

April 22, 1969

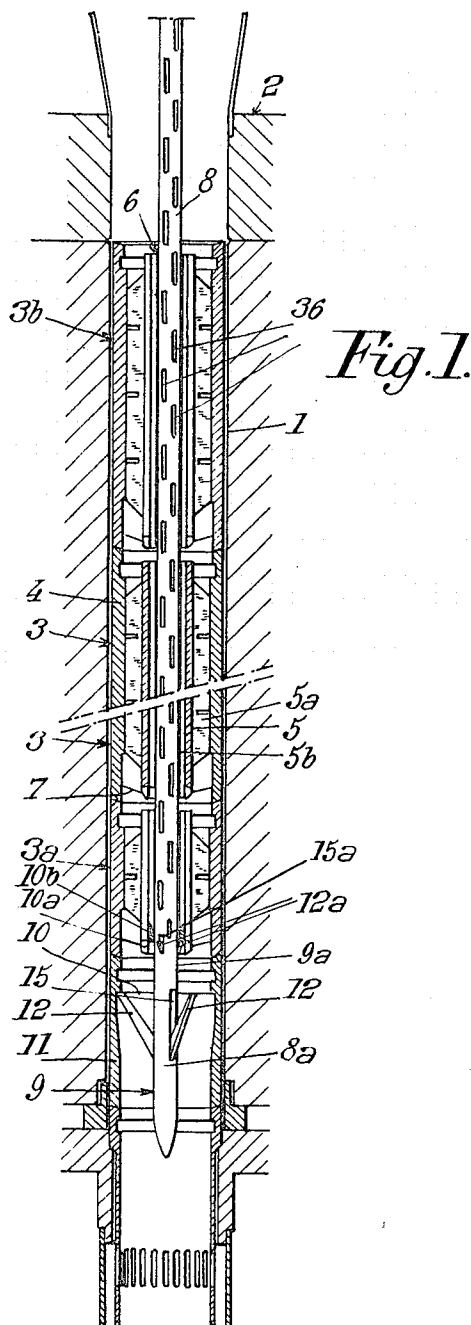
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3,440,139

