

May 5, 1964

F. MAUD ETAL
IRRADIATION VAULT

3,132,251

Filed Oct. 27, 1960

2 Sheets-Sheet 1

FIG. 4

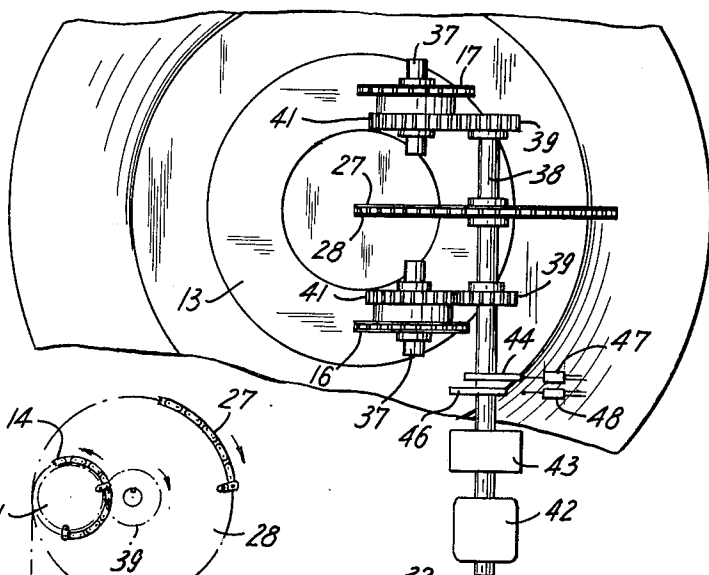


FIG. 1

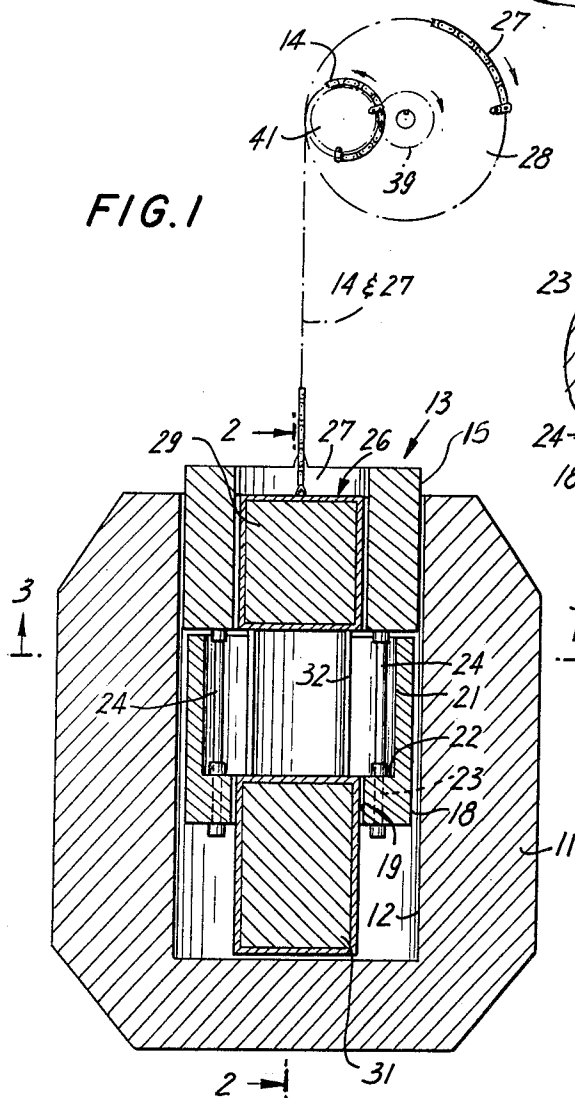
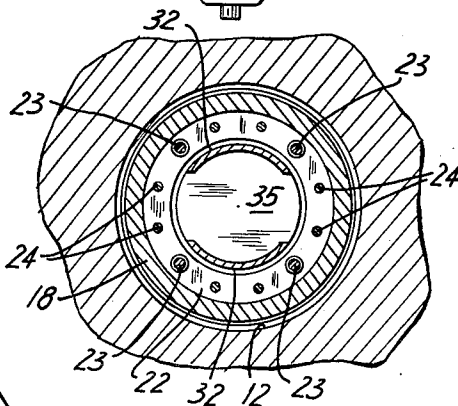


