

PATENT SPECIFICATION

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(54) IMPROVEMENTS IN OR RELATING TO GRIPPING MEANS FOR HANDLING NUCLEAR REACTOR FUEL ASSEMBLIES

(71) We, VLADIMIR IVANOVICH BATJUKOV, ulitsa Prygunova, 9, kv. 29, OLEG NIKOLAEVICH VJUGOV, ulitsa Novaya, 24, kv. 2, ALEXANDR IVANOVICH FADEEV, ulitsa Engelsa, 21, kv. 46 and T SOLAK GRIGORIEVICH SHKHIAN, naberezhneya Zhdanova, 6, kv. 16, all of Gorky, U.S.S.R., all citizens of the Union of Soviet Socialist Republics, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to gripping means for handling nuclear reactor fuel assemblies the heads of which are internally recessed to receive gripping jaws.

According to the present invention, there is provided gripping means for handling nuclear reactor fuel assemblies the heads of which are internally recessed to receive gripping jaws, the gripping means comprising a housing accommodating a slider movable with respect to the housing, and gripping jaws each having a tail and a tooth at opposite ends thereof, the jaws being pivotally mounted on the housing in the region of their tails and being arranged to be received in longitudinal slots provided in the body of the slider, the end faces of said slots nearest the teeth of the gripping jaws being slanted with respect to the longitudinal axis of the gripping means such that the gripping jaws can be splayed out to grip a fuel assembly by relative movement of the slider and housing bringing the slanted slot end faces into contact with the teeth of the gripping jaws.

Gripping means embodying the invention and for handling nuclear reactor fuel assemblies, will now be particularly described, by way of example, with reference to the accompanying diagrammatic drawings, in which:

Figure 1 is a sectional elevation of the gripping means with the head of a fuel assembly shown in dashed lines;

Figure 2 is a section on line II—II of Figure 1; and

Figure 3 is a sectional elevation of the gripping means taken at a moment a slider of the gripping means is introduced into the head of a fuel assembly.

The gripping means 1 now to be described forms part of a nuclear reactor refuelling machine which for reasons of brevity will not be described herein otherwise than is necessary for a proper understanding of the gripping means.

As shown in Figure 1, the gripping means 1 is telescopically accommodated within a manipulator tube 2 of the refuelling machine. The manipulator tube 2 is movable vertically. The gripping means 1 comprises a housing 3 accommodating a slider 4 which is axially movable with respect to the housing 3.

Four gripping jaws (Fig. 2) are pivotally mounted on the housing 3 by means of axles 5 passing through the tails 6 of the jaws 7. At their ends opposite to the tails 6 (Fig. 1) the gripping jaws 7 are provided with teeth 8. Each of the teeth 8 has a working surface 9 and a camming surface 10. More than two gripping jaws are required.

The slider 4 is provided with longitudinally extending slots 11 arranged to receive the gripping jaws 7 (Fig. 1 and 2). The lower end faces 12 (Fig. 1) of the longitudinally extending slots 11 are slanted with respect to a longitudinally axis 13 of the gripping means 1 and are arranged to come into contact with the camming surfaces 10 of the teeth 8 upon the slider 4 moving up relative to the housing 3. This relative upward movement of the slider 4 results in the teeth 8 of the gripping jaws 7 being splayed out to engage in an internal recess or groove 14 (Fig. 3) provided in the head of a fuel assembly 15.

The gripping jaws 7 (Fig. 1 and 3) are biased to lie in a non-splayed out state in which they lie up against the body of the slider 4 by means of pushers 16 and springs 17 accommodated in holes 18 provided in the

housing 3. The pushers 16 interact with the tails 6 of the gripping jaws 7.

The lower end of the slider 4 is provided with a head 19. The opposite end of the slider 4 is mounted on a support 20 which interacts with the housing 3 through a spring 21. The support 20 is connected by means of a shackle 22 to a chain 23 of the refuelling machine's drive (only a portion of one link of the chain 23 is shown). Each link of the chain 23 has axles 24 whose ends are received in longitudinal slots 25 provided on the internal surface of the manipulator tube 2. The slots 25 are rectilinear and parallel to the longitudinal axis of the manipulator tube 2. The slots 25 end at some distance from the lower end of the manipulator tube 2; the end faces of the slots 25 serve as supporting surfaces 26 arranged to limit downward movement of the housing in the manipulator tube and to support the housing in its lowermost position.

On the internal surface of the housing 3 there is provided an annular shoulder 27 which serves as an abutment surface arranged to limit downward movement of the slider 4 relative to the housing by contact with an end face 28 of the support 20.

