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(54) Title: MANUFACTURE OF SHAPED CONTAINERS USING COMPRESSIVE NECKING AND INTERNAL PRESSURE

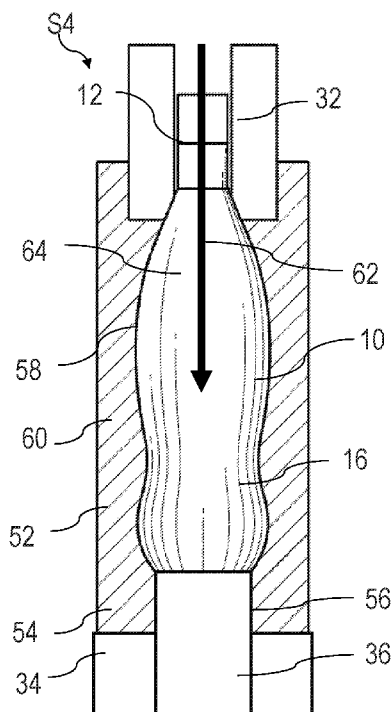


FIG. 5B

(57) Abstract: A method for forming a shaped container includes introducing a preform (10) to a necking station (S1-S4) of a necking assembly (20) and compressively necking an open end (12) of a preform (10) at one or more stations (S1-S4) of the necking station (20). The method also includes introducing the preform to a dual process station (S4) of the necking assembly (20). At the dual process station (S4), the open end (12) of the preform (10) is compressively necked and the preform (10) is also blow formed. Blow forming the preform (10) includes pressurizing an interior of the preform (10) to expand the preform into a mold (52) of the shaped container. A necking assembly (10) and a dual process station (S4) suitable to carry out the method are also disclosed.



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MANUFACTURE OF SHAPED CONTAINERS USING COMPRESSIVE NECKING AND INTERNAL PRESSURE

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit of U.S. Provisional Patent Application No. 62/175,788, filed June 15, 2015, which is incorporated by reference herein in its entirety.

FIELD OF THE INVENTION

[0002] This invention relates to the formation of shaped containers, and more particularly to the formation of shaped containers using compressive necking and internal pressure.

BACKGROUND

[0003] Containers are well known and widely used for beverages. Some containers have upright cylindrical side walls while other containers are shaped containers having more complex or different shapes. Various processes are known for forming a shaped container. For example, in some processes, compressive die necking is performed on a preform, which is ultimately formed into a finished beverage container, such as a bottle or can, through a number of necking stations to reduce the open end diameter of the preform. In these processes, a separate blow-forming station is utilized to expand the preform into the shape of a mold either before or after the necking is completed. However, because the expansion of the preform is performed at a separate station, extra time is required to produce the containers.

SUMMARY

[0004] The terms “invention,” “the invention,” “this invention” and “the present invention” used in this patent are intended to refer broadly to all of the subject matter of this patent and the patent claims below. Statements containing these terms should be understood not to limit the subject matter described herein or to limit the meaning or scope of the patent claims below. Embodiments of the invention covered by this patent are defined by the claims below, not

this summary. This summary is a high-level overview of various aspects of the invention and introduces some of the concepts that are further described in the Detailed Description section below. This summary is not intended to identify key or essential features of the claimed subject matter, nor is it intended to be used in isolation to determine the scope of the claimed subject matter. The subject matter should be understood by reference to appropriate portions of the entire specification of this patent, any or all drawings and each claim.

[0005] Described is an improved process for shaping a cylindrical preform, such as but not limited to, a cylindrical aluminum alloy preform, into a bottle or other beverage container having a reduced neck. The preform has one closed end and may or may not have a thickness gradient along its sidewall. The process includes using compressive die necking to reduce the open end diameter of the preform in combination with a pre-selected station or stations that also perform a secondary blow forming function. In this way, the preform is compressively necked in and then forced to expand by internal pressure into the fixed shape mold. The compressive necking and blow forming into the shaped container can be done at one dual process station.

[0006] In some examples, a method for forming a shaped container includes: introducing a preform to a necking station of a necking assembly; compressively necking an open end of the preform at the necking station; introducing the preform to a dual process station of the necking assembly subsequent to the necking station; compressively necking the open end of the preform at the dual process station; and blow forming the preform at the dual process station, wherein blow forming the preform comprises pressurizing an interior of the preform to expand the preform into a mold of the shaped container. In some cases, the preform is an aluminum alloy preform. The preform includes a coating in some examples.

