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Declarations under Rule 4.17:

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[Continued on next page]

(54) Title: FLEXIBLE PIPE FITTING

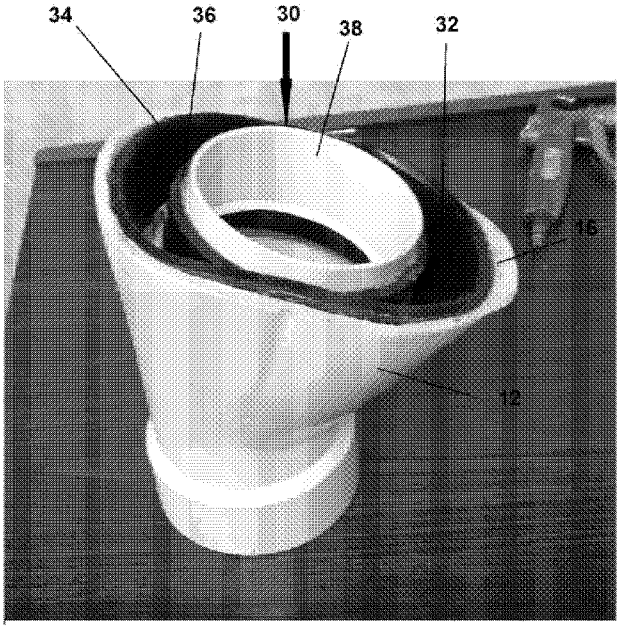

FIGURE 7

(57) Abstract: A flexible pipe fitting for joining a first length of pipe to a second length of pipe at an arbitrary angle is provided. The apparatus includes a primary fitting having a substantially circular opening at a first end thereof for receiving an end of a first length of pipe, and an enlarged opening at a second end thereof for receiving a first flexible coupling member. The first flexible coupling member includes an outer wall having an outer surface engaging an inner surface of the enlarged opening, and an inner wall having a lower end connected to a lower end of the outer wall. The inner wall further includes a substantially circular opening therein for receiving a second, rigid member. The inner surface of the second, rigid member is configured to receive an end of the second length of pipe. The enlarged opening in the primary fitting is preferably fish-mouth shaped, or alternatively, cone shaped. Adhesive, such as PVC cement may be used to bond the various fittings, and lengths of pipe together to form a sealed joint.

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— *with international search report (Art. 21(3))*

— *with amended claims and statement (Art. 19(1))*

FLEXIBLE PIPE FITTING

FIELD OF THE INVENTION

The present invention relates generally to pipe fittings, and methods of assembling pipe fittings, and in particular to a flexible pipe fitting and method for assembling pipes at various angles.

BACKGROUND OF THE INVENTION

A variety of fittings and connectors have previously been developed for joining fluid-conveying pipes and other components. Common connectors include couplings, crosses, elbows, tees, unions and wyes. These connectors are used to join two lengths of pipe, such as PVC pipe for carrying fluids. Elbows are used to account for direction changes in the pipe string. Common elbow fittings are at fixed angles and include 90 degree elbows, 45 degree elbows, and 22 ½ degree elbows.

Flexible couplings, such as those manufactured by Fernco, also exist in the marketplace. While flexible, these couplings are limited in their range of motion to approximately 5 degrees and cost significantly more than standard PVC pipe. Further, these couplings require pipe clamps to be placed at each end of the fitting to secure the coupling to the pipe, and are made of rubber.

Swivel or ball fittings, such as are disclosed in U.S. Patent No. 2,286,565, have also been used to allow for connecting pipes that are not aligned at angles which are common to elbow fittings as discussed above. However, these types of fittings have multiple additional parts and components, such as o-rings, compression fittings and the like, that can create additional opportunities for leakage.

SUMMARY OF THE INVENTION

The present invention overcomes these limitations by providing a variable fitting that has no gaskets, swivels, or moving parts that could leak. The device and method of the present invention are intended to replace existing pipe fittings that only provide for a fixed angle or are made of flexible materials that are inferior due to the lack of rigidity and increased risk of failure or blockage.

Use of the present invention allows for joining of two pipes together at arbitrary angles. It also replaces the need to stock several fixed angle pipe fittings, such as 45 degree and 22 ½ degree fittings.

According to one aspect of the present invention, there is provided an apparatus for joining a first length of pipe to a second length of pipe at an arbitrary angle. The apparatus includes a primary fitting having a substantially circular opening at a first end thereof for receiving an end of said first length of pipe, and an enlarged opening at a second end thereof. A first flexible coupling member may be positioned in the enlarged opening. The first flexible coupling member includes an outer wall having an outer surface engaging an inner surface of the enlarged opening, and an inner wall having a lower end connected to a lower end of the outer wall. The inner wall further includes a substantially circular opening therein for receiving an end of the second length of pipe.

A further aspect of the invention includes a second, rigid member having an outer surface engaging the substantially circular opening of the inner wall. An inner surface of the second, rigid member is configured to receive the end of the second length of pipe.

Yet another aspect of the present invention is the use of an adhesive interposed between the various components of the apparatus for bonding the components together.

According to another aspect of the present invention, the first, flexible member may be formed of a polymeric material that is strong, resilient and unaffected by soil conditions. That material may be inert and resistant to chemicals, ultraviolet rays, fungus growth, and normal sewer gases. In addition, the polymeric material may be leak-proof, root-proof and seals against infiltration and exfiltration. Preferably, the polymeric material may be elastomeric polyvinyl chloride (PVC). Similarly, the primary fitting and the second, rigid member may preferably be formed of a rigid plastic material selected from a group consisting of PVC, CPVC, ABS, SDR 21, SDR 26 and SDR 35.

According to a further aspect of the invention, the enlarged opening is fish-mouth shaped to allow for a significant range of motion. Alternatively, the enlarged opening may be substantially cone shaped.

These and other objects, features and advantages of the present invention will become apparent with reference to the text and the drawings of this application.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a front perspective view of a fish mouth pipe fitting according to a presently preferred embodiment of the invention.

FIGURE 2 a top view of the fish mouth pipe fitting shown in FIGURE 1.

FIGURE 3 is a front elevation view of the fish mouth pipe fitting shown in FIGURE 1.

FIGURE 4 is a side elevation view of the fish mouth pipe fitting shown in FIGURE 1.

FIGURE 5 is a side sectional view of the fish mouth pipe fitting of FIGURE 3 shown along the line A-A.

FIGURE 6 is a bottom view of the fish mouth pipe fitting shown in FIGURE 1.

FIGURE 7 is a side perspective view of the fish mouth pipe fitting shown in FIGURE 1 with a flexible fitting inserted into the fish mouth opening.

FIGURE 8 is a front perspective view of the fish mouth pipe fitting shown in FIGURE 1 with a flexible fitting inserted into the fish mouth opening.

FIGURE 9 is a top view of the fish mouth pipe fitting shown in FIGURE 1 with a flexible fitting inserted into the fish mouth opening.

FIGURE 10 is a front perspective view of a fish mouth pipe fitting according to an alternative embodiment of the invention.

FIGURE 11 a top view of the fish mouth pipe fitting shown in FIGURE 10.

FIGURE 12 is a front elevation view of the fish mouth pipe fitting shown in FIGURE 10.

FIGURE 13 is a side elevation view of the fish mouth pipe fitting shown in FIGURE 10.

FIGURE 14 is a side sectional view of the fish mouth pipe fitting of FIGURE 12 shown along the line A-A.

FIGURE 15 is a bottom view of the fish mouth pipe fitting shown in FIGURE 10.

FIGURE 16 is a side perspective view of the fish mouth pipe fitting shown in FIGURE 10 with a flexible fitting inserted into the fish mouth opening.