DEVICES FOR HANDLING ANNULAR CHARGES

Filed June 13, 1966

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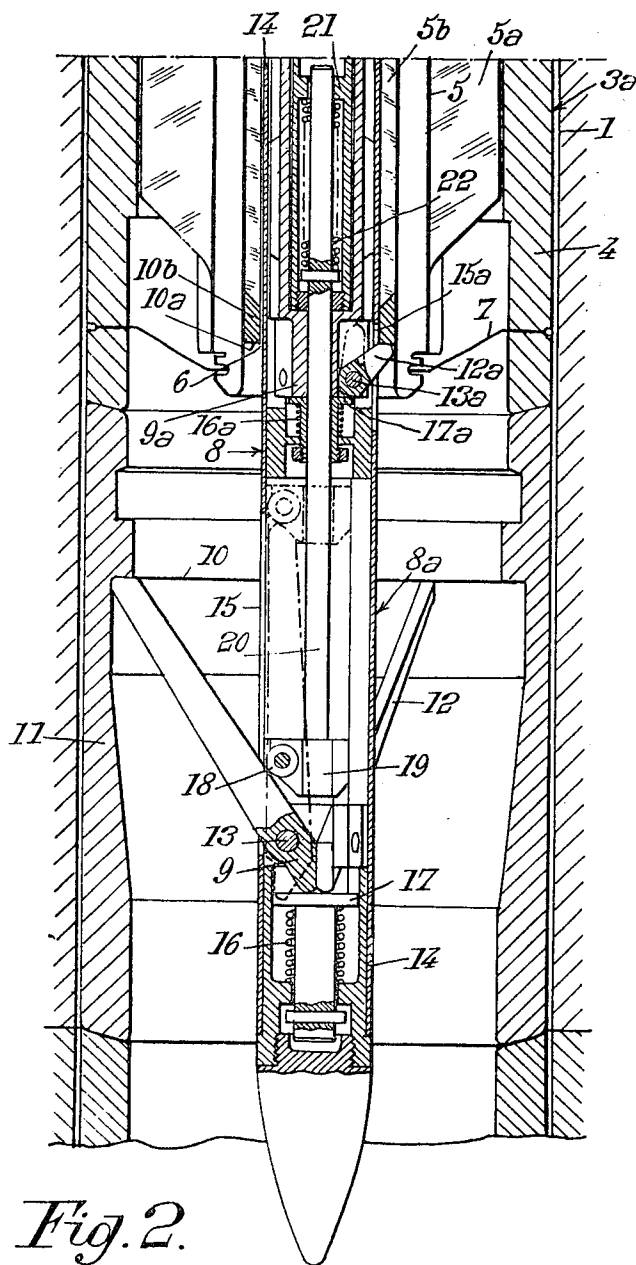
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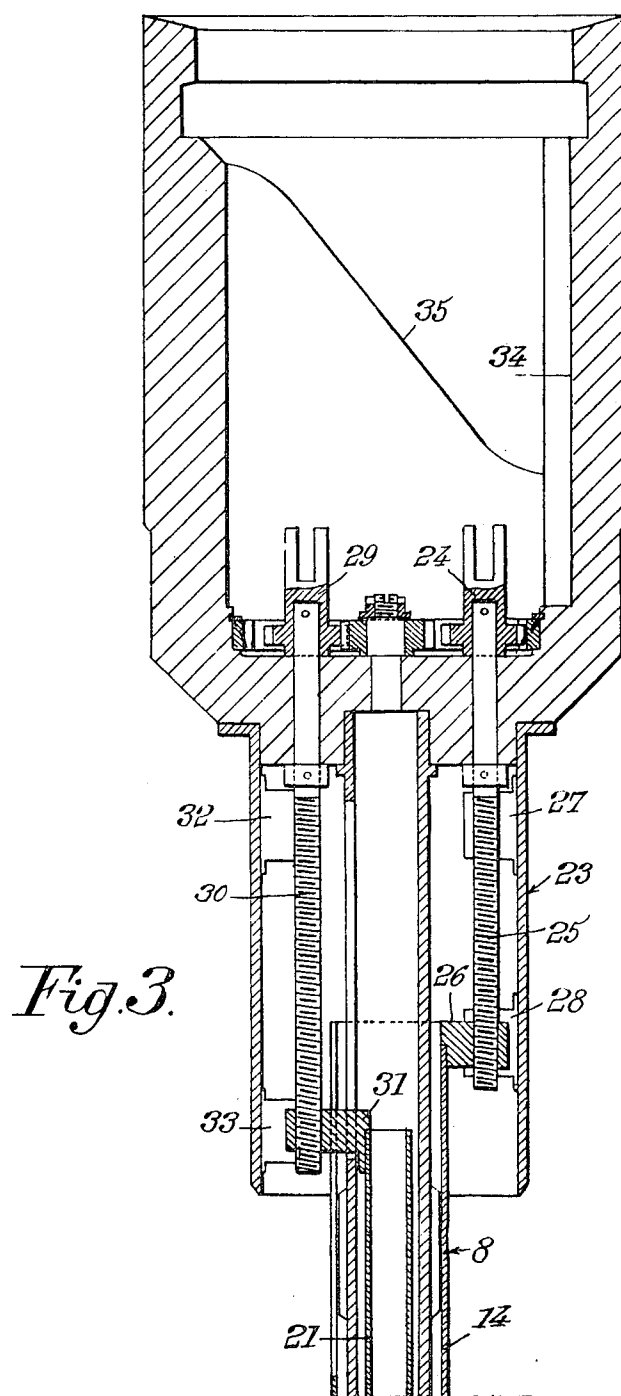
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DEVICES FOR HANDLING ANNULAR CHARGES
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Filed June 13, 1966, Ser. No. 557,192

