

(19) World Intellectual Property Organization  
International Bureau



(43) International Publication Date  
24 October 2002 (24.10.2002)

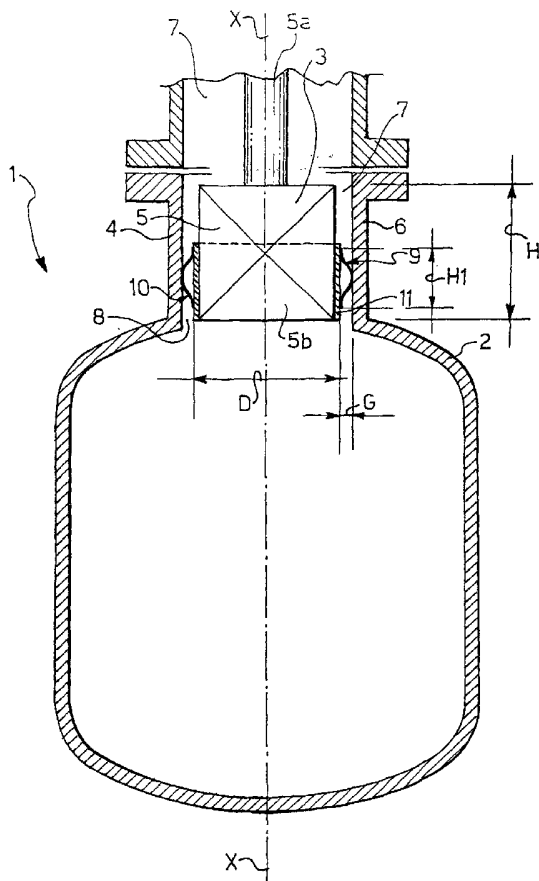
PCT

(10) International Publication Number  
**WO 02/083287 A1**

- (51) International Patent Classification<sup>7</sup>: **B01J 8/00**, F16J 15/08
- (72) Inventor; and  
(75) Inventor/Applicant (for US only): **RIZZI, Enrico** [IT/CH]; Via Montale, 10, I-22070 Grandate (IT).
- (21) International Application Number: PCT/EP02/03839
- (74) Agent: **ZARDI, Marco**; M. Zardi & Co. S.A., Via Pioda, 6, CH-6900 Lugano (CH).
- (22) International Filing Date: 8 April 2002 (08.04.2002)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:  
01109067.7 11 April 2001 (11.04.2001) EP
- (81) Designated States (national): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZM, ZW.
- (71) Applicant (for all designated States except US): **AMMONIA CASALE S.A.** [CH/CH]; Via Sorengo, 7, CH-6900 Lugano-Besso (CH).
- (84) Designated States (regional): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM),

[Continued on next page]

(54) Title: SEALING MEANS FOR CHEMICAL REACTOR



(57) Abstract: A safe, reliable chemical reactor (1, 20) with a simple construction, easy to assemble and to disassemble comprises a casing (2), a male member (3) supported by the casing (2) and inserted with a certain clearance in a female member (4) associated to the casing (2), as well as a metallic foil (10) capable of being deformed fixedly connected to the male member (3) and protruding into said clearance (8), in order to hinder the fluid passage through the clearance.

WO 02/083287 A1



European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

**Published:**

— *with international search report*

*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

## SEALING MEANS FOR CHEMICAL REACTOR

## DESCRIPTION

Field of application

5 The present invention relates to a chemical reactor, of the type comprising a casing, a male member supported by the casing and inserted with clearance in a female member associated to the casing, as well as sealing means to hinder the fluid passage through the clearance between the  
10 male and female members.

Prior art

Chemical reactors of the above specified type generally have a big size and, when manufacturing the various elements which they consist of, too strict mechanical  
15 tolerances cannot be imposed, as this would reflect in unjustifiably high costs of construction. In fact, the various elements have under all aspects rather coarse tolerances, specifically as far as their dimensions, alignments, concentricity and surface finishing are  
20 concerned. In fact, such structures belong to the category of carpentry and boiler shop that has construction requirements completely different from those of the precision mechanics.

Thus, in general, the coupling between elements, such as  
25 for example the insertion of male members into female members, is usually arranged in such a way to guarantee a certain clearance, in order to avoid the danger of sticking, force-fitting during assembling or, even worse, the impossibility of inserting a member into the other one.

30 Thus, it is usually accepted that a certain clearance exists between the elements, once assembled. However, it is

- 2 -

not accepted, or it is accepted only to a limited extent, that fluids, that are provided on either side of the coupled members, are able to freely pass through this clearance.