FIGURE 17 is a top view of the fish mouth pipe fitting shown in FIGURE 10 with a flexible fitting inserted into the fish mouth opening.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

As best shown in **FIGURES 1-6**, the present invention is an innovative flexible pipe connector **10** having a primary fitting **12** which has a substantially circular opening

14 at a first end thereof, and a fish-mouth shaped opening **16** and a second end thereof. The circular opening **14** at the first end is configured to receive an end of a pipe **20** therein. The size of the circular opening **14** corresponds to the exterior diameter of the pipe to be received therein such that a tight, friction fit is created. For example, standard PVC and CPVC pipe, schedule 40 and schedule 80, used in plumbing applications have nominal diameters of ½", ¾", 1", 1 ¼", 1 ½", 2", 2 ½", 3", 4", 5", 6", 8", 10", 12", 14" and 16". The circular opening **14** may preferably be sized to accommodate one of these pipe sizes. Alternatively, the fish-mouth shaped opening **16** can be formed directly into the end of a length of pipe. The specific geometry of the fish-mouth opening **16** can be varied to accommodate a greater or lesser range of angles without departing from the spirit of the invention. An infinite number of angles between 0 degrees and 42 degrees can be achieved.

As shown in **FIGURES 7-9**, a flexible coupling **30** may be provided in the opening **16** to allow for a pipe to be inserted into the opening **16** at a variety of angles. The flexible coupling **30** may include a first, flexible member **32** having an outer wall **34** with a shape similar to the shape of, and configured to engage, the opening **16**, and an inner wall **36** having a substantially circular opening therein for engaging a second, rigid member **38**. The second, rigid member **38** has an opening therein for receiving a length of pipe (not shown) to be joined to the length of pipe **20** which is connected to the circular opening **14** in the fitting **12**. Alternatively, the opening in the inner wall **36** may be sized to receive the length of pipe (not shown) without the need for a second rigid member **38**.

The first, flexible member **32** is formed of a polymeric material that is strong, resilient and unaffected by soil conditions. The material must also be resistant to chemicals, ultraviolet rays, fungus growth, and normal sewer gases due to the inert nature and physical properties of the material. The material must also be leak-proof, root-proof and seal against infiltration and exfiltration. According to one preferred embodiment of the present invention, the first, flexible member **32** is made of elastomeric polyvinyl chloride (PVC).

The outer wall **34** of the first flexible member **32** is secured and sealed against the inner wall of the opening **16**. Similarly, the inner wall **36** of the first flexible member **32** is secured and sealed against the outer surface of the second rigid member **38**. Preferably, some type of water-resistant or water-proof adhesive, such as PVC cement, that will bond to the two different materials is used.

The pipe connector **10** preferably comes pre-assembled in that the outer wall **34** of the first flexible member **32** has been pre-glued to the opening **16** of the primary fitting **12** and the inner wall **36** of the first flexible member **32** has been pre-glued to the outer surface of the second rigid member **38**. Use of the pipe connector **10** at this point is as simple as priming one end of the outer surface of the pipe **20** and the inner surface of the circular opening **14**. Glue or PVC cement is then applied to the outer surface of the end of the pipe **20** and/or the inner surface of the circular opening **14**. The end of the pipe **20** is then inserted into the circular opening **14** and given a quarter turn. Once the glue/cement is dry, primer is applied to both the inner surface of the second rigid member **38** and the outer surface of the second pipe (not shown). Glue or PVC cement is then applied to the inner surface of the second rigid member **38** and outer surface of the

second pipe (not shown), and the end of the second pipe is inserted into the second rigid member **38** and given a quarter turn. Once the glue is dried, the fitting is ready for use.

The primary fitting **12** and second, rigid member **38** are preferably formed of a plastic material such as PVC or CPVC. Other plastics, such as ABS, SDR 21, SDR 26, SDR 35 as well as others that may now, or in the future be used in plumbing applications, may also be used. Other rigid or semi-rigid materials other than plastics, such as metals or composite materials, are also contemplated.

An alternative embodiment of the present invention is shown in **FIGURES 10-17**. This alternative embodiment is identical to the preferred embodiment shown in **FIGURES 1-9**, with the exception of the shape of the enlarged opening **16,** and the shape of the corresponding outer wall **34** of the first flexible member **32**. Instead of a fish-mouthed shape, the enlarged opening **16** and outer wall **34** according to the alternative embodiment are substantially cone shaped. In all other respects, the alternative embodiment is identical to the preferred embodiment of **FIGURES 1-9**, wherein like reference numerals indicate like components. As such, to avoid repetition, a specific description of the remaining components of the alternative embodiment will not be discussed.

The foregoing is provided for purposes of illustrating, explaining, and describing embodiments of the present invention. The specific components and order of the steps listed above, while preferred is not necessarily required. Further modifications and adaptation to these embodiments will be apparent to those skilled in the art and may be made without departing from the scope or spirit of the invention.

CLAIMS

1. An apparatus for joining a first length of pipe to a second length of pipe at an arbitrary angle comprising:

a primary fitting having a substantially circular opening at a first end thereof for receiving an end of said first length of pipe, and an enlarged opening at a second end thereof, said enlarged opening being substantially larger than an outer diameter of the second length of pipe; and

a first flexible coupling member positioned in the enlarged opening, said first flexible coupling member having an outer wall having an outer surface engaging an inner surface of the enlarged opening, and an inner wall having a lower end connected to a lower end of the outer wall, said inner wall further including a substantially circular opening therein for receiving an end of said second length of pipe.

2. The apparatus of claim 1, further comprising a second, rigid member having an outer surface engaging the substantially circular opening of said inner wall of said first flexible coupling member, and an inner surface for receiving the end of the second length of pipe.

3. The apparatus of claim 2, further comprising adhesive interposed between the first flexible coupling member and the enlarged opening, and between the first flexible coupling member and the second, rigid member for bonding said components together.

4. The apparatus of claim 2, wherein the first, flexible member is formed of a polymeric material that is resilient and unaffected by soil conditions.

5. The apparatus of claim 4, wherein the polymeric material is inert and resistant to chemicals, ultraviolet rays, fungus growth, and sewer gases.

6. The apparatus of claim 4, wherein the polymeric material is leak-proof, root-proof and seals against infiltration and exfiltration.

7. The apparatus of claim 4, wherein the polymeric material is elastomeric polyvinyl chloride (PVC).

8. The apparatus of claim 2, wherein the primary fitting and the second, rigid member are formed of a rigid plastic material.

9. The apparatus of claim 8, wherein the rigid plastic material is selected from a group consisting of PVC, CPVC, and ABS.

10. The apparatus of claim 1, wherein the enlarged opening is fish-mouth shaped.

11. The apparatus of claim 1, wherein the enlarged opening is substantially cone shaped.

AMENDED CLAIMS
received by the International Bureau on 22 October 2015 (22.10.2015)

1. An apparatus for joining a first length of pipe to a second length of pipe at an arbitrary angle comprising:

a primary pipe fitting having a substantially circular opening at a first end thereof for receiving an end of said first length of pipe, and an enlarged opening at a second end thereof, said enlarged opening being large enough relative to an outer diameter of the second length of pipe to permit the second length of pipe to be oriented at an arbitrary angle relative to the primary pipe fitting; and

a first flexible pipe coupling member positioned in the enlarged opening, said first flexible coupling member having an outer wall having an outer surface engaging an inner surface of the enlarged opening, and an inner wall having a lower end connected to a lower end of the outer wall, said inner wall further including a substantially circular opening therein for receiving an end of said second length of pipe to permit the second pipe to be inserted therein at an arbitrary angle relative to the primary pipe fitting.

2. The apparatus of claim 1, further comprising a second, rigid member having an outer surface engaging the substantially circular opening of said inner wall of said first flexible coupling member, and an inner surface for receiving the end of the second length of pipe.

3. The apparatus of claim 2, further comprising adhesive interposed between the first flexible coupling member and the enlarged opening, and between the first flexible coupling member and the second, rigid member for bonding said components together.

4. The apparatus of claim 2, wherein the first, flexible member is formed of a polymeric material that is resilient and unaffected by soil conditions.

5. The apparatus of claim 4, wherein the polymeric material is inert and resistant to chemicals, ultraviolet rays, fungus growth, and sewer gases.

6. The apparatus of claim 4, wherein the polymeric material is leak-proof, root-proof and seals against infiltration and exfiltration.

7. The apparatus of claim 4, wherein the polymeric material is elastomeric polyvinyl chloride (PVC).

8. The apparatus of claim 2, wherein the primary fitting and the second, rigid member are formed of a rigid plastic material.

