

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
28 August 2008 (28.08.2008)

PCT

(10) International Publication Number
WO 2008/103203 A1

- (51) International Patent Classification:
F28F 9/02 (2006.01) *F28F 9/013* (2006.01)
- (21) International Application Number:
PCT/US2007/086008
- (22) International Filing Date:
30 November 2007 (30.11.2007)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
10 2007 008536.4
21 February 2007 (21.02.2007) DE
- (71) Applicant (for all designated States except US): **MO-DINE MANUFACTURING COMPANY** [US/US]; 1500 Dekoven Avenue, Racine, WI 53403-2552 (US).
- (72) Inventors; and
- (75) Inventors/Applicants (for US only): **NIES, Jens** [DE/DE]; Lichtensteinerstr. 48, 71088 Holzgerlingen (DE). **STRAHLE, Roland** [DE/DE]; Greuthweg 4, 72669

Unterensingen (DE). **KASINGER, Rainer** [DE/DE]; Muhlgartenstrabe 2, 72221 Haiterbach (DE). **ORSO, Jochen** [DE/DE]; Negelerstrasse 65, 72764 Reutlingen (DE).

(74) Agent: **GIGOT, Stephen, A.**; Michael Best & Friedrich LLP, 100 East Wisconsin Avenue, Suite 3300, Milwaukee, WI 53202-4108 (US).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM,

[Continued on next page]

(54) Title: HEAT EXCHANGER HAVING A PLASTIC COLLECTING TANK

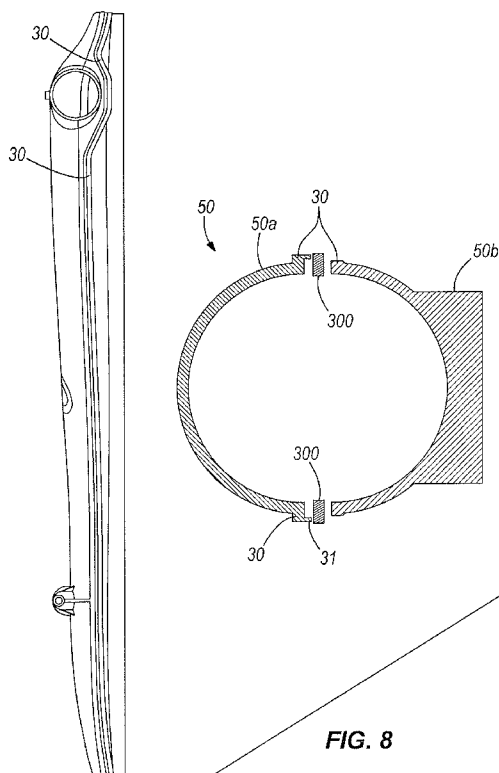


FIG. 8

(57) Abstract: The invention relates to a heat exchanger, such as, for example, a liquid cooler, charge air cooler or the like, having two-part collecting tanks which are composed entirely of plastic and have inlet or outlet connecting pipes. One collecting tank part can have openings for receiving the ends of tubes, with the tube ends being adhesively connected therein, and with the two collecting tank parts being welded to one another at a weld seam which runs around the periphery of their walls. The two tank parts form an oval to round collecting tank cross section between the tubes, and the weld seam is situated in a seam preparation which is formed as a thickened portion of the walls of the tank parts. As a result of the invention, the heat exchanger is of particularly pressure-resistant design and is very production-friendly.



ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM),
European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI,
FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, PL,
PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM,
GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report*

HEAT EXCHANGER HAVING A PLASTIC COLLECTING TANK**CROSS-REFERENCE TO RELATED APPLICATIONS**

[0001] Priority is hereby claimed to German Patent Application No. DE 10 2007 008536.4 filed February 21, 2007, the entire contents of which is incorporated herein by reference.

FIELD OF THE INVENTION

[0002] The present invention relates to a heat exchanger, such as, for example, a liquid cooler, having a two-part collecting tank which is composed entirely of plastic, with one collecting tank part having openings for receiving the ends of tubes, with the tube ends being adhesively bonded therein, and with the two collecting tank parts being welded to one another at a weld seam which runs around a periphery of their walls.

SUMMARY

[0003] DE 10 2006 002 627.6 and DE 10 2006 002 789.2 disclose conventional heat exchangers having two-part collecting tanks connected by means of a welding process, without going into any more detail as to how the collecting tank parts must be configured for a welded connection and how the welded connection and the production of the heat exchanger can be carried out in a cost-effective manner. In addition, the earlier applications specify a production method for heat exchangers in which a flat-tube/fin block having free flat tube ends is provided, with the flat-tube/fin block which has free flat tube ends being soldered in a soldering furnace, with a plastic collecting tank which has receiving openings for the flat tube ends, or a first collecting tank part with receiving openings of said type, being placed on the free flat tube ends of the soldered flat-tube/fin block, and with an adhesive being introduced into a gap between the flat tube ends and the wall of the receiving openings.

[0004] Patent Application No. DE 10 2006 055 458.2 discloses another heat exchanger having collecting tank parts which are adhesively bonded to one another. The collecting tank parts have numerous ribbed portions which are intended to improve the stability of the collecting tank.

[0005] It is generally known for example from DE 32 33 913 A or from DE 32 47 502 A to form the collecting tank of a heat exchanger from a plastic upper part and a plastic lower part and to connect these by means of vibration welding. The lower parts can include planar plates which have openings into which the ends of round tubes can be inserted, usually by expanding the latter. There appears to be a capacity for improving the inner pressure stability of the heat exchangers, because the cross section of the collecting tank contains very abrupt transitions.

[0006] It is the object of the invention to propose a heat exchanger which can be produced cost-effectively and whose collecting tanks are of particularly pressure-stable design despite being composed of plastic.

[0007] Because the tank parts form a collecting tank cross section which is oval to round in cross section, and because the weld seam is situated in a seam preparation which is formed as a thickened portion of the wall of at least one tank part, the pressure stability could be noticeably increased. The thickened portion extends as a strip preferably around the edges of both walls. The seam preparation abuts against another at the end sides of the walls and thereby preferably forms an I-shaped butt joint.

[0008] The weld seam takes on a stepped profile in the region of the inlet or outlet connecting pipe. In the remaining region, the weld seam runs approximately without shoulders around the periphery of the tank parts. The profile is recessed from the first-mentioned profile of the weld seam in the region of the inlet or outlet connecting pipe, that is to say steps are provided in the profile. The proposed embodiment likewise makes it possible to reduce as far as possible the protrusion of the collecting tank beyond the cooling network formed from flat tubes and fins, which contributes to a space saving.

[0009] The weld seam is a gas weld seam, which is particularly preferred, or a friction weld seam. The weld is carried out without additional material.

[0010] In addition, it is possible by means of the recessed profile of the weld seam to provide a very large flow cross section for the inlet or outlet connecting pipe. It is astonishing that it has been possible to form the collecting tanks substantially without outer stiffening ribs even though the wall thickness of the collecting tanks is comparatively low.

