Feb. 16, 1965 R. J. PREST 3,170,065

METHOD FOR MANIPULATING RADIOACTIVE MATERIAL

Original Filed May 15, 1956 2 Sheets-Sheet 1

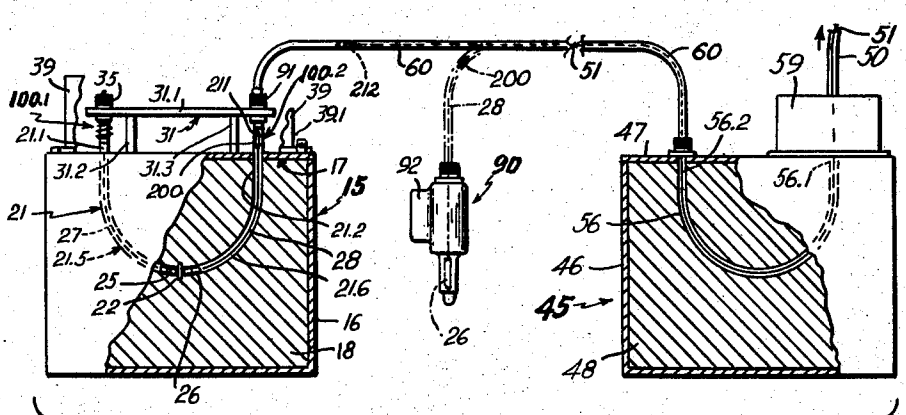


Fig. 1

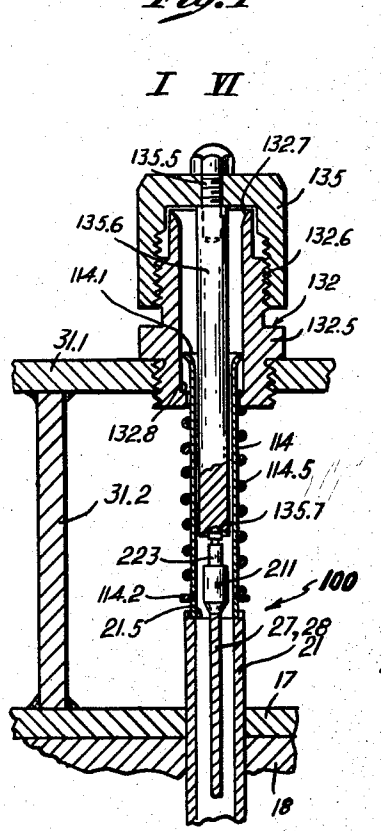


Fig. 3

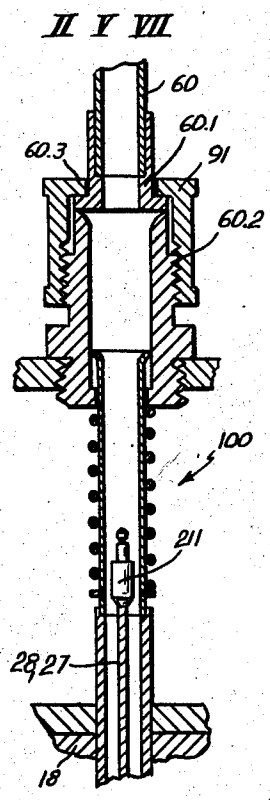


Fig. 4

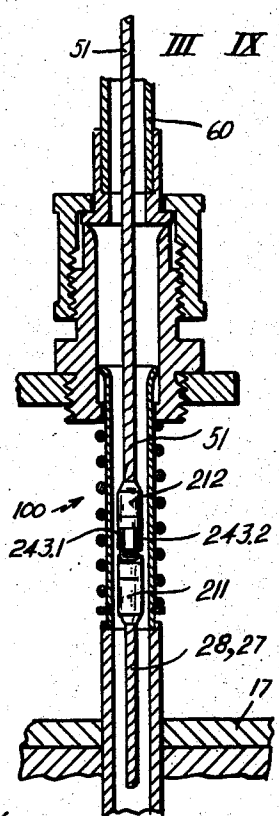


Fig. 5

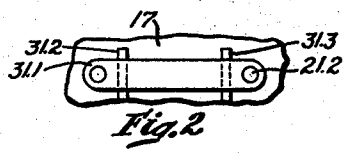


Fig. 2

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METHOD FOR MANIPULATING RADIOACTIVE MATERIAL

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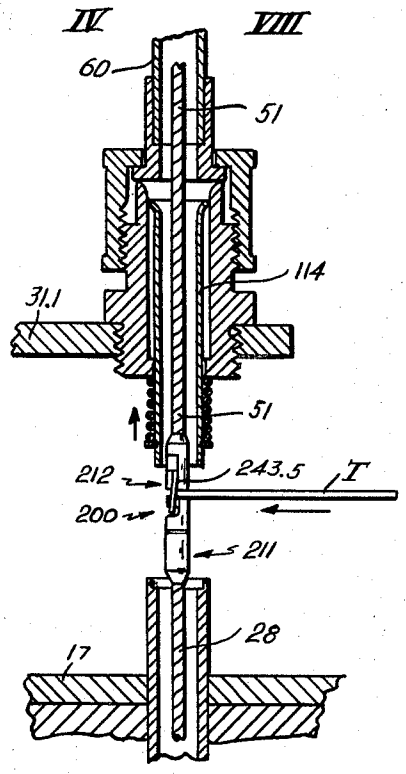


Fig. 6

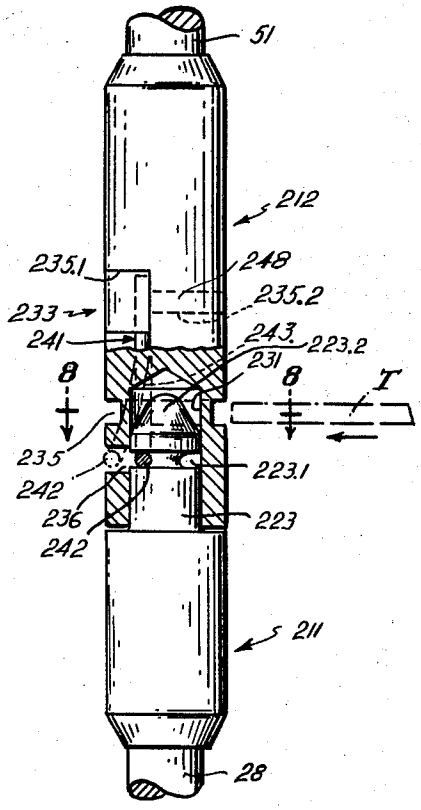


Fig. 7

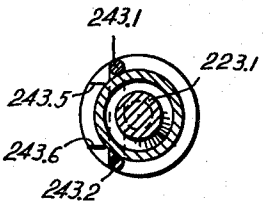


Fig. 8

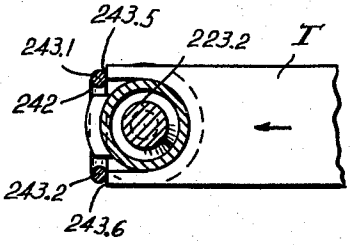


Fig. 10

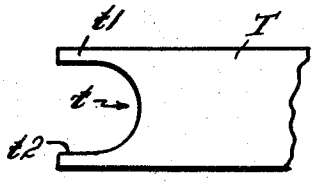


Fig. 9

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3,170,065
METHOD FOR MANIPULATING RADIOACTIVE MATERIAL

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Original application May 15, 1956, Ser. No. 585,081, now Patent No. 2,976,423, dated Mar. 21, 1961. Divided and this application Feb. 8, 1961, Ser. No. 87,938
5 Claims. (Cl. 250—106)

This invention relates to a method or system of manipulating radioactive material, such as sources of gamma radiation consisting of an encapsulated cobalt isotope. The present application is a division of copending application Serial No. 585,081, filed May 15, 1956, now U.S. Patent No. 2,976,423.

Radioactive material which is used for various industrial purposes, such as for radiographic testing by means of panoramic or directional radiographic exposure devices, has to be exchanged upon exhaustion, for example by means of source changers of the type providing for storing and shipping of a fresh source as well as for receiving an exhausted source. Such exchange involves the detaching and attaching of containers and propelling means for the radioactive material with full attention to the safety of the personnel that carries out these operations, it being understood that sources which are referred to as exhausted are nevertheless capable of inflicting considerable damage if not properly shielded.

