Nov. 27, 1956 E. N. HIESTAND 2,772,361

RADIOACTIVE SOURCE HOLDER

Filed Dec. 21, 1953 5 Sheets-Sheet 1

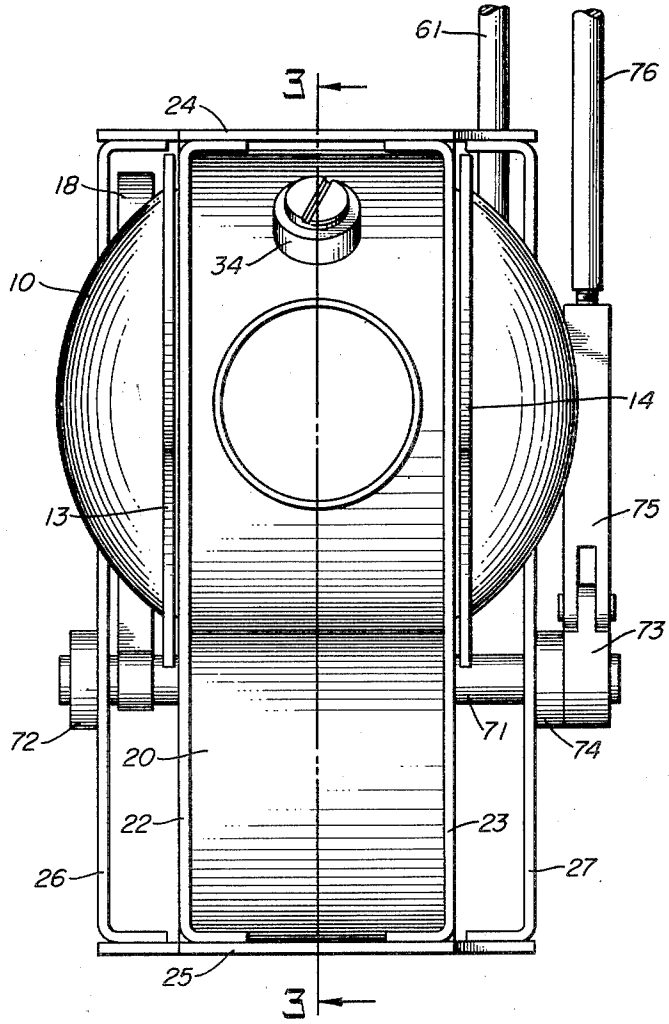


Fig 1

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RADIOACTIVE SOURCE HOLDER

Filed Dec. 21, 1953 5 Sheets-Sheet 2