Claims priority, application France, June 21, 1965,
21,658

Int. Cl. G21c 3/36

U.S. Cl. 176—30

9 Claims

ABSTRACT OF THE DISCLOSURE

An installation for handling a plurality of vertically stacked annular fuel elements including a support member for supporting the stack of fuel elements and positioned between the lowest annular fuel element and the bottom of the channel in which the fuel elements are located. A tubular probe having a catching device located at one end thereof, and movable between an expanded and a retracted position, is movable through the said annular passage with the catching device in the retracted position; after which the catching device is expanded to engage the support member for removing the support member and the stack of annular fuel elements upon upward movement of the tubular probe. The catching device may include fingers pivotable about an axis from the retracted position within the tubular probe to an expanded position whereat the fingers engage an internal bearing surface on the supporting member.

The invention relates to devices for handling annular charges having a central passage open at both of its ends. The expression "device" comprises the handling apparatus and the annular charges to be handled by said apparatus.

The invention is more especially but not exclusively concerned with devices of this kind for handling annular fuel elements of nuclear reactors. The handling consists particularly in removing these fuel elements from reactor channels or in introducing these elements into said channel.

The chief object of the present invention is to provide a device of the above described kind which is better adapted to meet the requirements of practice than those used up to this time.

A device according to the present invention comprises a sounding rod having an operating end adapted to move from one end of the central passage to the other end, main catching means provided at this operating end and adapted to have two different positions, to wit a retracted one and an expanded one and control means adapted to place said main catching means either in said retracted position or in said expanded position.

A supporting part is connected with the annular charge to be handled, at the end thereof opposed to that from which said rod is introduced into the central passage, said supporting part being adapted to cooperate with the main catching means in their expanded position for removing the charges from the channel by retracting movement of the rod.

Preferred embodiments of the present invention will be hereinafter described with reference to the appended drawings in which:

FIG. 1 is an axial section with parts in view of a device for handling annular fuel elements of a nuclear reactor, according to the main feature of the invention.

FIGS. 2 and 3 are partial sections, on a larger scale, of parts of the device shown in FIG. 1.

In a nuclear reactor, the annular fuel elements, which are generally called "cartridges," are introduced in ver-

tical channels. Every vertical channel 1 opens at its upper end, at the level of a plate 2 shown in FIG. 1.

The fuel cartridges are piled up so as to form a column in every reactor channel 1, each cartridge 3 comprises

5 A casing 4, generally in graphite, the outer diameter of which is slightly lower than the inner diameter of channel 1, in such manner that casing 4 may slide in channel 1,

And a fuel element can, generally in magnesium, provided with outer fins 5_a ensuring the centering of said fuel element can 5 in casing 4, and inner fins 5_b having a central passage 6 coaxial with said casing 4, said fuel element can being maintained in said casing 4 by wires 7 generally in steel.

15 The charge of a channel of a nuclear reactor comprises generally a lower cartridge 3_a having no fuel element and located at the lower part of channel 1, a given number of fuel cartridges 3 piled up on one another, the lower fuel cartridge thereof being carried by cartridge 20 3_a, and an upper cartridge 3_b approximately identical to fuel cartridges 3, but having no fuel, said cartridge 3_b being disposed at the upper part of channel 1 on the column of fuel cartridges 3.

It is reminded that up to this date the handling of 25 fuel cartridges 3 and cartridges 3_a and 3_b was effectuated by a device carrying them at their upper part. Such a device cooperates also with the upper part of casing 4 of the cartridge to be handled.

Such handling has two inconveniences, to wit:

30 It is necessary to remove first the upper cartridge 3_b, then every cartridge 3 and finally the lower cartridge 3_a.

The channel 1 may be closed when the upper part of casing 4 of said cartridges 3 or cartridges 3_a and 3_b is destroyed accidentally.

35 In this last case, all the fuel cartridges and the lower cartridges located under the cartridges 3_a or 3_b the casing of which is destroyed, are inaccessible to the removing device.