5 Sealing means has been suggested, in order to hinder the passage of the fluids through the clearance. For example, it has been suggested to insert into the clearance gaskets of the gland packing type, fastened to the male member when inserted into the female member. In this way the fluid  
10 passage is practically impossible. However, this technique implies the drawback of the time consuming and arduous assembling of the gland packing gaskets, practically carried out on site, in a completely craftmade way and requiring a direct accessibility of the operator. The  
15 drawback of the progressive damaging of the gland packing baskets has also been observed. This is due to the unavoidable mutual small displacements of the coupled members, with fraying for abrasion and subsequent erosion of the gland packings and with loss, by the gland packings,  
20 of part of the materials which they are woven with, until the complete dissolution of the gland packing itself occurs.

#### Summary of the invention

The problem underlying the present invention is that of  
25 devising a chemical reactor of the above specified type, which presents such structural and functional characteristics as to overcome the drawbacks mentioned with reference to the prior art.

Such problem is solved by a chemical reactor of the above  
30 specified type, which is characterized in that said sealing means comprises a foil within said clearance.

Advantageously, said foil is fixedly connected to the male member and protrudes into said clearance towards the female

member.

Further features and the advantages of the chemical reactor according to the present invention will become clearer from the following description of an indicative and non-limiting  
5 example of embodiment thereof, made with reference to the attached drawings.

#### Brief description of the drawings

Figure 1 shows a schematic section and elevation view of a chemical reactor according to the invention;

10 Figure 2 shows an enlarged perspective view of a detail of the chemical reactor of Figure 1;

Figures 3, 4, 5 show schematic views of a detail of the chemical reactor according to the invention of Figure 1; taken in subsequent steps of its operation;

15 Figure 6 shows a schematic elevation view of a chemical reactor of the invention, according to a further embodiment thereof;

Figure 7 shows a partial, perspective and exploded view of the detail of Figure 2 according to an alternative  
20 embodiment; and finally

Figure 8 shows a partial, perspective view of the detail of Figure 2 according to a further alternative embodiment.

#### Detailed description

With reference to the attached figures, a chemical reactor  
25 is indicated in its whole with reference numeral 1.

Chemical reactor 1 comprises a casing 2 and a male member 3 inserted with clearance into a female member 4. In particular, in the combustion reactor 1 the male member 3 is a burner 5, which has an elongated and cylindrical shape

- 4 -

having axis X-X, supported by the casing at an end 5a thereof, and exhibits an opposite cantilevered end 5b, coaxially inserted with clearance into the female member 4, which is a shell 6 defining an opening 7 in the casing 2.

5 Between the outer surface 3a of the male member 3 and the inner surface 4a of the female member 4 an annular clearance 8 is formed. The male member 3 has a large, cross-sectional dimension in the range from 300 to 1500 mm. In the example, it has a diameter of about 600 mm. The  
10 clearance 8 has a large dimension as well, in the order of 1-2 cm. In the example, the clearance has a radial dimension G of about 10 mm.

The male member 3 and the female member 4 are inserted the one in the other by a height H.

15 The chemical reactor 1 further includes sealing means 9 arranged in the clearance 8, in order to hinder the fluid passage through the clearance itself.

The sealing means 9 comprises a metallic foil 10, made in the example of stainless steel, of a small thickness S, with S falling in the range from 0,1 to 1 mm, so to be  
20 capable of being deformed. In the example S is 0,3 mm.

The foil 10 is fixedly connected to the male member 3 and protrudes into said clearance up to press the female member 4.

25 Preferably, the foil 10 is fixedly connected to the male member 3 through a rigid sleeve 11, preferably made of steel, which is in turn fixedly connected to the male member 3, for example being welded onto the element 3 itself or being fitted onto it in a forced fit arrangement.  
30 In this way the sleeve 11 is an integral part of the male member 3.

The foil 10 is made of an annular band 12 with a

predetermined height H1, for example comprised between 20 and 150 mm, preferably of about 1/10 of the diameter D. The annular band 12 has a first edge 13, which is placed at the cantilevered end 5b of the male element 3 and is fastened to the sleeve 11, for example with welding spots 11a, and has a second edge 14 opposite to the first edge 13, which is leaning and pressing against the sleeve 11, and has also an intermediate sealing portion 15, which is in press contact with the female member 4.

10 According to a preferred embodiment, the annular band has a substantially omega shaped section, wherein the two wings of omega correspond to the edges 13, 14, whereas the arc shaped portion of omega corresponds to the intermediate sealing portion 15.

