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(54) **A lifting device for nuclear fuel elements**

(57) A lifting device comprising a support or lifting mast, a gripper head displaceable towards and away from the support the gripper head comprising gripper pawls 9 capable of gripping fuel elements 1 in a nuclear reactor, the pawls being pivotable in perpendicular planes, wherein the gripper head further includes a double ring member (11) one ring portion (19) of the double ring member being rotatable relative to the other ring portion (15) of the double ring member, the non-rotatable ring portion carrying a securing lever (28) and the gripper pawls (9), the rotatable ring portion transmitting its rotary movement to the gripper pawls (9) the end positions of the pawls being determined by the securing lever.

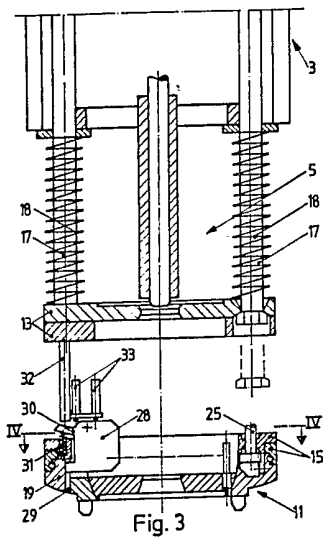

Fig. 3

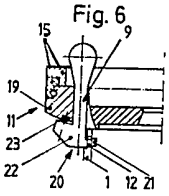

Fig. 6

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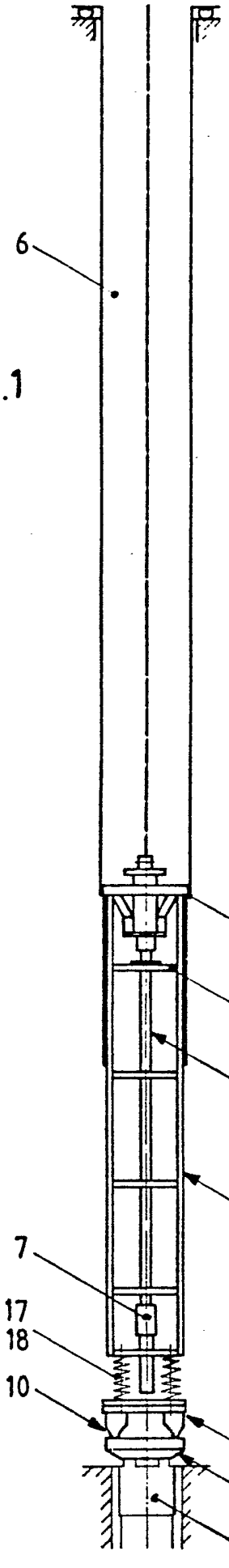


Fig.1

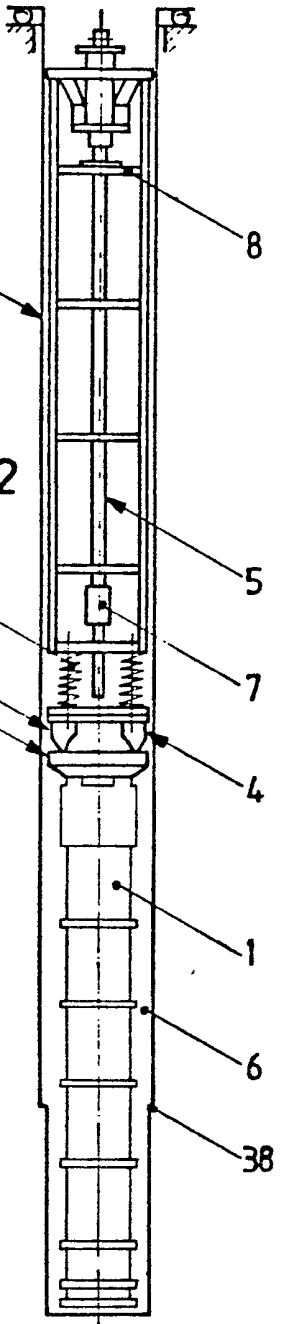
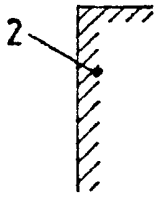


