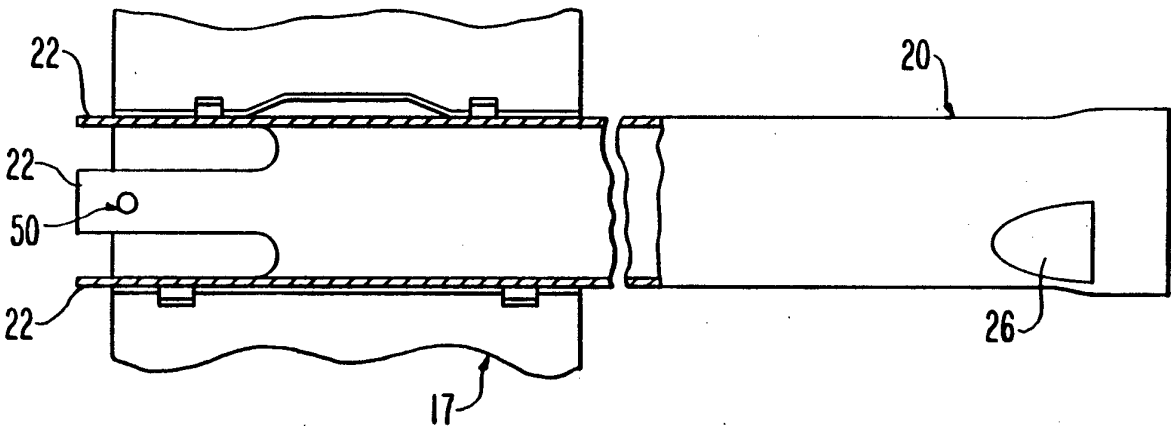




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(21) International Application Number: PCT/US93/03049 (22) International Filing Date: 31 March 1993 (31.03.93) (30) Priority data: 07/951,853 28 September 1992 (28.09.92) US (71) Applicant: COMBUSTION ENGINEERING, INC. [US/US]; 1000 Prospect Hill Road, P.O. Box 500, Windsor, CT 06095 (US). (72) Inventor: HATFIELD, Stephen, C. ; 80 R Day Street, Granby, CT 06035 (US). (74) Agents: MULHOLLAND, John, H. et al.; ABB Combustion Engineering Nuclear Power, Combustion Engineering, Inc., 1000 Prospect Hill Road, Windsor, CT 06095 (US).		(81) Designated States: AU, BB, BG, BR, CA, CZ, FI, HU, JP, KP, KR, KZ, LK, MG, MN, MW, NO, PL, RO, RU, SD, SK, UA, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG). Published <i>With international search report.</i>
(54) Title: SPACER GRID RETAINER  (57) Abstract A retainer (20) for retaining a grid (17) on a fuel assembly. The retainer (20) has at least one aperture (26) at one end thereof for receiving a shoulder on a guide control tube and legs on the other end thereof for welding to the grid. The one end of the retainer is captured between the shoulder and a surface on the bottom nozzle of the fuel assembly when the guide tube is attached to the bottom nozzle. The retainer reduces the rotation of the guide tube resulting from torquing of the screws which connect the guide tube to the bottom nozzle thereby increasing the integrity of the assembly.		

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SPACER GRID RETAINER

FIELD OF THE INVENTION

This invention relates to a nuclear reactor fuel assembly and, more particularly, to a nuclear reactor fuel assembly skeleton structure and, still more particularly, to a device which retains a nuclear fuel rod spacer grid on a fuel assembly.

BACKGROUND OF THE INVENTION

Commercial nuclear reactors used for generating electric power include a core composed of a multitude of fuel assemblies which generate heat used for electric power generation purposes. Each fuel assembly includes an array of fuel rods and control rod guide tubes held in spaced relationship with each other by grids of "egg-crate" configuration spaced along the fuel assembly length.