FIG. 3



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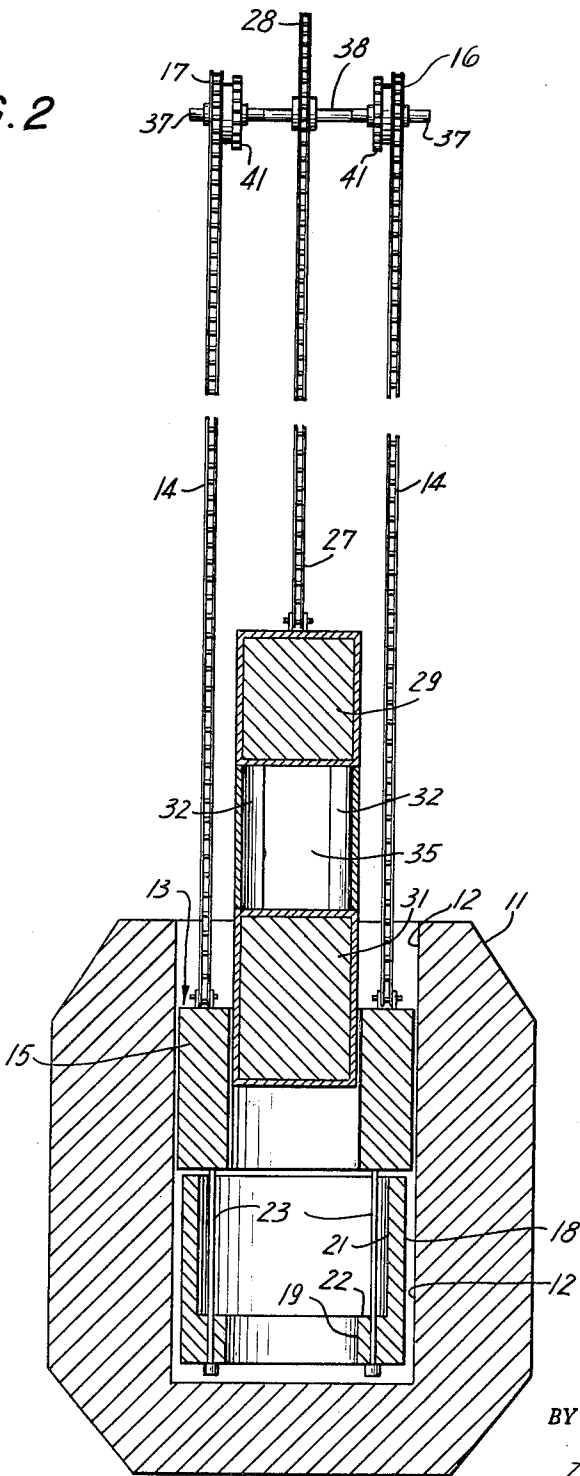
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FIG. 2



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IRRADIATION VAULT

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5 Claims. (Cl. 250-106)

This invention relates to an irradiation vault and more particularly to an irradiation vault in which large radioactive sources may be stored and objects can be exposed to heavy dosages of radiant energy.

It has become necessary in such fields as medicine, food sterilization and numerous industrial applications to expose objects to very large dosages of nuclear irradiation. The danger to operators in exposing material to large quantities of nuclear irradiation makes operating procedures very dangerous. In order to protect operators from excessive radiation, the irradiation must be performed in large protective vaults providing absolute safety against overexposure. These vaults are formed of very heavy shielding material. Because the radioactive sources employed are so large the walls of the vault must be very thick.

In addition the vault must be readily loaded and unloaded. A removable cap must be provided to permit access to the irradiation chamber in which the object is exposed to the radioactive source. The movable cap is also formed of a heavy thick shielding material. If the radioactive source is stored in the vault, it is difficult to load and unload the vault while protecting the operators from exposure to radiation during the loading and unloading operations.

