July 4, 1972 P. M. JONES ET AL 3,674,636

NUCLEAR REACTOR MEANS FOR MINIMIZING LATERAL VIBRATIONS

Filed Oct. 28, 1968 2 Sheets-Sheet 1

FIG. 1.

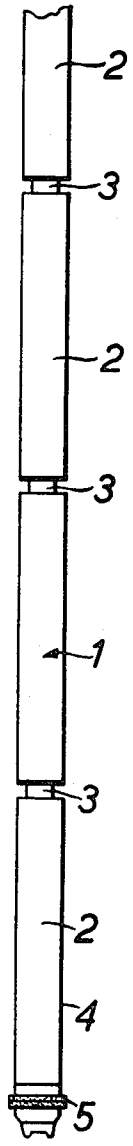
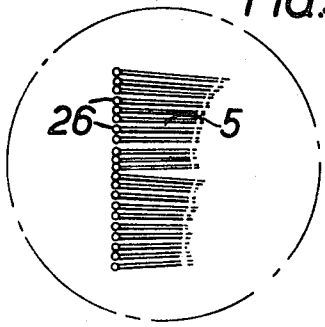


FIG. 3.



NUCLEAR REACTOR MEANS FOR MINIMIZING LATERAL VIBRATIONS

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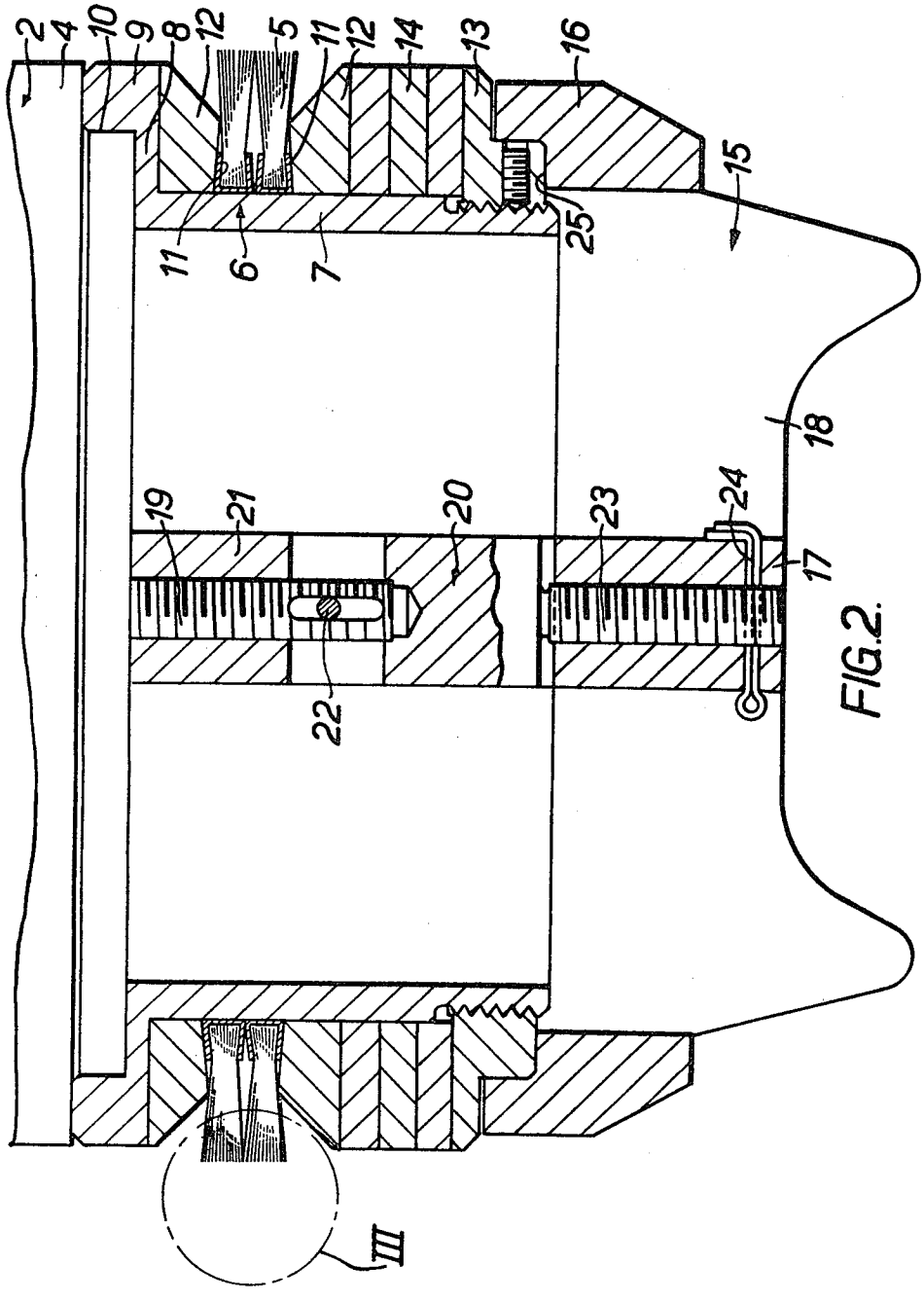

