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Moore et al.

[11] **3,735,550**

[45] **May 29, 1973**

[54] LOADING OF FUEL RODS

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[21] Appl. No.: **105,392**

[52] **U.S. Cl.** .....**53/22 R**, 53/86, 53/112 R

[51] **Int. Cl.** **B65b 31/02**

[58] **Field of Search** .....53/22 R, 86, 112 R

[56] **References Cited**

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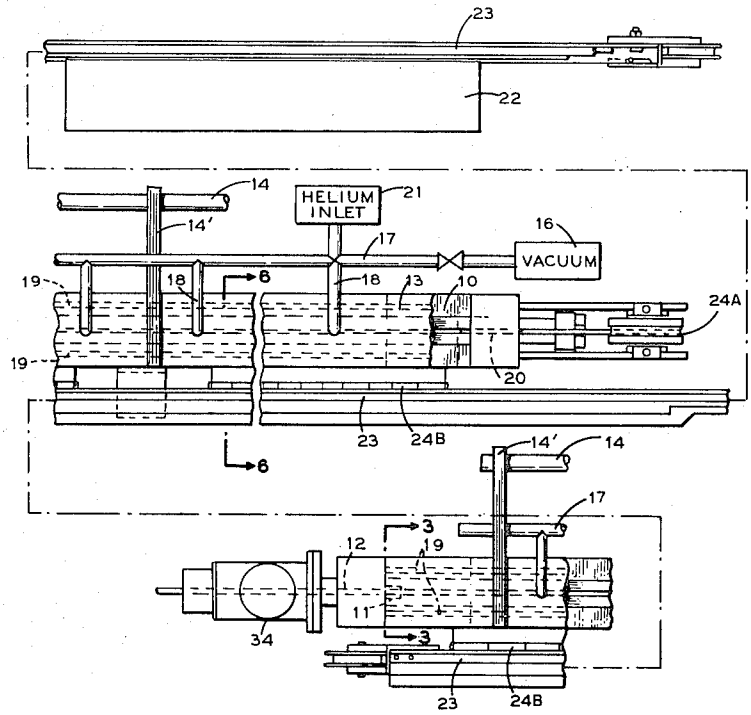
Primary Examiner—Travis S. McGehee

Attorney—J. Maguire

[57] **ABSTRACT**

A method of loading fuel rods of the nuclear variety with radioactive pellets wherein the rod is evacuated, subsequently filled with an inert gaseous atmosphere, loaded with such pellets in linear array, and sealed. The pellets in this method are brought in linear array from a supply station to a predetermined situs and then are transferred in such array into a linear bed which is subsequently sealed, evacuated of atmosphere and then filled with helium. The pellets are then transferred in such linear array from the bed to a communicating fuel rod and the latter is sealed in form for use in the core of a nuclear reactor.

