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SUPPORTS FOR COMBUSTIBLE ELEMENTS IN ATOMIC PILES OR REACTORS HAVING VERTICAL CHANNELS

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FIG. 1.

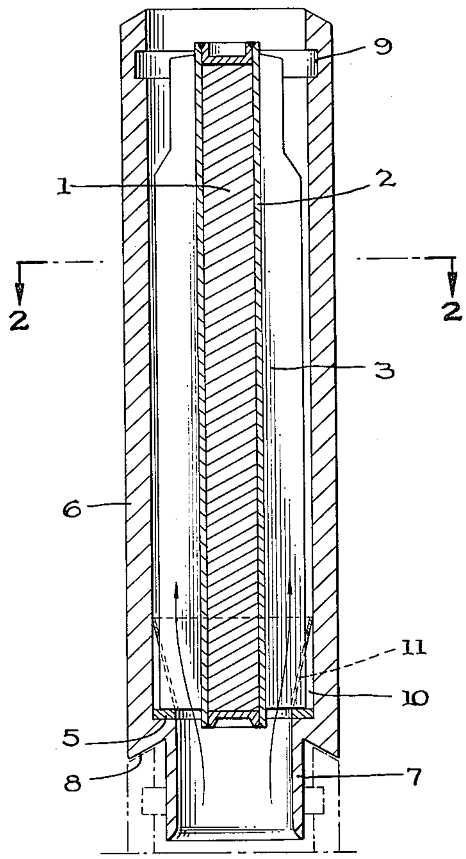
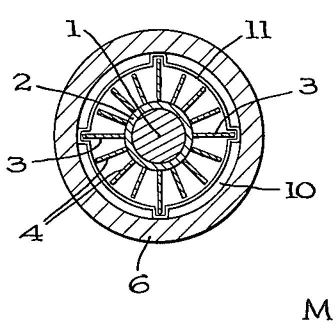


FIG. 2.



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SUPPORTS FOR COMBUSTIBLE ELEMENTS IN ATOMIC PILES OR REACTORS HAVING VERTICAL CHANNELS

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4 Claims. (Cl. 204—193.2)

The present invention relates to an improved support for combustible elements, i.e. fuel elements in atomic piles or reactors having vertical channels.

In a number of types of atomic piles or reactors, the fuel elements have the form of cylindrical bars, of revolution or not, housed one above the other in vertical channels formed in the moderator pile.

If no special arrangements are made, the bars will rest one upon the other and the bar which is placed in the lower part of a channel is thus subjected to a compressive force equal to the weight of all the other bars contained in this channel.

The following solutions have previously been suggested in order to remedy this drawback:

(1) The bars or fuel elements are associated with mechanisms which cooperate with housings in the channel walls to provide individual support for the bars. Each bar is provided with a system of latches which latches, when the bar comes into contact with the bar immediately therebeneath, move apart and engage the housings provided in the channel walls. Such a solution requires hinged mechanisms which must be able to operate under high temperature conditions and in the presence of radiation, and under these conditions the mechanisms must have a good mechanical behaviour, taking into account the fact that the bars on which they are fixed vary considerably in their dimensions and shapes.

(2) A reinforcement which is resistant and not very absorbent is introduced inside each fuel element or bar, which reinforcement must be able to withstand the compressive forces exerted by the bars. Such an arrangement gives rise to difficult problems relating to the manufacture of the bars and relating to the mechanical behaviour of the bars during different thermal cycles (owing to differential contraction), and under radiation (owing to contraction, expansion and other deformations, resulting from neutron irradiation and fissions).

(3) Each fuel element or bar is fixed to an external reinforcement which is not very absorbent and is capable of supporting the weight of the upper bars. This reinforcement consists of an element which is arranged longitudinally of the axis of the bar and effectively supports the upper bars, and of parts for hooking the bar on to this element. These parts, which are rather complex, generally involve additional absorption, increase the spacing between the different bars of a channel which reduces reactivity, impede the cooling of the ends of the bars, and increase the load loss in the channel. Furthermore the cost of production of the parts is often high.

(4) The fuel elements or bars are surrounded by an external reinforcement or shell the lower part of which carries on its internal face a throat or suitable shoulder on which rests the lower part of the bar connected thereto. Thus the weight of the superimposed bars is supported by the reinforcements or shells which are mounted one on the other by means of suitable bearings. These shells or reinforcements are also provided with annular throats disposed internally or externally which enable them to be handled by a remote-controlled device. A space is left between the upper end of a bar and the lower end of the bar situated thereabove, in order to allow for deformation or contraction of the bars during the operation of the reactor. This system has nevertheless the drawback that it impedes the cooling of the ends of the bars and gives rise to a substantial load loss.