Fig.2



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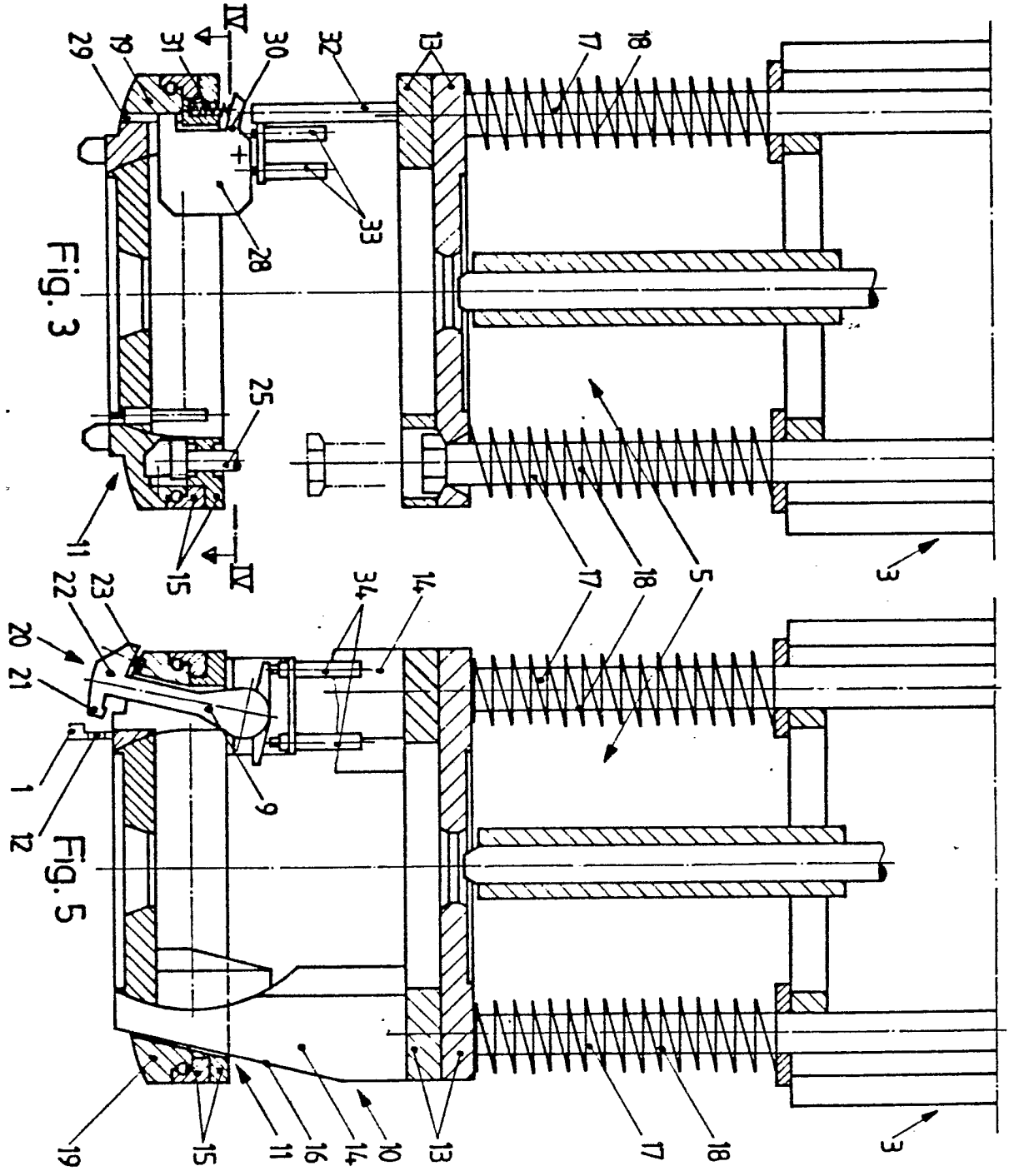