FIG.2.

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NUCLEAR REACTOR MEANS FOR MINIMIZING LATERAL VIBRATIONS

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U.S. Cl. 176—77 5 Claims

ABSTRACT OF THE DISCLOSURE

Lateral vibrations of a component when subjected to coolant flow in a channel of a nuclear reactor core structure during lifting and lowering of the component from and into the channel are minimised by the provision of radially projecting spring bristles at the lower end of the component, the bristles being of a length so as to locate the lower end of the component by engagement with the channel wall.

BACKGROUND OF THE INVENTION

This invention relates to nuclear reactors and is particularly concerned with a problem which can arise in operation of a nuclear reactor of the gas cooled graphite moderated type which is designed for on-load refuelling. In such a reactor coolant gas is passed upwardly through channels in the reactor core structure, such channels containing fuel elements or components such as control rods. The fuel elements typically comprise an outer graphite sleeve containing clusters of fuel pins supported within the sleeve by support and spacer grids. Each fuel channel contains a stringer of such fuel elements, each fuel element being jointed to its neighbours in the stringer so that the stringer as a whole is dischargeable from and chargeable into the fuel element channel. Coolant gas is conducted from the fuel element channels through charge pipes which connect with stand pipes at the reactor charge face. The stand pipes are normally blocked by shield plugs and coolant gas passes through outlet ports in the charge pipes and is collected in a common hot gas plenum. From the hot gas plenum the hot coolant gas is circulated through heat exchangers and then back to the fuel element channels. On load refuelling of such a reactor is carried out whilst the reactor is operating at power and coolant gas flow is maintained through the fuel element channels during refuelling.

During refuelling a fuel stringer is discharged from its fuel channel by lifting the fuel stringer from the fuel channel through the associated charge pipe and stand pipe, the fuel stringer being lifted into a charge machine on the reactor charge face. Similarly a fuel stringer is recharged into the fuel channel by lowering from the charge machine through the stand pipe and associated charge tube. Whilst the fuel stringer is being raised or lowered during refuelling the action of coolant flow can cause lateral vibration of the fuel stringer in the fuel channel or charge pipe with likelihood of damage, particularly to the elements of the fuel stringer.

Similarly components such as control rods can be liable to vibration when subjected to coolant flow in a channel.

It is an object of the present invention to provide means for preventing or at least minimising such lateral vibration of components when subjected to coolant flow in a channel of a nuclear reactor core structure whilst being lifted from or lowered into the channel.

SUMMARY OF THE INVENTION

According to the invention a nuclear reactor component chargeable into and dischargeable from a channel in the core structure of a nuclear reactor is provided in the region of its lower end with radially projecting spring bristles arranged on a circumferential line with respect to the longitudinal axis of the component.

In one aspect the invention is particularly applicable to a nuclear reactor fuel stringer comprising a number of fuel elements jointed one to another. According to the invention in such a fuel stringer at least one of the lower fuel elements in the stringer is provided with radially projecting spring bristles arranged circumferentially around the fuel element.

Preferably the spring bristles are fitted to the bottom fuel element in the stringer of fuel elements.

DESCRIPTION OF THE DRAWING

One embodiment of the invention will now be described by way of example with reference to the accompanying drawings in which:

FIG. 1 is an elevation of the lower part of a stringer of fuel elements.

FIG. 2 is a detail, on a larger scale, of the lower end of the bottom fuel element in the stringer of fuel elements shown in FIG. 1.

