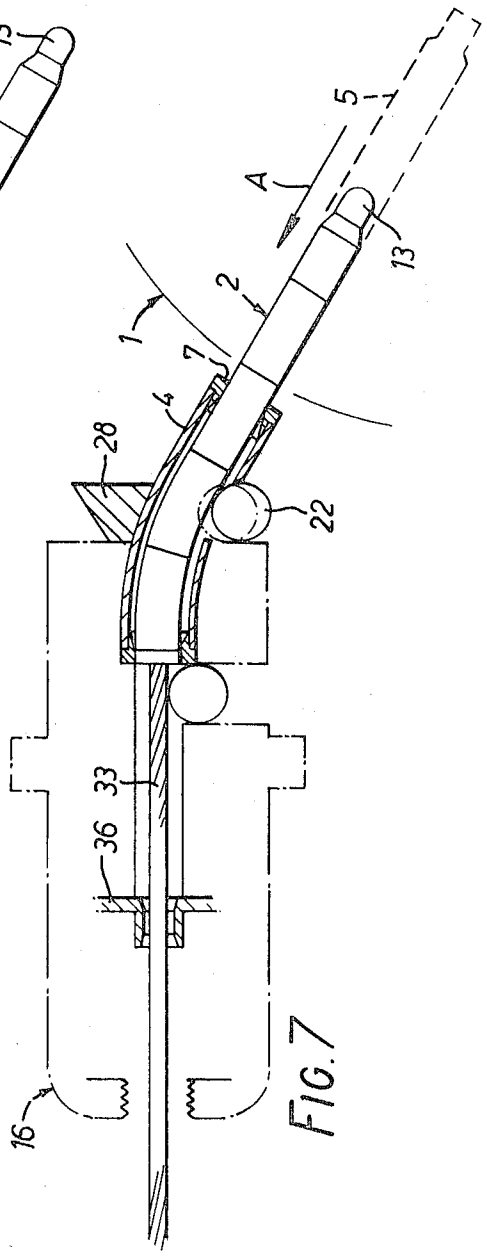



FIG. 7

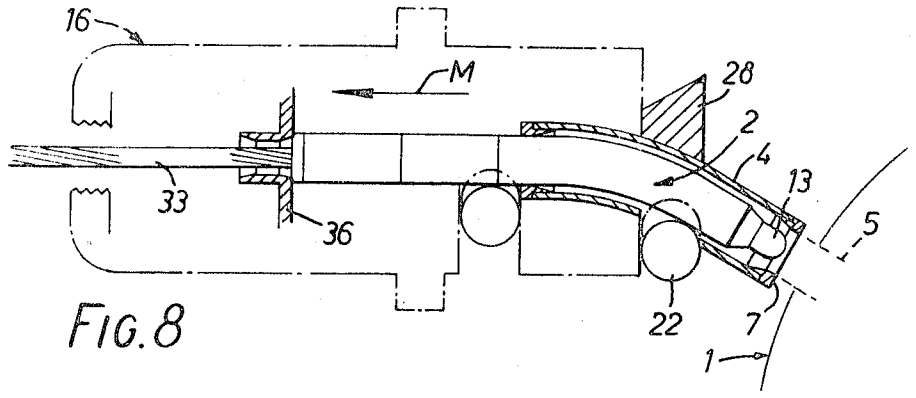



FIG. 8

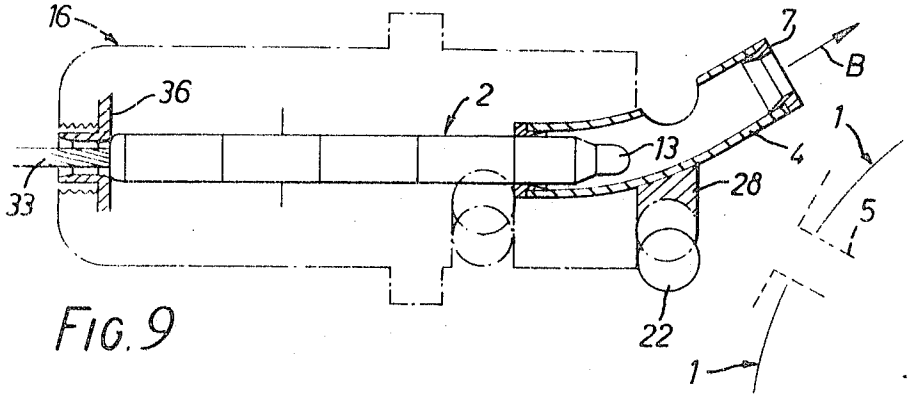



FIG. 9

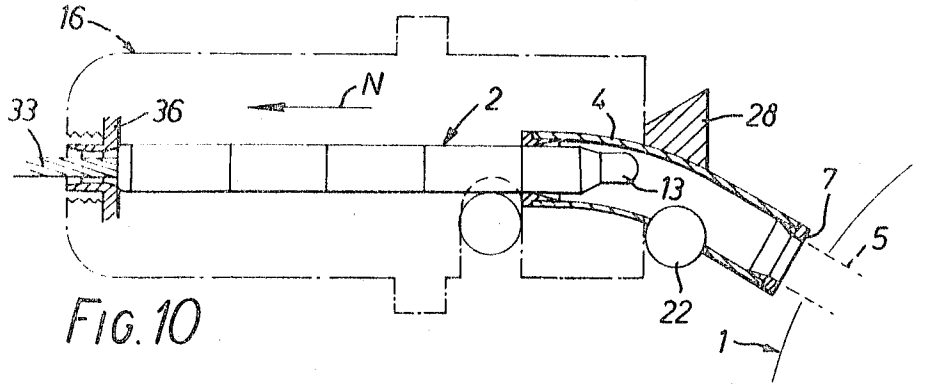



FIG. 10

# HANDLING OF RADIO-ACTIVE SOURCES

According to the invention, a method of handling an isotope capsule carried at the end of a radio-active source holder comprises retracting the source holder from one position into a curved passage of a guide member through an inlet at one end of the passage, turning the guide member through an angle of less than 360° about the central axis of the other end of the passage, and then ejecting the source holder through the inlet into a different position.

The invention also extends to manipulating apparatus for withdrawing and inserting a radio-active source holder from and to a hole in a shielded transport container for the source holder and for transferring the source holder to and from a location beyond the container. Such apparatus comprises a curved tube adapted to receive the source holder and mounted for rotation about the central axis of one of its ends so that the other end can be selectively brought into alignment with the hole in the container or with at least one guide path for the source holder externally of the container, and an operating mechanism for effecting rotation of the curved tube only in response to movement of the source holder through the operating mechanism under the influence of a remotely driven control cable attached to the source holder. Thus, if the source holder is in a transport container located in one room, it can be retracted along a predetermined path and into the tube of which the inlet is in alignment with the path, and the tube is swung through an angle of, say, 180° until its inlet is aligned with a second path leading to a different room, such swinging taking place only when the source holder has been fully retracted into the tube. The source holder is then ejected along said second path.

The invention will now be described by way of example with reference to the accompanying drawings, wherein:

FIG. 1 is a diagrammatic representation of a transport container for a radio-active source fitted with a withdrawal and manipulating mechanism for transferring the source to a point of use;

FIG. 2 is a sectional side elevation of a preferred container and preferred manipulator;

FIG. 3 is a sectional side elevation of a slightly modified operating mechanism of the FIG. 2 manipulator but shown in a different condition of operation;

FIG. 4 is a cross-section on the line IV—IV in FIG. 3;

FIG. 5 is a diagrammatic perspective view of a component of the operating mechanism of FIGS. 2 to 4;

FIGS. 6 to 10 are diagrammatic representations of the operating mechanism in various conditions for explaining the operating sequence, and

FIG. 11 is a diagram showing a planar projection of a cam track provided in the FIG. 5 component.