[0007] In some cases, introducing the preform to the dual process station comprises positioning the preform in a mold cavity of the mold. In various examples, the shaped container

is a bottle. In certain cases, the necking station is a first necking station, and the method further comprises introducing the preform to a second necking station of the necking assembly subsequent to the first necking station and prior to introducing the preform to the dual process station and compressively necking the open end of the preform, wherein the diameter of the open end of the preform is reduced subsequent to the second necking station compared to the diameter of the open end of the preform subsequent to the first necking station.

[0008] In various cases, introducing the preform to the dual process station comprises closing mold halves of the mold around the preform, constraining a preform constraining ring of the dual process station at a base portion of the mold, and inserting a dome plug of the dual process station into the mold.

[0009] In various examples, a necking assembly for forming a shaped container comprises a necking station configured to apply compressive necking to a preform to reduce a diameter of an open end of the preform, and a dual process station configured to apply compressive necking to the preform to reduce the diameter of the open end of the preform and also configured to blow form the preform by pressurizing an interior of the preform to expand the preform into a shape of a mold cavity of a mold. In some examples, the necking station comprises a necking die assembly, a preform constraining ring, and a dome plug. In various cases, the dual process station includes a necking die assembly, a preform constraining ring, a dome plug, and a mold. The mold can be a linear dual active mold or a hinged-style mold or any other suitable mold. In various examples, the necking station is a first necking station and the necking assembly comprises a plurality of necking stations, and wherein the plurality of necking stations are configured to progressively reduce the diameter of the open end of the preform.

[0010] In some examples, a dual process station for a necking assembly configured to form a shaped container comprises: a compressive necking component configured to

compressively neck an open end of a preform; and a blow forming component configured to blow form the preform by pressurizing an interior of the preform to expand the preform into a mold of the shaped container. The compressive necking component comprises a necking die assembly, a preform constraining ring, and a dome plug. The blow forming component comprises a mold. The mold is a linear dual active mold or a hinged-style mold or other suitable mold. In some cases, the mold is a bottle-shaped mold.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] Illustrative embodiments of the present invention are described in detail below with reference to the following drawing figures:

[0012] Figure 1 illustrates an example of a preform.

[0013] Figure 2 is a schematic of a non-limiting example of a necking assembly with a number of shaping stations for forming a shaped bottle from the preform of Figure 1.

[0014] Figure 3 illustrates the preform of Figure 1 at one of the shaping stations of the necking assembly of Figure 2.

[0015] Figure 4 illustrates the preform of Figure 1 at another one of the shaping stations of the necking assembly of Figure 2.

[0016] Figure 5A illustrates the preform of Figure 1 at another one of the shaping stations of the necking assembly of Figure 2 during a necking process.

[0017] Figure 5B illustrates the preform of Figure 1 at the shaping station of Figure 5A during a blow forming process.

DETAILED DESCRIPTION

[0018] The subject matter of embodiments of the present invention is described here with specificity to meet statutory requirements, but this description is not necessarily intended to limit the scope of the claims. The claimed subject matter may be embodied in other ways, may include

different elements or steps, and may be used in conjunction with other existing or future technologies. This description should not be interpreted as implying any particular order or arrangement among or between various steps or elements except when the order of individual steps or arrangement of elements is explicitly described.

[0019] Disclosed herein is an improved process for forming a shaped beverage container, such as, but not limited to, a bottle or can, from a preform 10. Referring to Figure 1, the preform 10 is a hollow unitary workpiece typically having an open upper end 12 opposite a closed lower end 14 and a sidewall 16. In some examples, the preform 10 has a dome 18 formed in the closed lower end 14. In one non-limiting example, the preform 10 has a diameter of about 2.5 in to about 3.0 in, a height of about 10.0 in to about 12.5 in, a wall thickness of about 0.006 in to about 0.020 in, and a dome depth of about 0.400 in to about 1.00 in., although the preform can have any suitable dimensions. The preform 10 may have a thickness gradient along its sidewall 16, although it need not.

[0020] In various examples, the preform 10 is an aluminum alloy preform, such as, but not limited to a 3xxx aluminum alloy preform. In some examples, the preform 10 can be a fully or partially annealed aluminum alloy. However, in other examples, the preform 10 may be constructed from various other materials suitable for bottles or other shaped beverage containers.

