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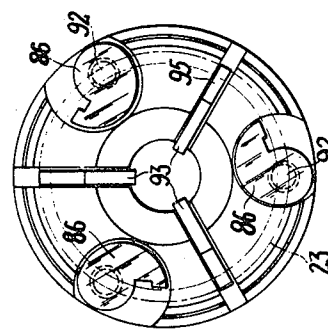
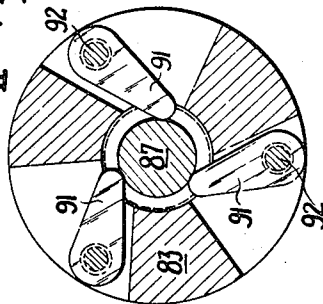
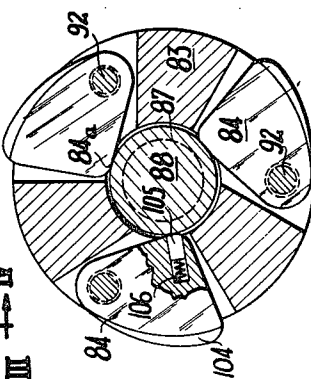
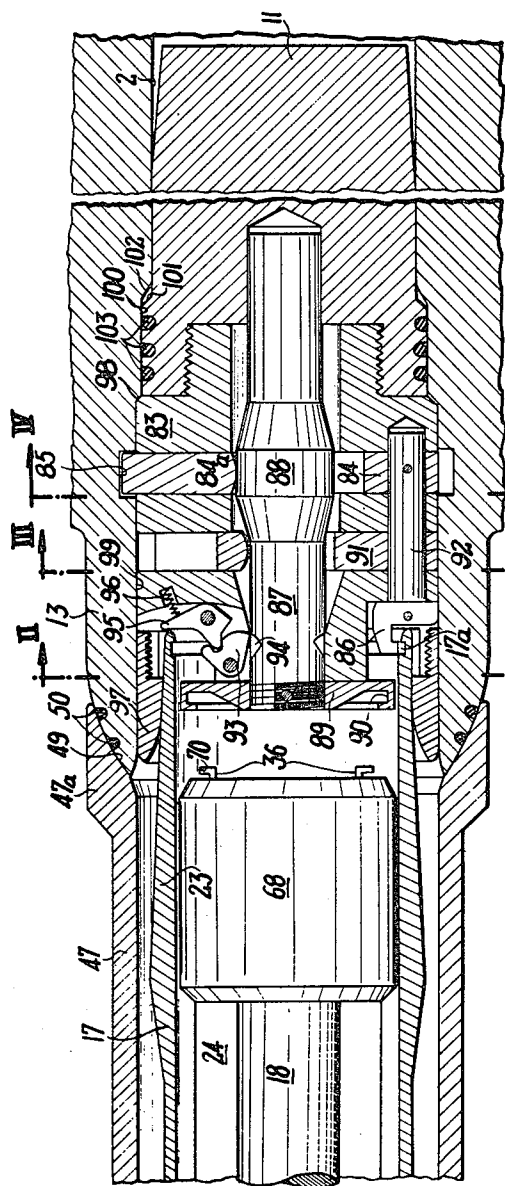
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PLUG FOR AN ATOMIC REACTOR CHANNEL

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PLUG FOR AN ATOMIC REACTOR CHANNEL
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In atomic reactors, it is frequently necessary to close the ends of channels or tubes containing a fluid under pressure by plugs which must:

Be impervious to the fluid and sufficiently durable;
Be capable of manipulation by special machines, particularly for the loading and the unloading of the channels with nuclear fuel, without manual intervention because of the radiations emitted by this fuel and with appreciable off-centre tolerances;

Not allow incorrect operations and, particularly during the manipulations of fuel, being adapted for removal only when the loading machine is fitted to the channel of the plug under consideration.