The grids are generally of a first and second plurality of half-slotted Inconel or Zircaloy straps in egg-crate configuration and are spaced along the fuel assembly to provide support for the fuel rods, maintain fuel rod spacing, promote mixing of coolant, provide lateral support and positioning for control assembly guide tubes and provide lateral support and positioning for an instrumentation tube. The grids along with the control assembly guide tubes and the top and the bottom nozzles form what is known as the skeleton of the fuel assembly. Typically, the guide tubes are screwed into the top and bottom nozzles and the multiple spacer grids are welded to the guide tubes. There is the problem, however, that the skeleton twists from the torquing of the screws as the guide tubes are fastened to the bottom nozzle reducing the integrity of the skeleton possibly to the point of causing the spacer grid to separate from the guide tubes. Previously, attaching the spacer grid to the guide tubes has required complicated

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machined or welded components which are costly or difficult to fix or replace if the spacer grid separates from the guide tube. Thus, it is a problem in the prior art to reliably and economically increase the strength and integrity of the skeleton assembly.

SUMMARY OF THE INVENTION

It is an object of the present invention to economically provide a device for reliably retaining a spacer grid on a fuel assembly.

It is a further object of the present invention to increase the integrity of a nuclear reactor fuel assembly skeleton structure.

It is a further object of the present invention to provide a device which reduces the twisting of the fuel assembly skeleton resulting from torquing of the screws which connect the bottom nozzle to the guide tubes.

It is a further object of the present invention to provide a simple, low cost device to replace more complicated machined and/or welded components to retain a spacer grid on a fuel assembly.

Additional objects, advantages and novel features of the invention will be set forth in the description which follows, and will become apparent to those skilled in the art upon reading this description or practicing the invention. The objects and advantages of the invention may be realized and attained by the invention of appended claims.

To achieve the foregoing and other objects, in accordance with the present invention, as embodied and broadly described herein in a nuclear reactor fuel assembly having top and bottom nozzles and nuclear fuel rod spacer grids therebetween for supporting at least one nuclear fuel rod and at least one guide tube fastened to the top and bottom nozzles, a device for retaining a nuclear fuel rod spacer grid on the guide tube and the top and bottom nozzles. The tubular retainer means has a first end and a second end and a lumen extending

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longitudinally therethrough. The retainer means has an upper portion located at the first end for retaining the spacer grid and a lower portion located at the second end for retaining at least one of the guide tubes. The lower
5 portion has an aperture communicating with the lumen whereby the guide tube is inserted through the lumen of the retainer means and a shoulder portion on the guide tube extends through the aperture to retain the lower
10 portion of the retainer means between the shoulder of the guide tube and a surface of the bottom nozzle when the guide tube is attached to the nozzle thereby retaining the spacer grid on the guide tube and bottom nozzle.

BRIEF DESCRIPTION OF THE DRAWING

The accompanying drawings, which are incorporated in, and form a part of, the specification, illustrate an embodiment of the present invention and, together with the description serve to explain the principles of the invention. In the drawings

FIG. 1 is side view illustrating the relationship of the retainer of the present invention to the spacer grids, guide tubes and the other components in the assembly.

FIG. 2a and 2b are side views of the retainer of the present invention.

FIG. 2c and 2d are cross-sectional views of the opposite ends of the retainer of the present invention taken along lines A-A and B-B in FIGS. 2a and 2b.

FIG. 3 is a side view illustrating the relationship of the retainer of the present invention to the guide tube and bottom nozzle.

FIG. 4a is an side view illustrating the relationship of the retainer of the present invention to the bottom spacer grid.

FIG. 4b is a cross-sectional view of the retainer of FIG. 4a taken along line C-C.

FIG. 5 is a side view of the bottom spacer grid with attached retainers.

