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DEVICES FOR ANCHORING AND EXTRACTING PLUGS IN AND FROM FUEL CHANNEL OF NUCLEAR REACTORS
Filed Aug. 10, 1962 2 Sheets-Sheet 1

FIG.2

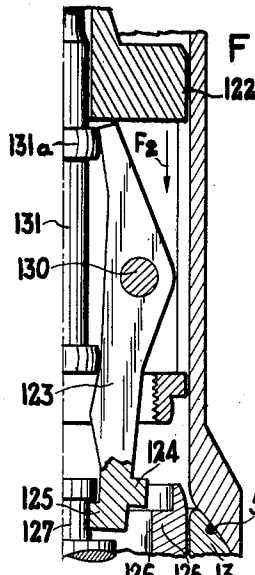


FIG.1

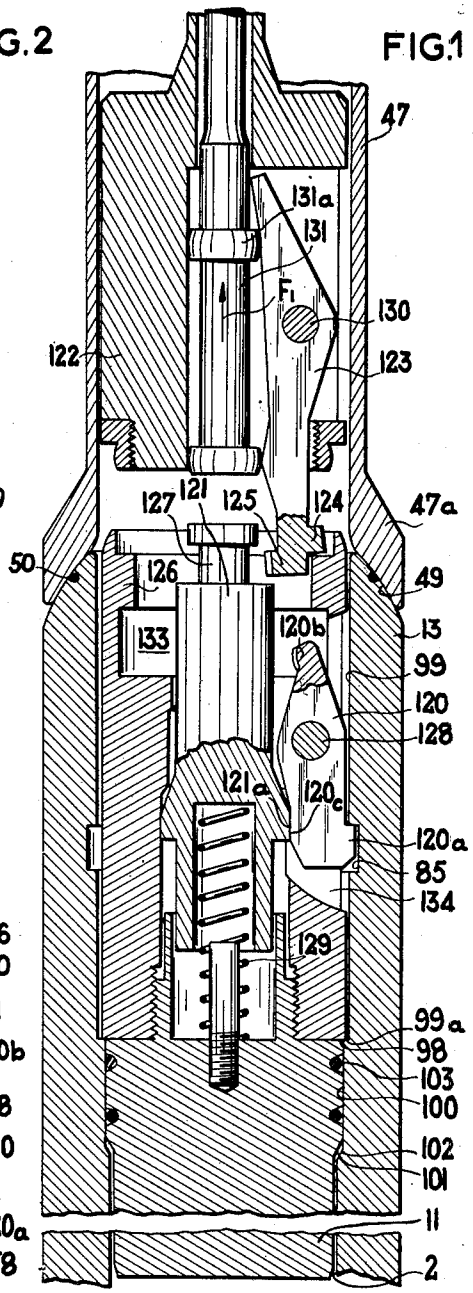


FIG.3

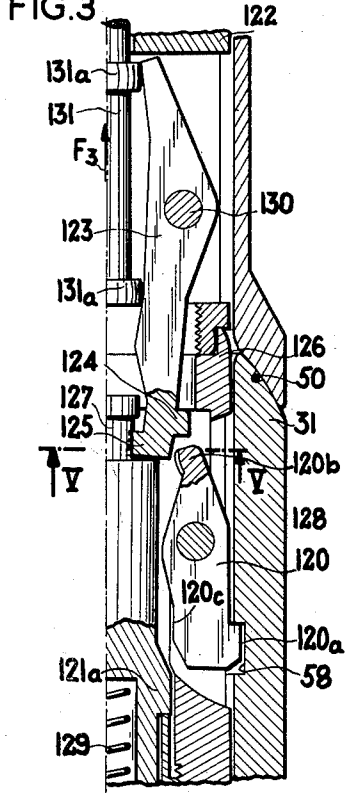


FIG.4

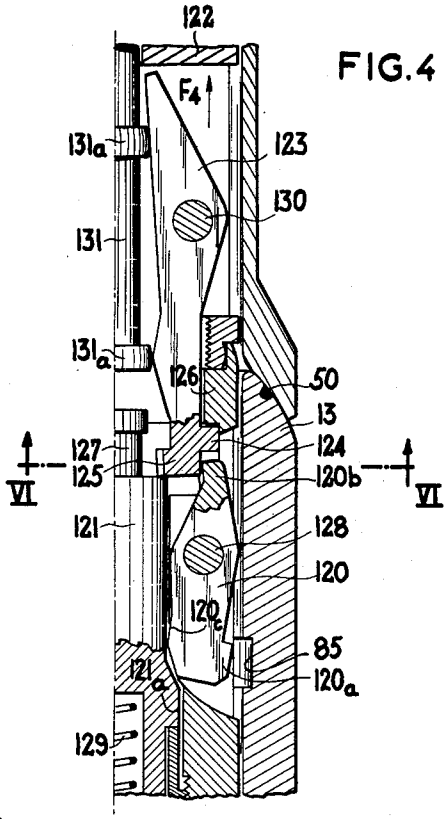


FIG.6

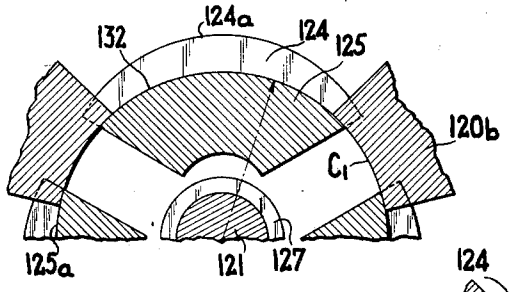
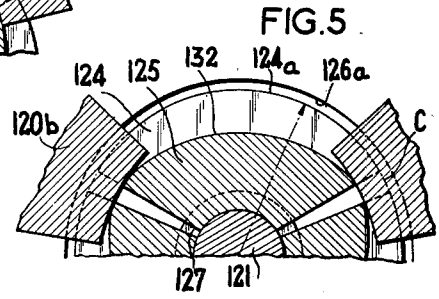


FIG.5



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3,125,123

DEVICES FOR ANCHORING AND EXTRACTING PLUGS IN AND FROM FUEL CHANNEL OF NUCLEAR REACTORS

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6 Claims. (Cl. 138—89)

This invention relates to a device for anchoring and extracting plugs in and from fuel channels of nuclear reactors which are adapted to receive nuclear fuel elements and through which a cooling fluid under pressure is circulated.

It is the object of this invention to provide anchoring and extracting devices of the type broadly set forth hereinabove which are designed with a view to meet various safety requirements while being capable of effecting a great number of channel opening and closing movements without failure.

More particularly, the device for anchoring and extracting plugs in and from fuel channels of nuclear reactors, which constitutes the subject-matter of this invention, is characterized notably in that it comprises, on a recessed portion of the plug, a plurality of pawls pivoted on said plug and adapted to lock same relative to the fuel channel to be closed, a member for locking said pawls which is axially movable inside said plug between two positions in which said pawls are locked and released relative to said channel, an inner shoulder adjacent to the open end of the plug and, on a clamp axially movable in relation to said plug, a plurality of levers axially fast on said clamp but pivoted thereon so as to be radially movable in relation thereto, each lever carrying on its end an outer projection and an inner projection, means for controlling the radial movements of said levers which are associated with means for controlling the axial movements of said clamp and lever assembly in relation to said plug between a first position in which said outer projections of said levers abut against the edge of said shoulder so as to stop said clamp at a predetermined distance from said plug, a second position in which said inner projections of said lever engage said locking member and said levers are retracted to permit their introduction into said plug, and a third position in which said clamp contacts said plug, said outer projections of said levers drivingly engage the shoulder and release the pawls and said inner projections keep said locking member in the unlocking position.

In addition to this main arrangement the invention also comprises other arrangements utilized preferably simultaneously as will be explained presently.

This invention contemplates more particularly a certain form of application and also certain forms of embodiment of the arrangements broadly set forth hereinabove; still more specifically, this invention is concerned, by way of novel industrial products, with devices of the type set forth which constitute a practical embodiment of the same arrangements, as well as the component elements and the special tools and means necessary for their construction, and finally any nuclear reactor equipped with devices of this character.