According to the present invention there is provided a plug for an atomic reactor channel comprising a latching means for co-operation with a loading and unloading machine, provided with a conveyor element adapted to be engaged into said channel and onto which the plug can be latched, and a control element adapted to actuate the said latching means while being displaced relatively to the conveyor element, said plug comprising in addition to a member ensuring the actual closing of the channel in which it is mounted, a first set of latching members for ensuring the connection of the plug to the conveyor element of the machine, a second set of latching members for ensuring the fixing of the plug on the wall of the reactor channel, an operating member co-operating with the control element of the machine and movable in the plug body between two extreme positions, one of which corresponds to the latched position of one of the sets of latching members and to the unlatched position of the second set of latching members, and the other to the opposite positions of these same latching members, and mechanical connecting means between the two sets of latching members, such that when one of the sets of latching members is latched in one of the extreme positions of the movable operating member, the other set of these latching members is unlatched.

The latching members belonging to the two aforesaid sets are advantageously formed by catches or hooks which are pivoted on pins (parallel or perpendicular to the general axis) carried by the plug and which co-operate with grooves formed respectively in the channel wall and in the conveyor element of the machine, this latter element preferably being of tubular form, the complete arrangement being such that all the hooks or catches remain engaged at least partially in their respective grooves when the operating member occupies an intermediate position.

As regards the operating member, it is preferably formed by a rod mounted so as to be able to slide in the plug along the general axis and shaped as a cam for the two sets of latching members. In order to avoid the resilient wear in the said grooves disturbing the operation of the catches or hooks, the operating member is designed in such a way that it acts on these latter in an irreversible manner in the only direction corresponding to their engagement in the corresponding groove and a positive mechanical connection is interposed between the two sets of latching members in order that the controlled displacement of the catches or hooks of one set in the aforesaid direction causes the displacement of the catches or hooks of the other set in the opposite direction.

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The invention will now be described by way of example with reference to the accompanying drawings, wherein:

FIG. 1 is a partial front sectional view of a channel plug according to the invention and also of the conveyor elements and control elements of a loading and unloading machine.

FIGS. 2, 3 and 4 are respectively transverse sections along the lines II—II, III—III and IV—IV of FIG. 1.

FIG. 5 is a partial front sectional view of another channel plug according to the invention, as well as of the elements of a machine adapted to extract and replace the said plug.

FIG. 6 shows the plug according to FIG. 5 in another operational position.

The plug according to the invention is adapted for shutting off the channels of a nuclear reactor, said channels containing fuel elements. FIG. 1 shows the end portion 2 of such a channel which is normally closed by the plug body 11 and which has a terminal flange 13 fitted externally with fluid-tight seals 50.

The loading and unloading machine for such channels comprises essentially:

A conveyor element in the form of a tube 17, this tube having an end 23 which is conical on the outside and is provided on the inside with a latching groove 17a;

A control element formed by an internal rod 18 which carries longitudinal fins 24 and, at its end, a tubular member 68 fixed on the fins 24, the said element comprising tongues 36, the ends 70 of which are formed as hooks;

And an intermediate tube 47 which is connected in fluid-tight manner to the interior of the machine by means enabling its end 47a to carry out axial or radial displacements and which carries at the forward end a conical or spherical opening 49 adapted to co-operate with the annular projection 13.

The machine is arranged in such a way as to be able to approach or move away from the tube assembly 17 and 47 and the rod 18 axially of the channel, to cause the rod 18 to slide inside the tube 17 and the ends 70 of the tongues to move away or approach one another radially.

As regards the plug, the body 11 thereof is provided with a detachable part 83, which carries a first set of catches 84 co-operating with a groove 85 formed in the channel and a second set of hooks 86 co-operating with the said groove 17a of the tube 17, the catches 84 and hooks 86 being equal in number (for example three, as shown in FIGS. 2 and 4). In addition, a single operating member formed by a sliding rod 87 is mounted in the element 83, the said rod being provided with a bulged or thickened portion 88 and carries a washer 89 on its rearward portion. This washer is formed with an internal groove 90 in which the ends 70 of the tongues 36 are adapted to engage.

The thickened portion 88 of the rod 87 operates in the sense of acting on the one hand on the catches 84 by contact with a surface 84a of the latter and on the other hand on the hooks 86 by contact with the keys or arms 91. The catches 84, the hooks 86 and the arms 91 are pivoted on the plug by means of pins 92 which are parallel to the general axis and with which they are made fast, for example by splines or dowels, these pins thus constituting a positive mechanical connection between the catches 84 and the hooks 86 and also with the arms 91.