Fig. 3

Fig. 5

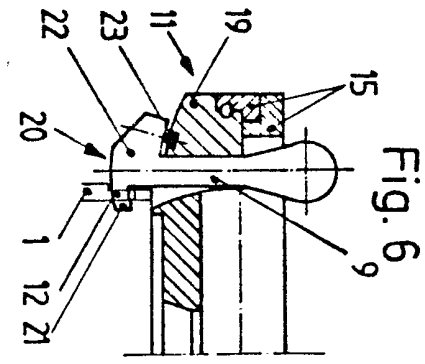

Fig. 6

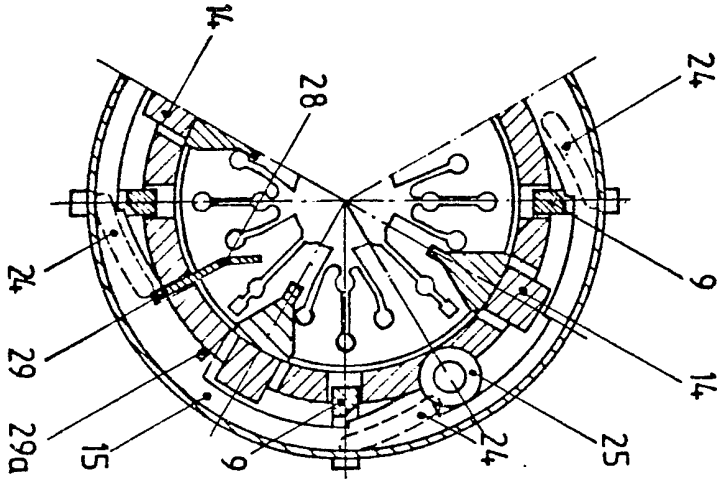

Fig. 4

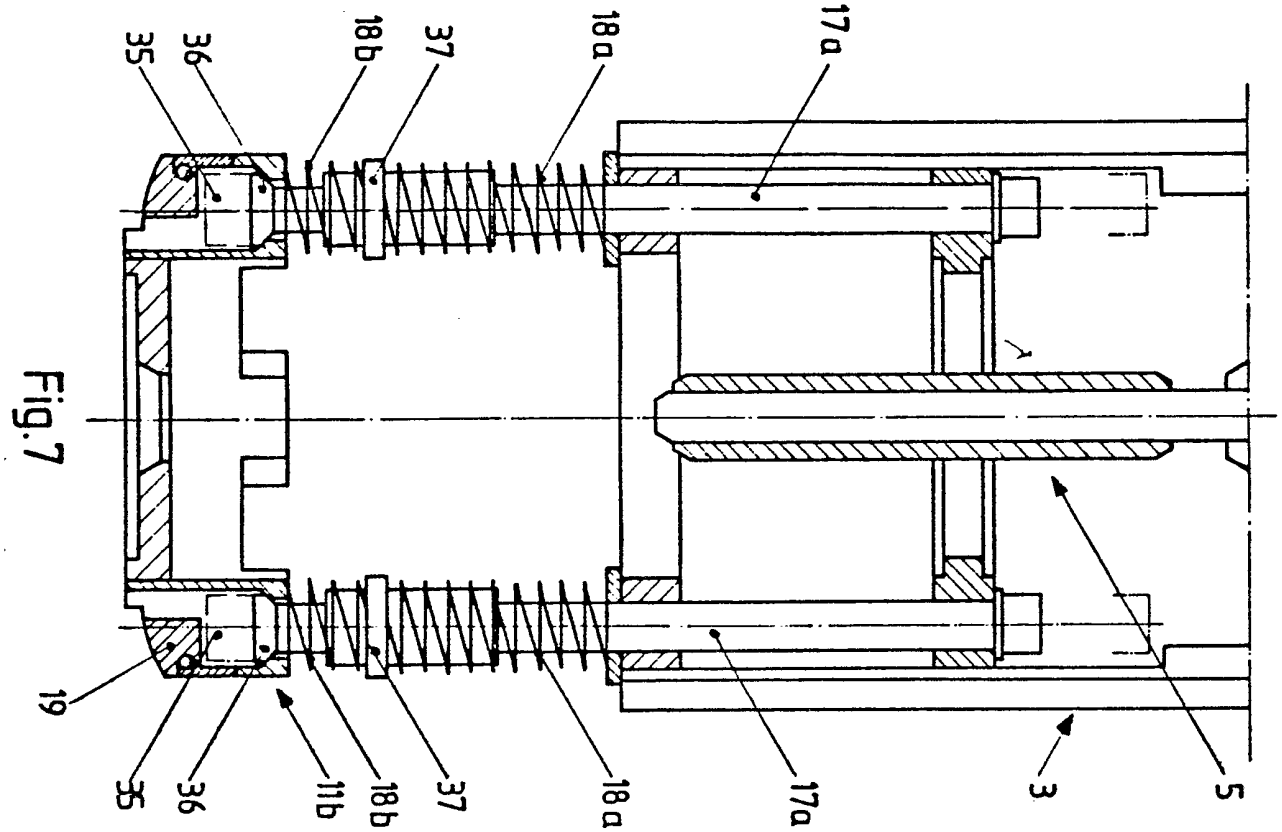

Fig.7

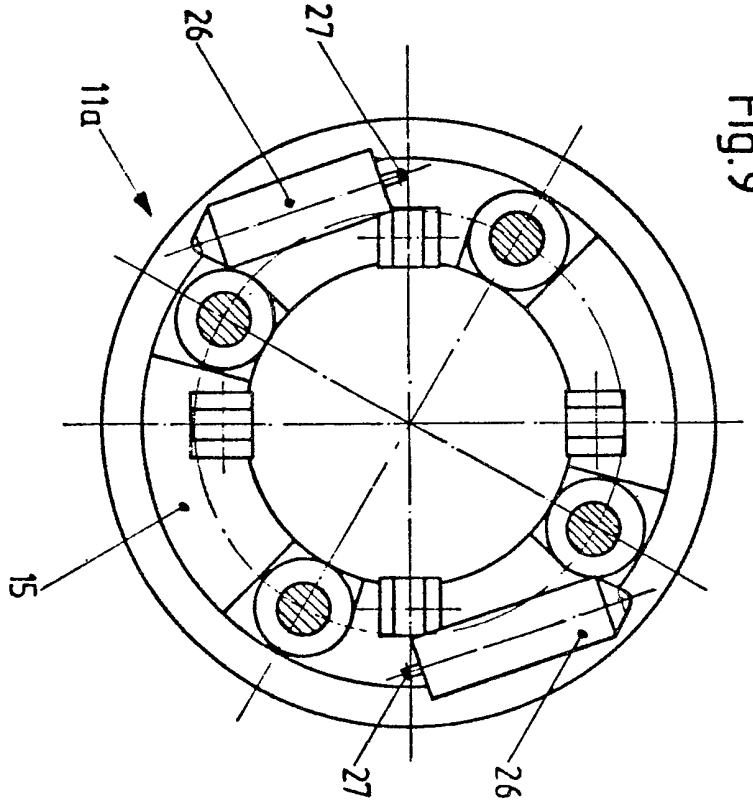

Fig.9

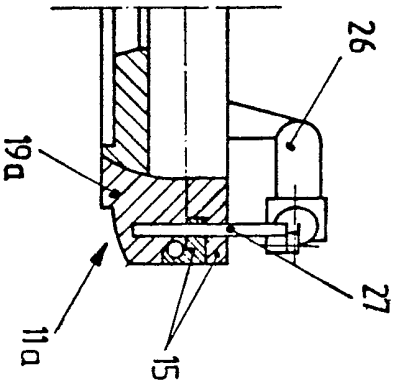

Fig.8

SPECIFICATION

Lifting device for fuel elements

The present invention relates to a lifting device for fuel elements. One known lifting device for fuel elements comprises pivotal gripper pawls, which form the gripper head or the gripping device for the fuel elements, and which are connected to a cylindrical housing. To actuate the gripper head, a drive arrangement is provided which is located relatively close to the pawls at the top of the housing. The drive arrangement is connected to each individual gripper pawl by separate rods. As a carrier of the housing and gripper pawl unit, a hollow body member is provided. In the interior of the body, the housing and pawl unit is dispaceable between stops. Such displaceability thus serves to provide locking members for the pawls provided between the stops in their external and internal position.

Such a gripper head would not be expedient in structures in which the distance between the pawls and their drive device is large. This is because the pawl actuating rods would need to be long and would therefore readily vibrate unless precautionary measures were taken. However, lifting devices for fuel elements are also known which comprise a plurality of telescopic members. In such an arrangement, however, it is necessary for the