Methods and systems according to the invention thus involve devices for utilizing radioactive material, such as the above-mentioned radiographic machines, devices for storing and transporting radioactive material, coupling devices for safely attaching and detaching the carrying and propelling components to each other, and apparatus for conveniently manipulating such devices while the radioactive material is amply protected.

Objects of the present invention are to provide a method or system of the above type which permits the optimally safe and yet convenient and quick exchange of radioactive material between a storage and transportation device and an exposure device and vice versa, to provide for positive operation of such a system which does not necessitate possibly unreliable remote control of attaching and detaching operations and which permits direct observation of such operations, to provide such a method of system which permits directly positive connection and disconnection of radioactive source carrying and propelling apparatus while the sources involved are fully shielded, to provide such a method or system which inherently promotes a prescribed safe sequence for withdrawing, exchanging and storing radioactive material, and generally to provide improved systems of the above type which are safe, certain and reliable as to construction and mode of operation and which are nevertheless comparatively inexpensive since they can be fabricated from mostly quite inexpensive material and commercially readily available components.

Briefly stated by way of a summary indicating its nature and substance, the invention introduces, in one of its principal aspects, apparatus for manipulating radioactive material that is carried by propelling means for transporting it between shielding devices, which apparatus comprises a guide tube that is connected to a first shielding device and has an open end, bushing means having at one end means for fastening thereto guide means that lead to a second shielding device, and have at the other end bridging guard means which can be axially withdrawn, and expedients for distancing the open end of the guide tube and the bushing means. The guard means bridge the gap between the bushing means and the open

end of the guide tube and preferably comprise a tube which slides within the bushing means and spring means tending to keep the tube outside the bushing in the aforementioned gap.

In another aspect, the invention involves apparatus for transporting and changing radioactive material by means of elongate carrying and propelling means which apparatus comprises a shielding container having two adjacent openings, within its container a continuously curved conduit such as a metal tube leading with its ends towards respective openings, and within the conduit approximately at the center of the shielding container, means such as a pin inserted transversely of the tube, for stopping the passage of a power source of radioactive material from one end to the other end of the conduit. The conduit openings of such apparatus are preferably provided with two gap bridging components, one for each of the two adjacent openings of the shielding container, which duplication provides for and promotes the safe exchange of sources.

In a further important aspect, the invention includes a connector for joining and detaching carrying means for radioactive sources including a receptacle member having an axial recess, a transverse recess on one side of the axial recess, spring means transversely movable in the transverse recess, and a peripheral groove making the spring means accessible, in combination with a plug member fitting the axial recess of the receptacle member and having a peripheral groove for engagement with the spring means, and in further combination with a spring lifting releasing means which fits the peripheral groove of the receptacle member and has a projection for lifting the spring means from the transverse recess of the receptacle member, for thus disengaging the receptacle and plug members. This connector, while having other uses, is especially practical in combination with the above-characterized system for propelling radioactive material between shielding devices, the entire system then comprising, in addition to the connector, two tubular guide means within or leading to respective shielding devices, support means for the guide means and for establishing a distancing gap therebetween, and elongate source carrying and propelling means such as cables in the tubular guide means, such that ends of a source carrying means can be placed in the gap.

These and other objects and aspects of the invention will appear from the following description of a typical embodiment thereof illustrating its novel characteristics. This description refers to a drawing in which:

FIG. 1 is a schematic elevation, partly in vertical section, of as sytem according to the invention, including exchanging and exposure devices;

FIG. 2 is a top elevation of the bridge top of the source changer shown in FIG. 1;

FIGS. 3, 4, 5 and 6 are axial sections of the top of the source changer, in four different conditions indicating its operation;

FIG. 7 is an elevation, partly in axial section, of a connector according to the invention;

FIG. 8 is a section on line 8—8 of FIG. 7;

FIG. 9 is the view of a tool for operating the connector according to FIGS. 7 and 8; and

FIG. 10 is a section similar to FIG. 8 but with the tool according to FIG. 9 applied thereto.