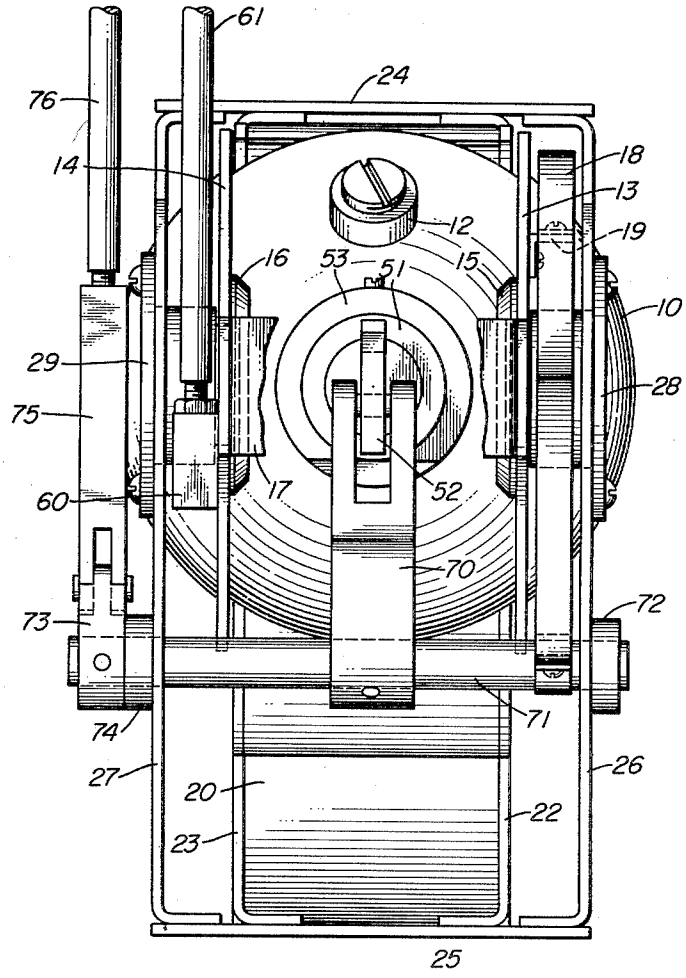


Fig 2

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RADIOACTIVE SOURCE HOLDER

Filed Dec. 21, 1953 5 Sheets-Sheet 3

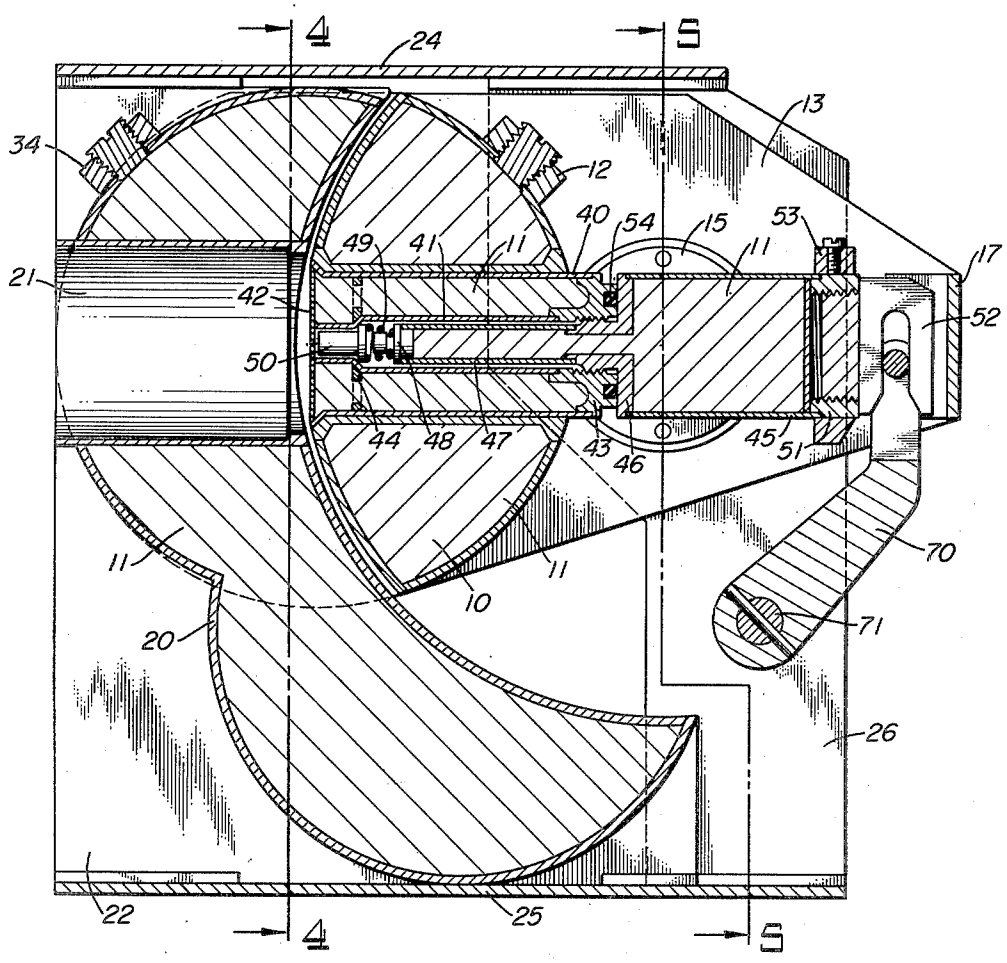


Fig 3

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RADIOACTIVE SOURCE HOLDER

