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(19)

(54) NUCLEAR REACTOR FUEL SUB-ASSEMBLIES

(71) We, UNITED KINGDOM ATOMIC ENERGY AUTHORITY, London, a British Authority 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:

This invention relates to fuel sub-assemblies for liquid metal cooled fast breeder nuclear reactors.

A fuel assembly for a liquid metal cooled fast breeder nuclear reactor comprises a multiplicity of slender fuel pins over which liquid metal coolant can be flowed in heat exchange. For convenience in replacing spent fuel the fuel assembly is divided into a plurality of sub-assemblies each comprising a bundle of spaced fuel pins within a tubular wrapper. The sub-assemblies are arranged to stand in side-by-side array and have lower end spikes for plugging into a fuel assembly supporting member. The spikes have side inlet ports for coolant which is supplied from the supporting member and flows upwardly through the tubular wrappers. Coolant inlets at the sides of the spikes provide a hydraulic hold down force for the sub-assemblies. In conventional fuel sub-assemblies the ports are rectilinear in the form of windows extending approximately through 45° about the longitudinal axis of the sub-assembly and have a wire mesh for filtering the coolant but the filter meshes are subject to fatigue damage due to buffeting by cross currents of coolant flow and to damage by contact with other reactor structure during fuel loading and unloading operations.

According to the invention a fuel sub-assembly for a liquid metal cooled fast breeder nuclear reactor comprises a bundle of spaced fuel pins enclosed by a tubular wrapper having a lower end spike adapted for plugging into a socket whereby the sub-assembly can be supported in upright cantilever manner, the spike having a double walled tubular section with a plurality of transverse rows of apertures forming inlet ports for coolant to flow upwardly through the wrapper and wherein filter mesh for the ports is sandwiched between the walls of the tubular section.

By sandwiching the filter mesh between two walls of a tubular section the mesh is supported on both sides thereby reducing fatigue damage due to buffeting by cross-current flows and providing protection against damage by contact with other reactor structure during loading and unloading of the sub-assembly.

Sub-assemblies according to the invention find application in a liquid metal cooled fast breeder reactor of the kind wherein a fuel assembly comprising a plurality of upright fuel sub-assemblies arranged in side-by-side array is submerged in a pool of liquid metal coolant.

A construction of fuel sub-assembly embodying the invention is described, by way of example, with reference to the drawings accompanying the Provisional Specification wherein:

Figure 1 is a fragmentary view of a fuel element sub-assembly for a liquid metal cooled fast breeder reactor,

Figure 2 is a sectional view showing a detail of the sub-assembly shown in Figure 1 and drawn to a larger scale,

Figure 3 is a fragmentary plan view drawn to a still larger scale of a detail shown in Figure 2, and

Figure 4 is a fragmentary sectional view of a liquid metal cooled fast breeder nuclear reactor.

The fuel sub-assembly shown in Figure 1 comprises a bundle 1 of spaced fuel pins 1a (only one being shown) enclosed by a tubular wrapper 2 of hexagonal cross-section. The wrapper 2 is adapted for plugging into a socket of a diagrid by a lower end spike 3 whereby the sub-assembly is supportable in upright cantilever manner. The fuel pins 1a are spaced apart by a series of spaced cellular grids 4 the grids being longitudinally spaced apart and secured to the wrapper 2 by notched corner posts 2a. The bundle 1 is surmounted by a bundle 5 of breeder elements 5a.

The lower end spike 3 has a double walled tubular section 6 shown in greater detail in

Figure 2 and the tubular section 6 has a plurality of transverse rows of apertures 7 forming inlet ports for coolant to flow upwardly through the wrapper 2. A filter mesh 8 for the ports is sandwiched between the walls of the tubular section. The double wall section comprises two co-axial sleeves 6a, 6b which have abutting steps 9 at one end and are locked together by transverse grub screws 10. One end of the section 6 has a key 11 and the other end a locating dowel 12 for engaging with adjoining sections designated 13, 14 in Figure 2 of the spike. The filter mesh 8 is of cylindrical form having a folded longitudinal seam 28 the outer sleeve 6a being formed with a longitudinal recess 29 in its inner surface to accommodate the seam as shown in Figure 3.