With the foregoing and other objects in view, the invention resided in the novel arrangements and combination of parts and in the details of construction hereinafter described and claimed, it being understood that changes in the precise embodiment of the invention herein disclosed may be made within the scope of what is claimed without departing from the spirit of the invention. Other objects and advantages will become apparent from the following description taken in conjunction with the accompanying drawings in which:

FIGURE 1 is a fragmentary axial section showing a fuel channel plug and a handling clamp provided with an anchoring and extracting device constructed according to the invention and shown in the approach position of the clamp;

FIGURES 2, 3 and 4 illustrate in half axial section certain component elements of the structure shown in FIG. 1, respectively in the three positions following the preliminary position of FIG. 1; and

FIGURES 5 and 6 are half cross-sections taken upon the lines V—V and VI—VI of FIGS. 5 and 6, respectively.

Referring first to FIG. 1 of the drawings, the reference numeral **2** denotes the end portion of a channel, duct or receptacle normally closed by a plug **11** and formed with an annular projecting portion **13** of cylindrical configuration.

To simplify the disclosure, the terms "outer" and "inner" are used herein with the meaning "remote from the channel axis" and "close to the channel axis" respectively, and the terms "front" and "back" denote elements or portions located respectively close to and remote from an observer placed externally of the reactor and looking thereat.

According to this invention, the front corresponds to the top and the back to the bottom of FIGS. 1 to 4 of the drawings.

The device for anchoring and extracting a plug in and from a fuel channel of this character comprises, according to this invention:

A series of pawls **120** carried by the plug **11** and adapted to engage a groove **85** formed in the wall of the end portion **2** of the channel for anchoring the plug therein;

A locking member **121** adapted to slide axially in a central passage formed in said plug for moving and subsequently holding the pawls **120** in their anchoring position (FIG. 1); and

A handling clamp **122** movable in the axial direction relative to the channel and adapted to actuate the aforesaid locking member **121** and to move the plug **11** in the axial direction.

Under these conditions and according to a specific feature of this invention, a set of levers **123** are pivotally mounted on the clamp **122**, each lever carrying on its back end an outer projection **124** and an inner projection **125**, and being so pivoted that these back ends may move from an outer limit position (FIG. 1) to an inner limit position (FIGS. 2, 3 and 5). Furthermore, the front portion of plug **11** is formed with a central recess **133** in which a locking member **121** is axially movable, said recess being formed with an inner annular shoulder **126** adjacent to its open end. The locking member **121** is formed with a peripheral groove **127** in the vicinity of this shoulder **126**.

It is advantageous to use locking pawls **120**, which are preferably three or more in number, disposed at spaced intervals around the plug **11** in longitudinal slots **134** formed therein, these pawls being pivoted on the plug by means of transverse pins **128**; each pawl **120** is formed on its back end with an outer heel **120***a* adapted to engage the groove **85** and on its front end with an inner face **120***b* of arcuate configuration (see FIGS. 5 and 6), the back end of the pawl being formed on the other hand with a bearing face **120***c*. The aforesaid locking member **121** consists of a substantially cylindrical rod formed with a widened-out portion **121***a* adapted to engage the inner bearing faces **120***c* of the pawls for actuating same. On the other hand a compression coil spring **129** constantly urges the locking member **121** to its uppermost

or front position in which it locks the pawls **120**, this spring being mounted between the member **121** and the bottom of the central recess **133**.

The levers **123** are disposed radially at spaced intervals around the clamp **122** and pivoted thereon by means of transverse pins **130**, their simultaneous pivoting movement being positively controlled in either direction by means of an axial rod **131** adapted to slide axially in the clamp by engaging the inner edge of the levers with collar portions **131***a* having preferably rounded edges. The projections **124** and **125** have an arcuate contour visible in FIGS. 5 and 6, the outer projection **124** being bound by an arcuate outer face **124***a*. Moreover, each lever **123** is formed, internally of the aforesaid face **124***a*, with a bearing face **132** also of arcuate configuration which is adapted to co-operate with the faces **120***b* of pawls **120**.