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DETAIL DESCRIPTION

Referring now to the drawings there is shown in FIG. 1 a nuclear reactor fuel assembly 10 comprising an array of fuel rods 12 held in spaced relationship with each other by fuel rod spacer grids 14 and 16 spaced along the fuel assembly length. The grid assembly includes upper spacer grids 14 and a lower spacer grid 16. Each fuel rod 12 comprises a hermetically sealed elongated tube, known in the art as the cladding, which contains a fissionable fuel material, such as uranium, in the form of pellets. The individual fuel rods 12 are supported in the fuel assembly by means of the spacer grids 14 and 16, such that an upwardly flowing liquid coolant may pass along the fuel rods and thereby prevent overheating and possible melting of the cladding. In a manner well-known in the art, the coolant, after passing through the reactor core and being heated through contact with the fuel rods, will be delivered to a heat exchanger and the heat extracted from the circulating coolant will be employed to generate steam for driving a turbine.

The fuel assembly 10 also includes an array of guide tubes 15, having control rods 30 adapted for slidable longitudinal movement therein, which are positioned to extend axially through selected cells in spacer grids 14 and 16. The control rods 30 serve as means for regulating the thermal output power of the reactor.

Each spacer grid 14 and 16 includes straps made of a non-zircaloy material such as Inconel or other material, interwoven to form two separate grid sections of egg-crate configurations. The openings formed are virtually aligned to form cells, and are of a sufficient size to receive fuel rods 12 or guide tubes 15.

Guide tubes 15 are attached to a top nozzle 40 and a bottom nozzle 45 by means of screws or some other affixing means and, along with the spacer grids 14 and 16, form the fuel assembly skeleton structure. The spacer grids 14 are attached to the guide tubes 15 by conventional means such as spot welding. The bottom

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spacer grid 16 is attached to the guide tubes 15 by a retaining means which is preferably retainer 20.

The retainer 20 will be described in more detail with reference to Figs. 2a, 2b, 2c, 2d, 3, 4a and 4b. Figs. 2a and 2b show two side views of retainer 20 rotated ninety degrees from each other. The retainer 20 is preferably made by stamping or forming an Inconel or stainless steel tube, but it is recognized that other materials and processes could be used.

The retainer 20 includes an upper end 21 for receiving the lower end 17 of the bottom spacer grid 16 and an lower end 29 for receiving the lower end 14 of the guide tubes 15. The upper end 21 of retainer 20 has four leg portions which are fastened to the lower end 17 of the bottom spacer grid 16, preferably by such means as spot welding as shown at 50 in FIG. 4a. FIG. 2d shows a cross-sectional view of the retainer 20 in FIG. 2a.

The lower portion 29 of the retainer 20 has an enlarged section 28, a flattened section 27 and two apertures 26. FIG. 2c illustrates the cross-sectional view of the lower portion 29 taken along line A-A.

As shown in FIG. 3, the lower end of each guide tube 15 is machined and welded to an end plug 14 to mate with the lower portion 29 of the retainer 20. The end plug 14 of each guide tube 15 has a shoulder portion 13 for mating with the retainer 20 and an attachment portion 18 for attachment to the bottom nozzle 45.

The apertures 26 receive the shoulder 13 of end plug 14. The flattened sectioned 27 mates with the end plug 14 and the enlarged portion 28 as is captured between a top surface 46 of the bottom nozzle 45 and the shoulder 13 of end plug 14 so as to axially constrain movement of the retainer 20.

Assembly of the skeleton structure will now be described. The legs 22 of the retainer 20 are welded to selected lower end sections 17 of the bottom spacer grid 16 such that each spacer grid cell which will later contain a guide tube is attached to a retainer. FIG. 5 illustrates the bottom spacer grid 16 with attached

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retainers 20. The grid 16 is then clamped during assembly of the skeleton structure.

The guide tubes 15 are attached to the top nozzle in the conventional manner, or, alternatively, by means of the retainers of the present invention. The guide tubes 15 pass through the selected sections of lower end 17 of spacer grid 16 and through the retainers 20. The shoulders 13 of the end plugs 14 protrude from the apertures 26 of the retainer 20. The attachment sections 18 of end plugs 14 are then attached to the bottom nozzle by means such as attachment screws. The lower section 29 of the retainer 20 is thereby captured between the surface 46 of bottom nozzle 45 and shoulder 13 of guide tube 15 and axial movement is thereby constrained.