40 The main object of the present invention is to prevent the above mentioned inconveniences.

According to the invention, for handling fuel cartridges 3 and cartridges 3_a and 3_b of a nuclear reactor, a sounding rod 8 is used. Said sounding rod has an operating end adapted to move from one end of the central passage 45 to the other end. Operating end 8_a is provided with main catching means 9 capable, under the action of control means, to have either a retracted position or an expanded position.

A supporting part 10 is connected to the charge to be handled at the end thereof opposed to that from which said sounding rod is introduced into the central passage. Supporting part 10 is adapted to cooperate with main catching means 9 in their expanded position for removing the charges from the channel by retracting movement of 55 said sounding rod 8.

According to a first embodiment of the invention, the charge to be handled is constituted by only a part of the column of cartridges piled up in the channel that is considered.

60 According to another feature of the invention, the charge to be handled constitutes all the cartridges of the column and cartridges 3_a and 3_b piled up in the channel that is considered.

This last solution is adopted for the following description. This solution is advantageous because it necessitates only one operation for charging or removing every reactor channel.

70 FIG. 1 shows a sleeve 11 located between lower cartridge 3_a and the bottom of channel 1. Sleeve 11 has an outer diameter approximately equal to the outer diameter of casing 4 of fuel cartridges 3 and cartridges 3_a and 3_b.

The inner walls of sleeve 11 are so arranged to constitute supporting part 10.

Sleeve 11 supports lower cartridge 3_a, the column of fuel cartridges 3 and the upper cartridge 3_b. It is constituted by a material having good mechanical characteristics, such as steel. It is advantageous for normalisation reasons, to give to the whole lower cartridge 3_a—sleeve 11, an axial length equal to the axial length of one of fuel cartridges 3 or of upper cartridge 3_b. The depth of channel 1 is a multiple of said common axial length. Main catching means 9 are constituted, as shown in FIGS. 1 and 2, by a device having three pivoting fingers 12. These three fingers are disposed at 120° at the lower part 8_a of sounding rod 8. They may, under the action of an appropriate control means which will be described hereinafter, have two positions:

A retracted position shown by one of said three fingers 12 in drill and dotted lines in FIG. 2,

An expanded position corresponding to FIGS. 1 and 2 in which said three fingers 12 cooperate with supporting part 10 arranged in sleeve 11.

Every finger 12 is adapted to pivot about an axis 13 disposed in such manner that, when the finger that is considered has its retracted position, it is approximately parallel to the sounding rod 8 axis, and that, when the finger that is considered has its expanded position, it makes, with the sounding rod 8 axis, an acute angle open upward, this angle being about 30°.

The second catching means 9_a are carried by sounding rod 8 and located above main catching means 9. Second catching means 9_a are capable, under the action of appropriate control means which will be described hereinafter, to have either a retracted position or an expanded position.

The second catching means 9_a are adapted to cooperate, when they are in their expanded position, with a supporting part 10_a provided in the fuel element can 5 of lower cartridge 3_a, said supporting part 10_a being located at the bottom of lower fins 5_b of said can.

The second catching means 9_a are also adapted to be expanded simultaneously with main catching means 9 and permit, when the whole of fuel cartridges 3 and of lower and upper cartridges 3_a, 3_b is to be removed from channel 1, to ease wires 7 which maintain can 5 in casing 4 and to prevent, if wires 7 are broken, that the can 5 of lower cartridge 3_a sticks into fingers 12 of the main catching means 9.

FIGS. 1 and 2 show that second catching means 9_a are constituted by a system having three pivoting fingers 12_a. These three pivoting fingers are disposed in staggered relation at 120° with respect to three fingers 12 of the main catching means 9. They may have either a retracted position, shown in FIG. 2 in drill and dotted lines, or an expanded position, shown in FIGS. 1 and 2.

FIGS. 1 and 2 show fingers 12_a in their expanded position, cooperating with a supporting part 10_a constituted by a portion 10_b located at the bottom of inner fins 5_b of the can 5 of lower cartridge 3_a.