As shown in FIG. 5 the outer faces **124***a* of the outer projections **124** are so shaped that in the innermost position of levers **123** they all lie on a same surface of revolution about the general axis (this surface of revolution being shown diagrammatically by the circle C), thus facilitating their movement along the inner cylindrical surface **126***a* of shoulder **126**. In addition, as shown in FIG. 6, the bearing faces **132** are so designed that in the position wherein the levers **123** grip the plug **11** by engaging its groove **127** they all lie on a common surface of revolution about the main axis (this surface being shown diagrammatically by the circle C_1), thus facilitating their engagement with the inner faces **120***b* of the pawls. Of course, the contours of the peripheral development of the inner faces **120***b* of pawls **120** and faces **132** of levers **123** are such that in the plug-retaining position of these levers (FIG. 6) the pawls cannot move through the gap then existing between the faces **132** of these levers. In FIG. 6 there is shown the most inadequate position in this respect, wherein the pawls are just level with these gaps in the peripheral direction, the most favourable position being of course the one in which each pawl is coincident or co-planar with the radial plane of a lever.

The clamp **122** may be part of a loading and unloading machine or device of any suitable type comprising preferably an intermediate clamp guiding sleeve **47**, connected in a fluid-tight manner to the casing or like enclosure of the machine or device through means permitting axial or radial movements of its lower end **47***a* formed preferably with a tapered or part-spherical mouth **49** adapted to engage in a fluid-tight manner a gasket or like sealing member **50** carried by the aforesaid annular projecting portion **13**, together with means controlling the sliding movement, in said intermediate sleeve **47**, of the clamp and lever assembly. However, these control means as well as the means controlling the axial movements of rod **131** (which are associated with said clamp control means) are not shown in the drawings.

The fluid-tightness of the plug **11** is obtained by forming thereon preferably a first shoulder **98** adapted to engage a stop-forming face **99***a* coincident with a change in diameter between two sections of the channel to be plugged, namely sections **99** and **100**. Moreover, this plug **11** formed below the shoulder **98** with another, somewhat tapered shoulder **101** coincident with another change in diameter **102** in the channel between sections **100** and **2**, but the tapered shoulder **102** is so located along the channel bore that it cannot abut against the shoulder **101** of the plug. Gaskets **103** are also disposed on the plug between the cylindrical portion extending between shoulders **98** and **101**.

This plug anchoring and extracting device operates as follows:

When the plug **11** is positioned in the fuel channel **2** the shoulder **98** of its solid portion engages the end face **99***a*, the joint being sealed by the gaskets **103**, the annular cavity **133** being relatively close to the upper

end of the channel. The plug is anchored by the heels **120***a* of pawls **120** engaging the annular groove **85**. These pawls are locked in this position by the engagement of their faces **120***c* with the widened-out portion **121***a* of rod **121** kept in the desired position by the coil spring **129**.

When it is desired to extract the plug **11**, the sleeve **47** is lowered until its end **47***a* engages the projecting annular portion **13** of the channel, whereafter, the control means associated with rod **131** being so adjusted that the levers **123** are spread outwardly as shown in FIG. 1, the members controlling the movements of clamp **122** in sleeve **47** are operated, until the outer projections **124** engage the shoulder **126**. Then the control rod is retracted in the direction of the arrow F_1 (FIG. 1) up to the axial position shown in FIG. 2, whereby the complete set of levers are rocked in the clockwise direction, as seen in FIGS. 1–4, about their pivot pins **130**, so that their lower ends lie inside the circle corresponding to the surface **126***a* of shoulder **126**. Then the inner projections **125** engage the groove **127** of locking rod **121** and bear against this rod, so that the clamp can be moved in the direction of the arrow F_2 until the outer projections **124** clear the shoulder **126**, as shown in FIG. 3, this movement being facilitated by the shape of faces **124***a* as already explained hereinabove with reference to FIG. 5. During this movement the inner projections **125** push the locking member **121** inwards against the resistance of spring **129** until the widened-out portion **121***a* leaves the faces **120***c* of pawls **120**. Under these conditions these pawls **120** are released but remain nevertheless engaged in groove **85**. Then rod **131** is moved upwards in the direction of the arrow F_3 to the position shown in FIG. 4, thus causing the levers **123** to spread outwards, with the twofold consequence that the heels **120***a* of pawls **120** are extracted from groove **85** due to the engagement of the lever faces **132** with the upper faces **120***b* of pawls **120**, and that the projections **124** are lowered beyond the shouder **126**. Due to the specific shape of these faces **132**, as already explained hereinabove with reference to FIG. 6, all the pawls **120** are safely held in the same radial position upon completion of said spreading movement, irrespective of the axial tolerances existing between the clamp and the plug. Finally, from the position illustrated in FIG. 4 the plug can be removed by pulling the clamp **122** in the direction of the arrow F_4.