The liquid metal cooled nuclear reactor shown in Figure 4 comprises a fuel assembly 15 submerged in a pool 16 of liquid sodium contained by a primary vessel 17. The primary vessel is suspended from the roof 18 of a concrete vault and there is a secondary vessel or leak jacket 19 enclosing the primary vessel. The fuel assembly is supported by a diagrid 20 and is surrounded by a core tank 21 which divides the pool of coolant into inner and outer regions 22, 23. A pump 24 (there are in fact several of such pumps) draws relatively cool coolant from the outer pool region 23 and pumps it upwardly through the fuel assembly in heat exchange therewith by way of the diagrid 20. Hot coolant flows from the fuel assembly through a heat exchanger 25 (there being in fact several of such heat exchangers) which discharges back to the outer region 23 of the pool. Heat energy is withdrawn from the heat exchanger and conveyed to steam raising plant by a secondary liquid sodium coolant flowing by way of ports 26, 27 of the heat exchanger.

The fuel assembly comprises a plurality of the hereinbefore described fuel sub-assemblies which are arranged to upstand in side-by-side array and are plugged into the diagrid 20 (as shown in Figure 2 wherein the diagrid is shown in broken line) being supported at their bases in cantilever manner.

It has been found that the described sub-assemblies according to the invention have a freedom from noise quality, which is probably due to reduced cavitation in the coolant flow on entry to the sub-assembly.

WHAT WE CLAIM IS:

1. A fuel sub-assembly for a liquid metal cooled fast breeder nuclear reactor comprising a bundle of spaced fuel pins enclosed by a tubular wrapper having a lower end spike adapted for plugging into a socket whereby the sub-assembly can be supported in upright cantilever manner, the spike having a double walled tubular section with a plurality of transverse rows of apertures forming inlet ports for coolant to flow upwardly through the wrapper and wherein filter mesh for the ports is sandwiched between the walls of the tubular section.

2. A fuel sub-assembly according to claim 1 wherein the double walled tubular section comprises two co-axial sleeves having co-operating abutting steps and mutual attachment means, the filter mesh embracing the inner sleeve.

3. A liquid metal cooled fast breeder nuclear reactor wherein the fuel assembly comprises a plurality of upstanding fuel sub-assemblies according to either of claims 1 and 2 arranged in side-by-side array and submerged in a pool of liquid metal coolant.

4. A fuel sub-assembly for a liquid metal cooled fast breeder nuclear reactor substantially as hereinbefore described with reference to Figures 1, 2 and 3 of the drawings accompanying the Provisional Specification.

5. A liquid metal cooled fast breeder nuclear reactor substantially as hereinbefore described with reference to the drawings accompanying the Provisional Specification.

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1596861 PROVISIONAL SPECIFICATION
3 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 1