Since the grid is clamped during skeleton fabrication, and each guide tube 15 is welded to the spacer grid 16, the guide tubes 15 are restrained from rotating during torquing of the attachment screws which connect the bottom nozzle 45 to the guide tubes 15. The twisting of the skeleton is thereby minimized and the integrity of the skeleton increased while maintaining a strong and secure connection between the spacer grid, guide tubes and bottom nozzles. Further, the retainers of the present invention are economical to produce and thereby provide a low cost means to increase the integrity of the skeleton structure.

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CLAIMS

1 1. In a nuclear reactor fuel assembly having
2 top and bottom nozzles and nuclear fuel rod spacer grids
3 therebetween for supporting at least one nuclear fuel rod
4 and at least one guide tube fastened to the top and
5 bottom nozzles, a device for retaining a nuclear fuel rod
6 spacer grid on the guide tube and the top and bottom
7 nozzles comprising:

8 a tubular retainer means having a first end and
9 a second end and a lumen extending longitudinally
10 therethrough;

11 said retainer means having an upper portion located
12 at said first end for retaining said spacer grid and a
13 lower portion located at said second end for retaining at
14 least one of said guide tubes

15 said lower portion having an aperture communicating
16 with said lumen whereby said guide tube is inserted
17 through said lumen of said retainer means and a shoulder
18 portion on said guide tube extends through said aperture
19 to retain said lower portion of said retainer means
20 between the shoulder of said guide tube and a surface of
21 said bottom nozzle when said guide tube is attached to
22 said nozzle thereby retaining said spacer grid on said
23 guide tube and bottom nozzle.

1 2. The device according to claim 1 wherein
2 said lower portion has a flattened portion and an
3 enlarged portion and said flattened portion mates with
4 the guide tube and said enlarged portion is retained
5 between said shoulder portion and a surface of said
6 bottom nozzle.

1 3. The device according to claim 1 wherein
2 said upper portion comprises a plurality of leg segments.

1 4. The device according to claim 3 wherein
2 said legs retain said spacer grid by means of spot
3 welding.

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1 5. The device according to claim 4 wherein
2 said plurality of legs is four legs.

1 6. The device according to claim 2 wherein
2 said lower portion has two flattened sections opposite
3 each other and two enlarged sections interposed there
4 between.

1 7. The device according to claim 6 wherein
2 said aperture comprises two apertures located one each on
3 said flattened sections.

1 8. The device according to claim 1 wherein
2 said retaining means is made from Inconel.

1 9. The device according to claim 1 wherein
2 said retaining means is made from steel.

1 10. A method of assembling a skeleton
2 structure for a nuclear reactor fuel assembly which
3 contains top and bottom nozzles, a plurality of guide
4 tubes having a shoulder portion located at the lower end
5 thereof, a plurality of spacer grids for supporting the
6 guide tubes, and a plurality of tubular retaining means
7 having at least one aperture at one end thereof for
8 attaching a spacer grid to the guide tubes comprising the
9 steps of:

10 fastening a first end of one of said tubular
11 retaining means to one of said plurality of spacer grids;
12 inserting said guide tube through said one of said
13 spacer grids and said tubular retaining means such that
14 said shoulder portion on the lower end of said guide
15 means protrudes from an aperture in a second end of said
16 tubular retaining means so as to fasten said guide means
17 to said tubular retaining means; and

18 fastening said guide tube to said bottom nozzle to
19 form said skeleton structure such that the second end of
20 said retaining means is retained between said shoulder

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21 and a surface on said bottom nozzle to provide axial
22 constraints on the skeleton structure.

1 11. The method according to claim 10 further
2 including the step of fastening said tubular guide tube
3 to said top nozzle.

1 12. The method according to claim 10 wherein
2 the step of fastening a first end of a tubular retaining
3 means to a spacer grid is carried out by welding.

1 13. The method according to claim 10 wherein
2 the step of fastening said guide means to said bottom end
3 portion is carried out by screwing said guide means to
4 said bottom end portion whereby said retaining means is
5 restrained from rotating during torquing of the screws.