internal telescopic member to pull the rods from the fuel elements through the gripper head. Because the rods are long, it is not possible, for reasons of space, to locate the drive device as close to the gripper pawls as would be desirable.

An adverse feature of such a known gripper head is that its horizontal cross-section due to the space requirement of the individual rods, is relatively large. Moreover, the locking members for the pawls are located in the interior of the lifting device and are not readily accessible.

The present invention seeks to provide a lifting device, in which the gripper head is displaceably mounted on its support (usually a lifting mast) and provided with pawls for gripping fuel elements in a nuclear reactor, which pawls are pivotal in perpendicular planes and are so formed that the gripper head may be used in lifting devices in a space-saving manner. Thus, the components necessary for mechanically securing the gripper pawls should be visible and should be readily accessible.

According to the present invention, there is provided a lifting device comprising a support or lifting mast, a gripper head displaceable towards and away from the support, the gripper head comprising gripper pawls capable of gripping fuel elements in a nuclear reactor, the pawls being pivotable in perpendicular planes, wherein the gripper head further includes a double ring member, one ring portion of the double ring member being rotatable relative to the other ring portion of the double ring member, the non-rotatable ring portion carrying a securing lever and the gripper pawls, the rotatable ring portion transmitting its rotary movement to the gripper pawls, the end positions of the pawls being determined by the securing lever.

By using a double ring arrangement, all of the gripper pawls can be moved utilising a single member, that is to say the rotatable portion of the double ring. Moreover, the pawls are directly moved by the rotatable portion. Accordingly, individual actuating rods for the pawls are no longer necessary. This means that the structure is no longer susceptible to the spacing of the pawls from the drive device which is used to open and close them and the pawls may thus be operated hydraulically. To permit the securing lever to block the rotatable part of the double ring, it has to be located close thereto, that is to say, at the end of the lifting device. This makes it easily visible during the operation of the device and readily accessible when breakdowns occur.

In a preferred embodiment, there is provided the gripper pawls each having a substantially inverted-T shape and a pivotable head portion which transmits the double ring downwardly, the front portion of the head being adapted to be inserted in suitable openings formed in the fuel element, the rear portion of the head carrying a pin acting as a gate block, the pin engaging from below in a gate groove, the gate groove being formed in the rotatable portion of the double ring such that one end of the groove is nearer the centre of the ring than the other end of the groove.