15 The foil 10 is applied onto the sleeve 11 through welding by means of the aforesaid welding spot 11a, whereas the sleeve 11 is fitted onto the male member 3 to which it is fixedly connected through welding or fitting. So doing, the member 3 (see figure 3) is ready to be inserted into the female member 4.

It shall be noted that the intermediate sealing portion 15 sufficiently protrudes from the male member 3 so to interfere anyway with the inner surface 4a of the female member 4. For example a clearance i is formed, with an interference of 3-4 mm. The provided interference will increase with the increase of the construction tolerances of the female member.

Inserting (see figure 4) the male member 3 into the female member 4 a pressing contact of the intermediate sealing portion 15 with the female member 4 is created and at least in the vicinity of the top of the intermediate sealing portion 15 firstly an elastic deformation and then according to the interference and to the dimensions of the sealing member, a permanent deformation of the foil 10 take

place.

While opening the chemical reactor for maintenance or for any other reasons it is necessary to disassemble the male member 3, the latter is easily extracted from the female member (see figure 5). The foil 10 is also extracted and has a spring back part and a permanent deformation part and can be reused for a possible subsequent reassemble or, when damaged, can be easily replaced.

A chemical reactor 20, according to a further embodiment of the invention is described with reference to figure 6, wherein the same structural and functional parts as those of the chemical reactor 1 have the same reference numerals.

In particular, in the synthesis reactor 20, the male member 3 is a cylindrical member, such as an heat exchanger 21 having opposite ends 21a supported by the casing 2 and a central part 21b, substantially a tube bundle, inserted with clearance into a female member 4 consisting of three superimposed coaxial annular catalytic beds 22.

Between the heat exchanger 21 and each of the three catalytic beds 22 two sealing means 9 are provided, each one being identical to the above described sealing means.

A foil 30 according to an alternative embodiment of the invention is described with reference to figure 7, wherein the parts that are structurally and functionally equivalent to those of the foil 10, have the same reference numerals. The foil 30 is advantageously made of a plurality of sectors all indicated with 31, in the example of four sectors, of the same angular amplitude, each easily obtained through drawing. Each sector is fixed to the sleeve by means of welding spots, strictly side by side with the adjacent sectors.

A foil 40, according to a further embodiment of the invention, is described with reference to figure 7, wherein



the parts that are structurally and functionally equivalent to those of the foil 10, have the same reference numerals. The foil 40 is advantageously provided at its free edge 14, with a plurality of slits 41, distributed at a regular pitch, thirty-two in the example, thanks to which the edge 14 will lean and press against the sleeve 11 with improved pliability.

The main advantage of the chemical reactor according to the invention lies in its faultless reliability and in its operating safety. An extended service life can be obtained, without requiring maintenance.

A further advantage of the chemical reactor according to the present invention lies in its simple construction. Further on we shall expect that it will be possible to exploit the invention not only when manufacturing new chemical reactors, in series or singularly, but also when retrofitting or revamping old chemical reactors, where the wear and corrosion generally have worsened the already coarse initial tolerances. Or, even where the revamping requires the application of seals onto surfaces onto which the application of seals was not foreseen (and hence not suitable for conventional sealing systems). For example, in the case of chemical reactors such as burners, where the female member is usually completely coated with refractory material in the form of a refractory cement cast or refractory bricks.

A further advantage of the chemical reactor according to the present invention lies in its simple assembling by personnel working outside of the reactor without particular precautions and, so to say, blindly.

A further advantage of the chemical reactor according to the present invention is that it is very easy to be disassembled, just by extraction from outside without previous disassembling operations inside it.

Obviously a man skilled in the art can make a plurality of modifications to the above described reactor in order to fulfil specific and peculiar requirements, all falling within the scope of protection of the invention as defined  
5 in the following claims.

- 9 -

## CLAIMS

1. Chemical reactor (1, 20), of the type comprising a casing (2), a male member (3) supported by the casing (2) and inserted with a certain clearance in a female member (4) associated to the casing (2), as well as sealing means (9) to hinder the fluid passage through the clearance between the male and female members, characterized in that said sealing means (9) comprises a foil (10, 30, 40) within said clearance (8).
2. Chemical reactor (1, 20) according to claim 1, characterized in that said foil (10, 20, 40) is fixedly connected to the male member and protrudes into said clearance (8).
3. Chemical reactor (1, 20) according to claim 3, characterized in that the foil (10, 20, 40) is formed by an annular band (12) of predetermined height (H1).
4. Chemical reactor (1, 20) according to claim 3, characterized in that said height (H1) of the annular band (12) is approximately equal to  $1/10$  of the cross-sectional dimension (D) of the male member (3).
5. Chemical reactor (1, 20) according to claim 4, characterized in that the annular band (12) has a first edge (13) fixedly connected to the male member (3) and an intermediate sealing portion (15) protruding into said clearance (8).
6. Chemical reactor (1, 20) according to claim 5, characterized in that the annular band (12) has a second edge (14) opposite to the first edge (13) leaning and pressing onto the male member (3).
7. Chemical reactor (1, 20) according to claim 6, characterized in that the annular band (12) has a substantially omega shaped section, wherein the omega wings