Should stiffened portions be necessary for certain applications, the inventors envisage forming said stiffened portions on the inside of the collecting tank.

[0011] It is provided that the cross section of the collecting tank is more approximately round in the region of the inlet or outlet connecting pipe and merges more and more into the flat-oval cross-sectional form in the direction of the edges of the heat exchanger. In other words, the collecting tanks become increasingly slim toward the edges of the heat exchanger or toward the ends of the collecting tanks. Said design is particularly space-saving and compact.

[0012] It is provided that the thickened portion contains surpluses which are defined taking into consideration the melting of the seam, so that the finished collecting tank constitutes a dimensionally stable product.

[0013] It is also provided that the seam preparation comprises a flange-like projection on the edge of one of the tank parts, which projection is arranged with a gap with respect to the edge of the other tank part, with the gap being suitable for receiving weld material, and the flange-like projection performing the function of a clean visible edge. The flange-like projection which forms the visible edge is accordingly situated on the outside of the collecting tank. Aftertreatment of the weld seam is therefore not necessary.

[0014] The gas weld seam is a hot gas weld seam. Welding is carried out for example using a welding device which is formed as a round or approximately flat tube with outflow openings for the hot gas. The hot gas brings the edges of the weld seam preparation which are to be joined up to welding temperature, that is to say the edges are thereby placed into a pasty state. The device is thereafter removed, and the two tank parts are pressed together at the weld seam preparation and welded there without the aid of an additional material. Said device is an approximately rectangular frame, since the periphery of the two tank parts has a corresponding approximately rectangular geometry. Said outflow openings in the tube are preferably formed on two opposite sides of the tube, so that the hot gas can simultaneously bring both seam parts, the upper and the lower seam part, up to welding temperature around the entire periphery of the weld seam.

[0015] Other aspects of the invention will become apparent by consideration of the detailed description and accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] The invention is described in an exemplary embodiment, for which purpose reference is made to the appended drawings.

[0017] Figure 1 shows an overall view of the heat exchanger having two collecting tanks.

[0018] Figures 2a and 2b show views of the one collecting tank from figure 1.

[0019] Figures 3a and 3b show views of the other collecting tank from figure 1.

[0020] Figure 4 shows the section A-A through a collecting tank.

[0021] Figure 5 shows the section B-B through a collecting tank.

[0022] Figure 6 shows the section C-C through a collecting tank.

[0023] Figure 7 shows the section D-D through a collecting tank.

[0024] Figure 8 shows two collecting tank parts, before being joined, with a welding device indicated in between.

[0025] Figure 9 shows a detail of the lower collecting tank part with tube ends.

[0026] Figures 10-13 show perspective views of refined embodiments of a part of a collecting tank.

[0027] Figure 14 shows an enlargement of figure 8.

DETAILED DESCRIPTION

[0028] Before any embodiments of the invention are explained in detail, it is to be understood that the invention is not limited in its application to the details of construction and the arrangement of components set forth in the following description or illustrated in the following drawings. The invention is capable of other embodiments and of being practiced or of being carried out in various ways. Also, it is to be understood that the phraseology and terminology used herein is for the purpose of description and should not be regarded as limiting. The use of "including," "comprising," or "having" and variations thereof herein is meant to encompass the items listed thereafter and equivalents thereof as well as additional

items. Unless specified or limited otherwise, the terms “mounted,” “connected,” “supported,” and “coupled” and variations thereof are used broadly and encompass both direct and indirect mountings, connections, supports, and couplings. Further, “connected” and “coupled” are not restricted to physical or mechanical connections or couplings.

[0029] The heat exchanger shown in a front view in figure 1 is a liquid cooler for motor vehicles, which has, in this case, been designed for use in trucks. The present invention could however involve other types of heat exchangers, such as, for example charge air coolers, and/or other applications of heat exchangers. The heat exchanger has a block of flat tubes 10 and corrugated fins 2 (figure 9).

[0030] The flat tubes 1 and the block composed of flat tubes 10 and fins 2 can be connected to one another in one single soldering process. The flat tubes 10 and the fins 2 can be produced from one or more “endless” sheet-metal strips. The sheet metal thickness for the flat tubes 1 is approximately in the range from 0.03 – 0.15 mm. The sheet metal thickness for the fins 2 is less than 0.10 mm. For truck applications, slightly thicker metal sheets can be used for the tubes, for example up to 0.20 mm (not shown here, but present in the cited earlier applications).

[0031] The free flat tube ends 11 of the soldered block are inserted into the openings 20 of the plastic collecting tanks 50. The walls of the openings 20 in this exemplary embodiment have injection openings 21 in order to be able to introduce an adhesive into the gaps 22 between the ends 11 and the walls of the openings 20. It is notable that the far ends 111 of the flat tubes 10 are seated tightly in the openings 20 and that the gap 22 for the adhesive only follows thereafter. This is intended to prevent the adhesive or the adhesive connection coming into direct contact with the cooling liquid. The fact that the far ends 111 of the flat tubes 10 do not project into the interior of the collecting tanks 50 contributes noticeably to the attainment of a very low loss of pressure (in this regard, compare also figure 5, in which one individual flat tube end 11 has been indicated by a dashed line). In addition, the collecting tank part 50b is provided between the flat tubes 10 with a corrugation which is likewise favorable for limiting the pressure loss. The details can likewise be gathered from a longitudinal section through a small piece of the lower collecting tank part 50b as per figure 9. In said figure – as in figure 1 – the view is of one of the narrow sides of the flat tubes 1.

[0032] However, before the adhesive bonding of the ends 11 is carried out, the collecting tank 50 is produced from a lower collecting tank part 50b, in which said openings 20 are provided, and an upper collecting tank part 50a. In the illustrated exemplary embodiment, the two parts 50a and 50b are connected to one another by means of a hot gas welding process along a seam preparation 30. Figures 2 and 3 show the collecting tanks 50 in two views in each case. The two collecting tanks 50 differ in said exemplary embodiment by the positioning of the inlet or outlet connecting pipe 3, 4. As also shown in figure 1, in the collecting tank 50 arranged at the top, the inlet or outlet connecting pipe 3 is situated in an approximately central position, and in the collecting tank 50 arranged at the bottom, the inlet or outlet connecting pipe 4 is arranged more in a non-central position. The weld seam preparation 30 is also formed accordingly. That is to say, as the figures show, the weld seam preparation 30 takes on a bent profile in the region of the inlet or outlet connecting pipe 3 or 4. It is thereby possible, despite the otherwise very flat design of the collecting tank 50, to provide the inlet or outlet connecting pipe 3, 4 with a considerable flow cross section, which brings some advantages not only in terms of the loss of pressure. In the exemplary embodiment shown, to each side of the inlet or outlet connecting pipe 3, 4 toward the ends of the collecting tanks 50, the cross section becomes increasingly flat and also smaller, varying from a more round cross section (figures 6, 7, 8) in the region of the inlet or outlet connecting pipe 3, 4 to a flat-oval cross section at the ends, for example figure 4, where the horizontal axis is greater than the vertical axis through the oval shown.