The improvement which is the object of the present invention relates to supports of the type comprising a cylindrical reinforcement or shell which is capable of receiving and concentrically surrounding the fuel element and has internal supporting surfaces for this element.

According to the present invention the reinforcement or shell is provided on its internal wall with a ledge which forms a supporting surface for longitudinal extensions associated with the body of the fuel elements, and wherein a part overlies the ledge, which part, internally, is conical or nozzle-shaped, and is provided with indentations within which at least some of the longitudinal extensions fit.

The part may be annular and may be formed integrally with the shell or reinforcement, or alternatively may comprise a separate insert.

The arrangement of the ledge and the conical or nozzle shaped part which overlies it ensures that the cooling of the ends of the fuel elements is improved instead of being impeded or reduced by the support, whilst the load loss is reduced compared with previous support systems.

According to one embodiment of the invention the longitudinal extensions of the body of the fuel elements are constituted by ribs. At their lower end these ribs are straight, that is to say radially extending or helical. In the latter case, in order that the indentations in the conical or nozzle shaped part may be easily formed, the pitch of the helices are made large relative to the diameter of the fuel element and are of the order of at least twice this diameter. In order not to reduce the section of flow of the cooling fluid too much, only the parts of the ribs which are farthest from the longitudinal axis of the element rest on the ledge. All or some, for example a submultiple of the total number, of the ribs of each fuel element may rest on the ledge.

The improvement which is the object of the invention may be advantageously applied to fuel elements of heterogeneous atomic piles having vertical channels, to the support of samples to be irradiated in a channel and to the irradiation of small parts enclosed in a sheath.

In order that the invention may be more readily understood reference will now be made to the accompanying drawings, showing schematically one embodiment according to the invention of an improved support for a fuel element in atomic piles having vertical channels. In the drawings:

FIGURE 1 is a vertical sectional view of one embodiment of the invention,

FIGURE 2 is a horizontal sectional view along the line II—II of FIGURE 1 showing the longitudinal extensions of the sheath of the fuel element in section.

As will be seen from FIGURE 1, the fuel element **1** is in the form of a solid or hollow cylindrical bar of fissile material, such as uranium. This element **1** is enveloped by a sheath **2** made of a metal which is not very absorbent, such as magnesium or aluminium.

This sheath **2** is provided with straight longitudinal extensions in the form of radially extending ribs or fins **3**. As will be seen from FIGURE 2, there are shorter ribs **4** which solely serve to effect thermal exchanges, whilst ribs **3** jointly serve to effect these exchanges and also to support the element **1**.

The support of the element **1** is ensured by a ledge which is machined from the base of a shell **6**, and which is covered by a support ring **5**. The shell **6** is made of a material which is not very absorbent with respect to neutrons, such as for example graphite of so-called "nuclear" purity. The lower portion **7** of this shell **6** is reduced in diameter and may thus penetrate within the top of a similar shell, shown in chain dotted lines in FIGURE 2, situated beneath the shell **6**. The various shells rest one on the other on spherical bearings **8** which tolerate slight mis-alignment between the shells.

The shell **6** has on its upper part an internal circular groove **9** permitting the assembled element **1** and shell **6** to be handled by means of a remote-controlled device, provided with hooking fingers, which is introduced through the upper part of the channel containing the shells and fuel elements supported thereby, and is then introduced through the open upper end of the shell **6**.

The ring **5** supports an annular part **11**, the internal surface of which is nozzle shaped or conical. The annular part **11** fills the lower region **10** of the shell **6** and is provided with identations in the form of vertical radially extending slots corresponding to the larger ribs **3**, within which slots the tips of these ribs **3** are located.

The optimum cooling of the ends of the elements is ensured by the narrowing of the cross-section of flow of the cooling fluid at the level of the portion **7** and region **10**.

It will be understood that various modifications may be made without departing from the scope of the present invention as defined in the appended claims. For example, the part **11** may simply comprise an internal bulge formed integrally with the base of the shell **6**.

We claim:

1. In a fuel element assembly, a fuel element, a plurality of longitudinal fins associated with said element, a cylindrical element supporting shell concentrically surrounding said element, an internal ledge within said shell constituting a bearing surface for a plurality of said fins, an indented part in said element overlying said ledge, an

internal conical wall within said indented part and indentations in said wall receiving a plurality of said fins.

2. In an assembly as described in claim 1, said fins including a plurality of fins having the same greater radial dimension and a plurality of fins having the same reduced radial dimension, said fins having said greater radial dimension being received within corresponding ones of said indentations.

3. In an assembly as described in claim 1, an annular insert member and means locating said annular insert member within said shell over said ledge, said internal conical wall being formed in said member.

4. In an assembly as described in claim 3, a support ring located between said ledge and said annular insert member.

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