13 Claims, 10 Drawing Figures



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SHEET 1 OF 3

FIG. 1

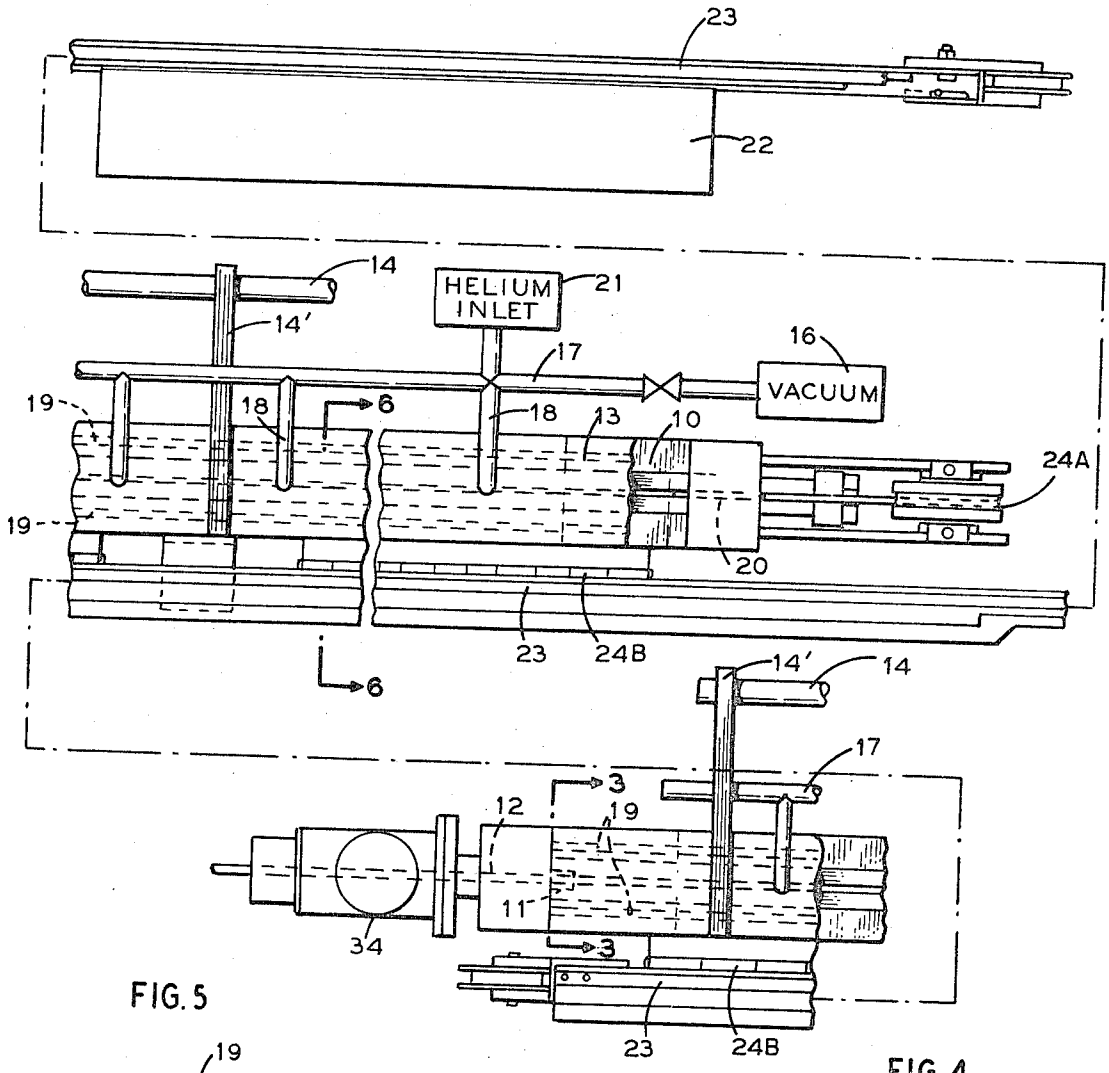

FIG. 5

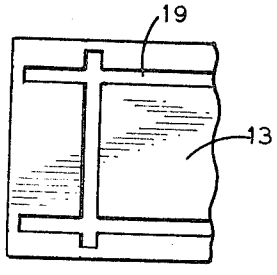

