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ARRANGEMENT OF CONTROL BARS IN AN ATOMIC PILE

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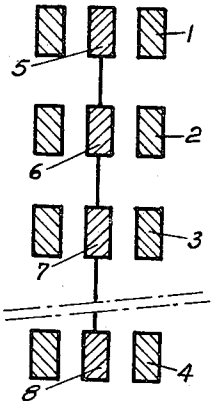

Fig.1

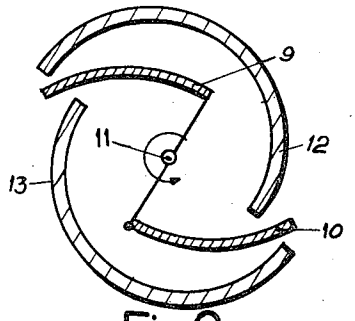

Fig.2

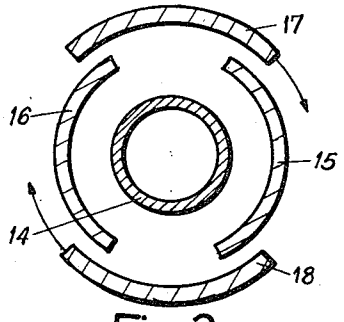

Fig.3

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ARRANGEMENT OF CONTROL BARS IN AN ATOMIC PILE

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It is known that it is essential to control an atomic pile, that is, to be able to govern its behavior; change its power level; and assure its correct functioning. A desired power level is obtained by adjustment of the flow of neutrons, the two being proportional. The flow of neutrons is controlled by introducing or removing a neutron-absorbing material, known as "control bars," which modifies the effective multiplication factor of the atomic pile.

In the study of a proposed atomic pile control it is necessary to solve certain difficulties by reconciling the requirements of control with other requirements of the proposed atomic pile. The arrangement of a large number of control bars is a factor which must take into account the requirements of the structure. A place must be provided for the bars when they are removed. Protection must be continuous regardless of location of the control bars. The closeness of fit and tightness of the passageway for the control bars present difficult problems.

It is known that in an atomic pile with thermal neutrons control of reactivity is obtained by absorbing bars having a displacement on the order of magnitude of the dimensions of the multiplier medium. This, particularly in pressurized piles, requires an amplitude of displacement not compatible with available room, and presents very complex problems of joints and protection.

Displacements of small amplitude are possible in certain piles (for example, the English DIDO reactor) by the use of oscillating "sabers." Unfortunately, this arrangement is inapplicable to most reactors because it requires a wide gap in the multiplier medium which usually prevents satisfactory mechanical behavior for the assembly.

The present invention relates to novel arrangements of control bars in an atomic pile, which, because of the small displacement of the bars, solves the problems of tightness, room required and protection.

This novel arrangement of control bars provides for displacement in relation to each other of the absorbing element or control bars and a portion of space inside the pile which includes a zone of substantial flow of neutrons and a zone free of neutrons, the neutron-free zone being obtained by a suitable arrangement of the fuel which increases its absorption of neutrons.

The principal advantage of small displacements of the control bars on the order of a few centimeters is that the displacements can be obtained by use of deformable membranes or by jacks of small stroke, as for example, cylinders and pistons. This considerably simplifies construction, and because of the small amplitude of displacement, solves the problems of joints, room required and protection.

In describing the embodiments shown in the accompanying drawings and without thereby limiting the scope of the invention, the novel arrangement of control bars in an atomic pile will be illustrated within the scope of the invention. These embodiments are to be regarded as constituting a part of the invention, it being understood that other equivalent constructions may be used without departing from the present inventive concept.

In the drawings, FIG. 1 is a schematic view of an embodiment of the present invention in which the absorbing element is displaced relative to the fuel;

FIG. 2 is a schematic view of another embodiment of the present invention; and

FIG. 3 shows schematically an embodiment of the invention in which the fuel is displaced relative to the absorbing element.

Referring to FIG. 1, it is seen that elements 1, 2, 3, and 4 of nuclear fuel, are arranged in tubes or rings at regular inetrvals over the entire height of the multiplier medium (not shown) following the general orientation of all of the fuel bars and can totally shield the absorbent medium.