The rod 87 is equipped with a locking device formed by catches 93, co-operating with a groove 94 formed on the periphery of the rod 87, these catches each being actuated by a feeler member 95. Each feeler member 95 is urged by a spring 96 which tends to engage the corresponding catch 93 in the groove 94 and its end is disposed on the trajectory of the tube 17 of the machine so that

it disengages the catch 93 when this tube occupies the desired operative position shown in FIG. 1. The centering of the tube 17 on the plug is facilitated by a ring 97 with a profiled inlet, this ring preferably being screwed on the member 83.

In order to determine the exact position of the plug 11 which corresponds to the positioning of the catches 84 opposite the groove 85, the plug is formed with a first shoulder 98, for example at the connection between the rear part 83 and the plug body, by providing on the end of the channel, in order to form an abutment, a corresponding change in section between two parts 99 and 100 of the channel. In addition, in order to improve the fluid-tight conditions of the plug, it is possible on the one hand to provide the latter with a second shoulder 101 by forming a detachment 102 by a change in section between the two parts of the channel 100 and 2, but this time by positioning the detachment or incline 102 in such a way that it does not form an abutment for the shoulder 101 of the plug, and on the other hand to arrange on the plug fluid-tight joints 103 in a cylindrical portion comprised between the shoulders 98 and 101, the part 100 of the channel co-operating with these joints being carefully machined.

In the case where the fluid-tightness would be assured not by joints 103 formed between cylindrical portions, but by a bearing of the plug against a fluid-tight seating (similar for example to the bearing of the shoulder 98 against the corresponding shoulder of the channel), the catches 84 can comprise sloping bearing surfaces 104 (FIG. 4), the elasticity necessary in order that the rod 87 can reach the forward end of its travel being provided by plungers 105 loaded by springs 106 interposed between the catches 84 and the thickened portion 88 of the rod. The slant angle of the surfaces 104 is then determined so that the anchoring cannot be cancelled out under the effect of an axial thrust exerted on the plug from inside the channel.

The operation of the plug according to the invention is as follows:

Under normal conditions, that is to say, when the assembly of the tubes 17 and 47 and the rod 18 is spaced apart, the rod 87 occupies the position illustrated, in which it is locked by the catch 93 engaged in the groove 94.

The catches 84 are themselves engaged in the groove 85 of the channel, while the hooks 86 are displaced inwardly. The plug is bearing by means of its shoulder 98 and the fluid-tightness of the channel is assured by the joints 103.

When it is desired to withdraw the plug, the tube 47 is moved axially forwards, this tube being centered on the annular projection 13 and the joints 50 ensure a fluid-tight communication between the reactor channel and the inside of the machine. The tube 17, the conical end 23 of which is centered on the ring 97, is then moved forward and, when the tube reaches the end of its travel, it causes the feeler member 95 to rock, thus unlocking the rod 87. The rod 18 is then moved forward and the tongues 36 are actuated in such a manner that their ends 70 are engaged in the groove 90 of the washer 89, and then the rod assembly 18 and 87 is retracted. The thickened portion 83, in passing over the members 91, causes the pivots 92 to turn, and this first of all engages the hooks 86 in the groove 17a of the tube 17, and then on completion of the movement extracts the catches 84 from the groove 85. By a simultaneous retraction of the rod 18 and the tube 17, it is then possible to extract the plug inside the tube 47, the end 23 of the tube 17 being engaged in said plug and the latter being locked with said tube by the hooks 86.

Once the plug is separated inside the loading machine from the assembly comprising the tube 17 and the rod 18, it is possible to press this latter inside the channel in order to find the protective shells and the fuel elements

which line this channel, and it is to be noted that the possibly off-centre end 23 capable of contacting the tube 47 by its portion of maximum diameter is not able, because of its conicity, to contact that part of the channel 100 which ensures fluid-tightness, nor its entry shoulder 98, but only the portion 2 of smaller diameter, after having possibly struck the shoulder 102 which does not contribute to the fluid-tightness.