Filed Dec. 21, 1953 5 Sheets-Sheet 4

Fig 4

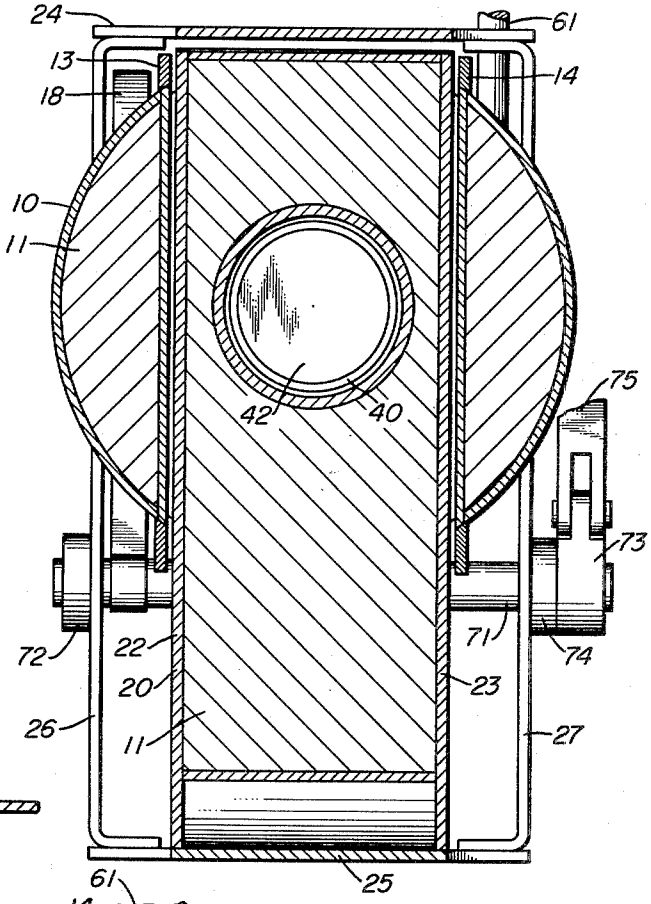
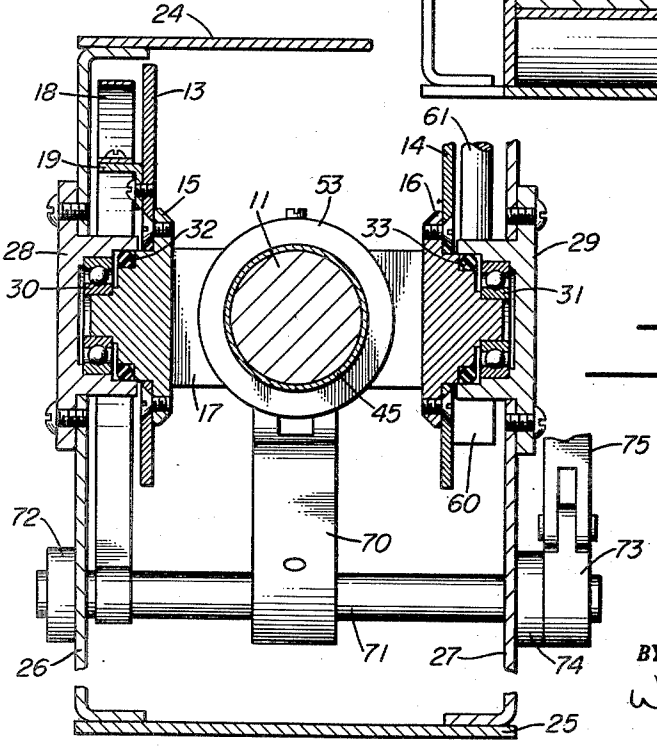


Fig 5



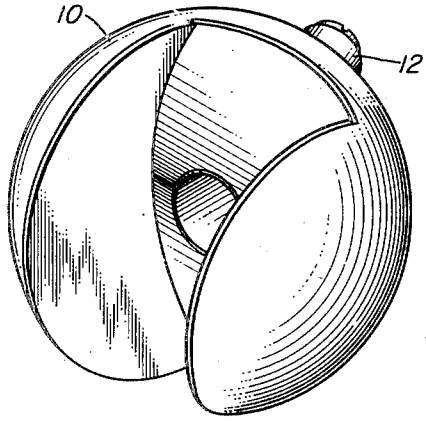
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RADIOACTIVE SOURCE HOLDER