[0033] In embodiments which are not shown, the cross section of the collecting tank 50 is for the most part approximately round as viewed over almost the entire length. Only at the ends of the collecting tank 50 is a smaller, approximately oval cross section then provided.

[0034] In contrast to flat-oval cross sections, the invention encompasses elongate-oval cross sections which are not excluded instead of the round cross sections. Elongate-oval cross sections are those in which the vertical axis is greater than the horizontal axis (not shown). The sections shown in the discussed figures have been shown in figure 3a. The sections A-A to D-D which are shown are situated in each case between two flat tubes 10. Said sections show the cross-sectional area of the collecting tank 50 which becomes smaller toward the end. The cross section of the collecting tanks 50 in a plane running through one of the flat tubes has been indicated in figure 5 by means of the two vertical dashed lines 12. Also shown in figure 5 is the protrusion 70 which is very small as viewed in the air flow

direction (arrow), which contributes to space saving. The slim design of the collecting tanks 50 is likewise very space-saving and does not lead to any flow-related disadvantages. In addition, the described cross-sectional design in connection with the welding of the tank parts 50a, 50b leads to extremely good pressure stability which makes it possible for the wall of the collecting tank 50 to be formed without any otherwise conventional outer stiffening ribs, even though the wall thickness of the collecting tank 50 is comparatively low. The weld seam 30 is indicated symbolically in figure 4. Said weld seam 30 has not been shown in the other cross sections (figures 5, 6, 7) but of course can be present there. As can be seen from the illustrations, the seam preparation 30 or the weld seam is situated outside the very short region of the inlet or outlet connecting pipe 3, 4 and approximately in a central plane of the collecting tank 50. In the case of flat-oval cross sections, the seam preparation 50 is thus situated approximately in the longer axis of the oval. Abrupt cross-sectional transitions in the collecting tank 50 are largely avoided.

[0035] Figure 8 is now suitable for indicating how the collecting tank parts 50a and 50b are welded to one another. Shown in said figure is firstly that the weld seam preparation 30 constitutes a thickened portion of the wall of the collecting tank parts 50a, 50b. The weld seam preparation 30 comprises a flange-like projection 31 which extends outward and along the seam 30. Said projection 31 is formed in the exemplary embodiment on the upper collecting tank part 50a, and covers the weld seam itself. A spacing is provided between the projection 31 and the seam thickened portion, which spacing is suitable for receiving weld material which escapes as the tank parts 50a, 50b are pressed together. The weld material remains hidden behind the projection 31, and there is therefore no need to carry out weld seam aftertreatment for visual reasons. The weld seam preparation 30 also comprises dimensional surpluses z in the thickened portion of the wall, which dimensional surpluses z serve as it were to compensate said escaping weld material, so that the dimensional stability of the collecting tank 50 can be ensured. In figure 14, said surpluses z , which are in the range of millimeters or less, have been indicated on both halves of the seam preparation 30. It can also be sufficient to provide surpluses z of said type only on one side, for example only on the tank part 50a. Also indicated in the cross section as per figure 8 is a welding device 300. Said welding device 300 is an approximately rectangular frame composed of a tube, since the latter extends around the entire periphery of the weld seam preparation 30. Provided in the tube are upward-pointing and downward-pointing openings through which hot gas exits in order to heat the weld seam preparation 30 up to welding temperature, that is to say to bring

said weld seam preparation 30 into a pasty state. Once said state is reached, the welding device 300 is removed, and the parts 50a, 50b are pressed together in a defined manner in the weld seam preparation 30 by means of a device, thereby leading to a sealed welded connection (not illustrated).

[0036] Figures 10-13 show different exemplary embodiments which can *inter alia* yet further improve the inner pressure stability of the collecting tank 50. In said embodiments, internal connections 60 have been provided which can be embodied as individual supports 61, 62 or else as a continuous partition. The individual supports 61, 62 need not be arranged in a row as shown in figure 11, but can be provided at suitable points in the collecting tank 50. In figures 10 and 11, a partition has been arranged in the longitudinal direction, and in figures 12 and 13, in contrast, in the transverse direction, of the collecting tank 50. It is however self-evident that longitudinal and transverse walls 60 can also be arranged together in one collecting tank 50. The design of the welding device 300 has been matched to the arrangement of the internal connection 60, since the internal connection 60 is likewise carried out by means of gas welding during the course of the production of the collecting tank 50. Said illustrations show the above-mentioned openings 301 from which the hot gas jet which impinges on the seam preparation 30 exits. The reference symbols in figure 10 also apply to figures 11-13. The illustrations are otherwise self-explanatory.

[0037] It is possible using partitions 60 to generate advantageous throughflow characteristics of the heat exchanger, as have been illustrated for example in the recently submitted German patent application with the file reference DE 10 2006 056 774.9.

[0038] The embodiments described above and illustrated in the figures are presented by way of example only and are not intended as a limitation upon the concepts and principles of the present invention. As such, it will be appreciated by one having ordinary skill in the art that various changes in the elements and their configuration and arrangement are possible without departing from the spirit and scope of the present invention as set forth in the appended claims.

CLAIMS

What is claimed is:

1. A heat exchanger comprising:
a collecting tank formed from at least two collecting tank parts which are composed entirely of plastic and have inlet or outlet connecting pipes, one of the at least two collecting tank parts having openings for receiving tube ends, the two collecting tank parts being welded to one another at a weld seam which runs around a periphery of their walls;
wherein the two tank parts form an oval to round collecting tank cross section between the tubes, and wherein the weld seam is situated in a seam preparation which is formed as a thickened portion of the wall of at least one tank part.
2. The heat exchanger according to claim 1, wherein the weld seam takes on a stepped profile in the region of the inlet or outlet connecting pipe, and lies approximately in a central plane of the collecting tank in the remaining region.
3. The heat exchanger according to claim 1, wherein the weld seam can be carried out without a supply of additional material, and is one of a hot gas weld seam and a friction weld seam.
4. The heat exchanger according to claims 1, wherein the thickened portion contains dimensional surpluses which replace melting weld material when the welding process is carried out.
5. The heat exchanger according to claim 1, wherein the weld seam or the seam preparation is formed as an I-shaped butt joint in the wall of the collecting tank.
6. The heat exchanger according to claim 1, wherein the collecting tank parts are formed substantially without outer stiffening ribs.

7. The heat exchanger according to claim 1, wherein the cross section of the collecting tank is more approximately round or elongate-oval in the region of the inlet or outlet connecting pipe and merges into a flat-oval cross-sectional form in the direction of edges of the heat exchanger.

8. The heat exchanger according to claim 1, wherein the collecting tank cross section is approximately round over most of its length, and is of approximately oval design at opposite ends.

9. The heat exchanger according to claim 1, wherein that the inlet or outlet connecting pipe is an integral part of one of the collecting tank parts.

10. The heat exchanger according to claim 1, wherein the seam preparation comprises a flange-like projection on an edge of one of the tank parts, wherein the projection is arranged with a gap with respect to the edge of the other tank part, with the gap being suitable for receiving weld material, and the flange-like projection providing a clean visible edge.