1 14. A skeleton structure for a nuclear reactor
2 fuel assembly comprising in combination:

3 a bottom nozzle

4 at least one guide tube wherein a lower end of
5 said guide tube has an attachment portion for attachment
6 to said bottom nozzle and a shoulder positioned between
7 the attachment portion and an upper end of said guide
8 tube.

9 a spacer grid assembly for supporting at least
10 one nuclear fuel rod and said at least one guide tube;
11 and

12 a retaining means having a first end and a
13 second end wherein said first end retains said spacer
14 grid and said second end has an aperture for receiving
15 and retaining said shoulder of said guide tube.

16 15. The device according to claim 14 further
17 comprising a top nozzle for attachment to an upper
18 portion of said guide tube.

1 16. The device according to claim 15 wherein
2 said second end has a flattened portion and an enlarged

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3 portion and said flattened portion mates with said guide
4 tube and said enlarged portion is retained between said
5 shoulder and a surface of said bottom nozzle.

1 17. The device according to claim 15 wherein
2 said first end comprises a plurality of leg segments.

1 18. The device according to claim 17 wherein
2 said legs retain said spacer grid by means of spot
3 welding.

1 19. The device according to claim 18 wherein
2 said plurality of legs is four legs.

1 20. The device according to claim 16 wherein
2 said second end has two flattened sections opposite each
3 other and two enlarged sections interposed there between.

1 21. The device according to claim 20 wherein
2 said aperture comprises two apertures located one each on
3 said flattened sections.

1 22. The device according to claim 15 wherein
2 said retaining means is made from Inconel.

1 23. The device according to claim 15 wherein
2 said retaining means is made from steel.