Filed Dec. 21, 1953 5 Sheets-Sheet 5

Fig 6



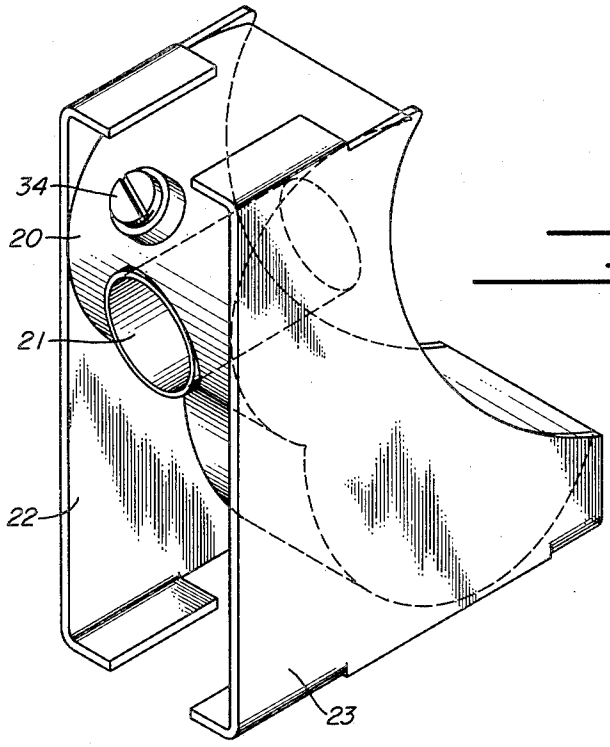


Fig 7

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United States Patent Office 2,772,361 Patented Nov. 27, 1956

2,772,361

RADIOACTIVE SOURCE HOLDER

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Application December 21, 1953, Serial No. 399,446

10 Claims. (Cl. 250—106)

This invention relates to shielded containers for radioactive sources, and, more particularly, to a remote-operation container for gamma radiation sources.

Modern industrial radiography utilizes the short penetrating rays of gamma radiation from sources such as cobalt-60, iridium-192, and other gamma-emitting isotopes, which are enumerated in the Isotopes Catalog, January 1953, Oak Ridge National Laboratory. An inherent property of such penetrating rays is that they will pass through a wood or metal object and indicate such passage by acting upon the emulsion of a photographic film. The radiographs so produced are interpreted by examination of the variation in the densities of the penetrating rays, as indicated by their action on the emulsion of a photographic film, and thus permit a determination to be made of the internal structure of the object being radiographically examined.

Various types of containers have been used for gamma sources, which permit the emission of rays through openings in the container. Such containers usually consist of a lead-lined box provided with a circular aperture fitted with a screwed cap or plug through which the passage of rays may be regulated and directed (collimated) toward objects placed in their path. Another type of container has been designed in the shape of a sphere with a hingedly mounted wedge-shaped cover which is adapted to fit a corresponding opening in the spherical shield. Still another type of container, which is suitable only for low-energy sources, has a tear-drop shape, with a handle operable to open the spherical end of the container, thus permitting the emission of rays.

All of the above-described types of containers require that the operating personnel be in the vicinity of the container when the object being examined is first exposed to radiation. The box-shaped container requires that the aperture can be removed by some manual means. The spherical-shaped container requires that the cover be raised. The tear-drop-shaped container requires that the handle be operated to open the end of the container. In each instance, operating personnel are exposed, at the very least, to stray radiation.

Another disadvantage of prior-art devices is that the aperture through which the rays are emitted cannot be collimated or varied in shape or size without the danger of exposing personnel to direct radiation, or else without disassembling and removing the gamma source entirely from the apparatus before the aperture size is changed.

Still another disadvantage of the prior art is that the shielded containers, as described above, do not permit the source-to-object distance to be varied so as to permit variation in radiographic techniques to be made without exposing the operating personnel to at least stray radiation.