11. The heat exchanger according to claim 1, wherein, outside the region of the inlet or outlet connecting pipe, the weld seam preferably runs approximately without abrupt shoulders around the periphery of the tank parts.

12. The heat exchanger according to claim 1, wherein the tank parts have at least one internal connection, with the internal connection having a seam preparation for a weld seam.

13. The heat exchanger according to claim 12, wherein the internal connection comprises a plurality of individual supports.

14. The heat exchanger according to claim 12, wherein the internal connection comprises a media partition.

15. The heat exchanger according to claim 12, wherein the partition constitutes a longitudinal and/or transverse partition in the collecting tank.

16. The heat exchanger according to claim 1, wherein an extension of the tubes into the collecting tank is comparatively small.

17. The heat exchanger according to claim 1, wherein the tubes are flat tubes having two narrow and two wide sides, and wherein the tube ends are adhesively bonded in openings of one of the collecting tank parts.

18. The heat exchanger according to claim 17, wherein the tube ends are not expanded or shaped in any other way.

19. The heat exchanger according to claim 1, wherein the flat tubes, together with corrugated fins, form a fin/tube block which is connected by soldering and has free flat tube ends inserted into the openings of the collecting tank.

20. The heat exchanger of claim 1, wherein the heat exchanger is one of a liquid cooler and a charge air cooler.

1/8

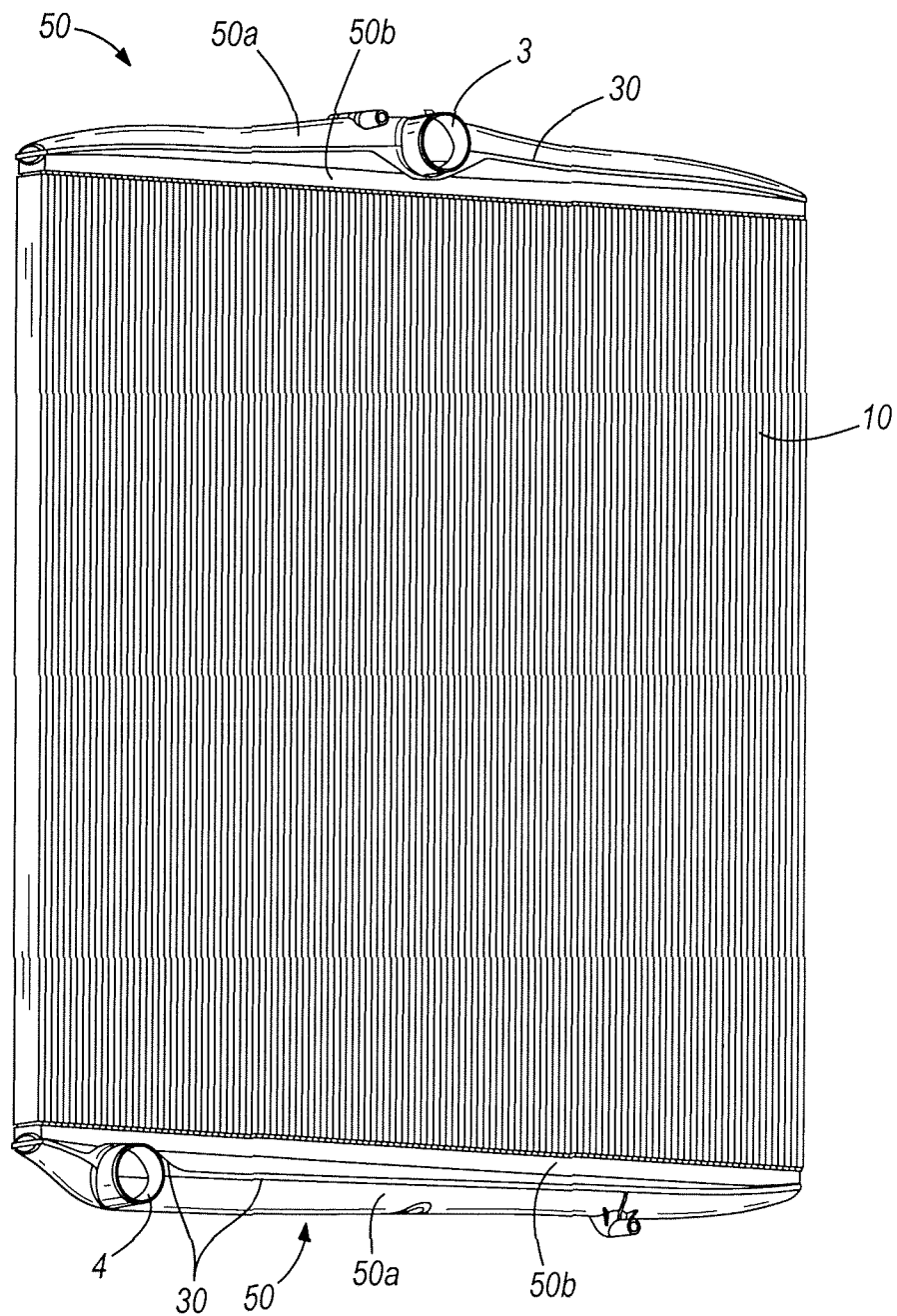


FIG. 1

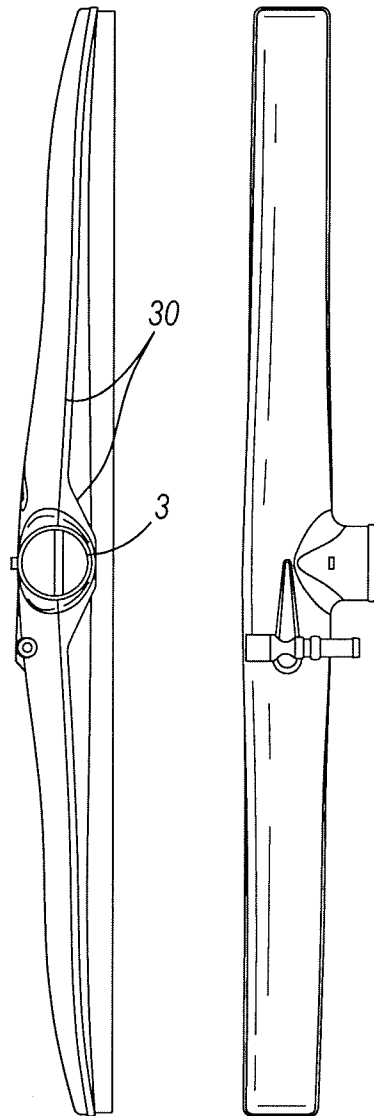


FIG. 2a **FIG. 2b**

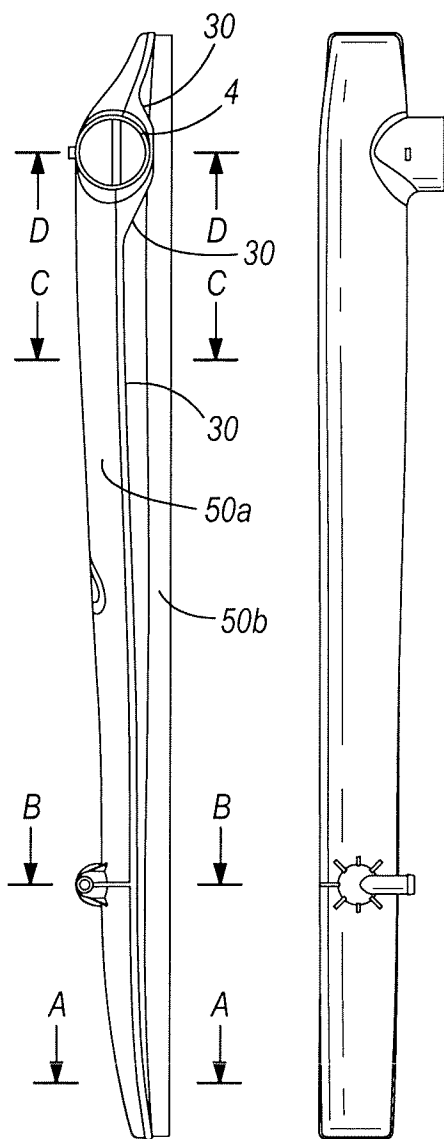


FIG. 3a **FIG. 3b**

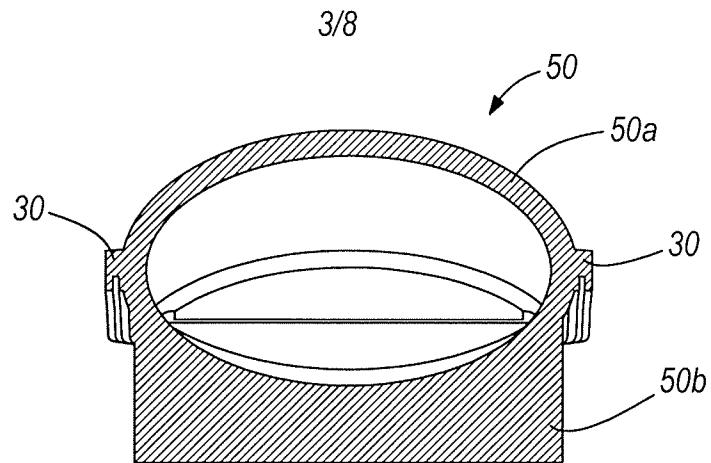


FIG. 4
SECTION
A-A

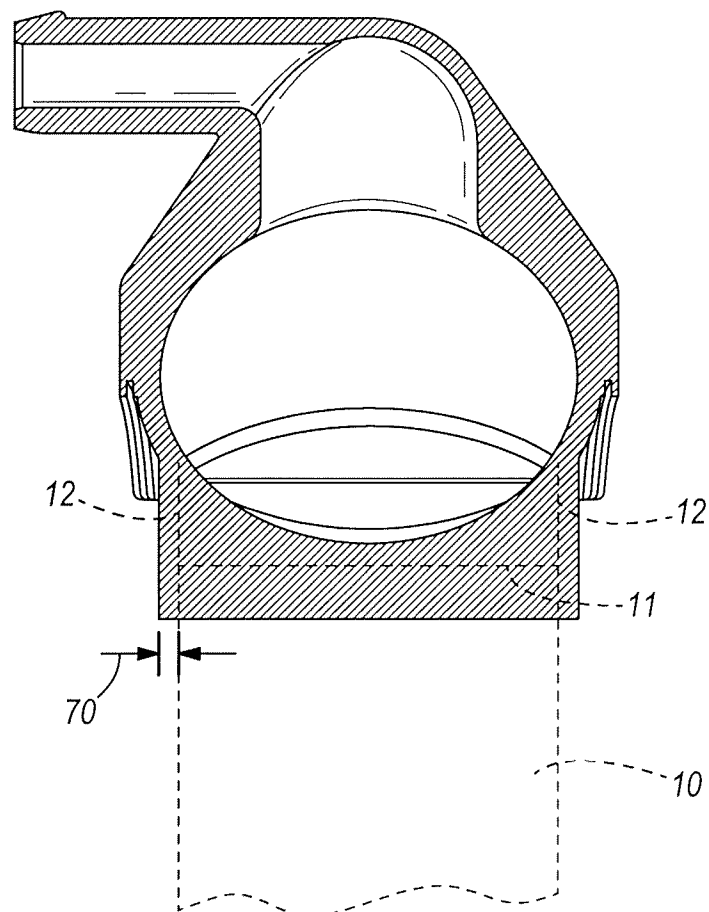


FIG. 5
SECTION
B-B

4/8

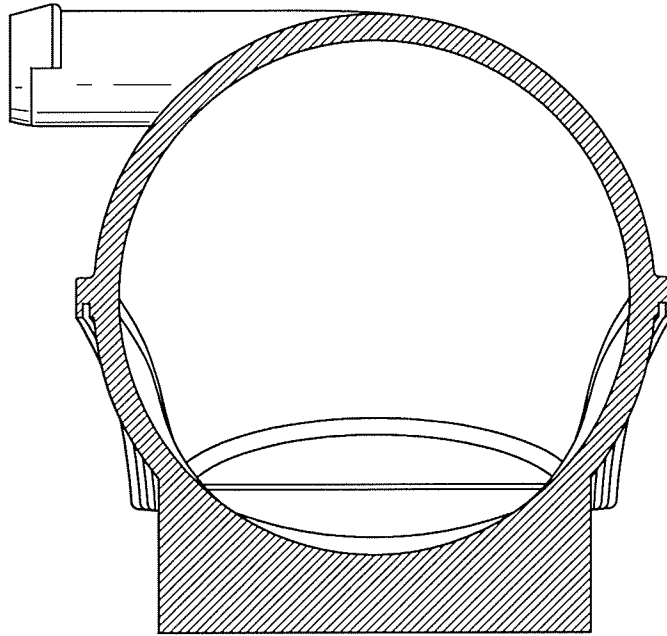


FIG. 6
SECTION
C-C

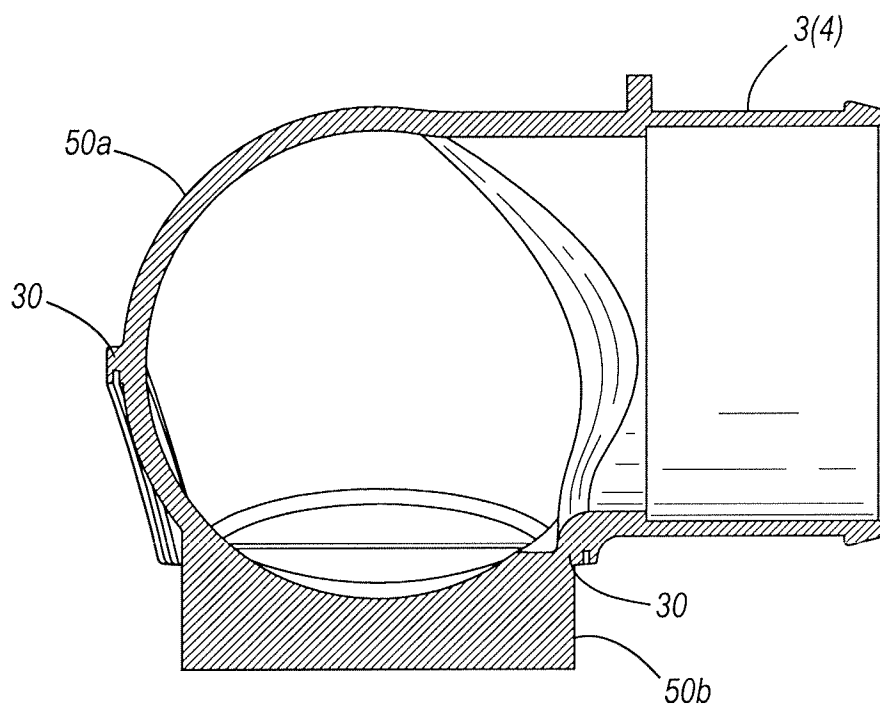
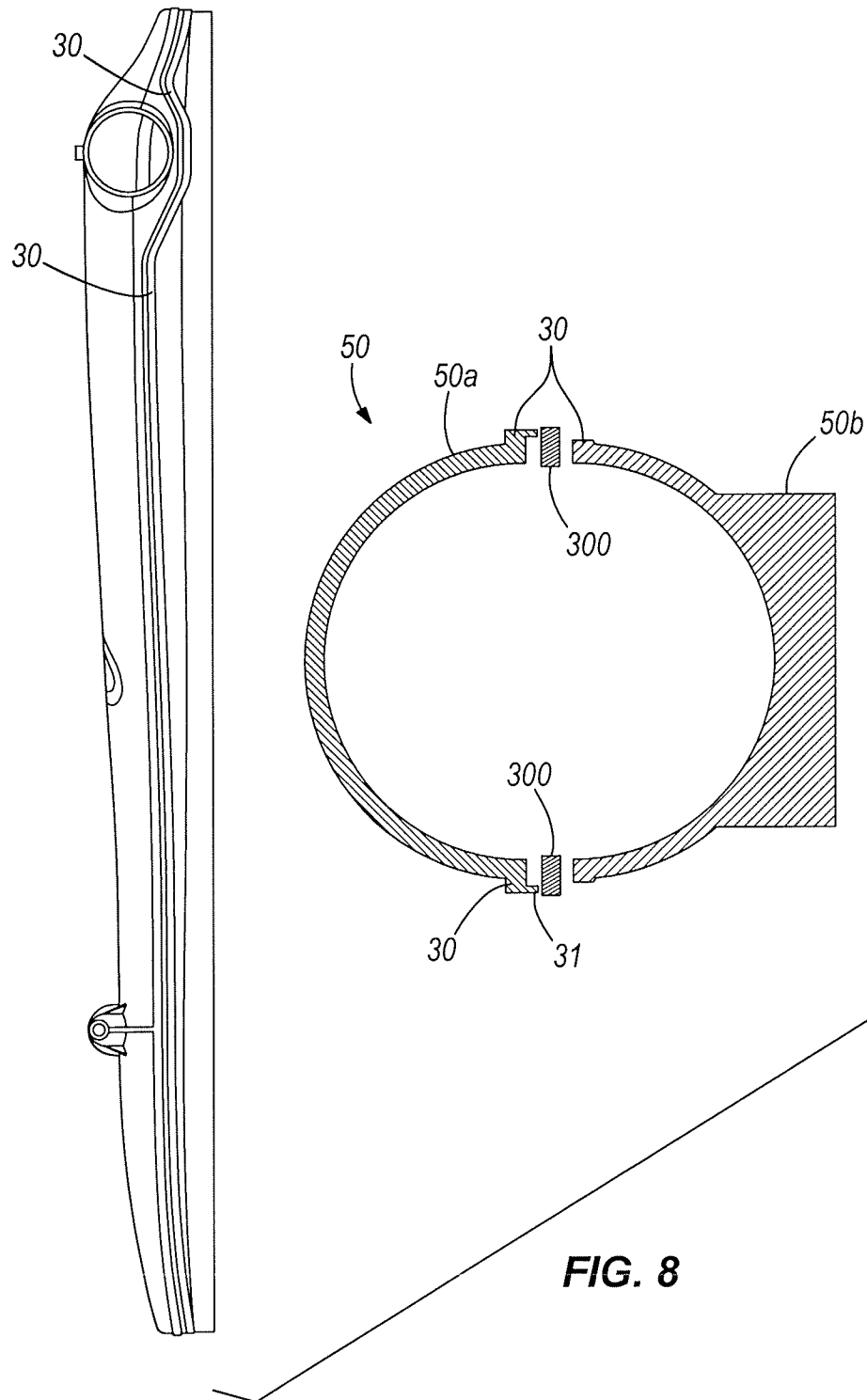
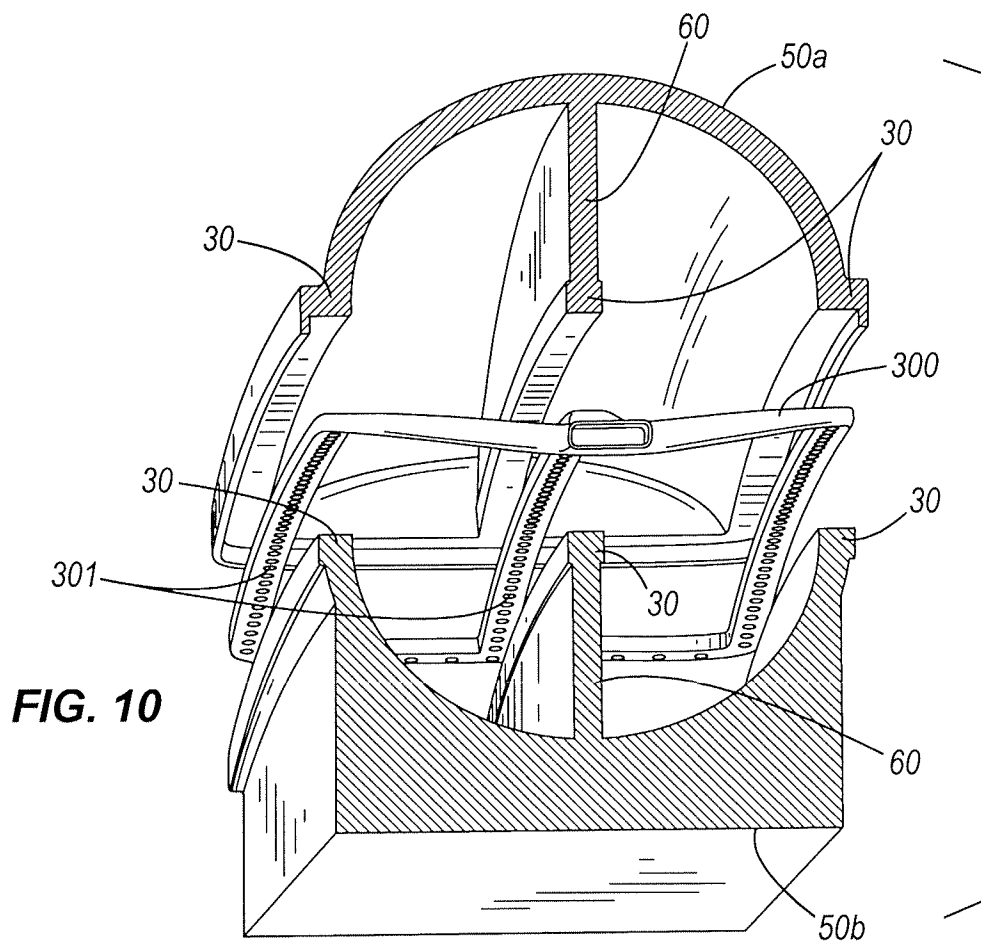
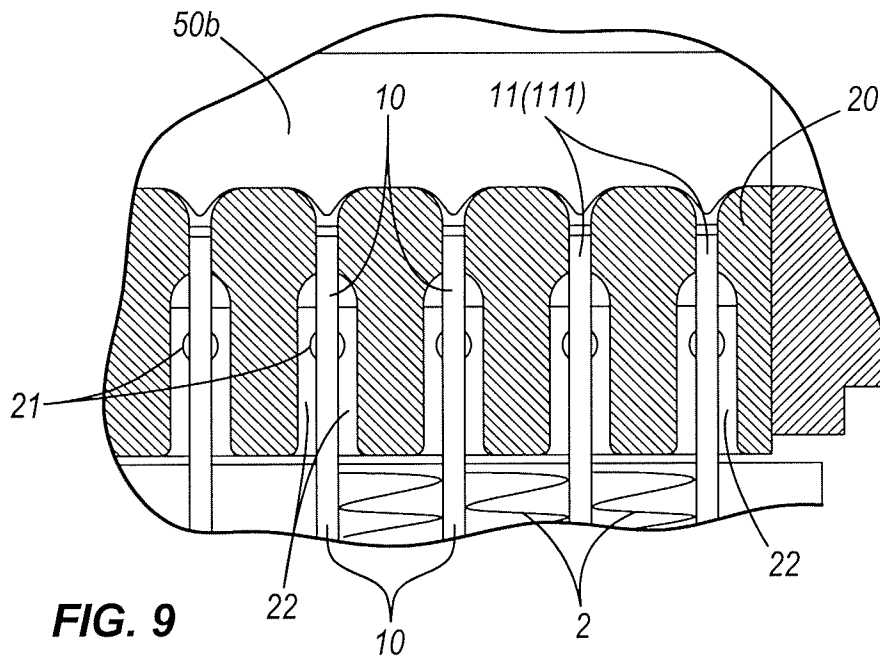