So it is necessary to load both the source and the object into the vault by mechanical handling apparatus. This equipment is very expensive and sometimes inefficient and dangerous since if a mechanical failure occurs while the source is outside of the vault operators using the equipment are subjected to very dangerous levels of radioactivity.

Therefore it is an object of this invention to provide an irradiation vault for exposing objects to very large doses of nuclear radiation in which the radioactive source may be safely stored during periods of inoperation.

A further object of this invention is to provide an irradiation vault which may be readily loaded with the object to be irradiated with no danger of exposing operators to radioactive energy during the loading operation or during the time in which the object is being irradiated.

A further object of this invention is to provide an irradiation vault in which both a movable exposure chamber and radioactive source are provided.

Still a further object of this invention is to provide an irradiation vault in which the radioactive source employed is moved to a safe position during the loading operation, and automatically returned to the exposure position when the exposure chamber is brought to the exposure position.

Apparatus embodying the principles of my invention for accomplishing these and many other objects may include a vault having an open chamber extending partially there-through. A movable exposure chamber and a movable radioactive source are concentrically arranged in the chamber. Means are provided for moving the exposure chamber with respect to the radioactive source so that the radioactive source is lowered to a first normal shielded position during the loading operation of said exposure chamber and moved to a second exposure position as the exposure chamber is moved to the exposure position. The configuration of and rate of motion between the exposure chamber and the source are chosen so that the source is shielded at all times.

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Other objects and advantages of my invention will become apparent from the following description when taken in view of the accompanying drawings, in which,

FIG. 1 is a cross-sectional view of an irradiation vault according to my invention showing a movable exposure chamber and a movable radioactive source mounted within said vault in an operating irradiating position.

FIG. 2 is a sectional view taken along the lines 2—2 of FIG. 1 showing the radioactive source in a storage position and the exposure chamber in an article loading and unloading position.

FIG. 3 is a cross-sectional view taken along the lines 3—3 of FIG. 1 illustrating the manner in which the movable exposure chamber is mounted within a shielded concentric radioactive source holder, and

FIG. 4 is a plan view showing the mechanical means for moving the exposure chamber and the shielded radioactive source holder with respect to each other.

Referring now to FIGS. 1 and 2, my invention generally comprises a vault 11 formed of a heavy shield such as lead and having an open cylindrical chamber 12 extending partially therethrough. The depth and diameter of the chamber 12 are chosen so that the wall thicknesses at the sides and at the bottom of the vault 11 are sufficient to provide adequate shielding of the radioactive source employed. A heavy hollow cylindrical sleeve and shield assembly 13 is supported slidably in the chamber 12 by means of two chains 14 which pass around sprockets 16 and 17 supported above the vault 11 by means not shown. The chains 14 are diametrically spaced from each other on the sleeve 15.

The sleeve and shield assembly 13 comprises a hollow cylindrical sleeve 15 and a cylindrical shield 18 having a longitudinal bore 19 extending therethrough suspended therefrom. A counter bore 21 in the sleeve 18 forms a shoulder 22. The cylindrical shield 18 is formed of a heavy shielding material such as lead and is secured to and suspended from the sleeve 15 on through bolts 23 which pass through the shoulder 22 of the cylindrical shield 18. The through bolts 23 are spaced around the periphery of the shoulder 22. A plurality of cobalt rods 24 or other radioactive source material of the desired curie size are vertically supported around the periphery of the shoulder 22 between the shield 18 and the sleeve 15. The number and size of cobalt rods to be employed is determined by the amount of radioactive exposure desired.

Concentrically and slidably mounted within the sleeve and shield assembly 13 is a cylindrical plug 26. The cylindrical plug 26 is supported within the sleeve and shield assembly 13 by means of a chain 27 connected to a sprocket 28 supported above the vault 11. The plug 26 is approximately as long as the depth of the chamber 12 and comprises upper and lower portions 29 and 31 formed of radioactive shielding material. The upper and lower portions 29 and 31 are connected together by oppositely spaced cylindrical sections 32 which form an open exposure chamber 35. This is best seen in FIG. 3. The sections 32 are formed of a non-shielding material such as aluminum.