FIG. 3

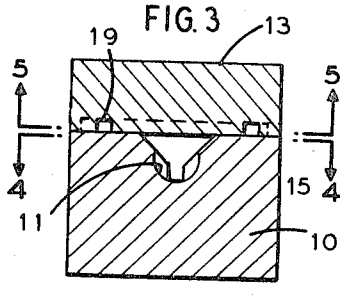

FIG. 4

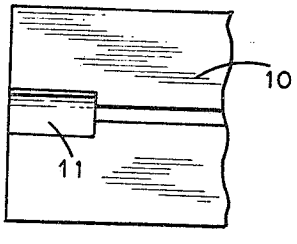

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FIG. 2

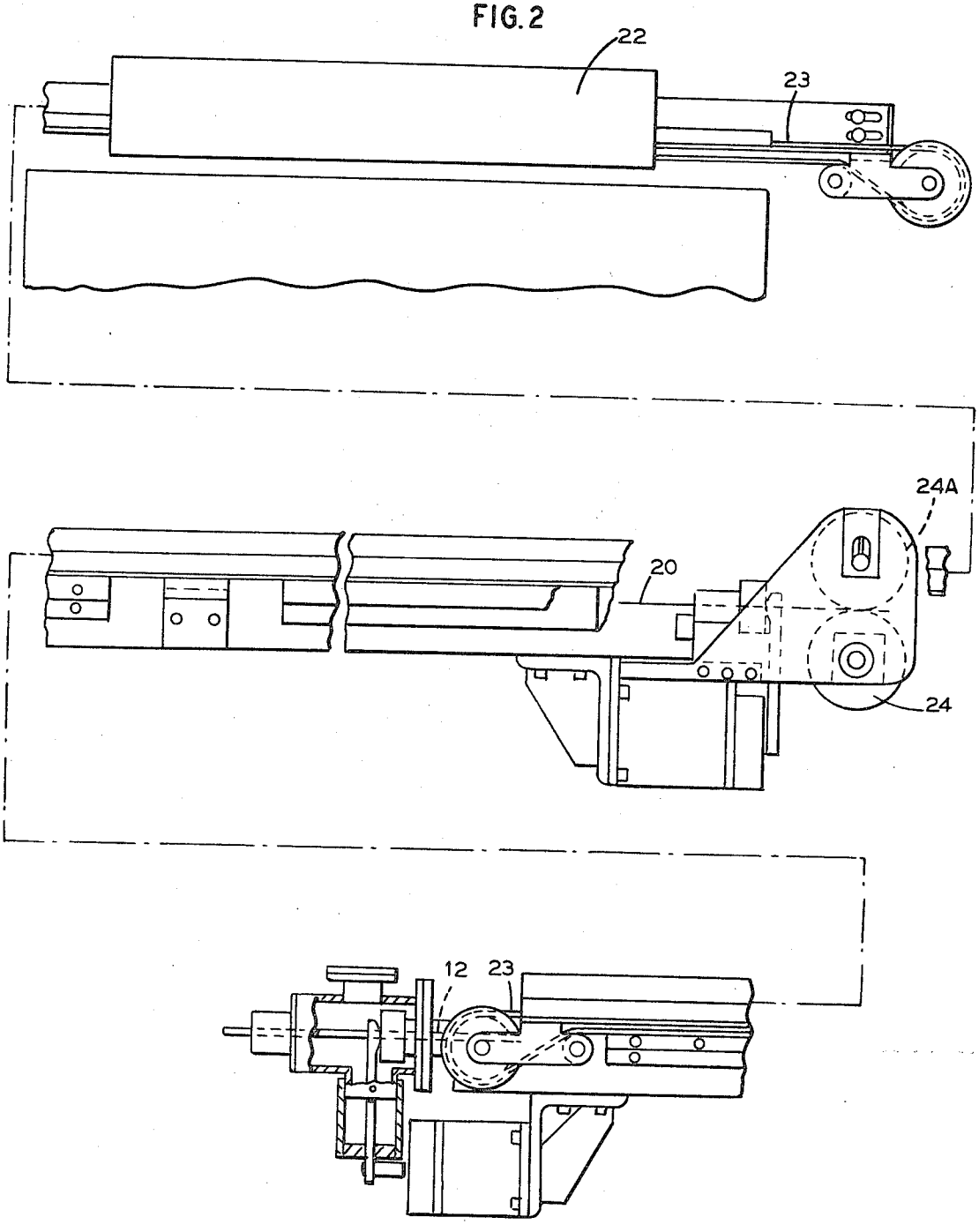