Mounted on the housing 3 are locking means 29 received in the slots 25 of the manipulator tube 2. Pivots 31 serve to pivotally mount catches 31 of the locking means 29 within slots 30. The catches are arranged to be received in a groove 30 provided in the support 20 to normally lock the slider 4 and housing 3 together. Apertures 34 are provided in the manipulator tube 2 in the region of the supporting surfaces 26 such that when the gripping means is lowered to a position in which the housing 3 is supported by means of the body of the locking means 29 on the surfaces 26, the catches 32 can swing outwards into the apertures 34 to release the slider 4 for continued downward movement. The groove 33 in the support 20 is shaped to push the catches 32 outwards into the apertures 34.

Also mounted in the housing 3 is a stop 35 which is arranged to come into contact with an end face 36 of the support 20.

Apertures 37 are provided in the support 20 through which the inside of the manipulator tube 2 communicates via a cavity 38 of the support 20 with a through hole 39 of the slider 4 which when a fuel assembly 15 is held by the gripping means 1 communicates with an internal cavity of the fuel assembly 15.

Operation of the gripping means will now be described.

Initially, the gripping means 1 (Fig. 1) suspended on the chain 23 lies fully inside the manipulator tube 2.

Under the action of the spring 21, the end face 36 of the support 20 interacts with the

stop 35 of the housing 3. The end faces 12 of the longitudinal slots 11 of the slider 4 are in contact with the camming surfaces 10 of the teeth 8 and the gripping jaws 7 are splayed out. The catches 32 are in contact with the internal surface of the manipulator tube 2 and are engaged in the groove 33 of the stop 20.

To pick up a fuel assembly 15, the refuelling machine's drive first lowers the gripping means 1 inside the manipulator tube 2. As this takes place, the gripping means 1 (Fig. 3) protrudes from the manipulator tube 2.

As the body of the locking means 29 comes to rest against the supporting surfaces 26 of the longitudinal slots 25, the housing 3 stops descending but the slider 4 and the support 20 continue to go down forcing the catches 32 from the groove 33 and into the apertures 34 of the manipulator tube 2. The slider 4 and support 20 moved down until the end face 28 of the support 20 abuts against the shoulder 27 of the housing 3. The camming surfaces 10 of the teeth 8 come out of contact with the end faces 12 of the longitudinally extending slots 11 of the slider 4. The springs 17 and pushers 16 cause the gripping jaws 7 to rotate about their axles 5 such that they lie up against the body of the slider 4 in a non-splayed out state.

The gripping means 1 is now ready to grip the fuel assembly 15.

The refuelling machine lowers the manipulator tube 2 and the protruding gripping means 1 to introduce the head 19 of the slider 4 into the internal cavity of the fuel assembly 15. As this takes place, the head 19 may come into contact with the body of the fuel assembly 15, but no contact is possible between the gripping jaws 7 and the body of the fuel assembly 15 because the gripping jaws are fully inside the longitudinal slots 11 of the slider 4. Thus the possibility of damaging the gripping jaws 7 by such contact is ruled out completely. The manipulator tube 2 is lowered until the gripping jaws 7 lie inside the internal cavity of the fuel assembly 15.

Next, the drive of the refuelling machine raises the chain 23 (Fig. 1) with the gripping means 1 to draw the gripping means inside the manipulator tube 2. The support 20 and the slider 4 go up first, but the housing 3 is initially held in place by the spring 21 and remains stationary until the end face 36 of the support 20 comes into contact with the stop 35 of the housing 3.

As the slider 4 is lifted with respect to the stationary housing 3, the end faces 12 of the longitudinal slots 11 come into contact with the camming surfaces 10 of the gripping jaws 7. The gripping jaws turn about the axles 5 and splay out. The teeth 8 locate in the internal groove 14 of the head of the fuel assembly 15 (shown by the dash line in

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Figure 1), and the working surfaces 9 of the teeth 8 come into contact with the fuel assembly 15. The fuel assembly 15 is thus gripped by the gripping jaws 7.

5 After the end face 36 of the support 20 comes into contact with the stop 35, the housing 3 of the gripping means 1 goes up together with the slider 4. The catches 32 are forced from the apertures 34 of the manipulator tube 2 into the groove 33 of the support 20. This safeguards against accidental displacement of the support 20 and slider 4 with respect to the housing 3, and, consequently, accidental disengagement of the gripping means 1 from the fuel assembly 15 as the latter is transported by the refuelling machine.

The gripping means 1 and the fuel assembly 15 are drawn inside the manipulator tube 2.

20 The force required to withdraw the fuel assembly 15 from its socket is transmitted from the slider 4 to the fuel assembly 15 through the planes of contact between the camming surfaces 10 of the teeth 8 and the end face 12 of the slider 4 and through the planes of contact between the working surfaces 9 of the teeth 8 and the body of the fuel assembly 15. Thus this force is transmitted only by the teeth 8 of the gripping jaws 7.

30 The rest of the gripping jaws 7 and the axles 5 mounting the gripping jaws 7 are not loaded which minimises the possibility of damage to them.