According to a modification of the invention as shown in FIGURE 5, the plug is formed by an internal element or body 11 and by an external element 83 following one another axially of the extreme portion 2 of the channel and capable of a limited relative displacement in this direction, the element 83 being provided with a mechanism capable of immobilising it in the channel in which the plug is forced, and the two elements are operated in such a way that together they define a peripheral groove 107 adapted to receive a resilient ring 108, the assembly being such that the thrust exerted on the body 11 by the fluid under pressure contained in the channel section 2 when the external element 83 is immobilised by the aforesaid mechanism axially contracts the ring 108 while expanding it radially against the wall of the channel.

The groove 107 is limited internally by the periphery of a cylindrical projection 109 fast with one of the elements (for example the element 83), this projection being adapted to slide with a small radial clearance in a bore 110 formed in the other element (in the present case, the body 11). The said periphery is polished and possibly lubricated so that the internal cylindrical wall of the ring 108 is able to slide thereon.

The groove 107 is limited axially by two parallel plane surfaces 11a and 83a belonging respectively to the elements 11 and 83. Known means prevent the extrusion of the material of the ring 108 (for example natural or synthetic rubber) into the gap which corresponds to the radial clearance existing between the projection 109 and the bore 110. The internal edge of the ring 108 near this gap is for example given a radius of curvature conforming to the hardness of the material of the said ring or a harder ring 111 is interposed at this position.

In order to limit the relative axial spacing of the elements 11 and 83, the ring 108 is sealed with the surfaces 11a and 83a and/or a rigid stop is interposed between these elements. The latter is for example formed by an axial rod 112 screwed into the body 11 and having a head 112a cooperating with an internal shoulder 109a of the projection 109.

According to another modification of the invention as shown in FIGURE 6, the two elements 11, 83 are advantageously provided with mechanical means enabling them to approach one another axially when there is no fluid under pressure in the channel section 2. These means may be formed by a movable threaded tie rod 113, shown in chain-dotted lines in FIGURE 6, which is adapted, after being manually positioned, of bearing with its head against the external end of the element 83, of extending completely through this element and especially its projection 109 and of being screwed on to an internal thread 114 formed in the body 11. As will be seen, this tie rod extends freely through the rod 112, which is hollow.

It is understood that the projection 109 permits the passage of the tie rod 113 without the latter touching the ring 108. It forms a common axis for the elements 11 and 83. By modifying its external diameter, it is possible to determine the value of the surface of the ring 108 perpendicularly of the axis, which corresponds to the fluid-tightness pressure desired at the contact of the ring 108 with the wall of the channel section 2, taking into account the pressure of the fluid contained in this channel and the material of the ring. As shown in the figures, it is desirable to form the projection 109 on an independent part of the element 83 and made fast with the latter, preferably by screw-threading.

In order to avoid the parts which it is necessary to cause to slide in the channel damaging the contact surface between the wall of the channel and the ring 108, it is possible to provide a very shallow groove 115 on the said wall at the required axial position. When the ring 108 is not compressed, the external surface is slightly withdrawn from the cylindrical surface enveloping the plug, so that there is no risk of damage thereto during the manipulations.

The body 11 is advantageously provided with a scraper ring 116 of flexible material, such as synthetic rubber, which provides a sufficient tightness between the said body and the wall of the channel to ensure a return movement of this body such that the ring 108 is expanded radially until in contact with the surface or groove 115, under the effect of the excess pressure which obtains in the channel relatively to the atmospheric pressure or to the lock chamber during release of the unloading machine, to which reference has been made above. The scraper ring 116 has grooves 116a adapted to collect the dust which it meets on the wall of the channel section 2. The external element 83 is similarly provided with a scraper ring 117 having grooves 117a for receiving dust, but contrary to the ring 116, this does not have to be fluid-tight. The groove 117a situated at the front of the ring 117 is subjected to the same pressure as the exterior of the plug, because of a duct 118 communicating with the axial passage through which the tie rod 113 is adapted to extend.