In FIG. 1 numeral 15 indicates the above-mentioned source changer, 45 indicates a panoramic exposure apparatus, and 90 indicates a snout for receiving a radioactive source from the exposure control apparatus. Both changer 15 and exposure device 45 incorporate as vital components shielding bodies and are herein also simply referred to as shields. It should be understood that 15 and 45 are merely examples and that the invention can

be applied to moving sources between two changers or other shielding apparatus.

The source changer 15 which is of a novel type especially useful for purposes of the present invention, has a steel housing 16 with a lid or top 17 welded thereto. The housing contains a U-shaped or otherwise tortuously shaped tube 21 for example of stainless steel which, with its open ends 21.1, 21.2, penetrates the cover 17 to which it is welded at these points. The housing is filled with shielding material 18, such as lead. Approximately in the center of the shield, the tube 21 has a transversely inserted pin 22 or similar stop device which defines the safe position of sources that are stored in or transported by means of this shield. The stop 22 divides the tube 21 into two halves 21.5 and 21.6. The shield is thus capable of confining (not necessarily simultaneously) two sources 25, 26 attached to respective carrying and propelling means such as cables 27, 28 herein referred to as source cables, each of which has at its other end a cable connector device. Normally, when the changer is used for storing or transporting, only one source and one half of the connector is present, as indicated at 211 of FIG. 1, 211 being the male half of a connector according to FIG. 7. Mounted on the cover plate 17 is a changer mount 31 which consists in this embodiment of a bridge plate 31.1, and two webs 31.2 and 31.3. The plate 31.1 carries, in the manner to be described below, changer heads 100 facing respective ends 21.1, 21.2 of the tube 21. These heads 100 will be described in detail with reference to FIGS. 3 to 6 and are individually indicated at 100.1 and 100.2 of FIG. 1.

A detachable housing for the bridge with its exchanging heads is indicated at 39 of FIG. 1, and a device for locking the closed housing to the changer top is indicated at 39.1.

The exposure apparatus 45 comprises in essence a housing 46 with a top plate 47 that has openings for the two ends 56.1, 56.2 of a tortuously shaped guiding and confining conduit 56 for example a stainless steel tube. The housing 46 is filled with shielding material 48 such as lead. To the tube end 56.1 is attached as a source guide means a flexible conduit 50 which confines a source propelling cable 51, herein also referred to as exposure cable. For normal operation, the cable 51 carries, by way of a connector 200, a source cable 28, within a flexible conduit 60 attached to the end 56.2 of the tube 56. A source 26 can be held, by means of the cable 28, at the safe position in the center of the shield 48. Also by means of cable 28, the source can be propelled into a snout device 90. The latter has a conventional screw coupling 91 for connecting it to the end of the tube 60, and may comprise a control switch housing 92. FIG. 1 shows the cables 28 and 51 and the connector 200 in dot and dash lines to indicate the exposure condition when the source 26 is in the snout, in order to distinguish from their position within the tube 60 when the latter is attached to the source changer, at head 100.2, for purposes of changing sources. At the end 56.1 of the tube 56 of exposure apparatus 45 can be arranged a safety control and signalling unit 59 which responds to the position of the connector 200 or to some other correspondingly arranged locating means.

As will become apparent, FIG. 1 shows in full lines the condition hereinbelow identified as V and shown in FIG. 4, when the source 26 is within the shield 15 and the flexible conduit 60 is not yet unscrewed from the exchanger head.

The exchanger heads, marked 100.1 and 100.2 in FIG. 1, constitute means for separately directing carrying means of radioactive material, such as sources 25 and 26, and are preferably of identical design that will now be described with reference to FIGS 3 to 6.

Each head has an adapter tube or bushing 132 which is screwed into the bridge sheet 31.1 of mount 31 which distances it from the top plate 17, and has a locking flange 132.5, an outside thread 132.6, a flared outer opening 132.7 and an inner opening with a rim 132.8.

A tube 114 which is slightly flared out at the upper end 114.1 and has at the other end a shoulder 114.2, is inserted in the opening 132.8 of the bushing 132 such that a spring 114.5 tends to expel it from the inside of the bushing and to press it into the recess 21.5 of the shield tube 21, thus fully closing the gap between the ends of the tube 21 and bushing 132.