- 10 -

form the first and the second edge (13), (14) and the arc shaped portion of omega forms the intermediate sealing portion (15).

8. Chemical reactor (1, 20) according to claim 7,  
5 characterized in that it comprises a sleeve (11) fixedly connected to the male member (3); said first edge (13) of the annular band (12) being welded to the sleeve (11) and said second edge (14) leaning and pressing onto the sleeve (11).

10 9. Chemical reactor (1, 20) according to claim 8, characterized in that the annular band (12) is made of sectors (31) singularly fastened to the sleeve (11).

10. Chemical reactor (1, 20) according to claim 6,  
15 characterized in that the second edge (14) of the annular band (12) is provided with transversal slits (41).

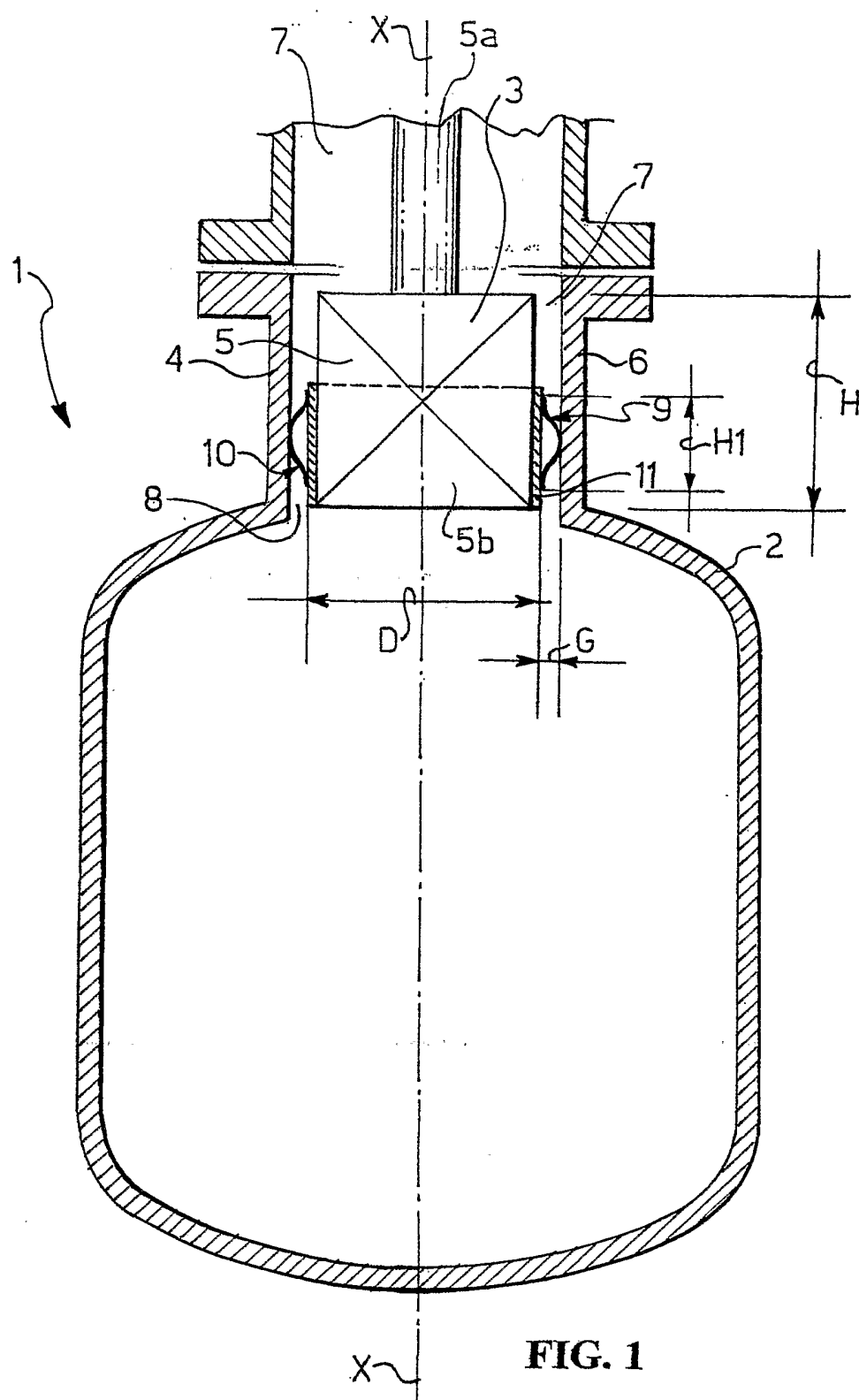
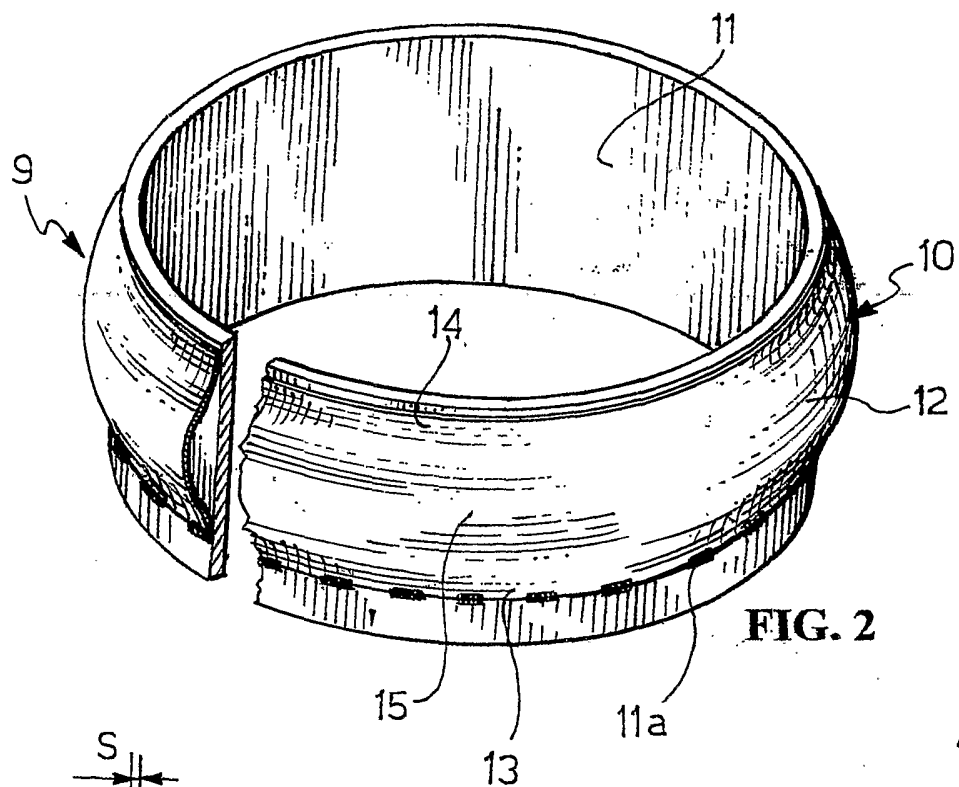
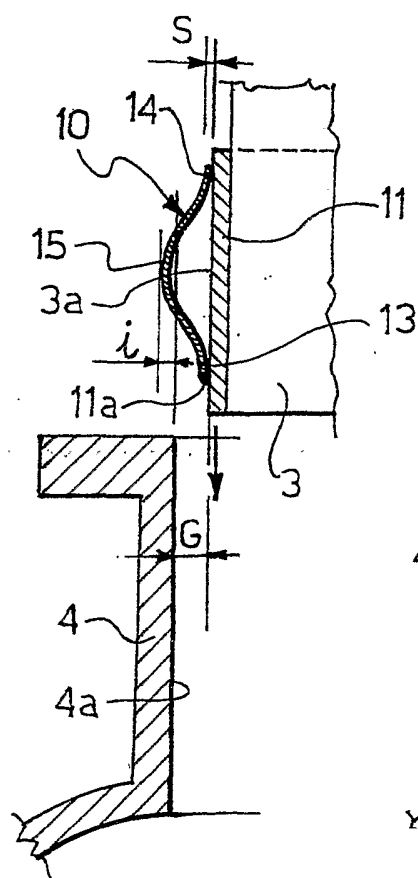