Referring firstly to FIG. 1, the diagram shows a shielded combination transport and exposure container 1 for a flexible source holder or pencil 2. The preferred container and source pencil are illustrated in more detail in FIG. 2, although it is to be understood that the invention is readily applicable to other containers and source holders or pencils. The source pencil carries an isotope capsule in a receptacle at one end and the entire pencil is shielded in a straight hole 5 in the container 1. Upon arrival of the container with pencil, the container is adapted for use as a storage and exposure container by being fitted with a remotely-controllable manipulator 3 which includes a curved tube 4 mounted for rotation about the central axis 6 at one of its ends.



When the isotope is to be usefully exposed, (a closure cap that was used to seal the hole 5 during transit and storage having been removed from the container and the manipulator 3 having been fitted to the container), the pencil 2 is withdrawn from the container in the direction of the arrow A in FIG. 1 by being pulled with a cable that enters the manipulator along the axis 6.

The flexible pencil 2 enters an inlet end 7 of the tube 4 and is withdrawn until it is entirely disposed in the tube or has even passed beyond it, this causing the tube to be rotated through 180° about the axis 6 so that the end 7 will now be aligned with a guide path 8 for the pencil, along which the pencil is pushed in the direction of arrow B, with the isotope capsule foremost, until it reaches a change-over block 9. The latter is rotatable and contains a curved hole which can be brought into alignment with a selected one of a plurality of guide paths 11 by turning the block. Continued pushing in the direction of one of the arrows C will then bring the pencil with isotope to the selected place of exposure, possibly with the interposition of further change-over blocks and/or tubes similar to the block 9 and tube 4. After use, the pencil 2 is brought to a different location for exposure or it is returned to its container 1 by movement in the direction of the arrows X, Y and Z.

Referring, now, to FIGS. 2 to 11, one or other of which shows in more detail the aforementioned container 1, pencil 2, manipulator 3, hole 5, tube 4 with its inlet end 7, and guide path 8 formed by a fixed tube, it should be mentioned first of all that a connector 12 (FIG. 2) on the container 1 serves, during transport and storage, to attach a screw-on cap (not shown) for closing the hole 5 and shielding the flexible pencil 2 which carries the isotope capsule in a receptable 13. When the cap has been removed, the manipulator 3 can be secured to the container by means of a mounting case 14. The manipulator carries an operating mechanism 16, the fixed tube forming the guide path 8. The rotatable tube 4 is secured in a rotary sleeve 17 of the operating mechanism. The connector 12 incorporates a lateral locking or safety screw 18 for locking the source holder or pencil 2 against withdrawal from the container by engaging in a groove 19 of the pencil. The pencil is constructed of a plurality of pivotally interconnected links so that it is flexible and can assume a curved shape. When the safety screw 18 is disengaged from the pencil, it engages instead in a socket 21 of the mounting case 14, thereby serving as a deterrent against the case being removed before the pencil has been locked against withdrawal from the container.

Other provisions are also made for safety reasons. For example, as best shown in FIG. 2 a roller 22 carried by the mounting case 14 at the end of a spring-influenced arm 20 extends through a slot in the side of the tube 4 and will not permit the pencil 2 to be pulled out of the container until a plate 23 is swung to free the roller by turning a special key 24 and until the arm 20 has been depressed. At this time, a signal 26 carried by the arm appears through a window 27 in the case 14 to indicate that the pencil is now in a potentially dangerous withdrawable or withdrawn condition. An eccentric cam disc 28 carried by the tube 4 of the operating

mechanism and adapted to depress the roller **22** as the tube is rotated prevents the roller **22** from returning under spring influence to its FIG. **2** blocking position in the tube unless the tube end **7** nearest the container **1** is in alignment with the hole **5** in the container. This is best seen by comparing FIGS. **6** and **10** (where the roller **22** is blocking withdrawal of the pencil **2** from the container **1**) with FIGS. **7** and **8** (where the roller has been depressed but could be returned to the blocking position) and with FIG. **9** (where the tube end **7** is no longer in alignment with the hole **5** and the cam disc **28**, which has swung through 180° together with the tube **4**, prevents the roller **22** from assuming a blocking position).