The transmission of the rotary movement of the rotatable portion of the double ring to the gripper pawls is thus produced in a simple manner enabling the device to be maintained compact. Moreover, apart from the conventional suspension of the pawls, further linkages and joints are avoided.

Desirably, slots are provided in the rotatable portion of the double ring into which the end positions of the rotatable portion of the double ring determined by the length of the gate grooves the securing lever pivots under the biassing force of a spring.

Advantageously, the securing lever includes an arm portion, the arm portion co-operating with a spring-loaded ram or tappet which is vertically displaceable in the support or lifting mast, whereby movement of the support or lifting mast towards the gripper head causes the ram or tappet to engage the arm of the securing lever so as to disengage the securing lever from the slot.

Further preferably, the gripper head additionally comprises a frame member which is urged against the end of a fixed guide pin or bolt attached to the support or lifting mast by compression springs, the frame member carrying a plurality of equiangularly spaced apart downwardly extending ribs, the non-rotatable portion of the double ring being retained by the ribs in a ball joint-like manner.

In such an arrangement, the double ring is mounted in the manner of a ball joint which makes it possible for the plane of the pawls to be adapted to the plane of the head of the fuel element.

Further advantageously, the non-rotatable portion of the double ring has cavities formed therein in which are received the ends of displaceable guide bolts attached to the support or lifting mast with radial clearance, each guide bolt having a collar formed thereon and at least one compression spring

being located between the collar and the support or lifting mast or the non-rotatable portion of the double ring. After contacting the head of the fuel element the gripper head can thus be laterally displaced.

Further desirably, two compression springs are provided around each bolt, the spring extending between the collar and the non-rotatable portion of the double ring being weaker than the spring extending between the collar and the support or lifting mast.

The invention will be further described, by way of example, with reference to the accompanying drawings, in which:-

Figure 1 shows an elevational view of a telescopic device for lifting a fuel element of a nuclear reactor, the device being shown in an extended position and located on a fuel element,

Figure 2 shows the lifting device of Figure 1 in a retracted state with the fuel element withdrawn into a guide tube forming part of the device,

Figure 3 shows an elevational view of a gripper head located at the end of a mast-shaped support member, the head and support member forming part of the lifting device shown in Figure 1,

Figure 4 is a sectional view taken along the line IV-IV of Figure 3,

Figure 5 is an elevational view of part of the device shown in Figure 1 and shows the pivotal mounting of a double ring with gripper pawls being shown in their open position,

Figure 6 shows a detail of the double ring shown in Figure 5 but with the gripper pawls in their closed position,

Figure 7 shows an alternative embodiment of a gripper head located at the end of a mast-shaped support,

Figure 8 shows a side view of an alternative arrangement for displacing the gripper pawls, and

Figure 9 is a plan view of the arrangement shown, in part, in Figure 8.

In Figures 1 and 2 there is shown a fuel element 1 from a nuclear installation which is, in the embodiment shown, to be transferred to a storage frame 2 located at a different level from the reactor. The lifting device shown in Figures 1 and 2 comprises a telescopic mast 3 which forms the external portion of the device and has a gripper head 4 for the fuel elements 1, and a rod-shaped gripper member 5 forming the internal portion of the device for gripping the control rods or blank rods located within the fuel element 1. The components of the telescopic device are displaceable in a guide tube 6 and are detachably interconnected in their upper region when the device is in its collapsed or telescoped state as shown in Figure 2.

With disengagement, the rods of the fuel element (not shown) may be pulled into the mast 3 by the gripper head. The lifting mast 3, which acts as a support for the gripper head 4, may be occupied over substantially its entire length, by the rods. The rod-shaped gripper member 5 has a shoulder portion 7 in its lower region and when this portion 7 strikes against an upper web member 8 formed in the lifting mast 3, the thus-pulled guide rods and the lifting mast 3 surrounding them may be lifted together. This lifting operation precludes the possibility that a drive unit for the purpose of actuating gripper pawls 9 (Figures 5 and 6), which pawls are connected to the gripper head 4 for gripping the fuel elements 1, can be provided unless the width of the lifting device below the web 8 is increased.