FIG. 10

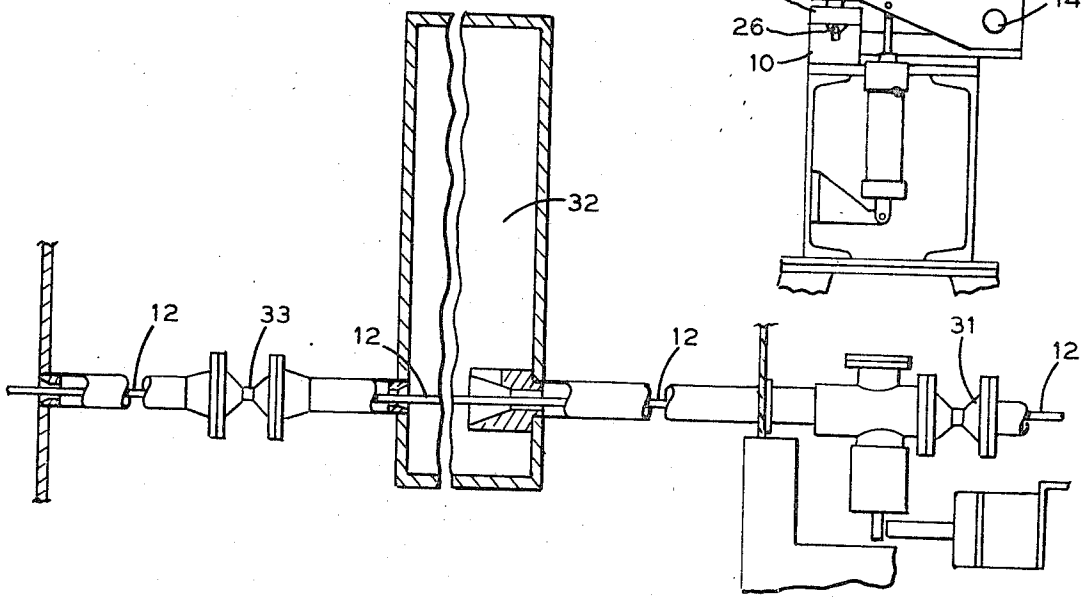


FIG. 9

FIG. 8

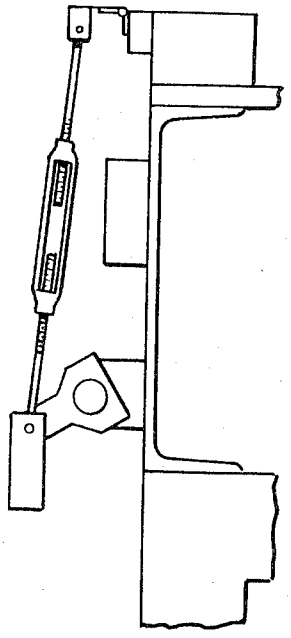


FIG. 6

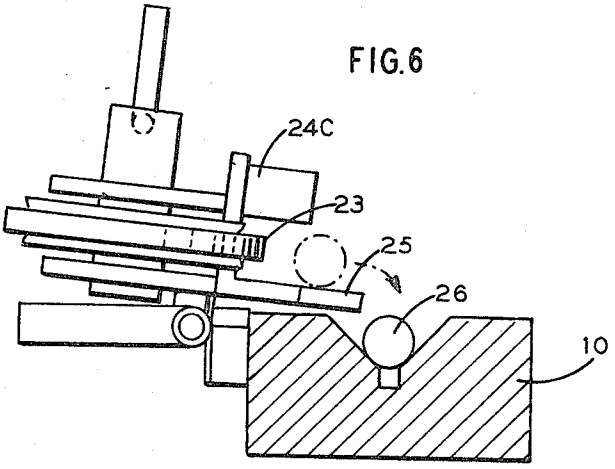
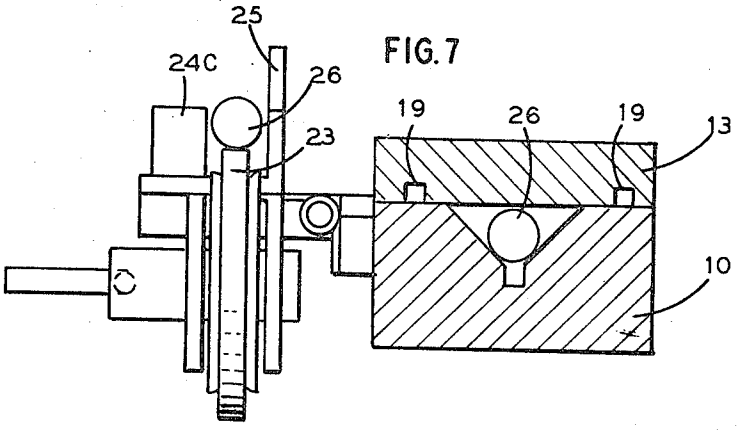


