Aug. 16, 1960 M. TRESHOW 2,949,202

LOADING AND UNLOADING DEVICE

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Fig. 1

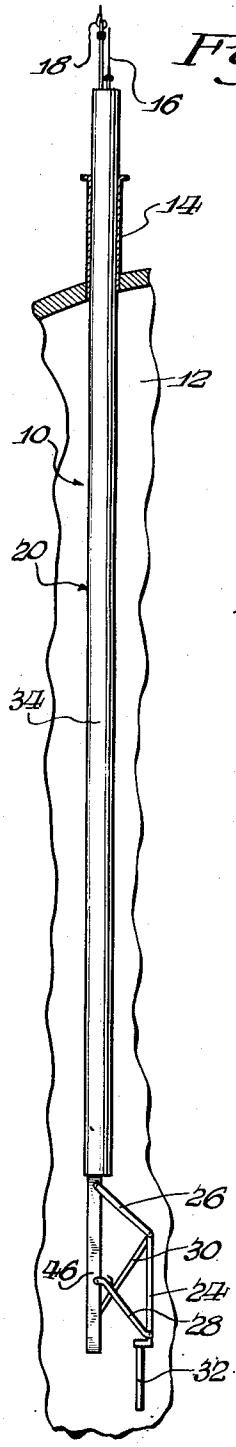

Fig. 2

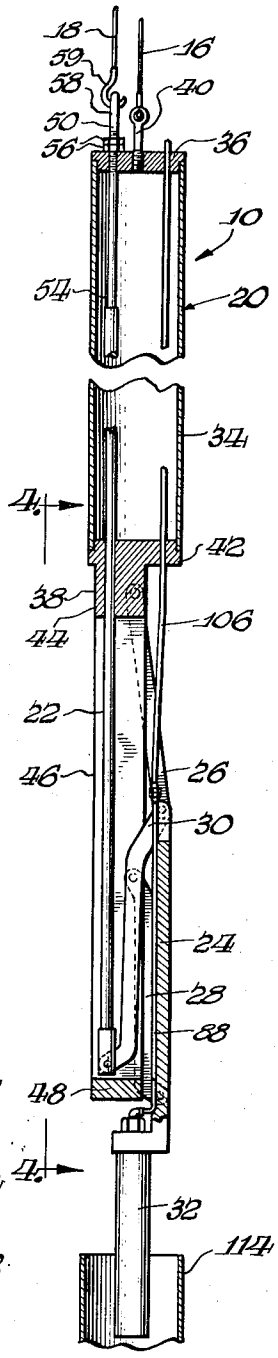

Fig. 3

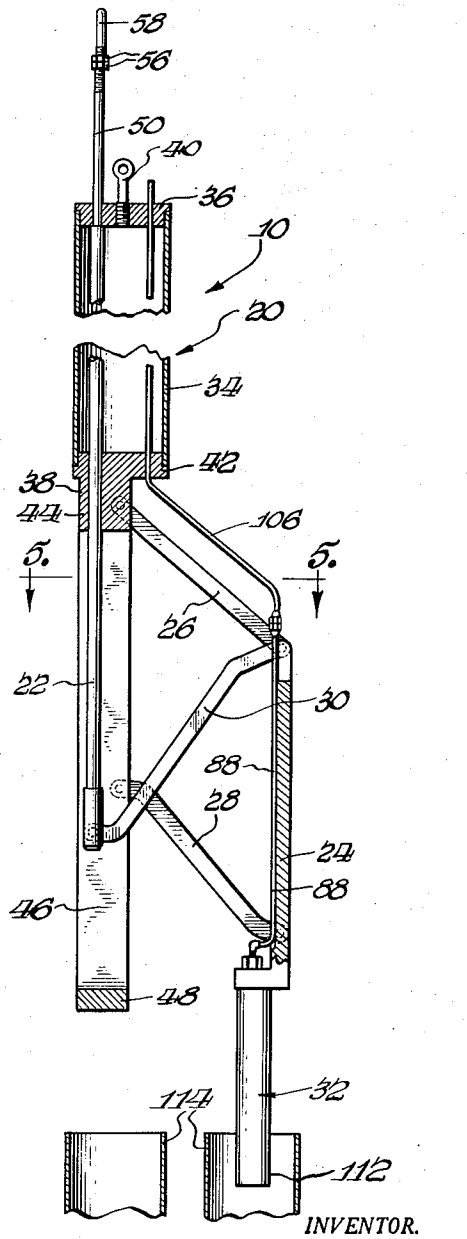

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Fig. 4

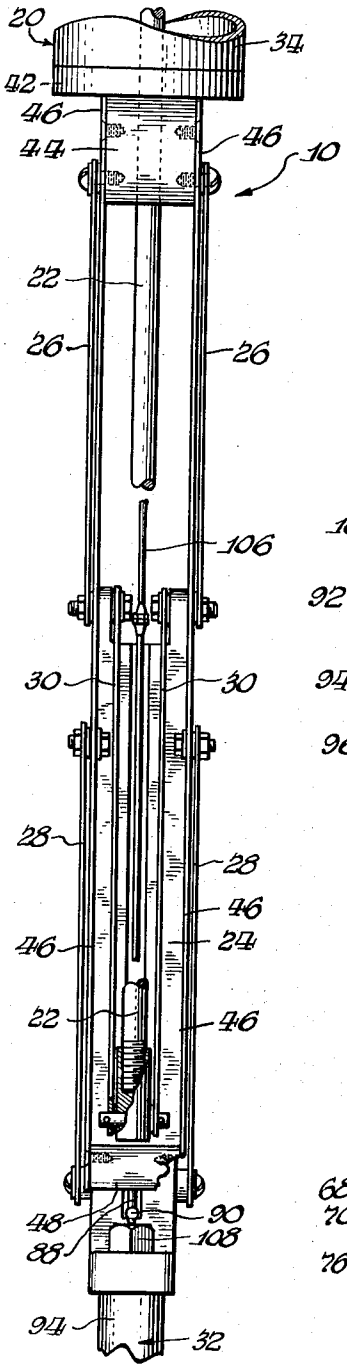


Fig. 5

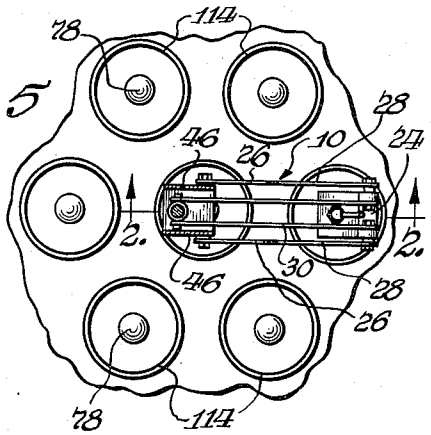
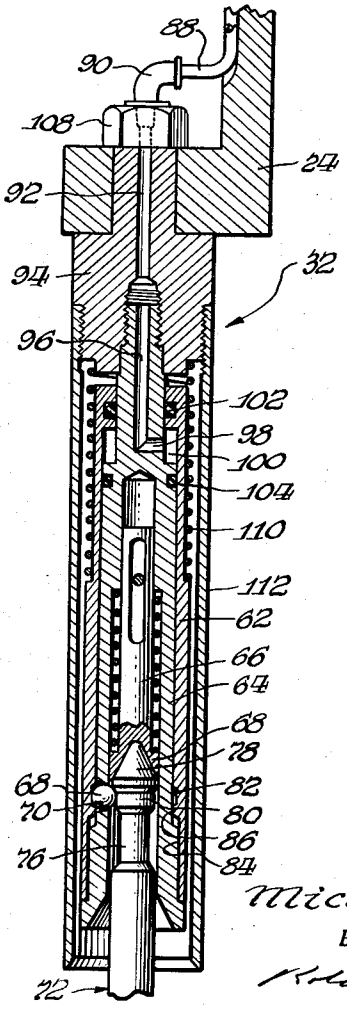


Fig. 6



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LOADING AND UNLOADING DEVICE

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Filed May 17, 1956, Ser. No. 585,582

1 Claim. (Cl. 214—658)

This invention relates to a loading and unloading device and more particularly to one for loading and unloading the fuel elements contained in a pressurized reactor.

Large, natural-uranium-fueled power reactors for central use are designed so that fuel may be loaded or unloaded at any time throughout the life of the plant. This requires some type of individual loading for each fuel element. In the case of a pressurized reactor, either liquid-cooled or boiling, this involves separate unloading means for each of the many fuel elements. If individual fuel tubes were provided for each fuel element, this would result in a greatly weakened pressure-vessel structure due to the large number of holes perforating the shell of the vessel. The subject invention allows the number of holes to be considerably reduced by providing means by which any one of a particular group of fuel elements may be withdrawn through a single tube.

A pressurized reactor as set forth in the copending Untermyer application, Serial No. 518,427, filed June 28, 1955, is to be visualized. In this reactor the fuel rods are arranged in groups having a hexagonal pattern with a fuel access tube placed directly over the center of each group. The unloading device disclosed herein, operates through this fuel access tube.