Each exchanger head has a cap 135 that can be screwed to the bushing thread 132.6 as shown in FIG. 3. The cap has fastened thereto a holddown rod 135.6 that has at its outer end a recess 135.7. With the cap on, and a source with its source cable 27 in the changer (for example in tube half 21.5 as shown in FIG. 1) the recess 135.7 receives the plug portion 223 of the connector half 211 thus securing the radioactive source.

Similar to FIGS. 1, FIGS. 3 to 6 also indicate the source cables with the male connector component 211, and FIGS. 4 to 6 show in addition and instead of the cap 135, the coupler 91 for the snout 90 which coupler sits on a coupler flange 60.1 that is fastened to the flexible conduit 60. The coupler 91 has a thread 60.2 and an inwardly extending rim 60.3. By means of this conventional arrangement, the outer end of a conduit such as the snout tube 60 can be firmly attached to each one of the heads, as indicated in FIGS. 4 to 6.

FIGS. 5 and 6 show in addition an exposure cable 51. The end of this cable 51 carries the other half 212 of the connector 200, whose half 211 was mentioned above as fixed to the source cable 28. In FIG. 5 the two halves are shown in fully connected position, whereas FIG. 6 indicates the uncoupling operation by means of the key T which is also shown in FIGS. 7, 9 and 10.

The connector proper, such as indicated at 200 of FIG. 1, will now be described with reference to FIGS. 7 to 10.

This connector consists of a plug member 211 and a receptacle member 212. FIGS. 7, 8 and 9 show the connector as attached to cables 28 and 51, but it will be understood that the connector can also be used for directly attaching thereto a snout capsule, such as indicated at 25 and 26 of FIG. 1.

As shown in FIGS. 7 and 8, the stud portion 211 of the connector has a cylindrical plug 223 with an annular recess 223.1 and a rounded conical head 233.2.

The receptacle portion 212 has a cylindrical recess 231 which fits the plug 223, and in its intermediate portion 233 the receptacle member has machined thereinto a generally speaking rectangular recess or box 235.1 which recess extends into the countersunk bore 235.2.

The spring 241 is generally speaking U-shaped with a transverse intermediate portion 242 which is parallel to an annular recess 235, and to a transverse slot 236 which corresponds to the annular groove 223.1 of the plug member 211, when the latter reaches into the cylindrical recess 231 of the receptacle member 212. The substantially parallel end portions 243.1 and 243.2 (FIGS. 8 and 10) of the spring 241 reach into the slot 236 which is deep enough to permit the spring portion 242 to rest in the annular recess 223.1 of the plug member, when the two connector members are attached to each other. Longitudinal recesses 243.5, 243.6 receive the arms of the spring 241 which is fastened to the receptacle member 212 by means of an insert 248 which, after staking is turned to the body diameter.

It will now be evident that the spring 241 in the locking position which is indicated with full lines in FIG. 7, firmly connects the receptacle member 212 to the plug member 211. If the spring 242 is lifted by means of a tool T it can be easily brought into the position which is indicated in dot and dash lines in FIG. 7 and also in FIG. 10.

It will be understood that the semicircular inner face of the tool T, marked *t* in FIG. 9, accommodates the circular groove 235 of the recess portion 212, and that

the two arms *t*1 and *t*2 are long enough to lift the spring **241** into the position wherein it releases the stud **223** as shown in FIG. 10.

For purposes of exchanging the exhausted radioactive source of apparatus of the type described above with reference to the shield **45** of FIG. 1, against a fresh source contained within a unit of the type of the shield **15**, the above-described arrangement operates as follows, it being understood that it can be used analogously with other installations of the same general character.

Shortly recapitulating, the exposure unit **45** comprises flexible tube **60** having at its end a snout unit **90** which is detachable therefrom by means of a coupler **91**. Within this flexible tube moves an exposure cable **51** to the end of which is attached to a source cable **28** by means of a connector similar to that described with reference to FIGS. 7 to 10. The source cable is in turn attached to the source proper by way of a connector that is not specifically described herein because its construction is immaterial, but which can be of the type of the connector according to FIGS. 7 to 10.