A further disadvantage of the above-described types of apparatus is that they will not readily permit radiographic examination under water, or in any medium other than air.

Therefore, it is an object of this invention to provide

a shielded container for radioactive sources that will provide adequate shielding for personnel in the area and will permit remotely controlled exposure to the radiation.

Another object of this invention is to provide a shielded container that will permit the radioactive source to be moved from the center to the front of the container by remote operation so as to permit variation in radiographic techniques.

Still another object of this invention is to provide a shielded container for radioactive sources that will permit controlled aperture sizes, ranging from a pencil beam to a hemispherical volume.

Still another object of this invention is to provide a shielded container for radioactive sources which may be remotely operated for radiographic examination in water, air, or any other medium.

Other objects and advantages of the present invention will be apparent from the following detailed description of a preferred embodiment thereof taken in connection with the attached drawings, in which like numerals refer to like parts, in the several views, and in which:

Fig. 1 is a front plan view of a container embodying the invention shown in the "open" position;

Fig. 2 is a rear plan view of a container embodying the invention shown in the "open" position;

Fig. 3 is a sectional elevational view on line 3—3 of Fig. 1;

Fig. 4 is a sectional view on line 4—4 of Fig. 3;

Fig. 5 is a sectional view on line 5—5 of Fig. 3;

Fig. 6 is a fragmentary elevational view showing the generally spherical shape of the shield; and

Fig. 7 is a fragmentary elevational view showing the shape of the shutter assembly. The shutter assembly has two convex surfaces and one concave surface, and is hereinafter described as having a "biconvexo-concave" shape.

A gamma source suitable for radiography requires that the source be shielded for the protection of the personnel in its vicinity. Thus, for any container, shielding is a primary factor in design. The high density of lead makes it a satisfactory shielding material and enables the container to be made smaller than other materials would permit. For example, in absorbing the radiations of iridium-192, iron is only one-third as effective as lead; hence, an iron sourceholder would be three times as large as one constructed primarily of lead. However, dense and radiation-absorbent materials other than lead may be used as shielding material.

The thickness of the shielding material is dependent on the energy of radiation from the source. Two inches of lead are adequate to protect the operating personnel from a 10-curie, iridium-192 source, while 7 inches of lead are required for a higher energy source, such as cobalt-60. Stated generally, the higher the energy of the radiation from this source, the larger the amount of shielding required, and, therefore, the container must be larger and heavier. For example, a lead sphere 5½ inches in diameter weighs 36 pounds; however, a lead cube 5½ inches on one side would weight 68 pounds. Because of the high density of lead, the relatively small volume of difference between a sphere and a cube makes a significant difference in the total weight of the sourceholder, thus making a spherically shaped container the most desirable.

A preferred embodiment of the invention, as shown by the drawings, includes as basic components: a generally spherically shaped shield assembly; a biconvexo-concave shaped shutter assembly; a generally cylindrically shaped source-carrier assembly; a shield-assembly actuating mechanism including actuating means; and, a source-carrier actuating mechanism including actuating

means, all hereinafter described in detail. All components are fabricated from stainless steel or other suitable materials, unless otherwise indicated.

The shield assembly comprises the generally spherically shaped metal shell **10** which is filled with lead **11**, or another radiation-shielding material, through fitting **12** and which has a cylindrical hole along one axis thereof (see Fig. 6), two shell-mounting side plates **13** and **14**, and an end brace **17**. A flat spiral spring **18** may be attached from the drive shaft **71** to side plate **13**, by spring bracket **19** affixed to side plate **13**, so as to aid the movement of the shield assembly to the "open" position in line with the aperture **21** in the shutter assembly.

The shutter assembly comprises the biconvexo-concave-shaped shell **20**, one section of this shell having a cylindrical aperture **21** therein, which is filled with lead **11** through fitting **34** and two shutter side plates **22** and **23**. To side plates **22** and **23** are affixed a top plate **24** and a base plate **25**, thus forming the basic structural frame of the container.