FIG. 7
SECTION
D-D

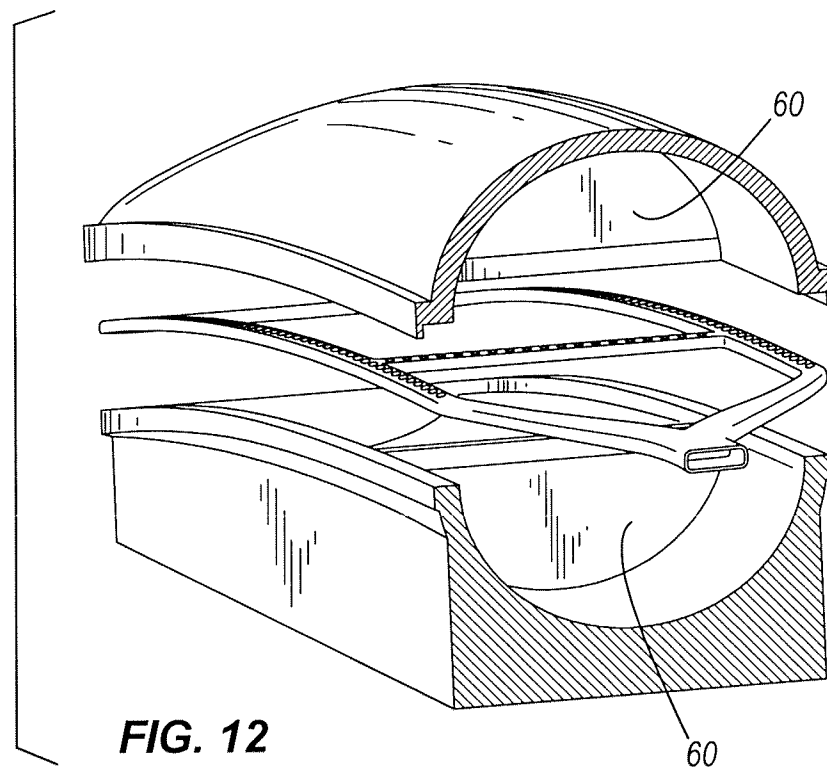
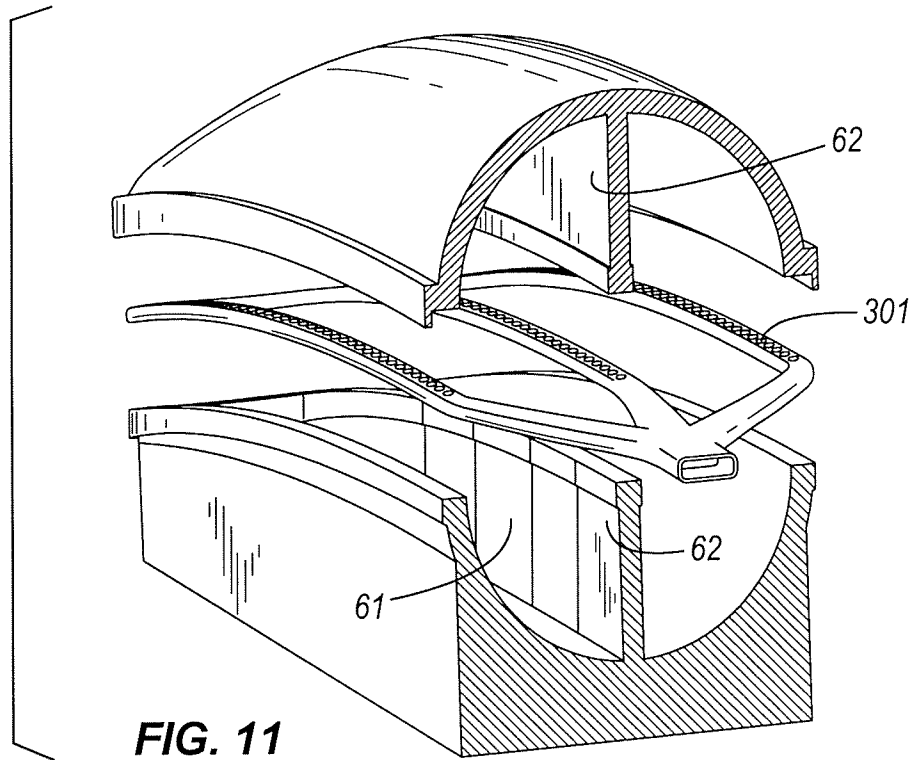
5/8