Assuming that the exposure device **45** contains a source which is for practical purposes exhausted (herein referred to as old source) and that the source changer contains in one of its tube halves a fresh or only partially exhausted source (herein referred to as new source), a complete cycle of the operations that are necessary for exchanging the old source with the new source is as follows.

It is assumed that the source changer **15** contains a new source in a capsule, indicated at **25**, within the half **21.5** of the tube **21**, which ends at **21.1** and head **100.1**. The other tube half **21.6** which ends at **21.2** is empty, contrary to the showing of FIG. 1 which indicates a later stage as pointed out above. It is further assumed that the exposure apparatus **45** has its old source withdrawn therewithin, again contrary to FIG. 1 for the above reason. It will be remembered that the source cable **27** of the new source **25** and hence the source itself are secured by the holddown rod **135.6** with its recess **135.7** engaging the end of plug **223** (FIG. 3).

In the following explanation, FIGS. 3 to 6 are used for describing the operation of both heads, **100.1** and **100.2** in order to reduce the number of figures, which is possible since the heads are and must be identical. The order of the consecutive steps is indicated in these figures, and identified in the following text, with the aid of Roman numerals. Numeral I as applied to FIG. 3 indicates the normal condition of the head **100.1** with the new source **25** secured by cap **135** and holddown rod **135.6**. The empty half of the changer, with head **100.2** is not separately illustrated; it looks exactly as FIG. 3 but without source cable **27**.

After unlocking and removing the cover **39**, the cap **135** with rod **135.6** of head **100.2** is removed and the coupler **91** of the snout end of tube **60** is screwed onto the bushing **132** after the snout **90** has been detached. This step II is illustrated in FIG. 4 but with the source cable omitted from that figure. The tube half **21.6** is empty and the source inside of shield **45**. The cap **135** of the other head **100.1** is of course left undisturbed for the time being.

The operator now retires to a safe distance and moves the old source **26** into the tube **60** and through its open end through the head **100.2**, until the source is at the safe point **22** of the tube **21**. The head **100.2** is now in condition III which is exactly shown in FIG. 5. After having made certain that the old source is safely located in the changer **15**, the spring loaded guide tube **114** is lifted (FIG. 6), thus exposing both connector components **211** and **212**, the one on the source cable **28** and the other on the exposure cable **51**. The connector spring **232** is now lifted with the key T, as explained with reference to FIGS. 7 to 10. This is the position IV as indicated in FIG. 6. The two halves of the connector are now pulled apart and the exposure cable **51** somewhat withdrawn, care being taken not to move the source cable **27**, so that the told source **26** is retained within the changer. This is position V, exactly shown in FIGS. 1 and 4. The exposure tube **60** is now disengaged from the threaded bushing **132** and the cap **135** is securely replaced thereon, rod **135.6** engaging the coupling half **211**. This stage is indicated at VI, FIG. 3.

The old source **26** is now secured safely within the tube half **21.6** and held by head **100.2**, whereas the new source **25** is still within **21.5** and held by head **100.1**. As mentioned above with reference to position V and indicated in FIG. 1, the connector half **212** at the end of the exposure cable **51** is near the end of its tube **60** from which the snout is still removed so that only the coupler **91** is attached thereto.

In order to transfer the new source **25** from the changer **15** to the exposure apparatus **45**, the cap **135** of the head **100.1** is removed, and the snout tube coupler **91** is screwed onto the bushing **132**. This is stage VII, indicated by FIG. 4. The exposure cable is now inserted into the bushing **132**, aided by its funnel shaped end **132.7** and the flared end **114.1** of the tube **114**, at which stage the situation is approximately that as shown in FIG. 5, but with the connector halves not yet engaged. The tube **114** is now again lifted and the two connector ends securely engaged, for which purpose the use of the tool T is not necessary. This stage VIII is indicated in FIG. 6. After having made very certain that the connection is complete, and after the guide tube **114** has been released to engage the shoulder **21.5** which is position IX, illustrated in FIG. 5, the operator retires to a safe distance and moves the new source from the changer **15** into the exposure unit **45**, leaving the tube half **21.6** below head **100.2** completely empty.