Affixed to top plate **24** and base plate **25** are two frame side plates **26** and **27**. Affixed to side plates **26** and **27** are two bearing housings **28** and **29** containing two ball-type bearings **30** and **31**, said bearings being held in position in housings **28** and **29** by closures **15** and **16**. The bearings **30** and **31** are sealed by O rings **32** and **33**, so that sea water, dirt, etc., will not interfere with the function of the bearings. The shield assembly rotates through an arc segment on the bearings so as to move the source from the "closed" position behind the completely lead-filled section of the shutter assembly to the "open" position in line with the aperture **21**. After the desired exposure time has elapsed, the shield assembly is returned to the "closed" position. The source-carrier assembly is of generally cylindrical shape and comprises two parts: the carrier body and the carrier cap. The carrier body has a tubular outer shell **40** and a coaxially located inner shell **41**. The annular space between the two shells is filled with lead **11**. The two shells are faced at one end with a thin, metal cap **42** which functions as a window for emission of gamma radiation. The two shells are joined at the other end by a tapped plug **43** which is grooved to receive an O ring **54** which forms a seal between plug **43** and plug **46** to keep sea water, dirt, etc., out of the source-carrier assembly. The carrier body is strengthened by a spacer **44**, which maintains the relative position of outer shell **40** and inner shell **41**. The outer shell **40** is flanged outwardly at the cap end so that the movement of the source-carrier assembly within the shield assembly is restricted when the source-carrier assembly is "retracted."

The carrier cap has a tubular shell **45** which is filled with lead **11**. At one end of shell **45** is a threaded plug **46** which has fastened thereto a plunger **47**, which has a diameter slightly less than the diameter of the inner shell **41** in the carrier body. The plunger **47** is filled with lead **11**. In the end of the plunger **47** is a spring retaining plug **48** which serves to provide a seat for the capsule spring **49**. The source capsule **50** is aluminum, or other material having a low neutron cross section, and is sealed after the source material has been placed therein, but before the capsule is irradiated in a reactor pile. The source capsule **50** is held in position against the cap **42** by the capsule spring **49**. The other end of the base **45** is fitted with an end plug **51** to which an interlocking means **52** for the source-carrier actuating mechanism is fastened. In this embodiment of the invention, the interlocking means is an open C shaped hook. The size of the slot in the interlocking means need be limited only by the radius in which the interlocking lever **70** will move. A collar **53** is adjustably fitted to the shell **45** so as to limit the movement of the source-carrier assembly within the shield assembly as it is "extended" through the aperture **21** toward the front of the shutter assembly.

The shield-assembly actuating mechanism comprises a control anchor **60** which is pivotably fastened to side plate **14** and control rod **61** affixed to said control anchor. The location of the control anchor in relation to the axis of the bearings **30** and **31** is such that a force exerted by the control rod, which is connected to the control anchor, aided by flat, spiral spring **18**, if used, will rotate the shield assembly through an arc segment to the open position in line with aperture **21**. When the force exerted by control rod **61** is reversed in direction, the shield assembly will return to a closed position behind the completely lead-filled section of the shutter assembly. A lock or catch arrangement (not shown) may be used to secure the shield assembly in the open or closed position. An actuating means, other than through a mechanical linkage, such as hydraulic cylinders or electrical solenoids, can be used to effect movement of the shield assembly.

The source-carrier actuating mechanism comprises an interlocking lever **70** which is contained in its forward or extending movement by interlocking means **52**, a drive shaft **71**, to which the interlocking lever **70** is rigidly affixed and which is mounted through frame side plates **26** and **27** and held in position at one end by collar **72**, a drive-shaft crank **73** which is rigidly affixed to the other end of drive shaft **71** and which is separated from side plate **27** by a spacer **74**, a connecting rod **75** hingedly fastened to the drive-shaft crank **73**, and a control rod **76** rigidly affixed to the connecting rod **75**. The action of the actuating mechanism is such that when the shield assembly is in the open position in line with aperture **21**, a force exerted by control rod **76** will cause the interlocking lever **70** to engage the interlocking means **52**, and the source-carrier assembly will be extended through the aperture **21** toward the front of the shutter assembly. When the force exerted by control rod **76** is reversed in direction, the source-carrier assembly will retract from within aperture **21** and the shield assembly may be rotated to the closed position. An actuating means, other than through a mechanical linkage, such as hydraulic cylinders or electrical solenoids, can be used to effect movement of the source-carrier assembly.