The plug can be refitted by repeating the same movements but in the reverse sequential order. When the inner projections **125** engage the bottom of groove **127** to free the opposite or outer projections **124** from shoulder **126**, the upper projections **120***b* of pawls **120** are released, thus tilting the heels **120***a* of these pawls and causing them to engage the outer groove **85** of the channel, and the upward movement of clamp **122** is attended by the same movement of levers **123** so that these levers will clear the inner surface **126***a* and carry along the locking member **121** until the widened-out portion **121***a* engages the inner faces **120***c* of the pawls. In this position, the levers **123** may be spread out again and the clamp lifted back into the loading machine. However, the clamp cannot be disengaged from the plug unless the latter is anchored in its channel by means of its pawls **120**. In fact, if the heels **120***a* are not engaged in the groove **85** the widened-out portion **121***a* cannot contact the inner faces **120***c* and the central groove **127** cannot move to its foremost position as shown in FIG. 1, which is the only position permitting the outward movement of the levers with a view to remove the inner projections **125** from this groove **127** and to position the outer projections **125** above the shoulder **126** in order to release the clamp.

Although the present invention has been described in conjunction with a preferred embodiment, it is to be understood that modifications and variations may be resorted to without departing from the spirit and scope of

the invention, as those skilled in the art will readily understand. Such modifications and variations are considered to be within the purview and scope of the invention and appended claims.

What we claim is:

1. A device for anchoring and extracting plugs in and from fuel channel of nuclear reactors, which comprises, on a recessed portion of the plug, a plurality of pawls pivoted on said plug and adapted to lock same relative to the fuel channel to be closed, a member for locking said pawls which is axially movable inside said plug between two positions in which said pawls are locked and released relative to said channel, an inner shoulder adjacent to the open end of the plug and, on a clamp axially movable in relation to said plug, a plurality of levers axially fast on said clamp but pivoted thereon so as to be radially movable in relation thereto, each lever carrying on its end an outer projection and an inner projection, means for controlling the radial movements of said levers which are associated with means for controlling the axial movements of said clamp and lever assembly in relation to said plug between a first position in which said outer projections of said levers abut against the edge of said shoulder so as to stop said clamp at a predetermined distance from said plug, a second position in which said inner projections of said lever engage said locking member and said levers are retracted to permit their introduction into said plug, and a third position in which said clamp contacts said plug, said outer projections of said levers drivingly engage the shoulder and release the pawls

and said inner projections keep said locking member in the unlocking position.

2. A device according to claim 1, in which said locking pawls are pivoted in longitudinal recesses formed at spaced intervals around said plug.

3. A device according to claim 2, in which all the outer faces of said levers, in the aforesaid retracted position, lie on a common surface of revolution about the channel axis, the diameter of said surface of revolution being smaller than that of said shoulder, and the outer surfaces of said inner projections are in the proper position for anchoring said levers on said shoulder along another surface of revolution co-operating with corresponding contours of the pawl end portions.

4. A device according to claim 1, in which said locking member consists of a rod formed with a cam portion adapted to engage said pawls and with a peripheral groove acting as an abutment relative to the inner projections of said levers in their retracted position.

5. A device according to claim 4, in which said levers have shaped portion and that said control member comprises two widened-out portions adapted to engage said shaped portions of said levers, and disposed on either side of the pivot pins of said levers.

6. A device according to claim 5, in which the surface of the pawl ends is greater than the maximum distance between the ends of said levers in their plug-anchoring position.

No references cited.