[0021] Preforms used in the methods described herein can be either coated or uncoated depending on the application. For example, a conventional can coating system can be applied on the preforms. A conventional can coating system includes inside spray, ink and over-varnish.

[0022] Figure 2 is a schematic of a necking assembly 20 having a number N of necking stations S1, S2, ... SN. For illustration purposes only, the necking assembly 20 is illustrated having necking stations S1-S4, although any number N of necking stations can be present, including fewer or more than four. The necking stations are arranged such that the preform 10

entering the necking assembly 20 is subjected to a number of necking steps, in which the diameter of the open upper end 12 is progressively reduced. In various examples, each necking station progressively reduces the diameter of the open upper end 12 slightly more than the diameter produced from the previous necking station. For example, referring to Figure 2, necking station S2 would reduce the diameter of the open upper end 12 slightly more than the diameter produced from necking station S1. Although Figure 2 illustrates the design of the necking assembly 20 as linear, the equipment design of the necking assembly 20 may be linear or rotary in nature depending on the speed and process requirements.

[0023] Figures 3 and 4 illustrate the preform 10 at necking stations S2 and S3, respectively. As illustrated in these figures, each necking station generally includes a necking die assembly 32, a preform constraining ring 34, and a dome plug 36. In general, at each necking station, the preform 10 enters the necking die assembly 32 and compressive necking begins. The preform 10 continues through a predetermined number of necking stations. Because the necking station S3 follows necking station S2, the necking die assembly 32 of necking station S3 is configured to form a diameter of the open upper end 12 of the preform 10 that is smaller compared to a diameter of the open upper end 12 of the preform 10 formed by the necking die assembly 32 of necking station S2.

[0024] In various examples, at least one necking station, such as necking station S4, is a dual process station that performs both necking and blow forming such that the preform 10 is subjected to compressive necking in combination with blow forming at a single station of the necking assembly 20. For illustration purposes only, the necking station S4 is identified as the dual process station; however, any other necking station could be used as the dual process station and, if desired, more than one necking station could function as a dual process station within the necking assembly 20.

[0025] In this example, at the dual process station S4, the preform 10 is compressively necked in at the open upper end 12 of the preform 10, and then the sidewall 16 of the preform 10 is forced to expand by internal pressure into the shape of a mold. In various examples, the mold can be the shape of a beverage container, such as a bottle or a can. Introducing blow forming into the necking process at the dual process station S4 is unique because it combines both compressive necking and blow forming into one machine. This may reduce the number of stations, thereby reducing manufacturing costs and creating a more efficient manufacturing process. Other container shaping methods include full body die necking, which does not shape the lower portion of the shaped container, generates visible necking transition lines and has shaping and expansion limitations. The method of shaping using compressive necking and internal pressure processes permits true full body shaping, removes transition lines during pressurization, and permits various container shapes including embossing and non-axisymmetric shapes.

[0026] Referring to Figures 5A and 5B, the preform 10 is illustrated in the necking station S4, which is the dual process station in this example. The dual process station S4 includes a mold 52 in addition to the necking die assembly 32, the preform constraining ring 34, and the dome plug 36 found in the non-combination necking stations. In various examples, the mold 52 can be a linear dual active mold or a hinged-style mold or other suitable mold. As illustrated in Figures 5A and 5B, the mold 52 is configured to partially surround the necking die assembly 32 in various examples. The mold 52 can also define a dome plug receiving channel 56 that is configured to receive the dome plug 36 when the mold 52 is closed, as described below.

[0027] In the illustrated example, after necking at necking station S3, the partially necked preform 10 then enters the dual process station S4, which is a combination necking and blow forming station. After entering the dual process station S4, mold halves 60 (only one mold half

60 is illustrated) of the mold 52 close such that the preform 10 is held within a mold cavity 58 and the preform constraining ring 34 is constrained at a base portion 54 of the mold 52. As illustrated in Figure 5A, a necking step is then completed using the necking die assembly 32 to reduce the diameter of the open upper neck 12 and a dome plug 36 completes the closed mold shape of the mold cavity 58. The necking die assembly 32 of station S4 is configured to reduce the diameter of the open upper end 12 of the preform 10.