In the embodiment of the invention which is shown in the drawings, the interlocking lever **70** tends to be in a position such that it cannot readily engage with interlocking means **52** when it is desired to actuate the source-carrier assembly. Therefore, means (not shown) for spring loading the interlocking lever **70** against a fixed-position stop so as to maintain the interlocking lever in a position such that it will readily engage the interlocking means **52** and be constrained thereby may advantageously be used. Spring loading of the interlocking lever **70** may also function to maintain the extended position of the source-carrier assembly when the shield assembly is in open position.

A latch (not shown) may be pivotally mounted on bearing closures **15** and **16** and will function to lock the source-carrier assembly in a retracted position while the shield assembly is being rotated to a closed position. The latch could be spring loaded in such a manner that the latch is always tending to engage with a notch atop interlocking means **52**.

Various control brackets and mountings (not shown) may be affixed to frame side plates **26** or **27**, or other components of the container, as are required by the particular shield assembly and source-carrier actuating means used.

If apertures smaller than aperture **21** in the shutter assembly are desired, a lead plug containing the desired aperture may be inserted into the shutter assembly. The lead plug interferes with the passage of the carrier out

through the shutter, but results in no inconvenience, because the only way of collimating a beam of radiation is by placing shielding in front of the source to absorb the radiation in all but the region of the desired beam. Hence, it is impossible to have a collimated beam and also have the source up against the object. It is advantageous that the design of this sourceholder permits the insertion of the desired aperture before the sourceholder is moved to the open position. Other units have to be opened before the aperture can be inserted, and in so doing the personnel are exposed to radiation from the source.

The source capsule **50** may be loaded into the source-carrier assembly at a safe distance, preferably while the entire container is under several feet of water. The carrier body with cap removed is left in the shield assembly and the container is then lowered in the water. The source capsule is then lifted by a pick-up tool and dropped through the open end of plug **43** into the carrier body. The carrier cap is then lowered and put in place with capsule spring **49** contacting the source capsule **50**. There is now sufficient shielding so that the entire container can be removed from the water and the final assembly operation performed at close range. The container is placed in a vacuum oven and thoroughly dried to remove all traces of moisture. Final assembly is made by tightening the threaded plug **46** into the tapped plug **43**, a seal being made by O ring **54**. The end brace **17** is fastened to side plates **13** and **14** and the container is ready for use.

The embodiment of the invention described and shown above may be operated in fresh water or seawater, in air, or in any other medium. When the container is at the desired location, the shield-assembly actuating mechanism is actuated so as to rotate the shield assembly from the "closed" position to the "open" position. The source-carrier actuating mechanism may then be actuated so as to "extend" the source-carrier assembly the desired distance into and through aperture **21**. This may all be done by remote operating actuating means and the personnel are shielded to a maximum degree from harmful rediation.

The thickness of the lead shielding material **11** and the size of the entire container may optionally be changed to furnish adequate shielding for sources of greater or lesser activity as desired, and may be so dimensioned as to reduce the intensity of radiations from any particular source at the outer surface, below the maximum levels permitted for transportation by common carrier.

One unique feature of this new sourceholder is that the holder can be located with the aperture against the object to be radiographed and fastened rigidly in place without interfering with the opening and closing of the holder. This is possible because neither a hinged cover nor a plug must be removed from the front of the source to expose it. The new holder is opened by swinging the source and its shield from behind the shielded portion of the shutter to a new position behind the aperture and then pushing the source and carrier out through the aperture if the application requires that the source be against the object. Separate remote controls may be provided for performing these two simple operations. In addition to this, a positive locking mechanism may be provided to assure that the holder is aligned in either a completely open or a completely closed position. A third remote control is provided to release this lock so that the holder may be opened or closed. The lock is both a safety feature and a convenience to the operating personnel.

The remote-operation container, according to the invention, may be used for underwater radiography. It may also be used for the examination of large castings and heavy forgings where, in order to obtain satisfactory radiographs, a source of such high intensity must be used that only a remote-operation container could comply with safety requirements.