If desired, a solid plug 26 having an open exposure chamber 25 therein may be employed.

As shown in FIGURES 1 and 2 the cobalt rods 24 are supported around the open exposure chamber 35 while the apparatus is in an operative position. As the sections 32 are easily penetrated by the radioactive energy, a uniform field of radiation is established in the chamber 35.

Referring now to FIGURES 2 and 4 the chains 14 are connected to the sprockets 16 and 17, respectively. The chains 14 are long enough to permit the sleeve and shield assembly 13 to bottom in the chamber 12. The sprockets 16 and 17 are each secured to a shaft 37 that is driven by a driveshaft 38 operating through gears 39

and 41. The sprockets 16 and 17 are driven in the same direction at the same rate of speed to uniformly raise and lower the sleeve and shield assembly 13. The chain 27 is connected to the sprocket 28 which is directly affixed to the driveshaft 38 so that the sprocket 28 rotates in a direction opposite to that of the sprockets 16 and 17 when the driveshaft 38 is rotated. The driveshaft 38 is driven by a reversible motor 42. A gear reduction box 53 is connected between the motor 42 and the driveshaft 38 to rotate the sprockets 16, 17 and 28 at the proper speed. Cams 44 and 46 secured to the driveshaft 38 are arranged to actuate limit switches 47 and 48, respectively, to stop the motor 42 when the plug 26 and sleeve and shield assembly 13 are in the proper position. The cam 44 opens the switch 47 when the plug 26 bottoms in the chamber 12 and cam 46 opens the switch 48 when the plug 26 is withdrawn from the chamber 12 and the open exposure chamber 35 is ready for loading. The motor 42 is energized manually by an operator by means not shown.

In operation, the sleeve and shield assembly 13 normally rests at the bottom of the chamber 12 as shown in FIG. 2. In this position the source is in a shielded storage position. The plug 26 and hence the exposure chamber 35 are withdrawn from the vault 11 to a loading position. In this position there is no danger of radioactive exposure to an operator manually loading the exposure chamber. The plug 26 completely shields the chamber 12.

When it is desired to lower the plug into the vault the motor 42 is started, driving the driveshaft 38 in a counter-clockwise direction to simultaneously lower the plug 26 into the chamber 12 while raising the sleeve and shield assembly 13 in the chamber 12. When the plug bottoms in the chamber 12 the exposure chamber 35 is positioned at about the midpoint of the vault 11 as shown in FIG. 1. At this point the cam 44 opens the switch 47 to stop the motor 42.

During the interval in which the plug 26 is descending into the chamber 12, the sleeve and shield assembly 13 is raised bringing the cobalt rods 24 to a point directly opposite the exposure chamber 35 and exposing any object within the exposure chamber 35 to intense nuclear radiation. The gears 39 and 41 and sprockets 16, 17 and 28 of the drive mechanism are chosen to provide a differential rate of motion between the sleeve and shield assembly 13 and the plug 26, so that the cobalt rods 24 are completely shielded during the time the sleeve and shield assembly 13 and the plug 26 are raised or lowered. The concentric shield 18 constantly shields the cobalt rods 24, consequently the thickness of the walls of the vault 11 can be reduced, making a smaller vault 11 possible but yet providing a positive safeguard against exposing personnel operating the apparatus.

The sleeve and shield assembly 13 and the plug 26 are supported in the exposure position for the required interval during which time the object to be irradiated is exposed to intense radiation. In order to remove the object from the vault the motor 42 is reversed, raising the plug 26 and simultaneously lowering the sleeve and shield assembly 13 to the bottom of the chamber 12 until the cam 46 opens the switch 48 to stop the motor 42. By making the sleeve and shield assembly 13 heavier than the plug 26, the plug 26 can be withdrawn from the exposure position by gravity merely by disconnecting the driveshaft 38 from the gear box 43.