9. The apparatus of claim 8, wherein the rigid plastic material is selected from a group consisting of PVC, CPVC, and ABS.

10. The apparatus of claim 1, wherein the enlarged opening is fish-mouth shaped.

11. The apparatus of claim 1, wherein the enlarged opening is substantially cone shaped.

12. The apparatus of claim 1, wherein the arbitrary angle is between 0 degrees and 42 degrees.

STATEMENT UNDER ARTICLE 19(1)

Pursuant to Article 19(1), Applicant hereby submits the following statement explaining the amendment submitted herewith.

NOVELTY

Claims 1, 2 and 10 were identified in the Written Opinion of the International Searching Authority as lacking novelty based on U.S. Patent No. 5,390,960 issued to Blake (hereinafter "Blake"). A claim lacks novelty under PCT Article 33(2) only if each and every feature of the claimed invention is disclosed in the cited reference. The present invention, as set forth in amended independent claim 1, and in dependent claims 2 and 10 is novel in light of Blake.

Blake teaches a fitting for mating a fluid flow main line with a branch line, wherein the fitting is mated to a T interposed in the main line which the branch line in intended to intersect. The primary purpose of the proposed fitting is to provide for relative telescoping movement between the fitting and the branch line. A plurality of staggered retaining rings 32, 46, 46' are seated in corresponding annular

recesses formed in the inner surface 36 of the conduit segment 28. As the earth settles, pressure is increased downwardly upon the vertical portion of the branch line 20. When the force achieves a level greater than what the retaining ring can endure, the ring will shear, and the branch line vertical portion will drop within the conduit segment 28 until it comes into engagement with the next highest retaining ring. The "outer diameter of the branch line 20 is substantially the same as the inner diameter of the expanded portion 38 of the fitting 24" (Column 4, lines 66-68).

The present invention concerns a fitting wherein two pipes are joined at various angles, rather than a telescoping fitting as taught by Blake. In fact Blake, with its branch line having an outer diameter that is substantially the same as the inner diameter of the expanded portion (column 4, lines 66-68), can only telescope and cannot pivot or adapt to various angles due to the tight fit between the two pipes that effectively requires the pipes be oriented in a straight line relative to one another. Independent claim 1 has been amended to more clearly recite this distinction. Claim 1, as amended, now recites "said enlarged opening being large enough relative to an outer diameter of the second length of pipe to permit the second length of pipe to be oriented at an arbitrary angle relative to the primary pipe fitting". The fact that the enlarged opening is larger enough than the outer diameter of the second length of pipe is what allows the angle at which the second length of pipe to vary. To the contrary, the angle of intersection of pipes cannot be altered in the fitting taught by Blake as the substantially same diameters of the two pipes prevents such movement.

Claims 2 and 10 depend directly or indirectly from independent claim 1 and contain all the limitations of the base claim 1. Accordingly, claims 2 and 10 are novel for at least the reasons set forth above with regard to independent claim 1.

INVENTIVE STEP

Claims 3, 4 and 6-9 were identified in the Written Opinion of the International Searching Authority as lacking inventive step based on Blake. Claims 3, 4 and 6-9 do not lack inventive step in view of Blake.

As above, Applicants contend that Blake fails to disclose or suggest the deficiencies of Blake with regard to the novelty of independent claim 1. Specifically, as discussed above, Blake actually teaches away from what is set forth in claim 1. Not only does Blake fail to expressly teach an "apparatus for joining a first length of pipe to a second length of pipe at an arbitrary angle" (emphasis added), the fact that Blake teaches a branch line having an outer diameter "substantially the same as the inner diameter of the expanded portion", expressly precludes orienting first and second pipes at any angle other than 180 degrees. The amendment to claim 1 requiring that the enlarged opening is "substantially larger than the outer diameter of the second length of pipe" is what permits the pipes to be oriented at such arbitrary angles.

Blake, on the other hand, teaches diameters of mating pipes that are "substantially the same", rather than "substantially larger" as set forth in claim 1. As claims 3, 4 and 6-9 depend, either directly or indirectly, from independent claim 1, they meet the test for inventive step for at least the reasons claim 1 does.

Claim 11 was identified in the Written Opinion of the International Searching Authority as lacking inventive step based on Blake in view of Hombach. Claim 11 does not lack inventive step in view of Blake and Hombach.

As an initial matter, Applicants contend that Hombach fails to disclose or suggest the deficiencies of Blake with regard to independent claim 1 as discussed above. As claim 11 depends, either directly or indirectly, from independent claim 1, meets the inventive step requirements for at least the reasons claim 1 meets the requirements.

Furthermore, Applicants contend that, as applied to the present situation, Blake and Hombach are non-analogous. Blake is concerned exclusively with the effects of earth settlement effects on a t-junction, and as such is directed to a telescoping pipe arrangement. Not only does the pipe connection system of Blake not concern attaching pipes at arbitrary angles, it specifically teaches away from such angles by requiring that "the outer diameter of the branch line 20 is substantially the same as the inner diameter of the expanded portion 38 of the fitting 24". Even though Hombach teaches a pipe hub having an enlarged opening, it would not have been obvious to combine this teaching with Blake, which specifically teaches the opposite - a pipe junction where both pipes have substantially the same diameters, thus prohibiting adjustment of the angle of one pipe relative to the other. As such, the combination of Blake and Hombach for this purpose is inappropriate and claim 11 meets the inventive step requirement.