As in the embodiment shown in FIGURES 1 to 4, the latching mechanism of the element 83 of the plug can comprise a catch 84 pivoted on the element 83 and adapted to be urged into a groove 85 formed in the wall of the channel section 2 by a thickened portion 88 on the sliding rod 87a. In the constructional form shown in FIGURE 6, this rod is hollow in order to permit the passage of the threaded tie rod 113 and carries a washer 89 formed with a groove 90.

The manipulation of the plug is carried out as follows:

With the loading machine connected to the channel and with the fluid pressure being substantially uniform in the lock chamber and the channel, the plug is placed in position, after having retracted the catches 84 by the rod 87 being pulled outwardly by means of the rod 18 (position shown in FIGURE 5), after which these catches are engaged in the groove 85 (position shown in FIGURE 6) by again pushing the rod 87a. With the element 83 thus immobilised, the pressure in the lock chamber is reduced. The element 11 is pushed outwardly (as indicated by the arrow F, in FIGURE 6) by the fluid under pressure contained in the channel and retained by the scraper ring 116, thus axially contracting the ring 108 and expanding it radially, thus pressing it into the groove 115. The plug then closes the channel in a fluid-tight manner.

If the channel is to be placed under vacuum, for example, in order to enable the reactor circuits to be correctly filled with cooling fluid, the tie rod 113 is introduced manually, as shown in chain-dotted lines in FIGURE 6, and the ring 108 is contracted axially with the same effect as in the preceding case, but this time by screwing the said tie rod in the screwthread 114. The head of the tie rod bears on the element 83 by means of the washer 89.

As will be obvious and as is moreover already apparent from the foregoing, the invention is not limited in any way to that of its methods of application or to those of the constructional forms of its various parts which have been more especially envisaged, but on the contrary covers all modifications.

What is claimed is:

1. In combination, a nuclear reactor channel, a plug for said channel, said plug comprising a body for closing said channel, a conveyor element, latching means on said plug cooperating with said conveyor element for engagement with said channel and for latching said plug to said conveyor element, a control element for actuating said latching means during displacement relative to said conveyor element, said latching means comprising a first set of latching members for connecting said plug to said conveyor element, a second set of latching members for securing said plug to said reactor channel and mechanical connecting means between said two sets of latching members so constructed and arranged that when one set of said latching members is latched said other set of latching members is unlatched, and an operating member cooperating with said control element and movable in said plug body between two extreme positions, one of said positions corresponding to the latched position of one of said sets of latching members and to the unlatched position of the other of said sets of latching members, and the other of said positions corresponding to the opposite positions of said sets of latching members.

2. In the combination described in claim 1, said latching members comprising latching catches, pins carried by said plug, said latching catches being pivoted on said pins and grooves in said channel and in said conveyor element receiving said catches.

3. In the combination described in claim 1, said latching members comprising latching hooks, pins carried by said plug, said latching hooks being pivoted on said pins and grooves in said channel and in said conveyor element receiving said hooks.

4. In the combination described in claim 1, said operating member comprising an operating rod slidably mounted in the longitudinal axis of said plug and a cam profile on said rod positively cooperating with each of said two sets of latching members.

5. In the combination described in claim 1, means for locking said operating member with respect to said plug body in one of said extreme positions of said operating member when said plug is secured to said reactor channel.

6. In the combination described in claim 1, said plug member comprising an external element and an internal element disposed one after the other in the longitudinal axis of said plug member, said external element carrying said latching members, means for limiting the movement of said internal element with respect to said external element and a deformable resilient ring between said external and internal elements and in contact with said channel when said external element is moved toward said internal element and when said external element is secured to said channel.

7. In the combination of claim 6, said operating member being tubular.

8. In the combination of claim 7, mechanical means extending through said tubular operating member for relative movement of said external and internal elements.

9. In the combination of claim 6, a cylindrical projection on said external element and a bore in said internal element receiving said projection, said resilient ring surrounding said projection.

10. In the combination of claim 6, a scraper ring and a fluid-tight joint in said plug member disposed on each side of said resilient ring.

11. In the combination described in claim 6, a sealing ring in said plug members disposed on each side of said resilient ring.

No references cited.