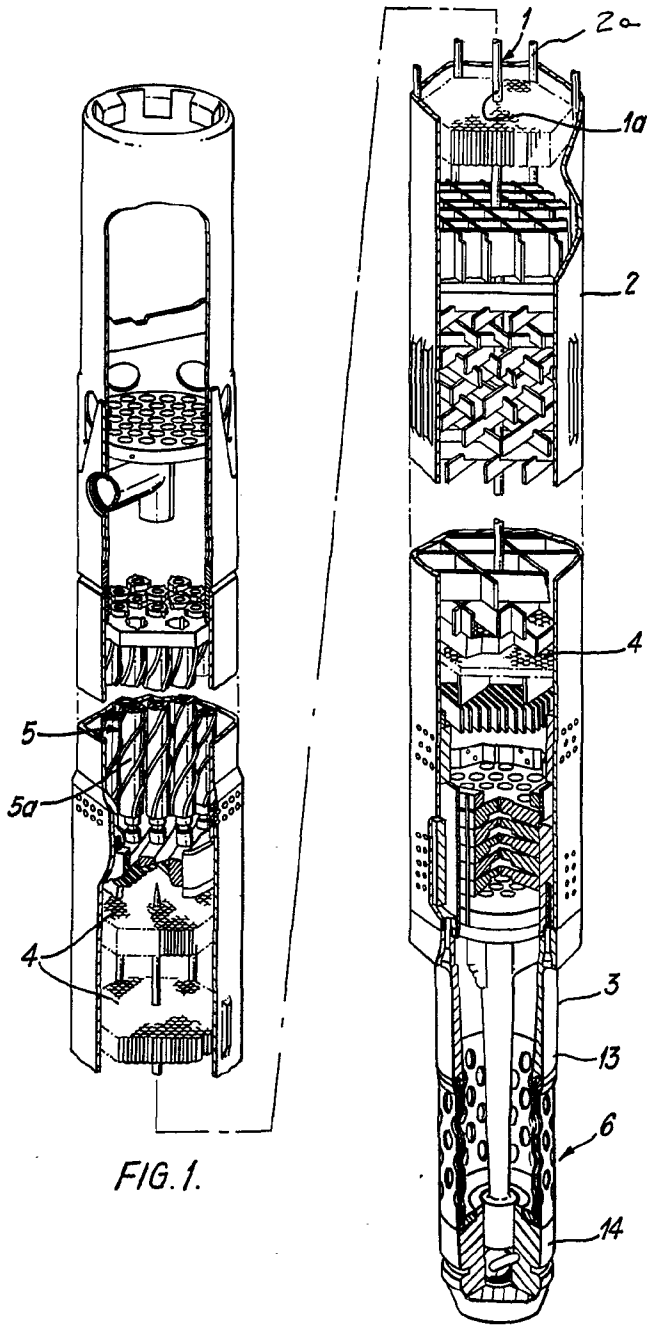

FIG. 1.

1596861 PROVISIONAL SPECIFICATION
3 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 2

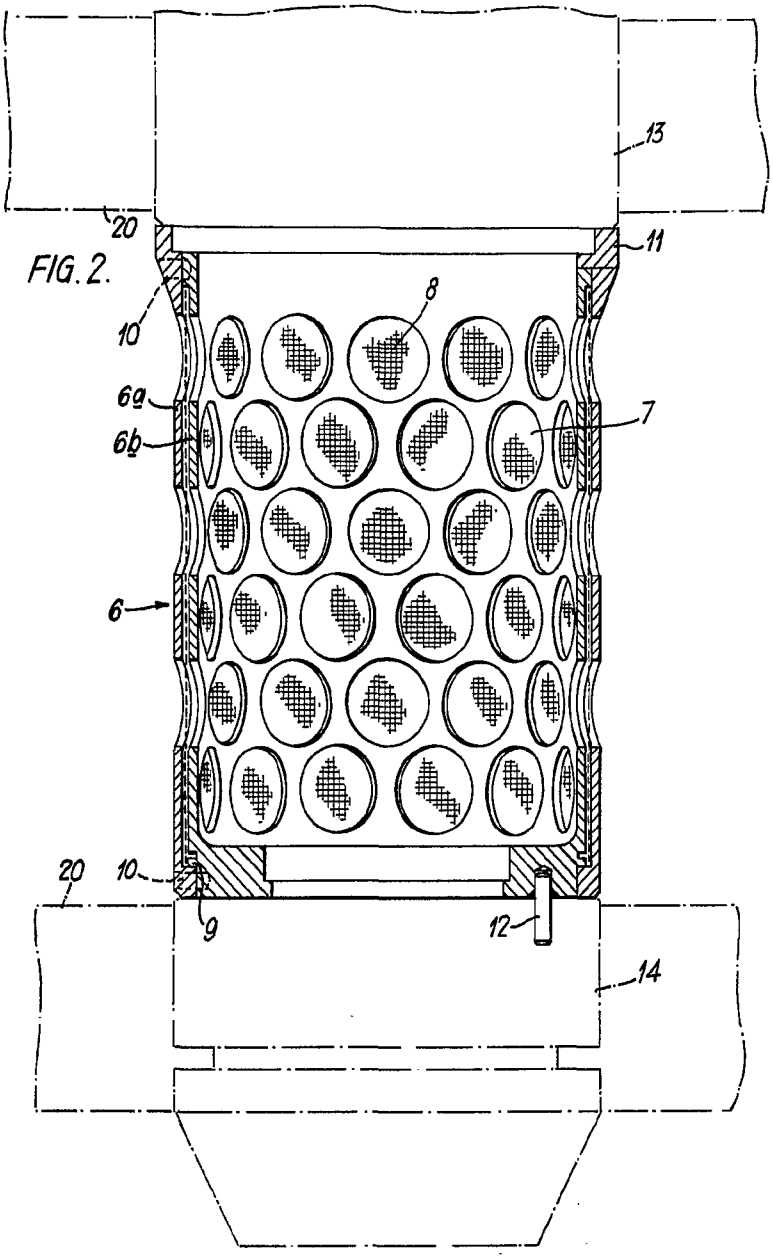

FIG. 2.

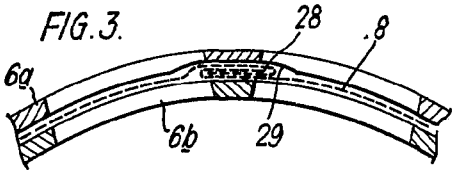

FIG. 3.

FIG.4.