FIG. 7



LOADING OF FUEL RODS

A device for use in the aforesaid method is provided with a linear bed having a sealing overlay for separable engagement therewith and a pivotally mounted conveyor running in adjacent relationship from a supply station to a situs substantially along the entire length of one side of the linear bed. The aforedescribed array of pellets are received from the supply station and are then transferred to such linear bed by the tilting action of the conveyor, at which time, the bed is sealed, evacuated of atmosphere and subsequently filled with helium. One end of the linear bed is provided with means for initially sealing such fuel rod in communicating relationship thereto, while the other end of the bed is provided with transfer means of the motive-actuated variety for providing movement to such linear array of pellets towards and into such communicating fuel rod which is subsequently sealed.

This invention relates to the processing of fuel rods of a nuclear nature.

More particularly, this invention relates to the loading of fuel rods with pellets of the nuclear variety in an inert atmosphere and includes a device for accomplishing the same.

At present, there is a relatively large demand for fuel rods of the nuclear variety. In the past, the procedures for loading pellets in tubes included techniques utilizing push rods and vibratory feeding. However, these procedures are not considered adequate to load large quantities of pellets on a regular basis. The known disadvantages of these procedures include poor control of the internal environment with exposure of the pellets to atmospheric contamination during the loading procedure. These procedures are also extremely tedious and slow, more or less, because of the pressure buildup in the rods.

What is needed is a procedure for loading such fuel rods without encountering the difficulties of the prior art.

The subject invention answers the needs of the art with special emphasis on the effective loading of such fuel rods in an efficient manner with optimum results in the shortest possible time including the avoidance of atmospheric contamination during such loading.

It is therefore an object of this invention to provide a method of loading fuel rods with pellets of a nuclear nature and a device for accomplishing the same.

Another object is to provide a method of loading such fuel rods in an effective and efficient manner for the attainment of optimum results in the shortest possible time.

A further object is a method of loading such fuel rods with assurance that the interior of such rod has the proper atmosphere.

A further object is the provision of a method wherein the pellets are assured of the proper environment within such fuel rod after loading for efficient and effective utility in the core of a nuclear reactor.

Other objects and many of the attendant advantages of this invention will become better understood from a reading of the following detailed specification when taken with the accompanying drawings wherein:

FIG. 1 is a top plan view of the device of this invention.

FIG. 2 is a side view of the device of FIG. 1.

FIG. 3 is a view taken on line 3—3 of FIG. 1 showing a cross-section of the empty bed in the closed position.

FIG. 4 is a view taken on line 4—4 of FIG. 3 showing the means for sealing the fuel rod operatively to the bed.

FIG. 5 is a view taken on line 5—5 of FIG. 3 showing the sealing overlay of the device.

FIG. 6 is a view taken on line 6—6 of FIG. 1 showing the bed in the open position for the reception of the radioactive pellets from the linear conveyor.

FIG. 7 is a view taken on line 6—6 of FIG. 1 showing the pellets in position in the sealed bed.

FIG. 8 is a side view showing a pivoting device for use with the tilting conveyor of FIGS. 6 and 7.

FIG. 9 is a side view of a device for use in applying a sealed overlay to the bed of the device of this invention.

FIG. 10 is a side view in section showing an apparatus for use in controlling the atmosphere during the sealing of the loaded fuel rod.

Similar numerals refer to similar parts throughout the several views.