FIG. 1

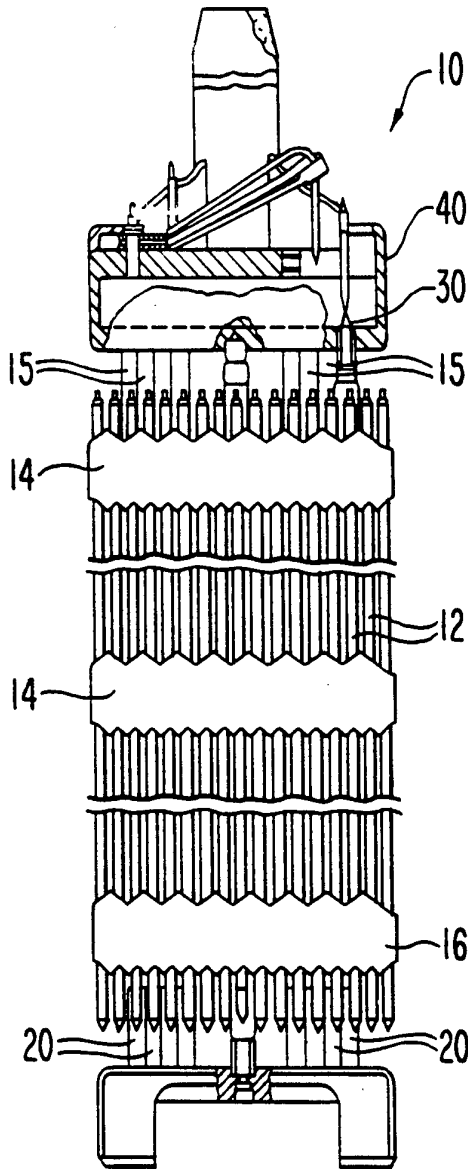


FIG. 2a

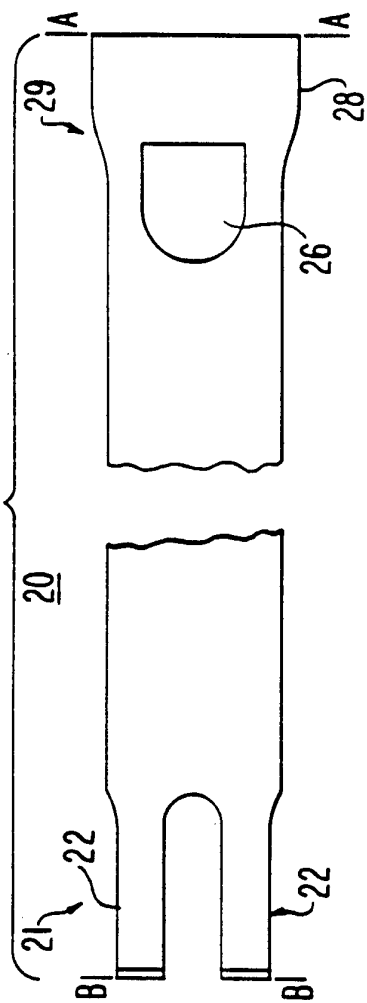


FIG. 2b

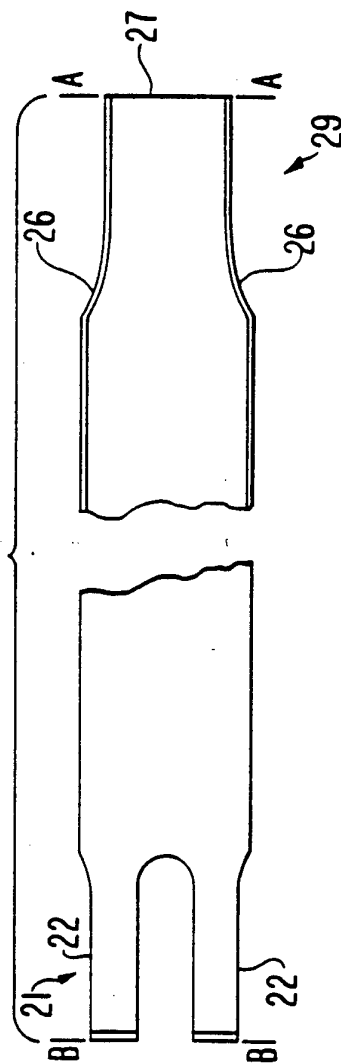


FIG. 2c

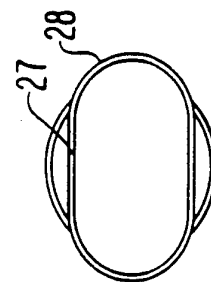
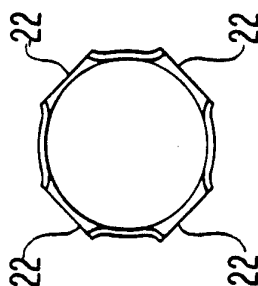