The gripper head 4 provided at the lower end of the lifting mast 3 is best seen in Figures 3 to 6 and comprises a frame member 10 and a spherically displaceable double ring 11 which actuates the gripper pawls 9. The pawls 9 are insertable into receiving openings 12 provided in the fuel element 1. The frame member 10 includes flanges 13 from which ribs 14 depend downwardly. The ribs 14 face inwardly towards the centre of the ring. The ribs are so shaped as to correspond to the shape of the double ring 11. More accurately, they correspond to the shape of a non-rotatable portion 15 of the double ring 11. The outer edges 16 of the ribs 14 form stops for the non-rotatable portion 15, so that the double ring 11 may execute a tumbling movement of about 2° such that, if necessary, the pawls 9 may grip curved or bent support surfaces of the fuel element 1.

The frame 10 is displaceably connected to the lifting mast 3 by means of guide bolts 17 which pass through a flange 13 and thus act as guides during displacement. The flange 13 is braced against the head of the bolts 17 by means of compression spring 18.

Effectively, the gripper pawl 9 is hammer-shaped. It is actuated by a rotatable portion 19 of the double ring 11. For this purpose, the gripper pawl 9 is mounted with its haft end located above the double ring 11 and with its head portion 20 suspended and passing through the rotatable portion 19. The front portion 21 of the head portion 20, during pivotal displacement, produces a connection with the fuel element 1. The rear portion 22 of the head portion acts as a support for an upright pin 23 which engages in a gate groove 24 formed in a downwardly directed end face of the rotatable portion 19. Four such pawls equiangularly disposed from one another are provided as shown in Figure 4. In the open position of the pawls 9, as shown in Figure 5, the gate grooves 24 extend anti-clockwise and are directed inwardly toward the ring centre. Thus, if the rotatable portion 19 partially rotates in a clockwise direction, the gripper pawls 9, as shown in Figure 6, are moved into their closed position. As a drive arrangement a pinion 25 meshing an internally toothed portion of the rotatable portion 19 may be provided. Alternatively, as shown in Figures 8 and 9, an adjustment piston and cylinder arrangement 26 may be provided. One end of the arrangement 26 is connected to an arm 27 forming part of the rotatable portion 19*a* of the double ring 11*a*.

In the end positions, the rotatable portion 19 and the non-rotatable portion 15 are interconnected, by means of a fixed but tiltable safety lever 28 forming part of the non-rotatable portion 15. For this purpose, slots 29, 29*a* are provided into which the safety lever 28 enters under the effect of a spring 31 engaging an arm 30. The safety lever 28 co-operates

with a tappet or ram 32 which is vertically resiliently arranged in the lifting mast 3 and is provided with a track alignment. The end positions of the safety lever 28 and the gripper pawls 9 are tapped by switches 33 and 34, which maintain the gripper pawls 9 in their end positions electrically and need not be further described herein.

In the embodiment shown in Figure 7, the double ring 11*b* has cavities or hollow spaces for receiving the heads 36 of the bolts 17*a* guided in the lifting mast 3. This allows the double ring 11*b* to be adapted to inclined support or abutment surfaces of the fuel element 1. Such inclination may have been caused by the action of heat. The hollow spaces or cavities 35 also allow, within pre-defined limits, a lateral displacement of the double ring 11*b*. As in the embodiments shown in Figures 3 and 5, springs are provided between the double ring 11*b* and the lifting mast 3 around the bolts or studs 17*a*. Two springs are provided around each bolt or stud, these being a longer, stronger compression spring 18*a* and a shorter, weaker compression spring 18*b*. Located between these two springs is a collar 37 forming part of the bolt 17*a*. When the double ring 11*b* makes contact with the fuel element 1, the compression spring 18*b* is initially compressed. If the downward movement is not then interrupted due, for example, to a breakdown, the compression spring 18*a* is compressed, which causes simultaneous upward displacement of the bolts 17*a*. This arrangement therefore provides an emergency cut-out for the apparatus.