The method of this invention encompasses loading fuel rods with a plurality of pellets of a radioactive variety by the transportation of such pellets in linear array along a movable longitudinal path from a supply station to a situs adjacent an open longitudinal bed and the transference of such pellets transversely into such bed, which is in the form of a V-shaped longitudinal trough, accompanied by the sealing of such bed or trough. The voids of the trough are then evacuated and subsequently refilled with an inert gaseous medium, at which time, the pellets are transferred from such longitudinal trough into such fuel rod by means of a ram and the fuel rod is sealed with a closure.

As shown in FIGS. 1–5, the device for use in this invention includes a bed in the form of a long trough 10 having a V-shaped channel provided at one end with sealing means for separable engagement to the open end of a fuel rod 12 of the nuclear variety. Referring now to FIGS. 1–3, the trough 10 is also provided with a lid or cover in the form of a sealing overlay 13 which is pivotally mounted by conventional means 14 in spaced relationship along the length of the trough 10 for separable engagement with the upper surface 15 thereof. The sealing means 11 of the trough as shown in FIGS. 3 and 4 is in the form of a receptive slot having an open end which fits snugly around the outer periphery or surface of the open end portion of a fuel rod 12 when such rod 12 is inserted into such sealing means. The other end of the receptive slot communicates with the V-shaped channel of trough 10.

A vacuum source 16 communicates with the lid or sealing overlay 13 through a trunk line 17 which is provided with access lines 18. The latter lines are operatively connected in spaced relationship along the length of the lid 13 and communicates with a series of interconnected channels 19 as shown in FIG. 5 for the evacuation of the trough 10 which communicates with fuel rod 12 as depicted in FIG. 1. Also, for simplicity of design, a source of an inert gaseous medium such as helium 21 is operatively connected to trunk line 17 for back-fill operations prior to transference of the pellets to the fuel rod 12.

As shown in FIG. 1 and 2, the end of the trough 10 adjacent the supply station is provided with a ram 20 which is driven by motive means 24. The latter ram 20 is insertable sealed in the V-shaped channel of the

trough 10 and functions to push the pellets of nuclear fuel along the length of the trough towards and into the open end of the fuel rod 12. In the preferred embodiment, the ram 20 is a nylon line of the cord-type variety.

Again, referring to FIGS. 1 and 2, a movable longitudinal path or U-shaped conveyor 23 extends from a supply station 22 to a coextensive position adjacent one side of the longitudinal V-shaped trough 10 opposite the side on which the sealing overlay 13 is positioned. The longitudinal path or conveyor 23 is pivotally mounted by conventional pivot means 24 in spaced relationship along the longitudinal side of the trough 10.

As shown in FIGS. 6 and 7, the conveyor 23 is provided with retention means 24 in the form of a guard rail and guide means 25 in the form of an elongated arm which substantially extends the length of the conveyor 23. The latter two means 24 and 25 both serve to maintain the radioactive pellets 26 in linear array as they are moved on the conveyor 23. During operation, the pellets 26 are received from a supply station 22 in linear array and are moved longitudinally along the conveyor 23. When the array of radioactive pellets are in line with a predetermined position adjacent the body of the V-shaped trough 10, the conveyor is pivotally tilted as shown in FIG. 6 and the pellets are deposited in the V-shaped channel of the trough by guide means 25. The conveyor is then returned to the original position as shown in FIG. 7 and the lid or overlay seal 13 is placed in position on the upper surface of the trough 10. The pivotal movement of the conveyor 23 may be accomplished by means of a device such as that shown in FIG. 8 while the overlay seal 13 may be applied to the upper surface of the V-shaped trough by means of a device as shown in FIG. 9.

In operation, as shown in FIG. 10, the open end of the fuel rod 12 is inserted through a sealing device 31 of the ball valve variety and into a chamber 32 having a controlled environment relative to atmosphere. The latter chamber is provided with access holes (not shown) of a sealed nature for the manual part of the procedure. The end of the rod in the chamber is then manually pushed through a second sealing device 33 also of the ball valve variety and a transition block 34 into separable engagement with the sealing means 11 of the V-shaped trough as shown in FIGS. 1 and 10.