The snout tube **60** is now disengaged from the bushing **132**, the snout piece **90** is attached by screwing it to the coupler **91**, the cover **39** of the changer **15** is replaced and padlocked, whereupon the exposure device is ready for operation with the new source and the old source can be shipped for exchange with a new source.

It should be understood that the present disclosure is for the purpose of illustration only and that this invention includes all modifications and equivalents which fall within the scope of the appended claims.

What is claimed is:

1. Method of exchanging sources of radioactive material in a first shielding means containing a first source of radioactive material, comprising the steps of

(1) providing the second shielding means adapted for receiving said first source of radioactive material,

(2) providing third shielding means containing a second source of radioactive material,

(3) providing conduit means between said first and second shielding means,

(4) transporting said first source through said conduit means from said first shielding means to said second shielding means,

(5) providing conduit means between said first and third shielding means, and

(6) transporting said second source through said conduit means from said third shielding means to said first shielding means.

2. Method of exchanging sources of radioactive material in a first shielding means containing a first source of radioactive material, comprising the steps of

(1) providing second shielding means adapted for receiving said first source of radioactive material,

(2) providing third shielding means containing a second source of radioactive material,

(3) providing conduit means between said first and second shielding means,

(4) transporting said first source by remote control through said conduit means from said first shielding means to said second shielding means,

(5) providing conduit means between said first and third shielding means, and

(6) transporting said second source by remote control through said conduit means from said third shielding means to said first shielding means.

3. Method of exchanging sources of radioactive material in a first shielding means containing a first source of radio material, comprising the steps of

(1) providing second shielding means adapted for receiving said first source of radioactive material,

(2) providing third shielding means containing a second source of radioactive material,

(3) providing conduit means coupled at a first end to said first shielding means and fitted for coupling at a second end alternatively to one or the other of said second and third shielding means,

(4) coupling said second end to said second shielding means,

(5) transporting said first source through said conduit means from said first shielding means to said second shielding means,

(6) transferring said second and from said second shielding means to said third shielding means,

(7) transporting said second source from said third shielding means to said first shielding means, and

(8) decoupling said second end of said conduit means from said third shielding means.

4. Method of exchanging sources of radioactive material in a radiographic apparatus having a first source of radioactive material and first shielding means therefor, and flexible cable-in-conduit type means including disconnectible source coupling means at one end of the flexible cable means for moving a source between a stored position in said shielding means and an exposed position, comprising the steps of

(1) providing second shielding means adapted for receiving said first source of radioactive material,

(2) providing third shielding means containing a second source of radioactive material having coupling means connectible to said end of said cable means,

(3) providing conduit means adapted for the passage of one of said sources and said flexible cable means between said first and second shielding means,

(4) propelling said first source through said conduit means by means of said cable means into a stored position in said second shielding means,

(5) decoupling said cable means from said first source while said first source is in said stored position in said second shielding means,

(6) transferring said conduit means with said cable means to said third shielding means containing said second source,

(7) coupling said second source to said cable means while said second source is in its stored position in said third shielding means, and

(8) withdrawing said second source by means of said cable means into said first storage means from said third storage means.

5. Method of exchanging sources of radioactive material in a radiographic apparatus having a first source of radioactive material and first shielding means therefore, and flexible cable-in-conduit type means including disconnectible source coupling means at one end of the flexible cable means for moving a source between a stored position in said shielding means and an exposed position, comprising the steps of

(1) providing second shielding means adapted for receiving said first source of radioactive material,

(2) providing third shielding means containing a second source of radioactive material having coupling means connectible to said end of said cable means,

(3) providing conduit means coupled at a first end to said first shielding means and fitted for coupling at a second end alternatively to one or the other of said second and third shielding means, and adapted for the passage of one of said sources and said flexible cable means therethrough,

(4) coupling said second end to said second shielding means,

(5) propelling said first source through said conduit means by means of said cable means into a stored position in said second shielding means,

(6) decoupling said cable means from said first source while said first source is in said stored position in said second shielding means,

(7) transferring said second end with said end of said cable means to said third shielding means containing said second source,

(8) coupling said second source to said cable means while said second source is in its stored position in said third shielding means, and

(9) withdrawing said second source by means of said cable means into said first storage means from said third storage means.

No references cited.

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