During the lowering of the lifting device, the gripper head 4 and the lifting mast 3 are spread apart from one another until the stop members are encountered. This is caused by, for example, the compression springs 18. The pawls 9, because they are not subjected to a load, are therefore opened. In this state, they are mechanically secured by the engagement of the safety lever 28 in the slot 29.

When the gripper head 4 is located in position on the fuel element 1 and with continued downward travel of the device, the tappet or ram 32 provided with a tail pivots the securing lever 28 out of the slot 29, whereupon the lifting mast 3 makes contact with a stop 38 formed on the guide tube 6 and the lifting is terminated.

During the initiation of the drawing out of a fuel element 1, the pinion 25 displaces the rotatable portion 19, and the gripper pawls 9 move into the receiving openings 12 of the fuel element 1. The subsequent lifting operation first causes the securing lever 28 to pivot into the slot 29*a* and thereby locks the gripper elements before the fuel element 1 is lifted.

CLAIMS

1. A lifting device comprising a support or lifting mast, a gripper head displaceable towards and away from the support, the gripper head comprising gripper pawls capable of gripping fuel elements in a nuclear reactor, the pawls being pivotable in perpendicular planes, wherein the gripper head further includes a double ring member, one ring portion of the double ring member being rotatable relative to the other ring portion of the double ring member, the non-rotatable ring portion carrying a securing lever and the gripper pawls, the rotatable ring portion transmitting its rotary movement to the gripper pawls, the end positions of the pawls being determined by the securing lever.

2. A lifting device as claimed in claim 1, wherein the gripper pawls each have a substantially inverted-T shape and a pivotable head portion which transmits the double ring downwardly, the front portion of the head being adapted to be inserted in suitable openings formed in the fuel element, the rear portion of the head carrying a pin acting as a gate block, the pin engaging from below in a gate groove, the gate groove being formed in the rotatable portion of the double ring. Such that one end of the groove is nearer the centre of the ring than the other end of the groove.

3. A lifting device as claimed in claim 1 or 2 wherein slots are provided in the rotatable portion of the double ring into which, the end positions of the rotatable portion of the double ring determined by the length of the gate grooves the securing lever pivots under the biassing force of a spring.

4. A lifting device as claimed in claim 3, wherein the securing lever includes an arm portion, the arm portion co-operating with a spring-loaded ram or tappet which is vertically displaceable in the support or lifting mast, whereby movement of the support or lifting mast towards the gripper head causes the ram or tappet to engage the arm of the securing lever so as to disengage the securing lever from the slot.

5. A lifting device as claimed in claim 1 or 2, wherein the gripper head additionally comprises a frame member which is urged against the end of a fixed guide pin or bolt attached to the support or lifting mast by compression springs, the frame member carrying a plurality of equiangularly spaced apart downwardly extending ribs, the non-rotatable portion of the double ring being retained by the ribs in a ball joint-like manner.

6. A lifting device as claimed in claim 1 or 2, wherein the non-rotatable portion of the double ring has cavities formed therein in which are received the ends of displaceable guide bolts attached to the support or lifting mast with radial clearance, each guide bolt having a collar formed thereon and at least one compression spring being located between the collar and the support or lifting mast or the non-rotatable portion of the double ring.

7. A lifting device as claimed in claim 6, wherein two compression springs are provided around each bolt, the spring extending between the collar and the non-rotatable portion of the double ring being weaker than the spring extending between the collar and the support or lifting mast.

8. A lifting device constructed and arranged to operate substantially as hereinbefore described with reference to and as illustrated in Figures 1 to 6, 7 or 8 and 9 of the accompanying drawings.

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