6/8



7/8



8/8

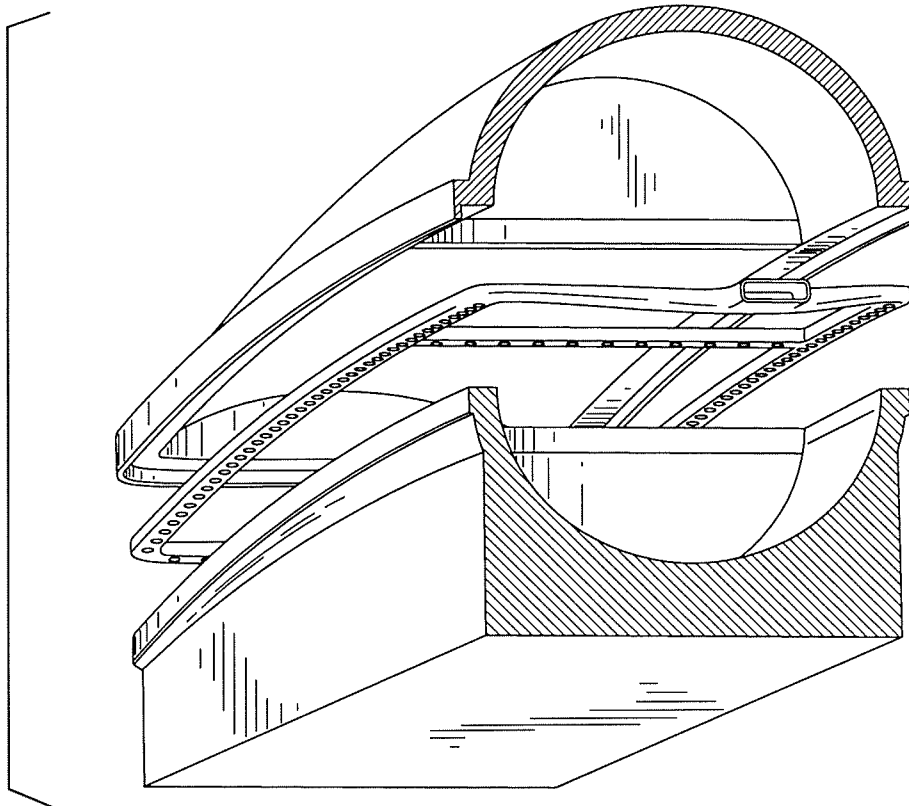


FIG. 13

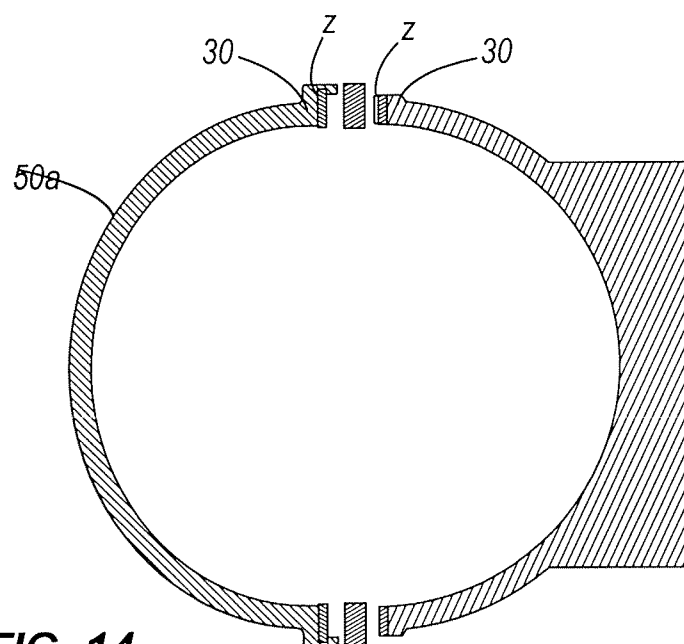


FIG. 14

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2007/086008

A. CLASSIFICATION OF SUBJECT MATTER <i>F28F 9/02(2006.01)i, F28F 9/013(2006.01)i</i> 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 8 : F28F 9/02 Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Korean utility models and applications for utility models since 1975 Japanese utility models and applications for utility models since 1975 Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) eKIPASS (KIPO internal) : oval, round, cross-section, tank, plastic		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 10-292996 A (BEHR GMBT & CO) November 4, 1998 See the claim 8, paragraph number 4, 5, 6 and 17, and 2, 5, and 14	1 - 6, 8 - 20
Y	US 5,036,914 A (NISHISHITA ET AL.) August 6, 1991 See column 2 line 57 to 68 and figure 5 and claim 1	2, 6, 8 - 11, 20
Y	US 4,576,223 A (HUMPOLIK ET AL) March 18, 1986 See the abstract and column 4 line 33 to line 48 and representative figure	3, 4, 5
Y	US 5,329,990 A (CHIGIRA) July 19, 1994 See figures 10 and 11 and column 3 line 49 to column 4 line 46	12 - 19
☐ Further documents are listed in the continuation of Box C. ☒ See patent family 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 application or patent 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 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 13 MAY 2008 (13.05.2008)		Date of mailing of the international search report 13 MAY 2008 (13.05.2008)
Name and mailing address of the ISA/KR  Korean Intellectual Property Office Government Complex-Daejeon, 139 Seonsa-ro, Seo-gu, Daejeon 302-701, Republic of Korea Facsimile No. 82-42-472-7140		Authorized officer LEE, Byung Jae Telephone No. 82-42-481-8560 

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2007/086008

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP10292996 A	04. 11. 1998	DE19722098A1	17. 09. 1998
		EP864840B1	26. 09. 2001
		ES2162358T3	16. 12. 2001
		US06068050	30. 05. 2000
US05036914 A	06. 08. 1991	US5036914A	06. 08. 1991
		US5092398A	03. 03. 1992
US04576223 A	18. 03. 1986	BR8306877A	31. 07. 1984
		DE3247502A1	19. 07. 1984
		DE3247502C2	09. 05. 1985
		EP0113003A1	11. 07. 1984
		EP113003A1	11. 07. 1984
		EP113003B1	03. 02. 1988
		ES275529U	16. 03. 1984
		ES275529Y1	25. 10. 1984
		ES527049A5	12. 07. 1984
		ES8405930A1	01. 10. 1984
		JP3018118B4	11. 03. 1991
		JP59119194A2	10. 07. 1984
		JP59119194	10. 07. 1984
		US4576223A	18. 03. 1986
US05329990 A	19. 07. 1994	JP04062393	27. 02. 1992
		JP2801373B2	21. 09. 1998
		JP4062393A2	27. 02. 1992
		US5251694A	12. 10. 1993
		US5329990A	19. 07. 1994