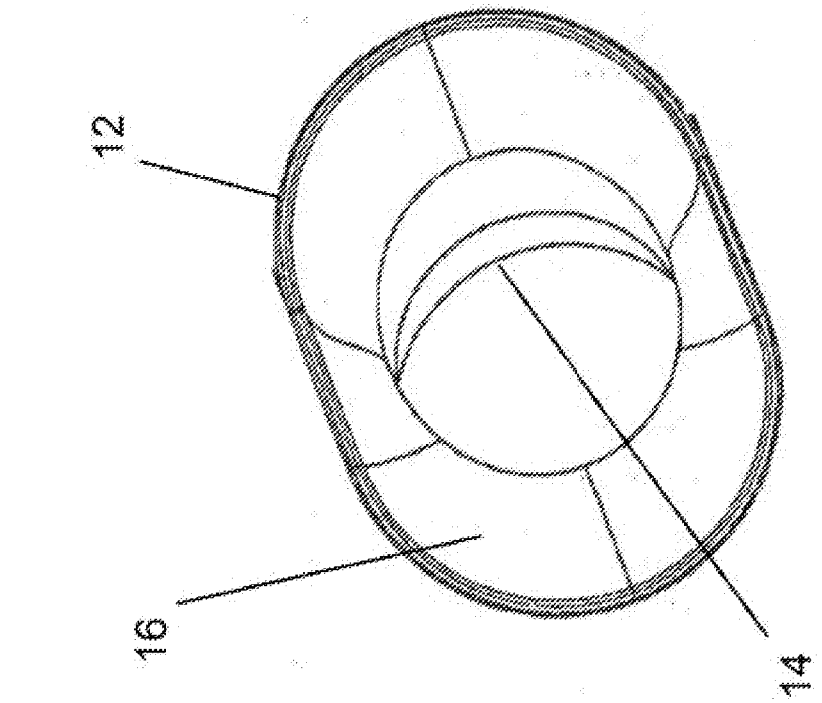

FIGURE 2

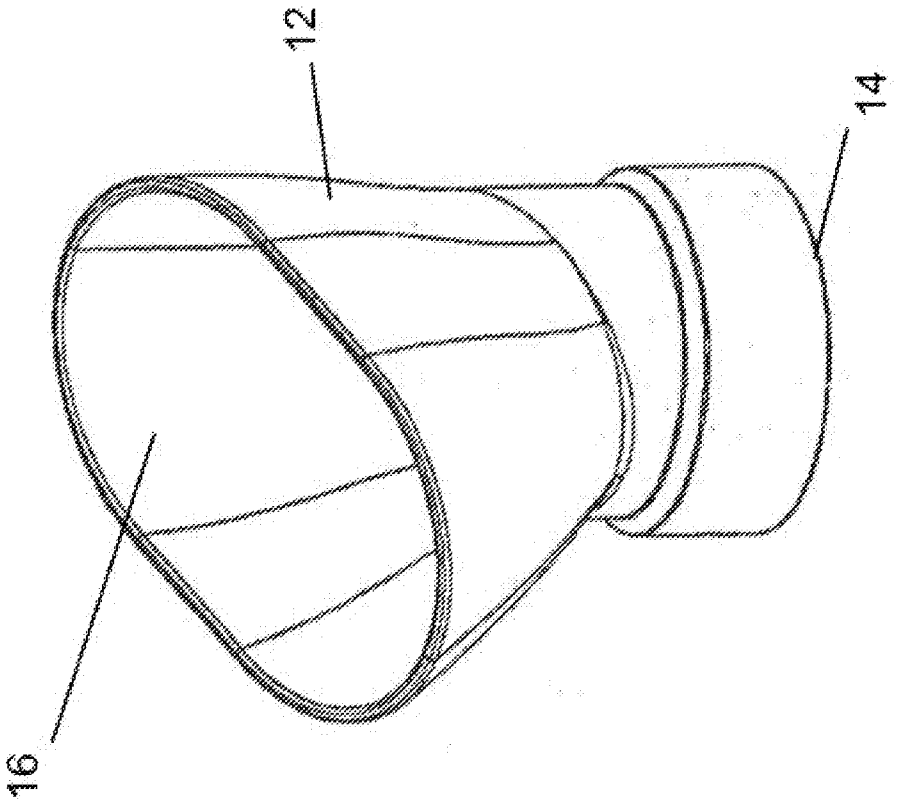

FIGURE 1

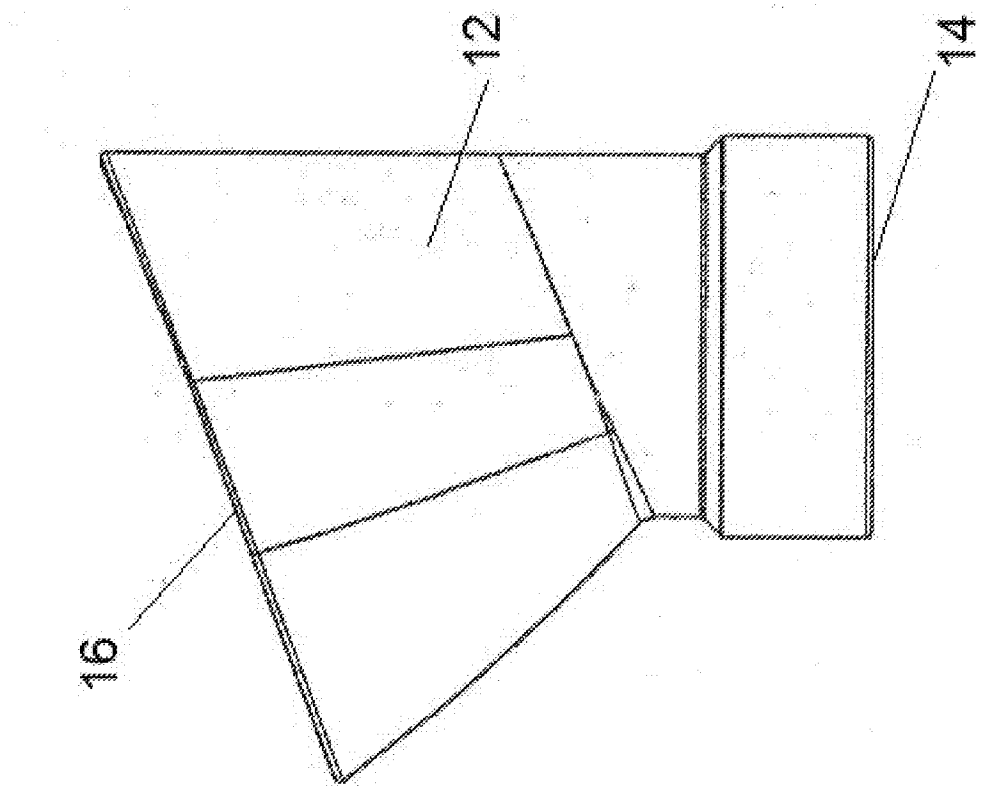

FIGURE 4

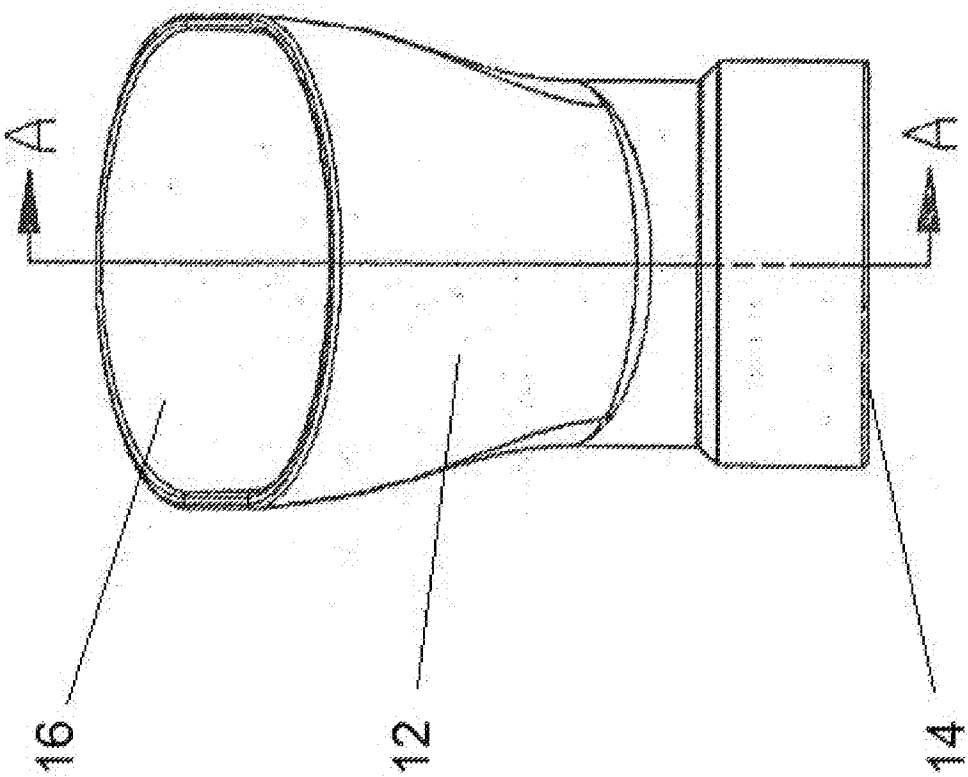

FIGURE 3

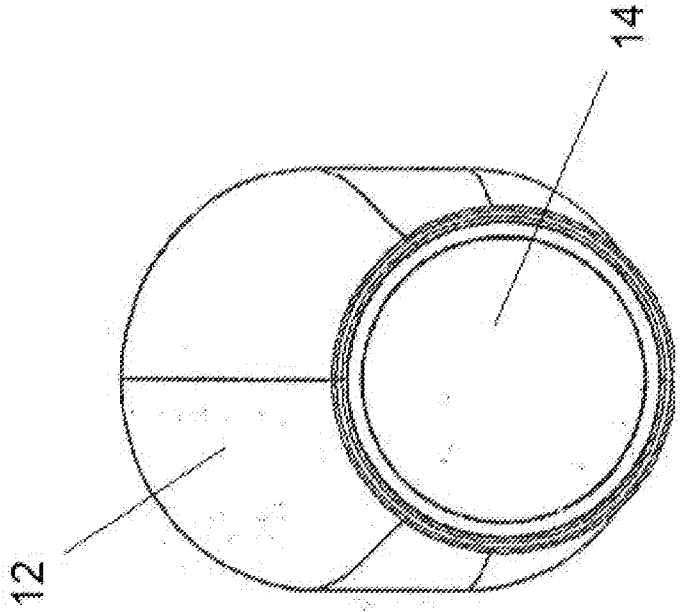

FIGURE 6

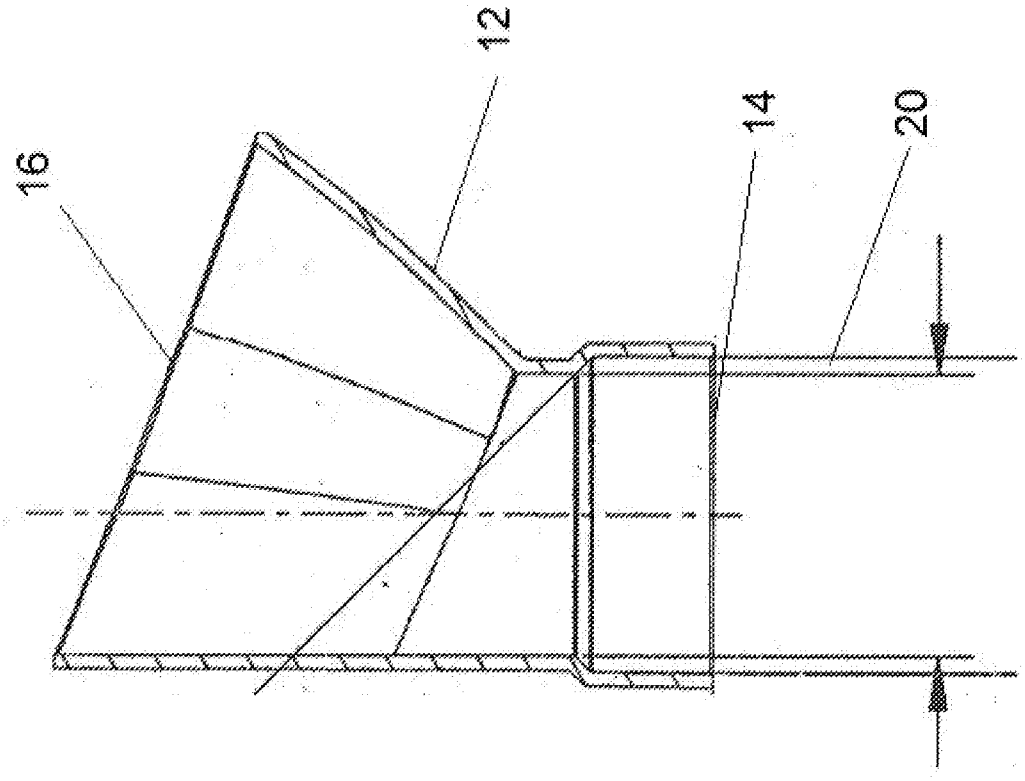

FIGURE 5

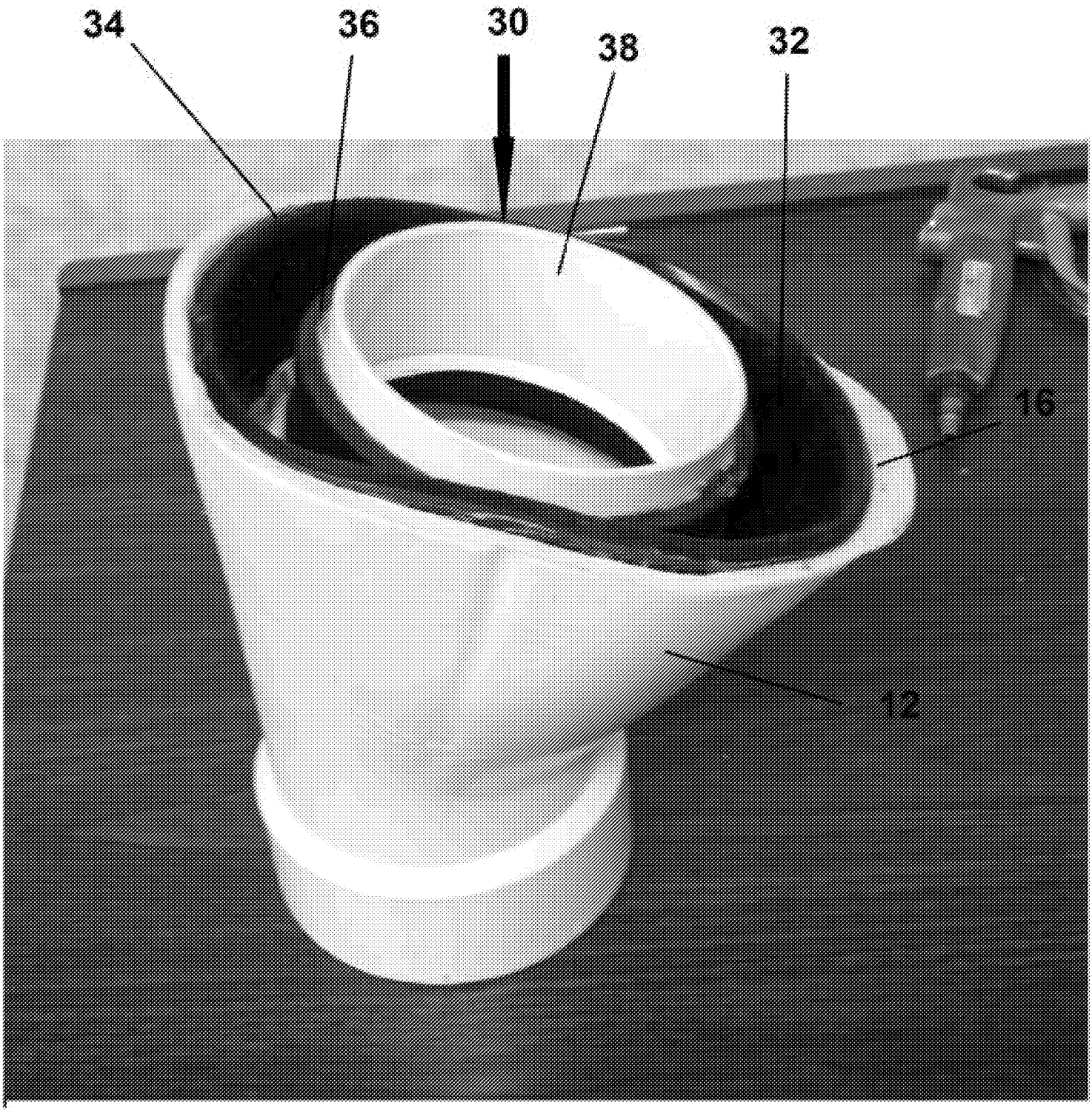

FIGURE 7

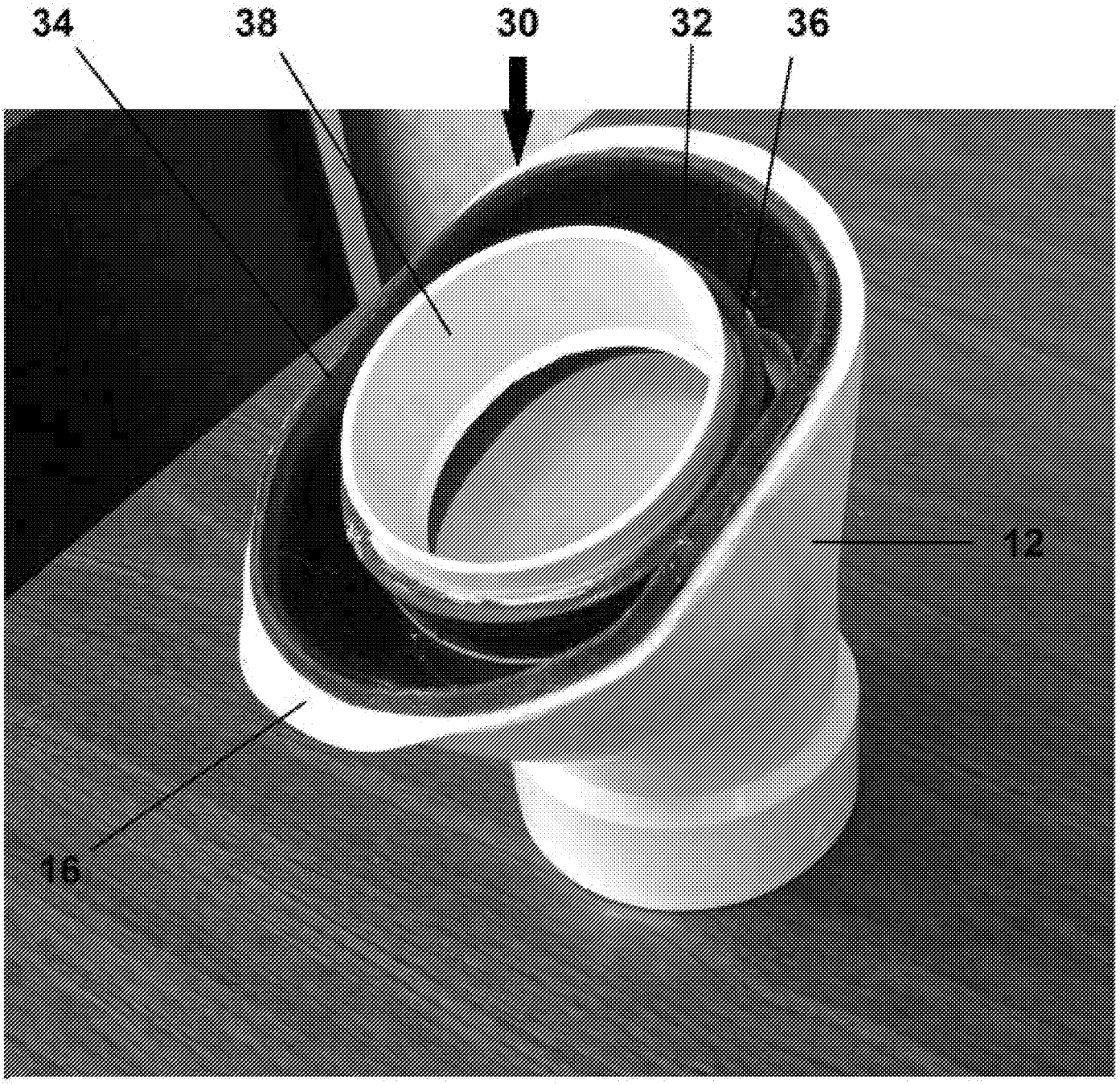

FIGURE 8

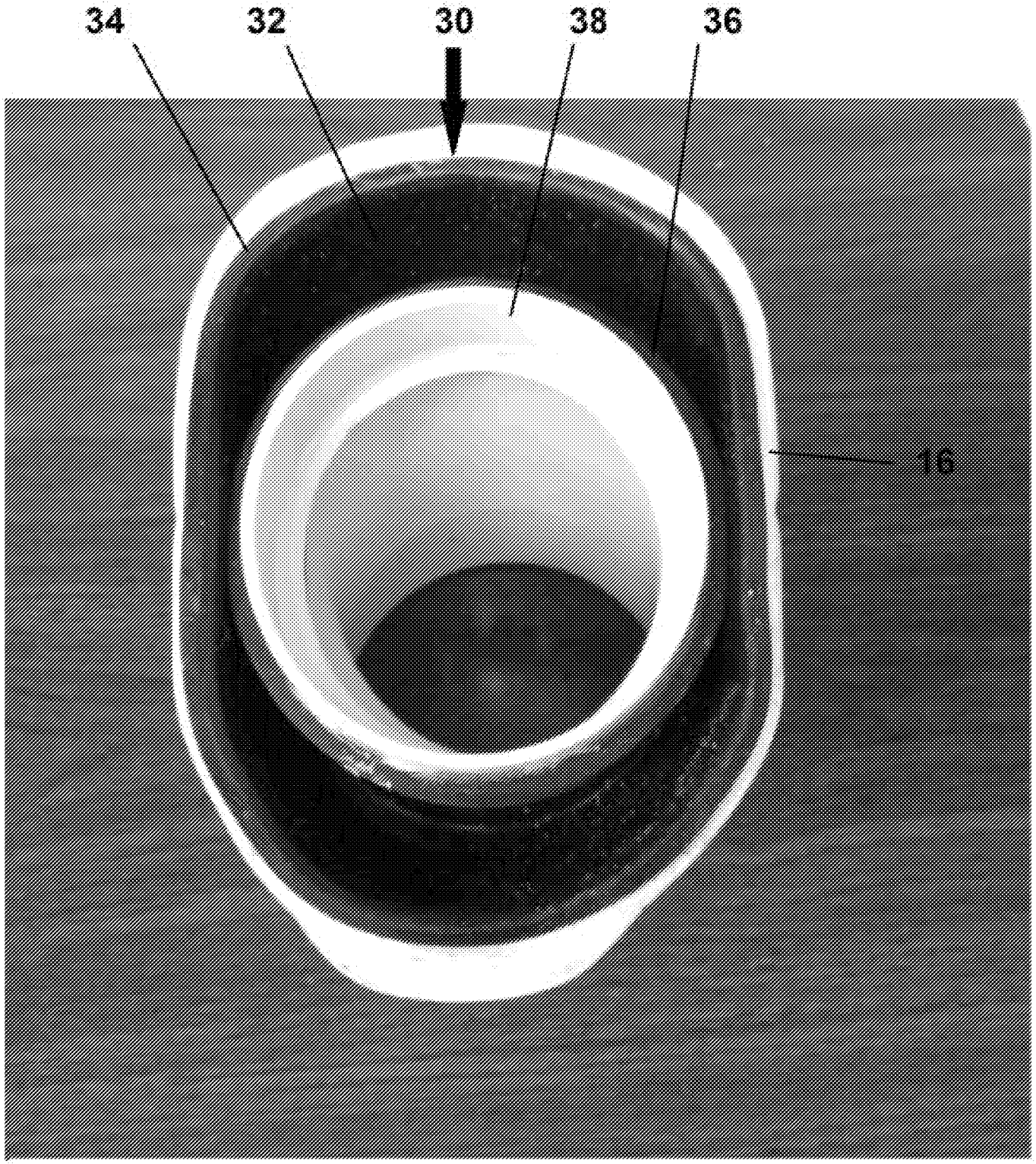

FIGURE 9

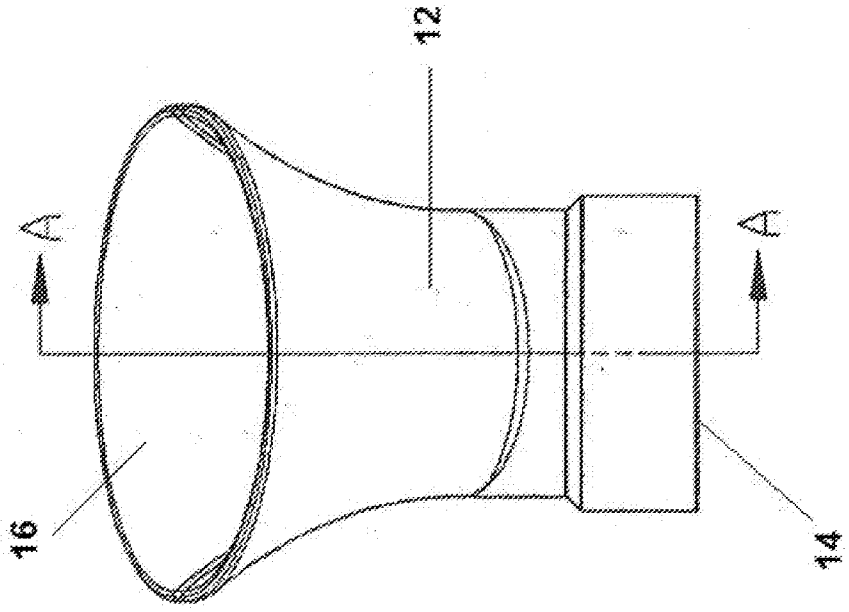

FIGURE 12

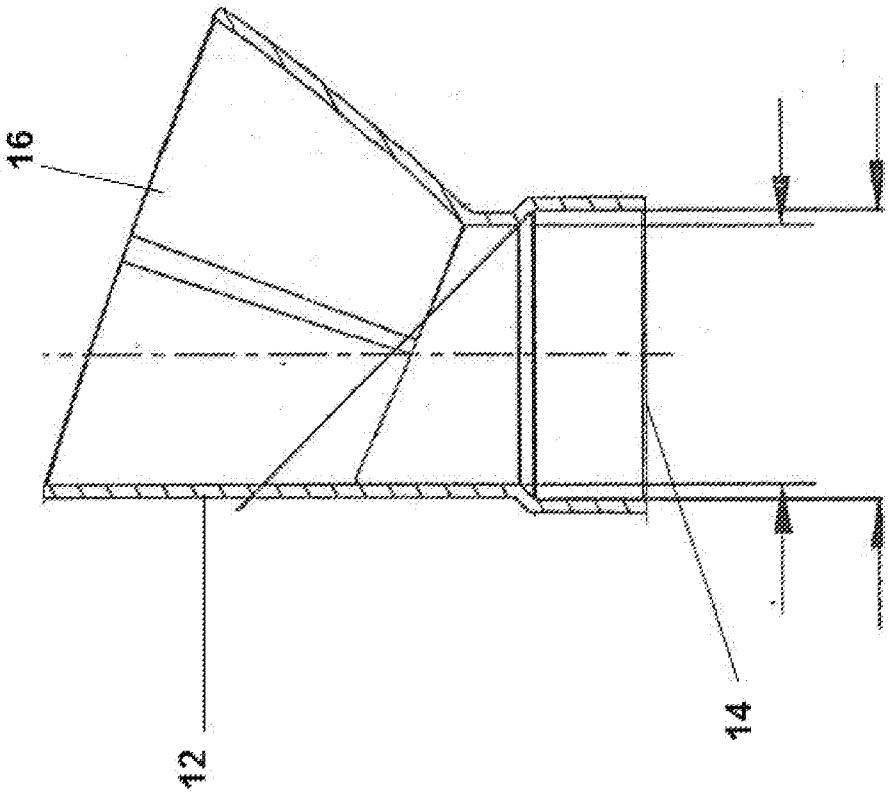

FIGURE 14