The operating mechanism **16** of the manipulator **3** comprises a housing **31** in which the aforementioned sleeve **17** that carries the tube **4** is mounted for rotation by roller bearings (see FIGS. **2** and **3**). The housing has an entry fitting **32** for a remotely-driven control cable **33** and it contains a hollow piston **34** through which the cable can pass at one end **36** which constitutes an abutment, the other end of the piston being open. The piston **34** is concentric with and surrounds the sleeve **17** and it is constrained to execute limited rectilinear movement in the housing **31** by stationary guide pins **37** of the housing engaging in straight grooves **38** of the piston **34** (FIGS. **3** and **4**) or of a sleeve **39** carried by the piston (FIG. **2**). A spring **41** biasses the piston towards the right-hand side as viewed in FIG. **2** to assume a limiting position in which one end of the piston strikes a stop in the form of a shoulder **42** provided intermediate the ends of the sleeve **17** or in which the abutment **36** strikes a stop constituted by the end of the sleeve **17.** Projecting from the piston **34** into a cam track **43** in the sleeve **17** there are two spring-influenced cam follower pins **44** (only one is shown in FIG. **2** and might suffice). The cam track is shown as a planar projection in FIG. **11** and it will be noted that it comprises two straight line portions which are parallel to the rotary axis of the sleeve **17** interconnected by two helical portions (also see FIG. **5**) so that the cam track is closed on itself. The arrangement is such that, when the sleeve **17** is in a rotary position at which the end **7** of the tube is in alignment with the hole **5** and the piston **34** abuts against the sleeve **17** (either with the abutment **36** against the end of the sleeve or with the end of the piston against the shoulder **42**, or both), then the cam follower pins **44** will be disposed at the respective commencements of the helical portions of the cam track.

Referring to FIG. **2**, when the cable **33** has been attached to the pencil **2** and it is desired to withdraw the pencil from the container **1**, a pull is exerted by the remote drive on the cable, the roller **22** having first been unlocked by turning the key **24** to swing away the plate **23.** The FIG. **2** condition of the operating mechanism and pencil is again reproduced in FIG. **6** diagram which also illustrates a second locking roller but this second roller is not essential and is not in fact included in the FIGS. **2** and **3** constructions. As the pencil is being pulled out of the hole **5** in the direction of the arrow A of FIGS. **1** and **7**, it rides on and depresses the roller **22** (FIG. **7**) and then enters the sleeve **17** through the tube **4** after having depressed the second roller, if this is provided. This condition is shown in FIG. **8** where the end of the pencil **2** has already been pulled up against the abutment **36** of the piston **34** and the pencil is located wholly within the sleeve **17** and tube **4.**

Further pull exerted on the cable in the direction of the arrow M in FIG. **8** will now cause the piston **34** to be carried along by the pencil against the action of the spring **41** until the piston strikes the adjacent end of the housing **31**, which is the other limiting position of the piston movement. Since the piston is constrained by the guide pin **37** to execute rectilinear movement and since the cam follower pins **44** were initially located at the commencements of the helical portions of the cam track **44** in the sleeve, displacement of the piston towards the left in FIG. **2** and in the direction of the arrow M in FIG. **8** from one limiting position to the other therefore causes the sleeve **17** to rotate as the cam follower pins traverse the cam track. By the time the piston **34** has struck the end of the housing, the pins **44** will have traversed the entire respective helical cam track portions and the sleeve **17** will have been turned through 180°, thereby also having turned the tube **4** (FIGS. **3** and **9**) to bring its end **7** into alignment with the guide path **8.** At this time the roller **22** is prevented from returning to its undepressed condition by the cam disc **28** which has been turned together with the tube **4.**