This invention will be better understood by reference to the following description and the appended drawings wherein:

Fig. 1 is an elevation, partly in section, showing the device suspended within a pressurized reactor;

Fig. 2 is an enlarged vertical sectional view taken on the line 2—2 of Fig. 5 and showing the device in its collapsed position;

Fig. 3 is a vertical sectional view taken on the same plane as Fig. 2 but showing the device in its maximum extended position;

Fig. 4 is an enlarged elevational view of a portion of the device taken on the line 4—4 of Fig. 2;

Fig. 5 is a horizontal sectional view taken on the line 5—5 of Fig. 3 and showing the respective position of each fuel element in a particular group; and

Fig. 6 is a sectional view of the gripper mechanism disclosed herein.

As illustrated in Fig. 1, a fuel-unloading device **10** is lowered into a sealed reactor tank **12** through an access tube **14** by means of a cable **16** suspended from a crane, not shown. The crane also controls a cable **18**, the purpose of which will be disclosed later.

The unloading device **10** generally consists of a carriage **20**, a movable rod **22** within the carriage **20**, an arm **24** supported from the carriage **20** by means of links **26**, **28**, and **30**, and a gripper **32** attached to the arm **24**.

The carriage **20** comprises a hollow cylinder **34** having a top plug **36** and a bottom plug **38**. The top plug **36** has attached at its center a lifting member **40** to receive the cable **16**. The lower plug **38** has an upper circular portion **42** which is secured to the cylinder **34** such as by welding, and a lower portion **44** which is rectangular in transverse section and somewhat smaller in its greatest transverse

dimension than the cylinder **34** is in diameter. Attached to the sides of the portion **44** of plug **38** are two extension plates **46** with a spacer **48** secured between the plates **46** at their lower extremity.

The arm **24** is attached to the carriage **20** by two sets of parallel links **26** and **28** which are pivotally attached to the extension plates **46** and the arm **24** and maintains the arm **24** parallel to the carriage **20**. The links **26** are pivotally attached to the upper end of the arm **24** and to the portions of the extension plates **46** that overlap the portion **44** of the plug **38**. The links **28** are pivotally attached to the arm **24** near its lower end and to regions of the extension plates **46** spaced from the portion **44** of plug **38**. The rod **22** is disposed within the carriage **20** and is axially movable parallel to the axis thereof by virtue of being slidably mounted in openings in the plugs **36** and **38**. The links **30**, which are two in number, are pivotally attached to the lower end of the rod **22** and to the arm **24** at its junction with links **26**. An upper portion **50** of the rod **22** extends through the plug **36** and beyond the upper end of the carriage **20**. The portion **50** is partially threaded and of a smaller diameter than the portion of the rod **22** below, so that a shoulder **54** is formed on the rod **22** which abuts the plug **36** and so constitutes a stop limiting the upward travel of the rod **22**. A second stop, limiting its downward travel, is formed by lock nuts **56**, engaging the threaded portion **50** of the rod **22**. An eye portion **58**, formed at the upper extremity of the rod **22**, receives a hook **59** attached to the cable **18**. An upward pull on the cable **18** shifts the rod **22** axially relative to the carriage **20**, resulting in lateral movement of the arm **24** away from the carriage **20** from the position of Fig. 2 to that of Fig. 3.

The gripper **32**, which is attached to the lower end of the arm **24**, is of the type shown and claimed in the copending Schultz application, Serial No. 392,531, filed November 16, 1953. As shown in Fig. 6, the gripper **32** comprises a hollow outer member **62**, a hollow inner member **64**, a plunger **66**, and a plurality of circumferentially spaced balls **68**, positioned in openings **70** in the inner member **64** decreasing in diameter from outside to inside of the inner member. The gripper **32** is adapted to grasp or release a fuel rod **72** at its upper end, which has a reduced neck **76**, a head **78** which is larger in diameter than the neck, and a shoulder **80** which lies between the head and neck and is respectively smaller and larger in diameter than the head and neck. The balls **68** engage either an internal groove **82** in outer member **62** or an internal surface **84** at the end of the outer member. The internal surface **84** is larger in diameter than the groove **82** and is separated therefrom by a shoulder **86**.

Fig. 6 shows the fuel rod **72** engaged by the gripper **32** so that it can be lifted thereby. In this position the balls **68** engage the shoulder **80** on the fuel rod **72** and the groove **82** in the outer member **62**. When the fuel rod **72** is to be released, it is supported from below, and the gripper **32** is lowered to bring the balls **68** opposite the reduced neck **76**. Now the balls **68** may move inwardly to permit the upward shifting of the outer member **62** by which relatively, the balls **68** move past the shoulder **86** to the internal surface **84**. Now the balls **68** may move outwardly to permit movement of the head **78** past the balls, whereby the fuel rod **72** is released from the gripper **32**. As the head **78** moves out of the gripper **32**, the plunger **66**, which is spring-urged, follows it to the point where its head lies at the balls **68** and holds them against the internal surface **84** of the outer member **62** and prevents the outer member from returning to the position of Fig. 6 in which the groove **82** lies opposite the balls **68**.