At this point, the method consists in the receiving of the radioactive pellets 26 from a supply station or source 22 by the relatively long conveyor 23 which transports or moves the pellets 26 in a straight line to a predetermined position along an adjacent side of the V-shaped trough 10. The conveyor 23 is then pivoted and the pellets are transversely transferred into such trough 10 without damage and the cover or lid 13 in the form of an overlay is placed in position over the trough 10 and sealed. The voids in the trough 10, especially those around the pellets 26 are then evacuated of atmosphere and subsequently refilled with an inert gaseous medium such as helium.

Subsequently, the pellets 26 are transferred along such trough under the atmosphere of helium into the open end of the fuel rod 12 by means of a pushing action on the part of the ram 20. It should be noted that the fuel rod 12 was initially sealed in communicating relationship to the trough 10 and the void therein was also evacuated simultaneously with those of the trough 10.

After transference of the pellets 26, the fuel rod 12 is separated from engagement with the trough 10 and withdrawn through the transition block 34 and sealing device 33 into the chamber 32 where a closure is fitted to the end thereof and the fully withdrawn fuel rod is then ready for use in the core of a nuclear reactor.

What is claimed is:

1. A process of loading fuel rods with pellets of a radioactive variety comprising:
   - Transporting said pellets along a pivotal longitudinal path from a supply station,
   - Transferring said pellets transversely from said path to an adjacent open V-shaped trough which communicates with the open end of said fuel rod,
   - Sealing said trough and said open end of said fuel rod in communicating engagement and evacuating the voids throughout,
   - Subsequently introducing an inert gaseous medium to said voids,
   - Transferring said pellets from said trough to said fuel rod, and
   - Sealing said open end of said fuel rod with a closure.

2. The process of claim 1 wherein said V-shaped trough is longitudinally adjacent said longitudinal path.

3. The process of claim 2 wherein said pellets are transferred to said V-shaped trough by pivoting said path transversely along its longitudinal axis.

4. The process of claim 3 wherein said trough is sealed in communicating relationship with said open end of said fuel rod by an overlay prior to evacuation of the voids of both.

5. The process of claim 4 wherein helium is introduced into the voids of said trough and said fuel rod.

6. The process of claim 5 wherein said pellets are longitudinally transferred from said trough to said fuel rod by means of a pusher.

7. A device for use in loading fuel rods with pellets of a radioactive variety comprising:
   - A base,
   - A V-shaped longitudinal trough mounted on said base and adapted to receive said pellets in linear array,
   - said trough having one end adapted to axially receive an open end of said fuel rod,
   - A movable longitudinal path of the U-shaped variety pivotally mounted in longitudinal relationship along one side of said V-shaped trough,
   - said path utilized for transferring said pellets from a supply station to said V-shaped trough,
   - A sealing overlay pivotally mounted along the other side of said V-shaped trough for separable overhead engagement with said trough,
   - said overlay provided with means for providing in sequence a vacuum and inert gaseous medium to said trough, and
   - Transfer means adapted for longitudinal movement of said pellets along said V-shaped trough into said fuel rod.

8. The device of claim 7 wherein said trough is provided with a V-shaped channel having means for sealing said fuel rod in communicating relationship when said overlay is sealed to said trough.

9. The device of claim 8 wherein said sealing means is a receptive slot for snugly fitting around the outer peripheral end portion of a fuel rod.

10. The device of claim 9 wherein said movable longitudinal path is provided, in adjacent linear relation-

ship, with a guard rail and guide means both of which form a U-shape with said path.

11. The device of claim 10 wherein said path is tilted to transversely transfer said linear array of pellets to said trough.

12. The device of claim 11 wherein the surface of said sealing overlay abutting said trough is provided with a maze of interconnected channels for use in evacuating and providing an inert atmosphere to the voids of said trough.

13. The device of claim 12 wherein said transfer means is a movable linear ram operatively sealed in the free end of said V-shaped channel of said trough.

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