Every one of fingers 12_a is pivoted about an axis 13_a disposed in such manner that:

When the finger that is considered has its retracted position, it is essentially parallel to the axis of rod 8,

And when the finger that is considered has its expanded position, it makes, with the axis of said rod 8, an acute angle, open upward, this angle being about 30°.

Main catching means and second catching means are both controlled by common control means which comprise a sliding tube 14 constituting the outer wall of rod 8, said sliding tube 14 comprising,

On the one hand, three rectangular openings 15 located opposite three fingers 12 of the main catching means 9, every one of said three rectangular openings 15 having an axial length approximately equal to that of fingers 12,

And, on the other hand, three rectangular openings 15_a located opposite fingers 12_a of second catching means 9_a,

every one of said three rectangular openings 15_a having an axial length approximately equal to the length of fingers 12_a.

Motor means are provided for acting on sliding tube 14 in such manner that tube 14 may have:

An upper position, in which openings 15 and openings 15_a are respectively above the fingers 12 of main catching means 9 and the fingers 12_a of second catching means 9_a, fingers 12 and 12_a being located in said sliding tube 14,

And a lower position, in which openings 15 and openings 15_a are drawn respectively to the level of the fingers 12 of main catching means 9 and the fingers 12_a of second catching means 9_a,

Said above mentioned fingers then spreading about sliding tube 14, under the action of resilient means.

Said resilient means are constituted by a spring 16 acting on a plate 17 for the fingers 12 of main catching means 9 and by a spring 16_a acting on a plate 17_a for the fingers 12_a of second catching means 9_a.

When sliding tube 14 is in its low position, the fingers 12 of main catching means 9 stay in their expanded position only under the effect of spring 16.

In order to prevent, during the handling, all risks of disconnection in the column of cartridges, locking means are provided to prevent accidental retraction of the fingers 12 of main catching means 9.

Said locking means are constituted by three abutments 18 adapted to lean on the three fingers 12 of main catching means 9 when these fingers are in expanded position, said abutments 18 above mentioned are supported by a head 19 mounted on a second rod 20 axially movable and adapted to have:

An upper position in which said locking means are in their retracted position shown in drill and dotted lines in FIG. 2,

And a lower position in which said locking means are in their expanded position shown in FIG. 2 and in which the three locking abutments 18 cooperate with the three fingers 12.

Sliding tube 20 is mounted on a sliding support 21 adapted to have, under the action of appropriate motor means, an upper position and a lower position, resilient means, such as spring 22, tending to apply three abutments 18 on three fingers 12, whatever the position of fingers 12 may be.

Motor means acting on sliding tube 14 to draw it from its upper position (main and second catching means being in retracted position) to its lower position (main and second catching means being in expanded position) and motor means acting on sliding support 21 to draw it from its upper position (locking abutments 18 being in retracted position) to its lower position (locking abutments 18 being in expanded position), comprise, on the one hand, control means 23 located at the top of rod 8 and, on the other hand, means adapted to rotate said control means.

Control means 23 comprise, on the one hand, a driving shaft 24 for rotating a first threaded rod 25 cooperating with a nut 26 rigid with sliding tube 14, two contacts 27 and 28 permitting to control the position of said sliding tube 14 and, on the other hand, a driving shaft 29 rotating a second threaded rod 30 cooperating with a nut 31 rigid with sliding support 21, two contacts 32 and 33 permitting to control the position of said sliding support 21.

In order to have a good positioning of said means for rotating and of said control means, a supporting part 34 is provided at the upper part of said control means 23, said supporting part 34 is also provided with a centering inclined surface 35 adapted to cooperate with a centering finger carried by said means for rotating said control means 23.

Sliding tube 14 is provided with passage orifices 36 shown in FIG. 1. This prevents perturbation in the circulation of carbonic gas in channel 1, caused by rod 8

when it is in central passage 6 of fuel cartridges 3 and cartridges 3_a and 3_b.