35 The refuelling machine moves the manipulator tube 2 to position the fuel assembly 15 above a socket in which said fuel assembly 15 is to be installed. By successively lowering the manipulator tube 2 and the gripping means 1, the fuel assembly is installed in the socket. The gripping jaws 7 are urged by the springs 17 and pushers 16 into the slots 11 to disengage the teeth 8 of the gripping jaws 7 from the internal groove 14 of the fuel assembly 15. The manipulator tube 2 is then raised with the gripping jaws 7 in a non-splayed out state, and the head 19 of the slider 4 leaves the internal cavity of the fuel assembly 15.

50 When the gripping means 1 is used to transfer fuel assemblies 15 from a reactor core to sockets of a storage for spent fuel assemblies, a cooling medium is passed through the fuel assemblies 15 to remove afterheat. This cooling medium flows from

the internal cavity of the manipulator tube 2, as shown by the arrows in Figure 1 of the drawings, through the apertures 37, the cavity 38 of the support 20 and the hole 39 of the slider 4, to the internal cavity of the spent fuel assembly 15 being handled.

60 The described form of gripping means is advantageous in that it ensures reliable gripping of fuel assemblies and minimises the possibility of the gripping jaws being damaged while handling fuel assemblies.

WHAT WE CLAIM IS:—

65 1. Gripping means for handling nuclear reactor fuel assemblies the heads of which are internally recessed to receive gripping jaws, the gripping means comprising a housing accommodating a slider movable with respect to the housing, and more than two gripping jaws each having a tail and a tooth at opposite ends thereof, the jaws being pivotally mounted on the housing in the region of their tails and being arranged to be received in longitudinal slots provided in the body of the slider, the end faces of said slots nearest the teeth of the gripping jaws being slanted with respect to the longitudinal axis of the gripping means such that the gripping jaws can be splayed out to grip a fuel assembly by relative movement of the slider and housing bringing the slanted slot end faces into contact with the teeth of the gripping jaws.

85 2. Gripping means according to claim 1, in which the jaws are biased into their non-splayed out positions within the slots by spring-urged pushers acting on the tails of the jaws.

90 3. Gripping means according to claim 1 or claim 2, wherein the slider is provided with a through hole arranged to allow cooling medium to be supplied to the fuel assembly during operation of the gripping means.

95 4. Gripping means for handling nuclear reactor fuel assemblies, substantially as hereinbefore described with reference to the accompanying drawings.

MATHISEN, MACARA & CO.,
Chartered Patent Agents,
Lyon House, Lyon Road,
Harrow, Middlesex, HA1 2ET.
Agents for the Applicants.

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COMPLETE SPECIFICATION

2 SHEETS

This drawing is a reproduction of
the Original on a reduced scale
Sheet 1

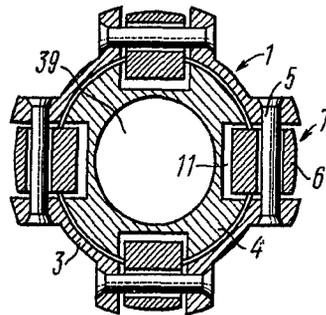
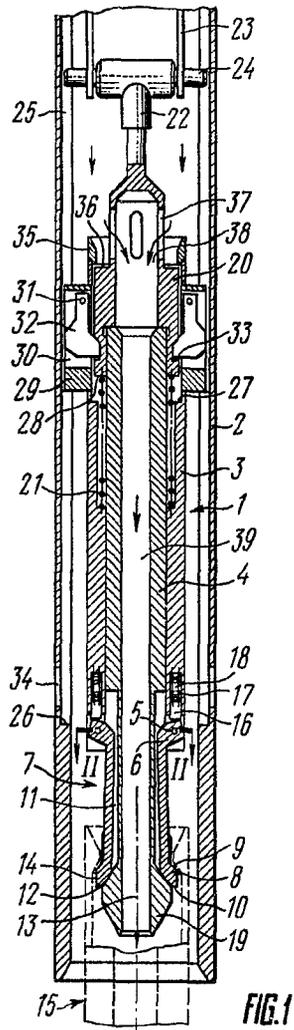


FIG. 2

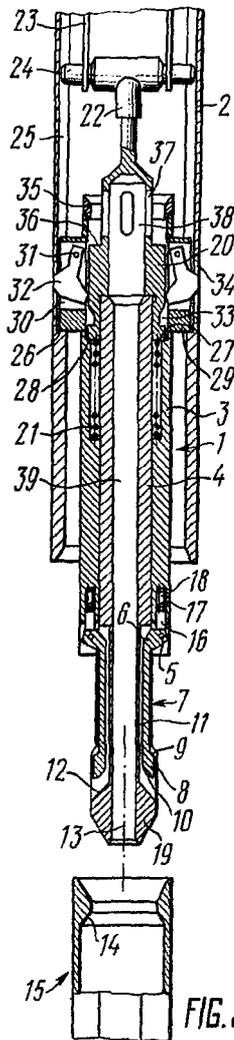


FIG. 3