FIG. 1



**FIG. 2**



**FIG. 3**

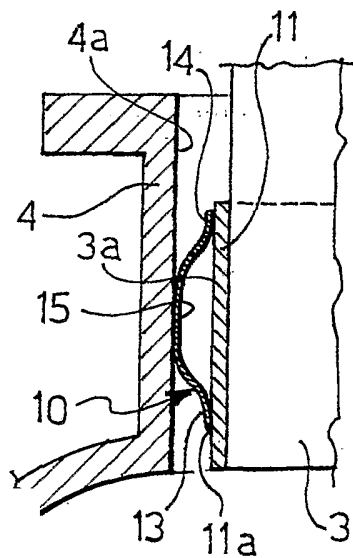


FIG. 4

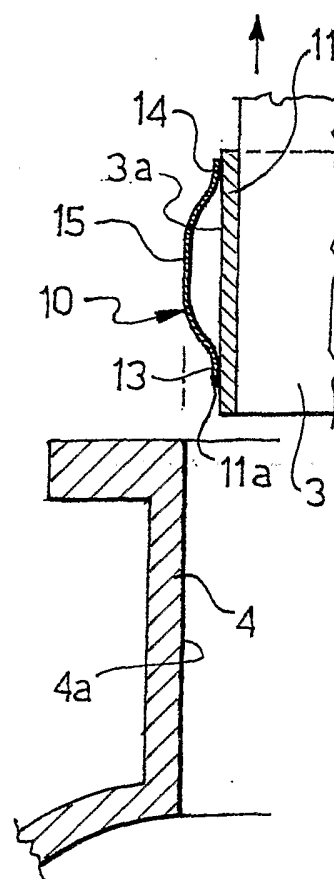