The discharging of the device is as follows:

Sounding rod 8 is introduced into central passage 6 of the cartridges piled up on one another in channel 1;

Sliding tube 14 is drawn to its lower position, indicated through contact 28, main and second catching means 9 and 9_a being expanded;

Sliding support 21 is drawn to its lower position indicated through contact 33, main catching means 9 being locked by abutments 18;

Rod 8 is removed from channel 1, the column of cartridges is also removed through fingers 12 of main catching means 9 and fingers 12_a of second catching means 9_a;

Cartridges are stocked in a stocking channel;

Sliding support 21 is drawn to its upper position indicated through contact 32, main catching means 9 being unlocked;

Sliding tube 14 is drawn to its upper position, indicated through contact 27, main and second catching means being retracted;

Sounding rod 8 is removed from the channel.

In a general manner, while the above description discloses what are deemed to be practical embodiments of the invention, said invention is not limited thereto as there might be changes made in the arrangement, disposition and form of the parts without departing from the principle of the invention as comprehended within the scope of the appended claims.

What I claim is:

1. An installation for handling a plurality of annular fuel elements having substantially the same outer diameter and piled coaxially, vertically one above the other in a channel of a nuclear reactor comprising, in combination, a tubular probe designed to pass completely through the central passage defined by the pile of annular fuel elements, the lower end of said probe having a main catching device attached thereto and moveable between a retracted position and an operative expanded position, control means for keeping the main catching device retracted as the probe passes downwardly through the central passage as defined by the annular fuel elements and for expanding the catching device to the said expanded operative position after the catching device has passed through said central passage, an annular sleeve member positioned between the lowest annular fuel element and the bottom of the channel, the outer diameter of the sleeve being approximately equal to the outer diameter of said annular fuel elements, and the upper surface of the sleeve being engaged by the bottom of the lowest annular fuel element such that the sleeve supports the weight of the lowest annular fuel element as well as the weight of the remaining annular fuel elements of the pile, the said sleeve further including an internal bearing surface arranged to be engaged by the main catching device when said device is expanded to said operative position, and said catching device being operative, in the expanded position, in response to upward pulling of the tubular probe, to cause upward movement of the sleeve with all of the annular fuel elements piled on the sleeve, one above the other.

2. An installation as claimed in claim 1 further comprising a second catching device located above the main catching device, second control means for moving the second catching device to a retracted position and to an

operative expanded position, an additional bearing surface located on the lowest annular fuel element, and said second catching device engaging the said additional bearing surface when the second catching device is in the operative expanded position.

3. An installation according to claim 2 wherein said second catching device comprises second pivoting fingers having both an expanded position in which the fingers cooperate with said additional bearing surface provided in said lower annular fuel element, and said fingers also having a retracted position.

4. An installation according to claim 3 wherein said second pivoting fingers are disposed in staggered relation with respect to the fingers of the main catching device.

5. An installation according to claim 2 further comprising means for operating main catching device and said second catching device simultaneously.

6. An installation according to claim 1 wherein said main catching device includes pivoting fingers regularly disposed at the lower part of said probe, said fingers being operated by said control means to occupy either a retracted position or an expanded position in which said fingers cooperate with said sleeve.

7. An installation according to claim 6, including locking means for preventing accidental retraction of the fingers of said main catching device.

8. A device according to claim 3 wherein said first and said second control means are constituted by common control means comprising a sliding tube constituting the outer wall of said probe, said sliding tube including first rectangular openings, every one of said first openings being located opposite a finger of said main catching device and having an axial length approximately equal to that of said last mentioned fingers and second rectangular openings, every one of said second openings being located opposite a finger of said second catching device and having an axial length approximately equal to that of said last mentioned fingers, and motor means acting on said tube in such manner that said tube may have an upper position in which the fingers of said two catching devices are located in said sliding tube and a lower position in which said fingers are spread about said sliding tube.

9. A device according to claim 8 wherein said sliding tube is provided with a plurality of orifices adapted to accelerate the circulation of a cooling gas through said channel.

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U.S. Cl. X.R.

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