While a particular embodiment of the present invention has been shown and described, it will be obvious to those skilled in the art that changes and modifications may be made without departing from the invention in its broader aspects, and, therefore, the appended claims are intended to cover all such changes and modifications as fall within the true spirit and scope of this invention.

What is claimed is:

1. A radioactive source container comprising a capsule for holding a radioactive source; a radiation-absorbing shield, one surface of which is equidistant at every point from a predetermined axis; a mounting for said capsule within said shield and pivotable about said axis; and a radiation-absorbing member having an aperture therethrough so located that radiation can be emitted through the aperture when said capsule is registering with the aperture and the radiation is absorbed when the capsule mounting has been pivoted away from the vicinity of said aperture, said capsule being axially slidable in said mounting for movement into said aperture.

2. A radioactive source container comprising a capsule for holding a radioactive source; a generally spherically shaped radiation-absorbing shield, one surface of which is equidistant at every point from a predetermined axis; a generally cylindrically shaped carrier for said capsule within said shield and pivotable about said axis; a radiation-absorbing shutter having an aperture therethrough so located that radiation can be emitted through the aperture when said capsule is registering with the aperture and the radiation is absorbed when the capsule carrier has been pivoted away from the vicinity of said aperture, and lever means engaging said capsule carrier for moving the capsule carrier into said aperture.

3. A radioactive source container comprising a radioactive source capsule mounted in a source carrier near the center of a generally spherically shaped shield filled with a radiation-shielding material and having removed therefrom a section conforming to the concave surface of a shutter; said shutter consisting of two sections, either of which serves to complete the generally spherical shape of the shield, one section having an aperture therethrough, the balance being filled with a radiation-shielding material, the other section being completely filled with a radiation-shielding material, lever means engaging the source carrier for moving the carrier and the capsule into said aperture.

4. A radioactive source container according to claim 3 in which the source carrier is generally cylindrical in shape and comprises a carrier body and a carrier cap: the carrier body having a tubular outer shell and a coaxially located inner shell, the annular space between the two shells being filled with a radiation-shielding material, the two shells being faced at one end with a metal cap and joined at the other end with tapped plug; the carrier cap having a tubular shell which is filled with a radiation-shielding material, said shell having at one end a threaded plug to which is fastened a plunger at the end of which is a spring-retaining plug and a capsule spring, said shell having at the other end an end plug to which an interlocking means is affixed.

5. A radioactive source container according to claim 3 in which the generally spherically shaped shield comprises a metal shell which has a cylindrical hole along one axis thereof, two shell-mounting side plates affixed to said shell, two shield-bearing closures affixed to said side plates and an end brace affixed between said side plates.

6. A radioactive source container according to claim 3 in which the shutter comprises a biconvexo-concave shaped metal shell, one section of the shell having a cylindrical aperture therethrough, two shutter side plates affixed to said shutter and a top plate and a bottom plate affixed to said side plates so as to form the basic structural unit of the container.

7. A radioactive source container according to claim 6 in which two frame side plates are affixed to the top

plate and bottom plate and two bearing housings are affixed to said frame side plates.

8. A remote-operation radioactive source container comprising a spherically shaped shield, a shutter, and a source carrier for a radioactive source capsule; said spherically shaped shield having a section removed so as to conform to the concave surface of the shutter, having a cylindrical hole along one axis thereof, and having rigidly affixed thereto an actuating means for moving said shield in an arc segment with relation to the shutter; said shutter having one concave surface and two convex surfaces, either of which convex surfaces serves to complete the spherical shape of the shield, one convex surface having an aperture therethrough to the concave surface; said source carrier being generally cylindrical in shape and having an actuating means engaging therewith for moving said radioactive source capsule while within said source

carrier from a point near the center of the aforesaid shield to a position within the aforesaid aperture in the shutter.

9. A remote-operation radioactive source container according to claim 8 in which the spherically shaped shell, the shutter, and the source carrier, are all at least partially filled with a radiation-shielding material.

10. A remote-operation radioactive source container according to claim 8 in which the actuating means may be selected from mechanical, electrical solenoid and hydraulic mechanisms.

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