By a displacement whose maximum amplitude is equal to the interval between the elements 1, 2, 3, and 4, the absorbent medium similarly disposed in clusters of cylindrical elements, 5, 6, 7 and 8 can, according to the invention, pass from an antireactivity of nearly zero (internal position relative to elements 1, 2, 3 and 4) to its maximum antireactivity (intercalary position relative to elements 1, 2, 3 and 4).

In FIG. 2 the absorbing element is in the form of cylindrical plates 9 and 10 rotatable about an axis 11 which is generally parallel to the direction of the fuel cartridges. Axis 11 is coextensive with that of the two cylindrical plates 12 and 13 of nuclear fuel material which can totally shield elements 9 and 10 from thermal neutrons.

In this embodiment a simple rotation of 45° varies the antireactivity of the control bars from their minimum to their maximum.

FIG. 3 shows another embodiment of the present invention, in which the nuclear fuel is movable relative to the absorbing material. As seen in this figure, the control bar is a stationary cylinder 14 with its long axis generally parallel to the direction of the system of the pile. The screen of nuclear fuel is disposed along four cylindrical portions 15, 16, 17 and 18 of which portions 15 and 16 are stationary and portions 17 and 18 are rotatable about the axis of the assembly. Thus rotation of the portions 17 and 18 uncovers the absorbing material and increases its antireactivity from the minimum of nearly zero to its maximum.

It is understood that these embodiments are illustrative only and are not to be construed as limiting the invention. The concept of the invention is to provide inside the pile a space deprived of thermal neutrons in which the absorbent medium is located and is more or less active.

Further, the present invention can be used to control atomic piles with high velocity neutrons by replacing the absorbing elements of the embodiments above with elements of nuclear fuel which participate in the fission depending on their relative position.

The problem of cooling the screening nuclear fuel elements used in the invention can be solved simply by foliating these elements in such a way as to facilitate their heat exchange with the cooling fluid of the pile.

Changes in or modifications to the above described illustrative embodiments of the present invention may now be suggested to those skilled in the art without departing from the present inventive concept. Reference should therefore be had to the appended claims to determine the scope of the invention.

What is claimed is:

1. In a nuclear reactor, apparatus for the control of reactivity entirely within the active zone of the reactor comprising at least one first element capable of modifying the reactivity of the reactor as a function of the neutron flux to which it is subjected and at least one second element of nuclear fuel material substantially totally shielding said first element from neutrons in one position and means for displacing said elements with respect to each other to vary the shielding of said first element,

said first element comprising a stationary cylinder of neutron absorbing material, said second element comprising a pair of opposed fixed cylindrical portions of nuclear fuel spaced from said cylinder and from each other and a second pair of cylindrical portions of nuclear fuel spaced from said cylinder and from each other and from said first pair of cylindrical portions and rotatable about said first pair of cylindrical portions, said cylinder and said cylindrical portions being coaxial.

2. In a nuclear reactor, apparatus for the control of reactivity entirely within the active zone of the reactor comprising at least one first element capable of modifying the reactivity of the reactor as a function of the neutron flux to which it is subjected and at least one second element of nuclear fuel material substantially totally shielding said first element from neutrons in one position and means for displacing said elements with respect to each other to vary the shielding of said first element, said second elements including a pair of opposed spaced cylindrical portions of nuclear fuel and said first element comprising a pair of curved neutron absorbing plate elements mounted for equal and opposite rotary

movement about the long axis of said cylindrical portions into and out of the space between said cylindrical portions.

3. In a nuclear reactor, apparatus for the control of reactivity entirely within the active zone of the reactor comprising at least one first element capable of modifying the reactivity of the reactor as a function of the neutron flux to which it is subjected and at least one second element of nuclear fuel material substantially totally shielding said first element from neutrons in one position and means for displacing said elements with respect to each other to vary the shielding of said first element, said second elements comprising annular spaced elements of nuclear fuel and said first elements comprising spaced cylinders connected for unitary movement within said second annular elements.

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