The dimensions of the chamber 12, sleeve and shield assembly 13 and plug 26 have been exaggerated for clarity. In practice these units are spaced as close to each other as possible while maintaining a sliding fit. Because of the sleeve and shield assembly 13 and the plug 26 and their respective rates of movement, the cobalt rods 24 are completely shielded during this interval. The cobalt rods 24 are shielded from above by the sleeve 15. The rate of motion of the sleeve and shield assem-

bly 13 and plug 26 and their respective sizes prevent any beam of radiant energy from passing outside of the vault through the exposure chamber 35 during the raising and lowering operations. When the plug 26 is up, the irradiated object can then be safely removed from the open exposure chamber 35 and the next object inserted.

The cobalt rods are now supported in a shielded storage position. It is to be noted that our invention may also be used as both a source shipping and exposure vault where the size of the radioactive source being used is small and the vault is accordingly smaller.

Although we have described our invention in detail it will be appreciated that many changes and modifications can be made by those skilled in the art without departing from the spirit of our invention. For instance the drive means for raising and lowering the sleeve and shield assembly and the plug can be readily modified. Also the size and configuration of the sleeve and shield assembly and the plug may be readily varied depending upon the size of the object to be irradiated and the size of the radioactive sources to be used. The detailed description here given is therefore not to be considered as limiting the scope of the invention which is to be limited only by the scope of the appended claims.

We claim:

1. An irradiation vault for storing a radioactive source and for irradiating material therein comprising a shielded vault having a central vertical recess extending partly therethrough, a tube-like shielding structure mounted for vertical reciprocal movement within said recess, radioactive material peripherally positioned within the lower half of said shielding structure, a cylindrical member separately mounted for vertical reciprocal movement within said shielding structure, said cylindrical member forming at its central portion an exposure chamber for receiving material to be irradiated and including plugs of shielding material closing the upper and lower ends of said chamber, the tube-like shielding structure and said cylindrical member being arranged so that the exposure chamber and peripherally disposed radioactive material are in horizontal alignment in the irradiating position, the cylindrical member in said position being substantially seated at the closed end of said recess, and the surrounding shielding structure being elevated from said closed end so that the upper plug of said cylindrical member together with the upper surrounding part of said tube-like structure form a shield at the recess opening, and operating means for lowering the shielding structure to the bottom of the vault recess and for raising the cylindrical member so that the exposure chamber is isolated from said radioactive material and is above said recess, such that the lower plug of said cylindrical member forms, together with the upper part of said tube-like structure a shield at the recess opening to permit recharging of the exposure chamber for subsequent operation of the vault.

2. An irradiation vault as specified in claim 1 wherein the lateral sides of the exposure chamber comprise spaced arcuate supports of non-shielding material.

3. An irradiation vault as specified in claim 1 wherein the tube-like shielding structure comprises a pair of cylindrical shields spaced to correspond with the length of the exposure chamber, one of said shields having an inner annular shoulder for mounting a plurality of rods of the radioactive material so that the rods extend vertically between said shields and concentrically about the exposure chamber in the irradiating position thereof.

4. An irradiation vault for irradiating material positioned therein comprising shielded vault structure having a central vertical recess extending partly therethrough, a pair of complementary separately operable telescopic elements, each movable vertically within said recess but in opposite directions to define irradiating and recharging positions respectively, the inner telescopic element forming an exposure chamber having shielding means at the upper and lower sides thereof, and the outer telescopic

element forming a cylindrical enclosing shield having peripherally located radioactive material carried within the lower part, and operating means for simultaneously raising the outer element and lowering the inner element so that said exposure chamber and radioactive material are in horizontal alignment in the irradiating position, and for lowering the outer element and raising the inner element so as to isolate the radioactive material within the vault and to raise the exposure chamber above said recess to a protected recharging position.

5. An irradiation vault as specified in claim 4 wherein the inner and outer telescopic elements are separately op-

erable by motor-controlled means at different vertical rates of speed with respect to each other between their respective irradiating and recharging positions.

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