The cam follower pins will now be disposed at the commencements of the straight cam track portions so that, as the pull on the cable **33** is released and the spring **41** returns the piston **34** towards the right in FIG. **3**, the pins **44** will ride along the straight cam track portions without turning the sleeve **17** and the pencil **2** is ejected in the direction of the arrow B in FIGS. **1** and **9.** Continued feeding of the cable **33** by the remotely-driven control will advance the pencil to wherever the path **8** may lead, the operating mechanism **16** remaining unaffected, with the pins **44** at the ends of the straight track portions and the commencements of the helical portions. The next occasion that the piston **34** will be displaced occurs on returning the pencil in the direction of arrows Y (FIG. **1**) and N (FIG. **10**), when the pencil will again strike the abutment **36.** As before, the sleeve **17** will turn through 180°, this time to bring the tube end **7** back into alignment with the hole **5** and to cause the cam disc **28** to release the roller **22.** Upon return movement of the piston, the sleeve will not turn and the pencil is fed into the hole **5**, after which the roller **22** will be back in the FIGS. **2** and **6** condition and can be locked with the key-actuated plate **23.**

It will be evident that the design of the cam track **43** determines the degree of rotation of the sleeve **17** on each to and fro movement of the piston and consequently, by altering the number of helical cam track portions and interconnecting straight line portions, it is readily possible to feed the pencil from the container into a selected one of a plurality of guide paths **8**, as previously described in relation to the paths **11** in FIG. **1.** Indeed, an operating mechanism similar to the one shown at **16** could be incorporated with the change-over block **9** in FIG. **1** or at any other desired location.

I claim:

**1.** A method of handling an isotope capsule carried at the end of a radioactive source holder, comprising retracting the source holder from one position into a curved passage of a guide member through an inlet at one end of the passage, turning the guide member through an angle of less than 360° about the central axis of the other end of the passage, and then ejecting

the source holder through the inlet into a different position.

2. Manipulating apparatus for withdrawing and inserting a radio-active source holder from and to a hole in a shielded transport container for the source holder and for transferring the source holder to and from a location beyond the container, comprising a curved tube adapted to receive the source holder and mounted for rotation about the central axis of one of its ends so that the other end can be selectively brought into alignment with the hole in the container or with at least one guide path for the source holder externally of the container, and an operating mechanism for effecting rotation of the curved tube only in response to movement of the source holder through the operating mechanism under the influence of a remotely-driven control cable attached to the source holder.

3. Apparatus according to claim 2 including a mounting case securable to the transport container and carrying the operating mechanism, the mounting case including a fixed tube constituting said external guide path and a socket for receiving a safety screw of the container when the screw is in a position at which it permits withdrawal of the source holder from the hole in the container.

4. Apparatus according to claim 3, wherein the curved tube is provided with a slot in its side and the mounting case carries a roller which is spring-influenced to engage through the slot when the said other tube end is aligned with the hole in the container.

5. Apparatus according to claim 4, wherein the mounting case carries a key-operated pivotable plate for locking the roller in its slot-engaging position.

6. Apparatus according to claim 4, wherein the curved tube carries a cam disc which is fixed for rotation therewith and is adapted to hold the roller out of engagement with the slot unless the said other tube end is aligned with the hole in the container.

7. Apparatus according to claim 2, wherein the operating mechanism comprises a housing, a sleeve mounted for rotation in the housing, the curved tube being fixed with its said one end in the sleeve, a hollow piston which is constrained to execute limited rectilinear displacement in the housing between one end of the housing and a stop on the sleeve and is concentric with and surrounds the sleeve, an abutment on the piston, the cable being able to pass through the sleeve, abutment and housing and the source holder being able to enter the piston up to the abutment when pulled through the sleeve by the cable, a spring for biassing the piston against the stop on the sleeve, a cam track provided on the sleeve and at least one cam follower pin projecting from the piston into the cam track, the cam track comprising at least two helical portions interconnected by straight line portions extending parallel to the rotary axis of the sleeve so that the cam track is closed on itself, and the arrangement being such that, when the source holder has been pulled by the cable up to the abutment and the pull is maintained to overcome the bias of the spring, the source holder will displace the piston from its limiting position against the stop on the sleeve to its limiting position against the said one end of the housing, during which time the sleeve and the curved tube fixed thereto are rotated by the cam follower pin traversing one of the helical cam track portions and, when the pull is released, the spring will return the piston to its limiting position against the stop on the sleeve, during which time the cam follower pin traverses one of the straight line cam track portions without causing the sleeve to rotate.

* * * * *