FIG. 3 is a detail of the part bounded by the circle III in FIG. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In FIG. 1 of the drawings there is shown a fuel element stringer **1** for a nuclear reactor. The stringer **1** comprises a number of fuel elements **2** joined in an articulated manner by interconnecting links **3**. Each of the fuel elements **2** comprises an outer graphite sleeve **4** containing clusters of fuel pins supported within the sleeve **4** by support and spacer grids (not shown). At the bottom of the sleeve **4** of the lowermost fuel element **2** in the stringer there is fitted a set of radially projecting spring bristles **5**. The spring bristles **5** project on a circumference beyond the limit of the outer surface of the sleeve **4** of the fuel element **2**.

As shown in FIG. 2 the spring bristles **5** are carried by an adaptor **6** fitted to the lower end of the sleeve **4** of the fuel element **2**. The adaptor **6** has a tubular body **7**. An end flange **8** with a rim **9** on the body **7** fits about a step **10** at the lower end of the sleeve **4**. The bristles **5** are in two sets mounted in circular holders **11** which fit on the body **7** of the adaptor **6** and are held on the body **7** of the adaptor **6** between clamping rings **12**. The holders **11** for the bristles **5** are held clamped between the rings **12** by a nut **13** screwed on the lower end of the body **7** of the adaptor **6**, spacer rings **14** being fitted between the nut **13** and the lower clamping ring **12**. The adaptor **6** is carried by a bottom support **15** which comprises an outer ring **16** joined to a central tubular boss **17** by radial webs **18**. The fuel element **2** has a central tie rod **19** which extends below the lower end of the fuel element sleeve **4**. A tie rod extension **20** having a tubular internally threaded body **21** is screwed onto the lower end of the tie rod **19** and is prevented from unscrewing by a split pin **22**. The tie rod extension **20** has an externally threaded lower end part **23** which is screwed into the central tubular boss **17** of the bottom support **15** and is prevented from unscrewing by a split pin **24**. The nut **13** of the adaptor **6** is stepped to seat in a step **25** formed in the outer ring **16** of the bottom support **15**.

During charging and discharging of the fuel element stringer into and from a fuel element channel of a nuclear reactor the bottom fuel element **2** of the stringer is located by contact of the bristles **5** with the wall of the fuel ele-

ment channel or with the wall of the charge pipe leading from the channel in the reactor core structure and lateral vibration of the fuel element stringer is minimised by the location provided by the bristles **5**. The arrangement can cope with gradual and step-wise changes in charge path diameter (for example a bristle length would suitably be chosen to provide wall contact at the maximum channel diameter). The arrangement only involves the use of very small quantities of additional neutron absorbing material in the fuel element stringer.

Also if because of low contact presure in the larger diameter sections of the charge path, some vibrations did occur, there would be a considerable cushioning effect protecting the outer sleeve of the bottom fuel element from damage.

By way of detail the bristles **5** may be of springy metal such as stainless steel. Stiff metal bristles would tend to scratch the walls of the fuel channel but this could be avoided as shown in FIG. 3 by forming blobs **26** on the ends of the bristles or by covering the ends of the bristles with a shoe.

We claim:

1. Means for minimizing lateral vibration of an elongated nuclear reactor component when subject to coolant flow in a vertical channel in a nuclear reactor core structure while the component is being lifted from or lowered into the channel suspended from its upper end, said means comprising spring bristles arranged on a circumferential line around a region at an end of the component which is the lower end when the component is being lifted from or lowered into the channel said bristles extending radially outwardly beyond the outer wall of said lower end.

2. Means for minimizing lateral vibration of a nuclear reactor fuel stringer when subjected to coolant flow in a vertical fuel element channel of a nuclear reactor core

structure while the fuel stringer is being lifted from or lowered into the fuel element channel suspended from its upper end, said fuel stringer comprising a number of fuel elements jointed one to another, said means comprising spring bristles arranged on a circumferential line around at least one of the lower fuel elements in the fuel stringer said bristles extending radially outwardly beyond the outer wall of said lower fuel element in the fuel stringer.

3. Means for minimising lateral vibration of a fuel element stringer as claimed in claim **2** characterised in that the spring bristles are provided at the bottom end of the lowermost fuel element of the stringer.

4. Means for minimising lateral vibration of a fuel element stringer as claimed in claim **3** characterised in that the bristles are of springy metal and are grouped together in brush like form.

5. Means for minimising lateral vibration of a fuel element stringer as claimed in claim **4** characterised that the outer ends of the bristles terminate in rounded blobs.

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