FIG. 5

3/4

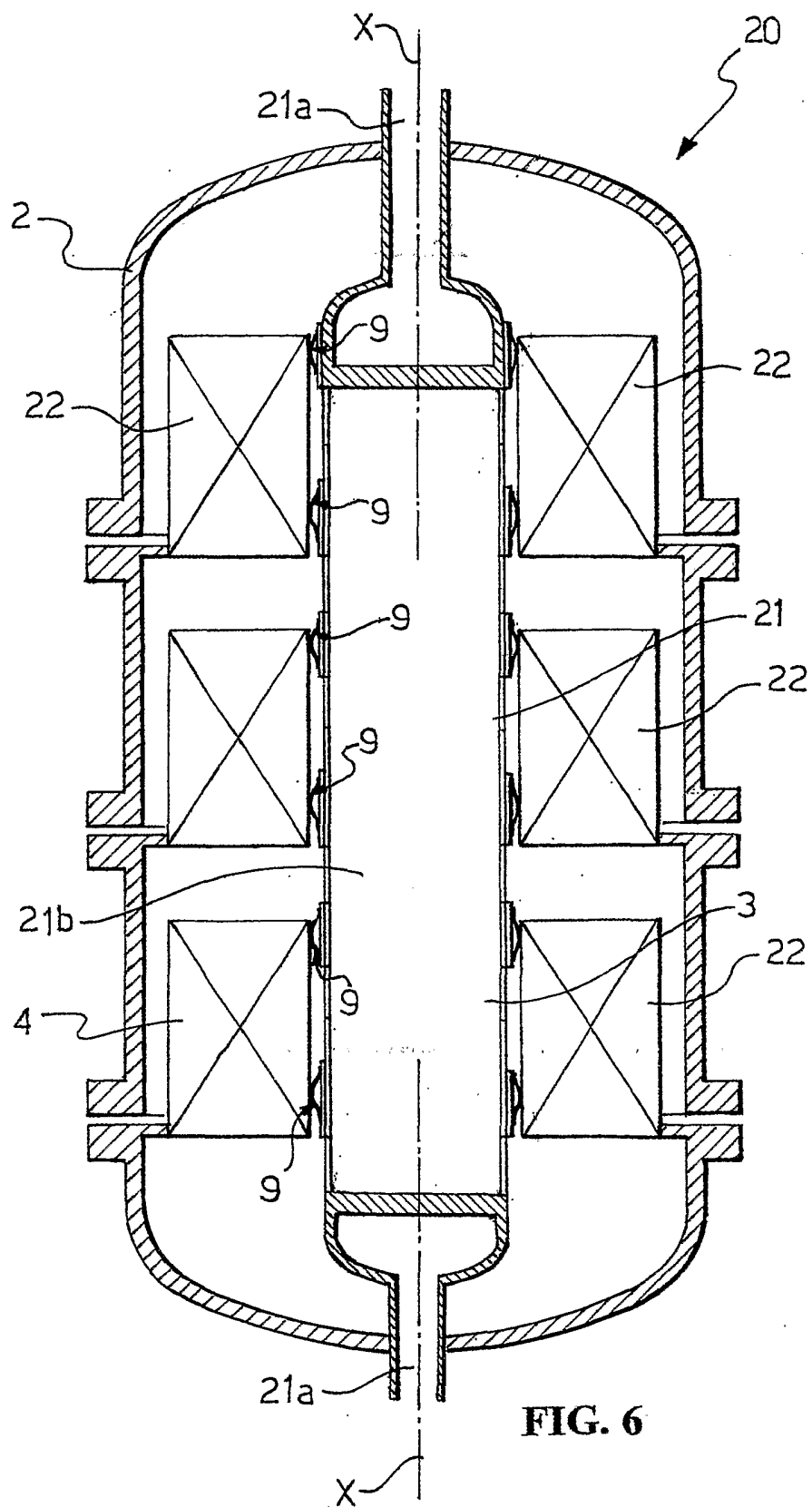
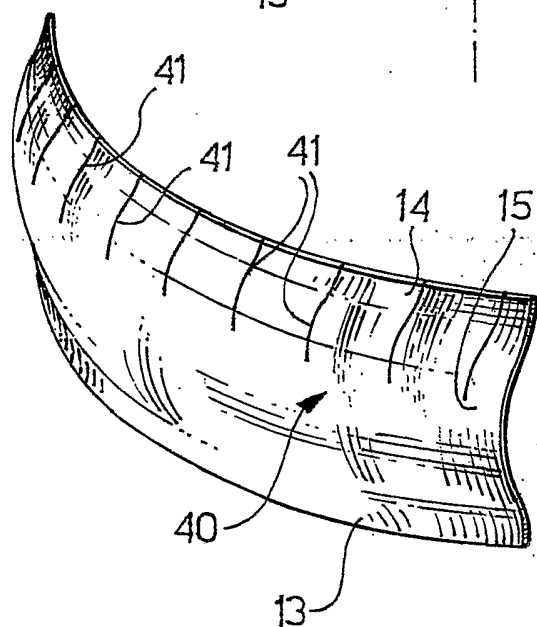
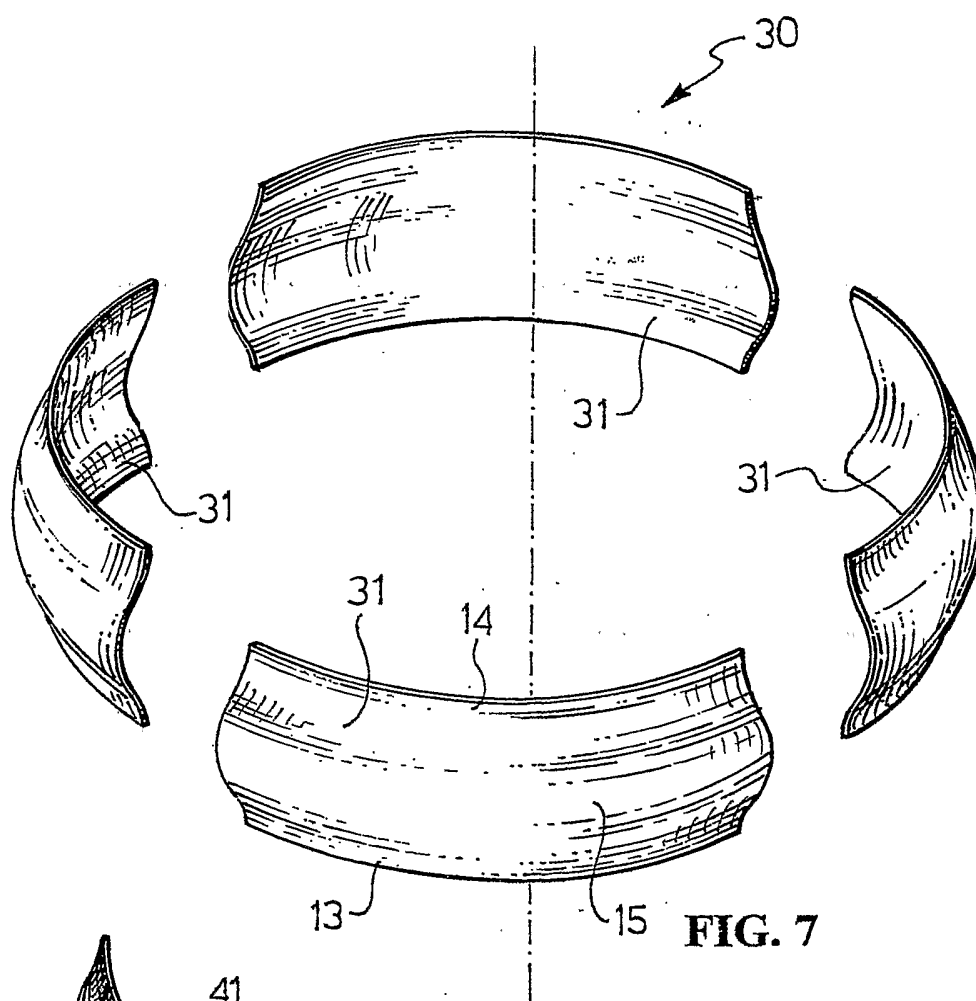