FIG. 2d



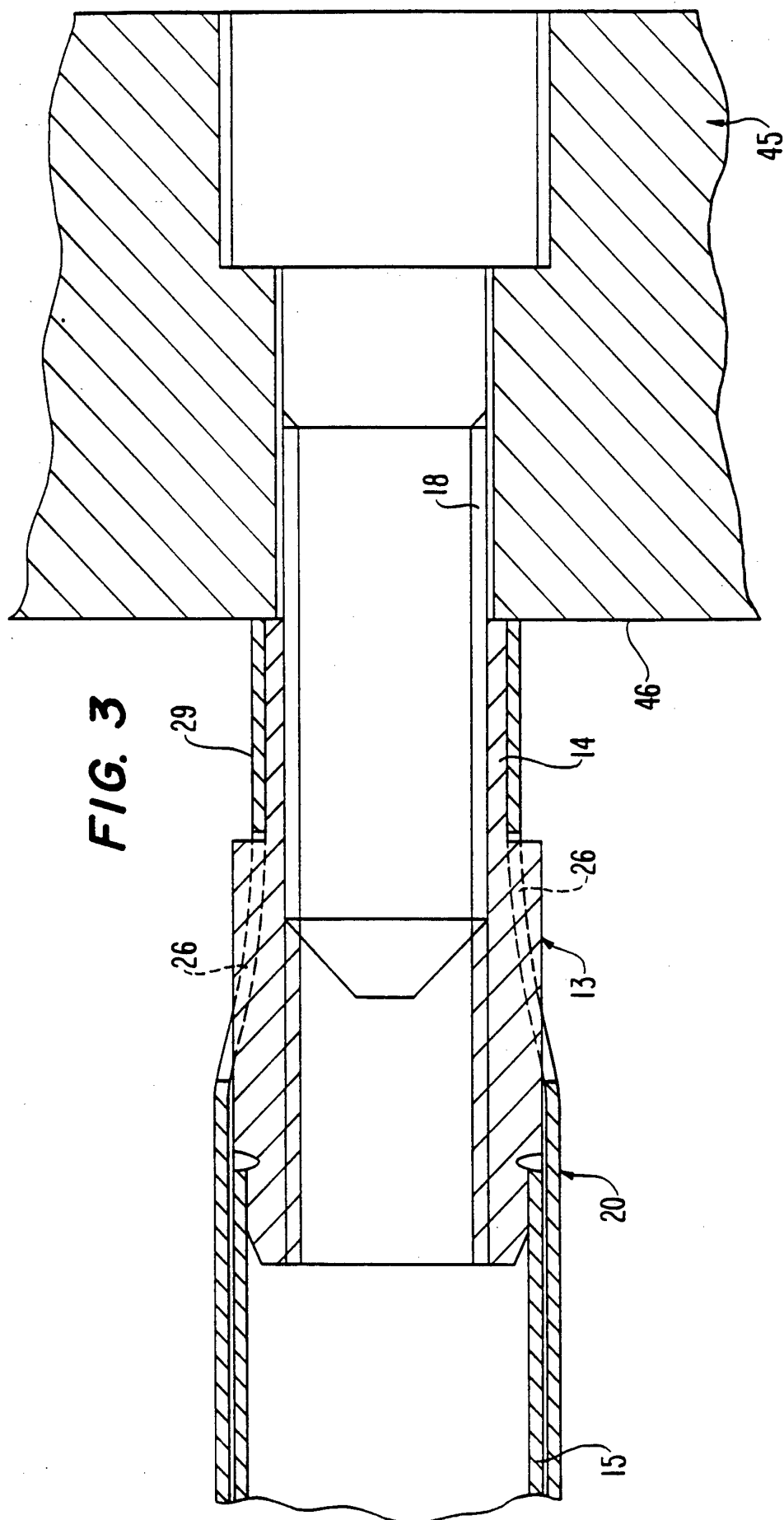


FIG. 4a

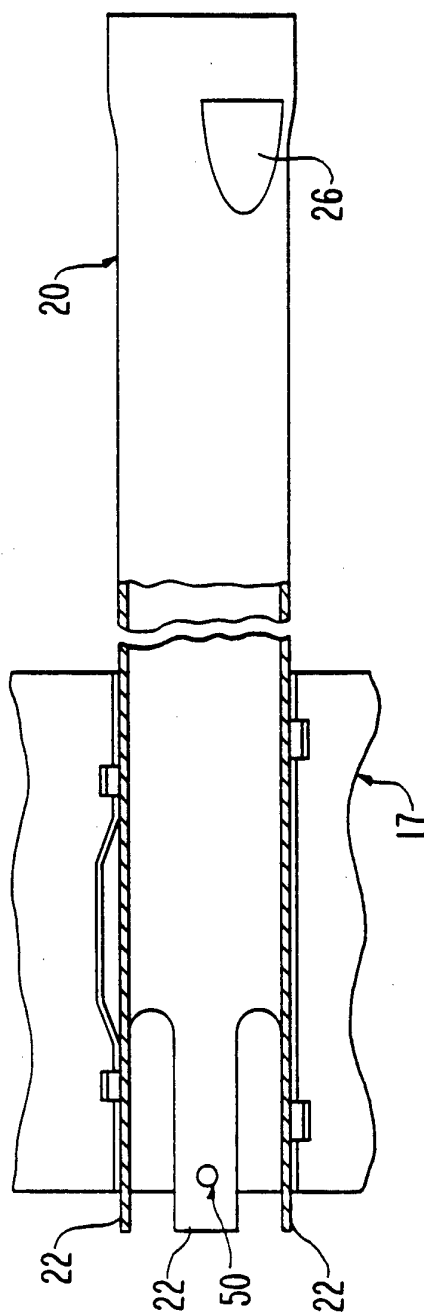


FIG. 4b

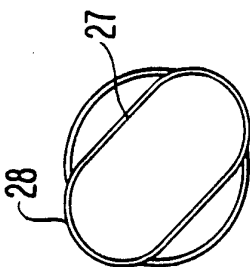
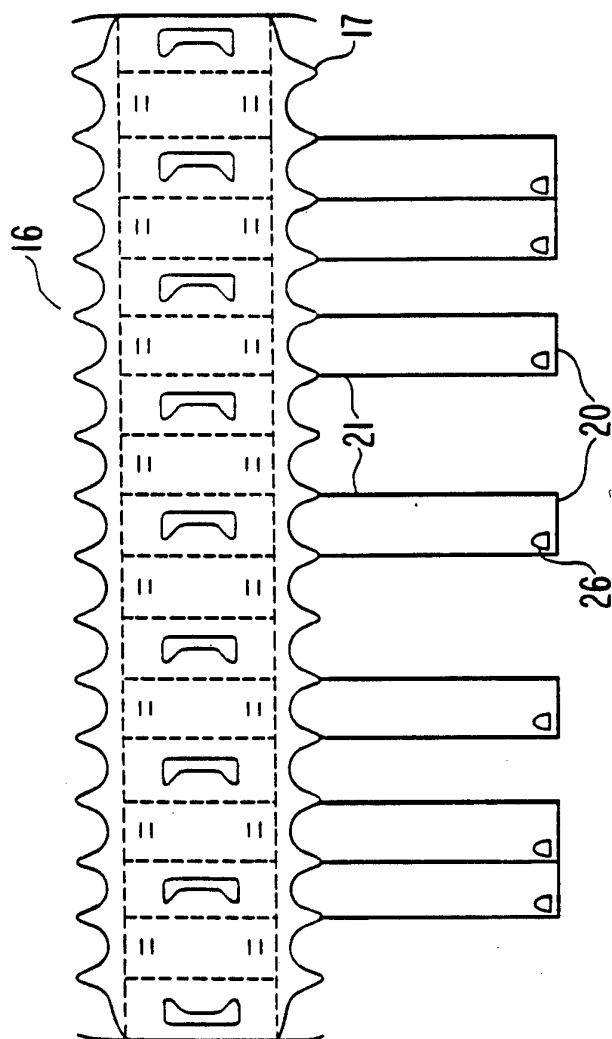


FIG. 5



INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 93/03049

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) ⁶		
According to International Patent Classification (IPC) or to both National Classification and IPC Int.Cl. 5 G21C3/332		
II. FIELDS SEARCHED		
Minimum Documentation Searched ⁷		
Classification System	Classification Symbols	
Int.Cl. 5	G21C	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched ⁸		
III. DOCUMENTS CONSIDERED TO BE RELEVANT⁹		
Category ⁹	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³
Y	US,A,3 954 560 (DELAFOSSÉ ET AL.) 4 May 1976 see the whole document	1-2, 8-10, 12, 14-16, 22-23
A	--- see the whole document	11, 13
Y	EP,A,0 175 496 (EXXON NUCLEAR COMPANY) 26 March 1986 see page 8, line 31 - page 10, line 32; figures 8-9	1-2, 8-10, 12, 14-16, 22-23
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IV. CERTIFICATION		
Date of the Actual Completion of the International Search		Date of Mailing of this International Search Report
25 AUGUST 1993		01 SEP 1993
International Searching Authority		Signature of Authorized Officer
EUROPEAN PATENT OFFICE		DEROUBAIX P.G

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
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**ANNEX TO THE INTERNATIONAL SEARCH REPORT
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