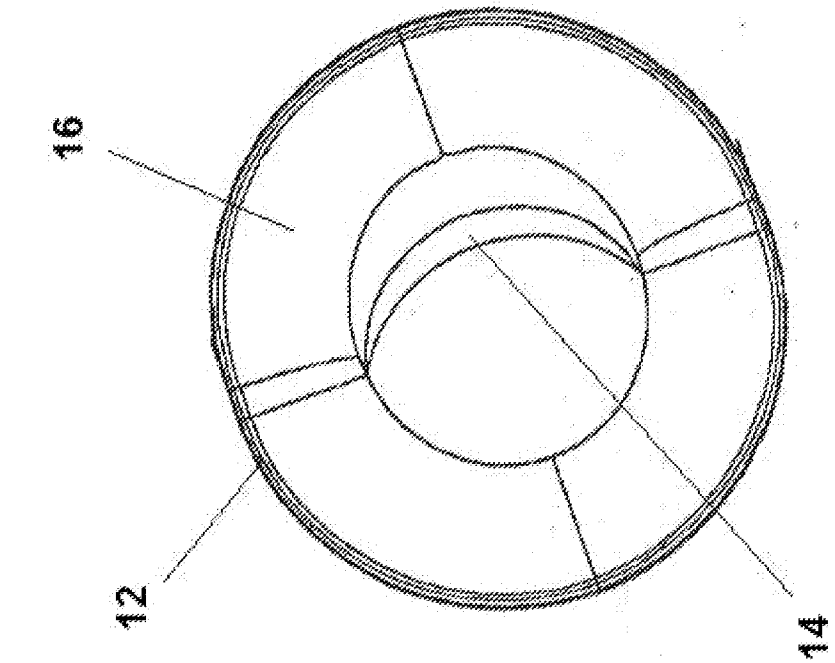

FIGURE 11

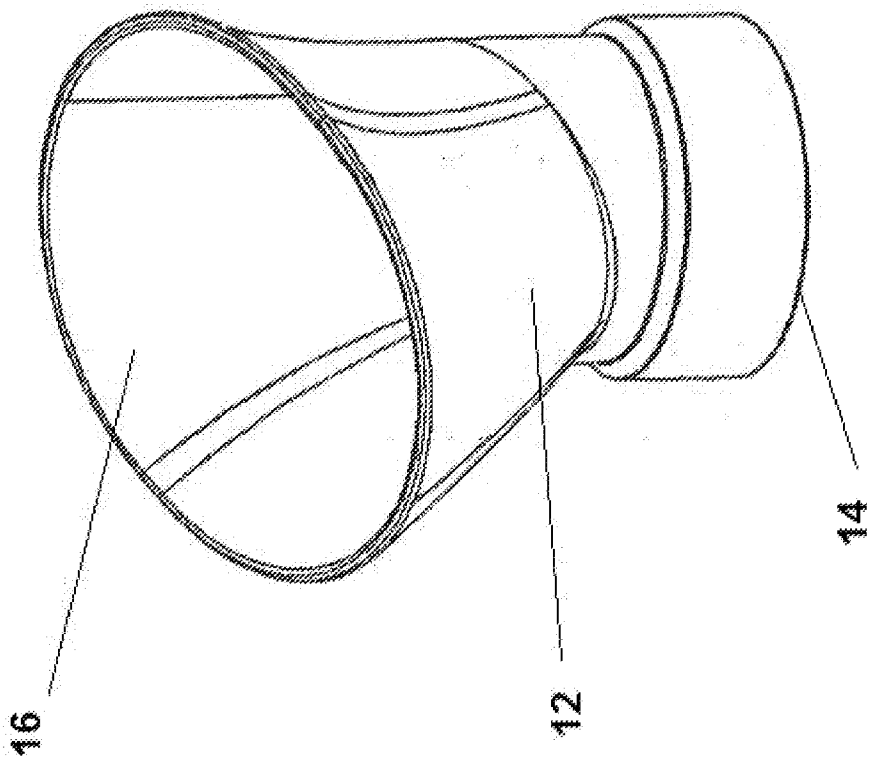

FIGURE 10

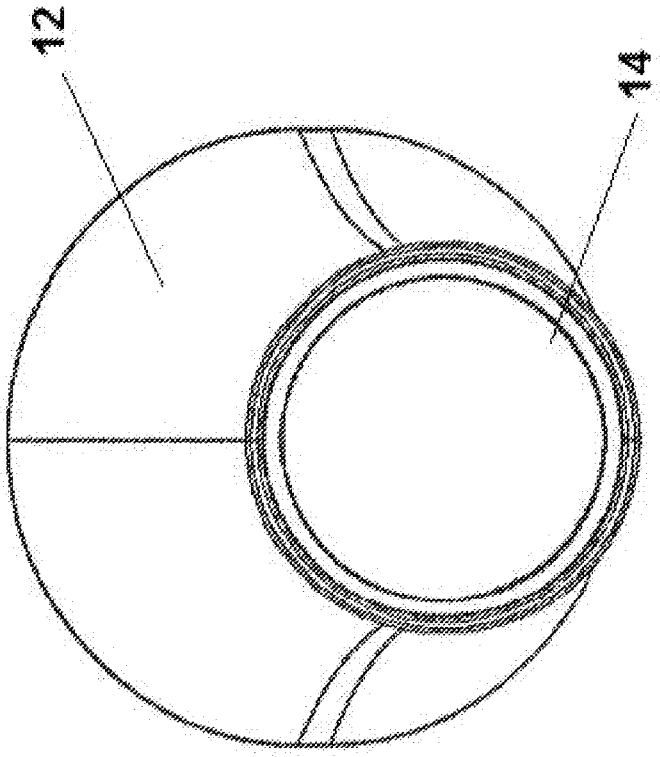

FIGURE 15

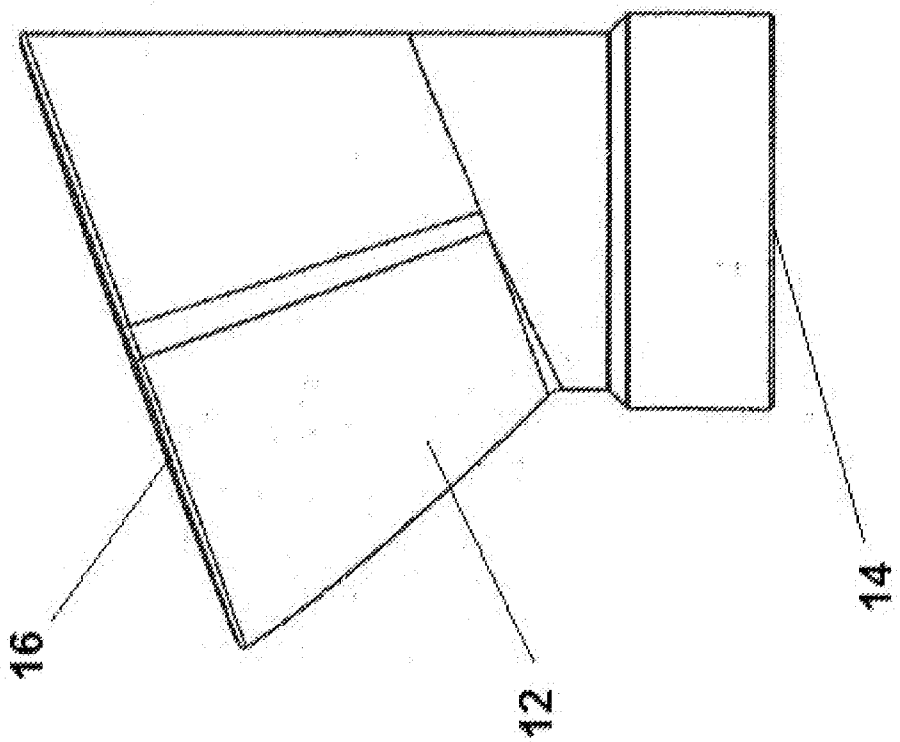

FIGURE 13

FIGURE 16

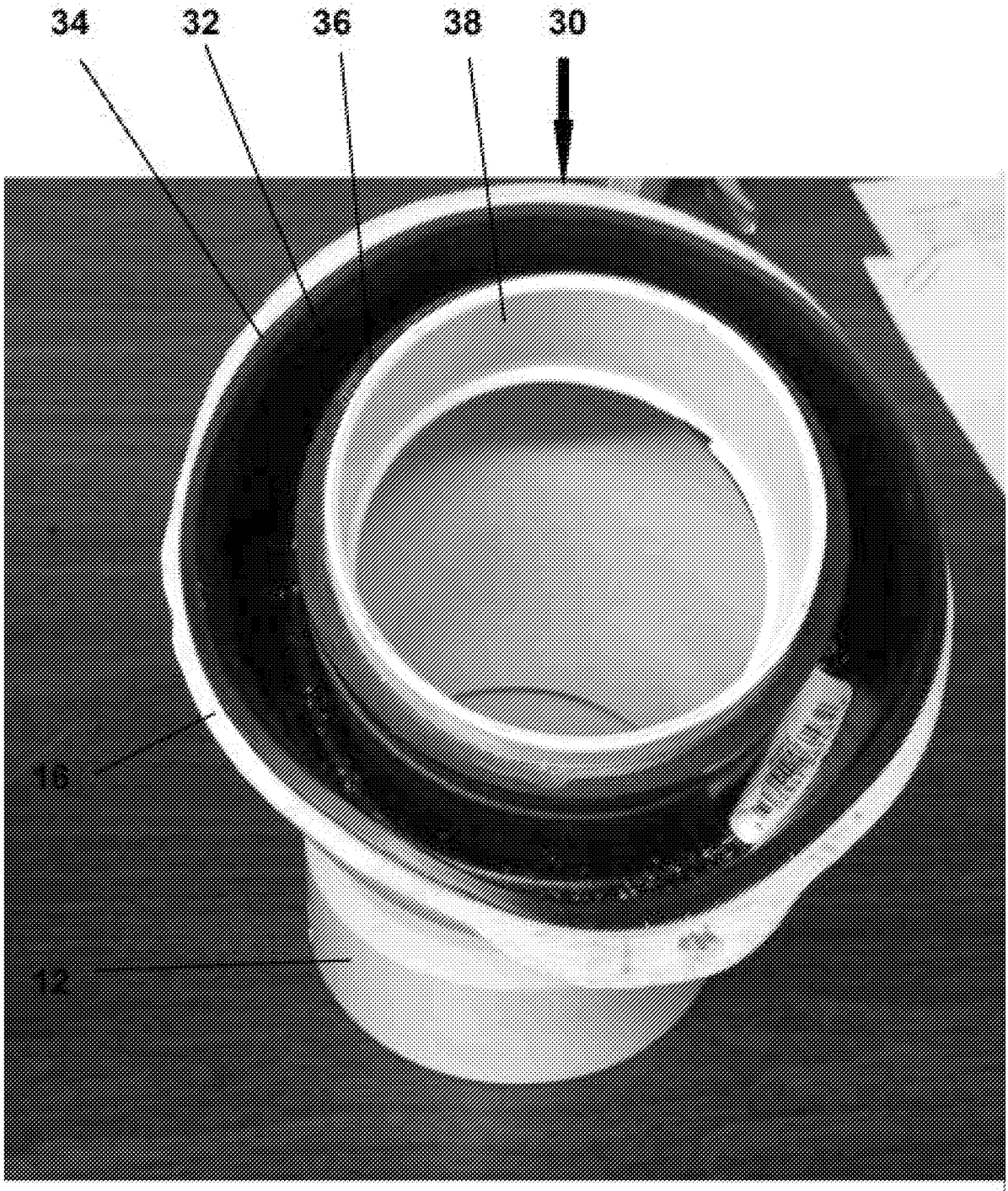

FIGURE 17

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US15/32994

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - F16L 27/073, 39/04 (2015.01)
CPC - F16L 27/073, 39/04
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): F16L 21/06, 27/073, 39/04 (2015.01)
CPC: F16L 13/116, 21/007, 27/073, 39/04