FIG. 6





## INTERNATIONAL SEARCH REPORT

International Application No

PCT/EP 02/03839

**A. CLASSIFICATION OF SUBJECT MATTER**  
 IPC 7 B01J8/00 F16J15/08

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)  
 IPC 7 B01J F16J G21C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 450 872 A (STANDARD OIL CO OHIO) 9 October 1991 (1991-10-09) page 4, line 39 - line 49 claims 1,14-16,20 ---	1
A	EP 0 841 301 A (AMMONIA CASALE SA) 13 May 1998 (1998-05-13) column 6, line 3 - column 7, line 26 column 8, line 10 - line 21 claims 1,3-8; figures 2,3 ---	1
A	EP 0 913 192 A (SULZER CHEMTECH AG) 6 May 1999 (1999-05-06) claims 1-5,7,8; figures 1,4,7-10 --- -/--	1-10

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

\* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

19 August 2002

Date of mailing of the international search report

26/08/2002

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
 NL - 2280 HV Rijswijk  
 Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,  
 Fax: (+31-70) 340-3016

Authorized officer

Vlassis, M

## INTERNATIONAL SEARCH REPORT

International Application No

PCT/EP 02/03839

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	PATENT ABSTRACTS OF JAPAN vol. 006, no. 149 (C-118), 10 August 1982 (1982-08-10) -& JP 57 068129 A (UBE IND LTD), 26 April 1982 (1982-04-26) abstract -----	1
A	US 5 799 954 A (LAYER JEFFREY F) 1 September 1998 (1998-09-01) column 3, line 19 -column 5, line 19 figures 1,2 -----	1-7
A	US 3 345 078 A (BIALKOWSKI LUDWIK S) 3 October 1967 (1967-10-03) the whole document -----	1,3

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/EP 02/03839

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
EP 0450872	A	09-10-1991	AT 114253 T	15-12-1994
			AU 661877 B2	10-08-1995
			AU 3026492 A	18-02-1993
			AU 698930 B2	12-11-1998
			AU 3777495 A	18-01-1996
			AU 7356491 A	19-12-1991
			BR 9101266 A	26-11-1991
			CA 2038289 A1	04-10-1991
			DE 69105230 D1	05-01-1995
			DK 450872 T3	12-12-1994
			EP 0450872 A1	09-10-1991
			JP 3075757 B2	14-08-2000
			JP 5096149 A	20-04-1993
			KR 170398 B1	15-01-1999
			US 6096106 A	01-08-2000
			US 6153152 A	28-11-2000
			US 5567398 A	22-10-1996
			US 5565009 A	15-10-1996
			ZA 9101838 A	24-12-1991
EP 0841301	A	13-05-1998	EP 0841301 A1	13-05-1998
			AU 735457 B2	12-07-2001
			AU 4359597 A	14-05-1998
			BR 9705467 A	25-05-1999
			CA 2219970 A1	12-05-1998
			CN 1182050 A	20-05-1998
			EP 1138630 A2	04-10-2001
			JP 10182101 A	07-07-1998
			US 6426054 B1	30-07-2002
EP 0913192	A	06-05-1999	EP 0913192 A1	06-05-1999
			BR 9804308 A	14-12-1999
			CN 1219444 A	16-06-1999
			JP 11137992 A	25-05-1999
			RU 2156652 C2	27-09-2000
			US 6170805 B1	09-01-2001
JP 57068129	A	26-04-1982	JP 1214711 C	27-06-1984
			JP 58048211 B	27-10-1983
US 5799954	A	01-09-1998	CH 692093 A5	31-01-2002
			DE 19753555 A1	16-07-1998
			FR 2758377 A1	17-07-1998
			GB 2321285 A ,B	22-07-1998
			SE 9704148 A	14-07-1998
US 3345078	A	03-10-1967	NONE	