The most significant difference between the gripper **32** of the present application and the gripper of the aforementioned Schultz application is that the outer member

62 is shifted upward with respect to the inner member 64 by means of fluid under pressure. As shown in Fig. 6, such fluid is supplied through a flexible line 88, an elbow 90, a passage 92 in a fitting 94, and passages 96 and 98 in the inner hollow member 64 to an annular space 100 enclosed by the inner and outer hollow members 64 and 62. The space 100 is sealed by annular seals 102 and 104 positioned in annular grooves formed in the members 62 and 64, respectively. The line 88 is attached to the arm 24 for support and is connected with a source of fluid under pressure (not shown) by a flexible tube 106 which, as shown in Figs. 2 and 3, extends through the cylinder 34 and openings in the plugs 36 and 38 for the cylinder.

The inner hollow member 64 is supported by the fitting 94 with which it has a threaded connection. The fitting 94 extends through the lower end of the arm 24 and is secured thereto by a nut 108 threaded on the fitting 94. When the gripper 32 is being lowered into the fuel rod 72 for engagement therewith, the outer hollow member 62 is shifted downward with respect to the inner hollow member 64 by a coil spring 110 which surrounds an upper portion of the outer member 62 and acts between an external shoulder thereon and the lower end of the fitting 94 which it embraces for a short distance. The hollow members 62 and 64 and the spring 110 are protected by a sleeve 112 which surrounds them in spaced relation and has a threaded connection with the fitting 94.

To unload any one of a group of six outer fuel rods 72 located around a central fuel rod 72 as shown in Figs. 3 and 5, the arm 24 and gripper 32 are positioned with respect to the carriage 20 as shown in Fig. 2, and the unloading device 10 is lowered through the access tube 14 by the cable 16 until the arm 24 of the unloading device 10 is within the reactor tank 12 and below the access tube 14. However, at this time the gripper is not, as shown in Fig. 2, inserted in a guide tube 114 for the central fuel rod 72, but lies just above this guide tube. The unloading device 10 is then rotated so as to be oriented toward a particular outer fuel rod 72 by means not shown. The rod 22 of the device 10 is then raised by the cable 18 until the shoulder 54 of the rod 22 abuts the top plug 36. With the rod 22 in this position, the arm 24 is disposed directly over the outer fuel rod 72 to be removed. The cables 16 and 18 are uniformly lowered with the weight of the unloading device supported by the cable 18, until the gripper 32 engages the head 78 of the outer fuel rod 72 as heretofore described. The unloading device 10 is then raised by the cables 16 and 18.

When the bottom of the fuel rod 72 is raised to a point above the fuel tubes 114 and free of any other obstructions, the weight of the unloading device 10 is transferred to the cable 16, and thus the slackening of the cable 18 results in the arm 24 returning to the relative position of Fig. 2, that is, adjacent the extension plates 46 of the carriage and free to enter the access tube 14. Now the unloading device 10 and the fuel rod 72 engaged thereby are lifted out of the reactor tank 12 through the access tube 14.

Installation of a new outer fuel rod 72 requires a reversal of the steps just described. The unloading device 10 and the new fuel rod 72 engaged thereby are lowered into the reactor tank 12 through the access tube 14, but the fuel rod is not permitted to enter the central guide tube 114. Now the arm 24 is laterally shifted to the position of Fig. 3 by raising of the rod 22 until the shoulder 54 thereon contacts the upper plug 36. Next the unloading device 10 and attached fuel rod 72 are lowered into the appropriate guide tube 114 until the fuel rod 72 is supported from below and raised with respect to the gripper 32 above the position of Fig. 3, so that the gripper may release the fuel rod.

When the central fuel rod 72 is to be removed or installed, the position of the arm 24 and gripper 32 with respect to the carriage 20 shown in Fig. 2 is maintained throughout the operations. In this position the gripper 32 is aligned with the central guide tube 114 so that it can readily engage the central fuel rod 72 for removal or lowering into correct position for installation.

The intention is to limit the invention only within the scope of the appended claim.

What is claimed is:

A device for loading and unloading fuel rods in and out of a reactor tank through an access tube in the top thereof to and from guide tubes in the tank parallel to but out of alignment with the access tube, said device comprising a carriage fitting the access tube and slidably mounted therein for axial movement into and out of the reactor, a gripper for engaging the ends of the fuel rods, means including parallel links connecting the gripper and the carrier for enabling the gripper to remain parallel to itself in all positions and thus to handle the fuel rods between the parallel guide tubes and a position of alignment with the access tube, and means fixing the parallel links against movement, whereby a fuel rod is moved into or out of its guide tube or through the access tube by axial movement of the carriage in the access tube.

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