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 practicable, search terms used)
PatSeer (US Granted, US Applications, EP-A, EP-B, WO, JP, DE-G, DE-A, DE-T, DE-U, GB-A, FR-A); Google; Google Scholar; ProQuest Fitting, Coupling, pipe, conduit*, Angle*, Flexible, Bendable, variabl*, Cone, Conical*, PVC, CPVC, ABS, adhesiv*, adhere*, adhering

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 5,390,960 A (BLAKE WR) 21 February 1995 figures 1 and 8; column 2, lines 30-40), ; column 3, lines 10-15; column 4, lines 10-40; column 5, lines 10-15; column 6, lines 50-55	1-4, 6-10 --- 5, 11
Y	US 2,791,450 A (HOMBACH CJ) 07 May 1957 figure 9; column 2, lines 35-50	11
Y	Inhibition of Fungal Growth and Material Characteristics of PVC and Wood/PVC composites doped with Fungicides (online). Apisit Kositchaiyonga and Narongrit Sombatsompop, 2013 (2013) [retrieved 06 August 2015 (06.08.2015)]. Retrieved from the Internet: <URL. http://www.kmutt.ac.th/p-prof/P-PROF%20website_thai%20version/inter%20conf_Thai/AMR.747.343.pdf page 1, paragraph 1	5
A	Frequently Asked Questions on PVC (online). JM Eagle, 2011 [retrieved 06 August 2015 (06.08.2015)]. Retrieved from the Internet: <URL. http://www.jmeagle.com/plastic-pipe/faq.html#pvc page 2 paragraph 8; page 4, paragraphs 5-8	3, 4, 6-9

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
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"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	Date of mailing of the international search report
06 August 2015 (06.08.2015)	26 AUG 2015
Name and mailing address of the ISA/ Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-8300	Authorized officer Shane Thomas PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

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