[0028] After the necking step is completed, the dual process station S4 is configured to pressurize the preform 10 to expand the sidewalls 16 of the preform 10 into the shape of the closed mold cavity 58. As illustrated in Figure 5B, an inert gas is injected into an interior of the preform 10, as illustrated by arrow 62, with sufficient pressure until the preform expands to fill the mold cavity 58. After the preform 10 expands into the shape of the closed mold cavity 58, the mold halves 60 open, the dome plug 36 is retracted, and a shaped container 64 formed from the preform 10 is extracted from the station S4. Although the dual process station S4 is described as the last station in the illustrated example, additional stations may follow the dual process station in various other examples.

[0029] Different arrangements of the components depicted in the drawings or described above, as well as components and steps not shown or described are possible. Similarly, some features and subcombinations are useful and may be employed without reference to other features and subcombinations. Embodiments of the invention have been described for illustrative and not restrictive purposes, and alternative embodiments will become apparent to readers of this patent. Accordingly, the present invention is not limited to the embodiments described above or depicted in the drawings, and various embodiments and modifications can be made without departing from the scope of the claims below.

CLAIMS

That which is claimed is:

1. A method for forming a shaped container comprising:
introducing a preform to a necking station of a necking assembly;
compressively necking an open end of the preform at the necking station;
introducing the preform to a dual process station of the necking assembly subsequent to the necking station;
compressively necking the open end of the preform at the dual process station; and
blow forming the preform at the dual process station, wherein blow forming the preform comprises pressurizing an interior of the preform to expand the preform into a mold of the shaped container.
2. The method of claim 1, wherein the preform is an aluminum alloy preform.
3. The method of claim 2, wherein the aluminum alloy preform includes a coating.
4. The method of claim 1, wherein introducing the preform to the dual process station comprises positioning the preform in a mold cavity of the mold.
5. The method of claim 1, wherein the shaped container is a bottle.
6. The method of claim 1, wherein the necking station is a first necking station, and wherein the method further comprises:
introducing the preform to second necking station of the necking assembly subsequent to the first necking station and prior to introducing the preform to the dual process station; and
compressively necking the open end of the preform at the second necking station, wherein a diameter of the open end of the preform is reduced subsequent to the second necking station compared to the diameter of the open end of the preform subsequent to the first necking station.
7. The method of claim 1, wherein introducing the preform to the dual process station comprises:
closing mold halves of the mold around the preform;

constraining a preform constraining ring of the dual process station at a base portion of the mold; and

inserting a dome plug of the dual process station into the mold.

8. A necking assembly for forming a shaped container comprising:
a necking station configured to apply compressive necking to a preform to reduce a diameter of an open end of the preform; and
a dual process station configured to apply compressive necking to the preform to reduce the diameter of the open end of the preform and also configured to blow form the preform into the shaped container by pressurizing an interior of the preform to expand the preform into a shape of a mold cavity of a mold.
9. The necking assembly of claim 8, wherein the necking station comprises a necking die assembly, a preform constraining ring, and a dome plug.
10. The necking assembly of claim 8, wherein the dual process station comprises a necking die assembly, a preform constraining ring, a dome plug, and the mold.
11. The necking assembly of claim 10, wherein the mold is a linear dual active mold.
12. The necking assembly of claim 10, wherein the mold is a hinged-style mold.
13. The necking assembly of claim 8, wherein the necking station is a first necking station and wherein the necking assembly comprises a plurality of necking stations, and wherein the plurality of necking stations are configured to progressively reduce the diameter of the open end of the preform.
14. The necking assembly of claim 8, wherein the preform is an aluminum alloy preform.
15. A dual process station for a necking assembly configured to form a shaped container, the dual process station comprising:
a compressive necking component configured to compressively neck an open end of a preform; and
a blow forming component configured to blow form the preform by pressurizing an interior of the preform to expand the preform into a mold of the shaped container.

16. The dual process station of claim 15, wherein the compressive necking component comprises a necking die assembly, a preform constraining ring, and a dome plug.
17. The dual process station of claim 15, wherein the blow forming component comprises the mold.
18. The dual process station of claim 17, wherein the mold is a linear dual active mold.
19. The necking assembly of claim 17, wherein the mold is a hinged-style mold.
20. The necking assembly of claim 15, wherein the mold is a bottle-shaped mold.

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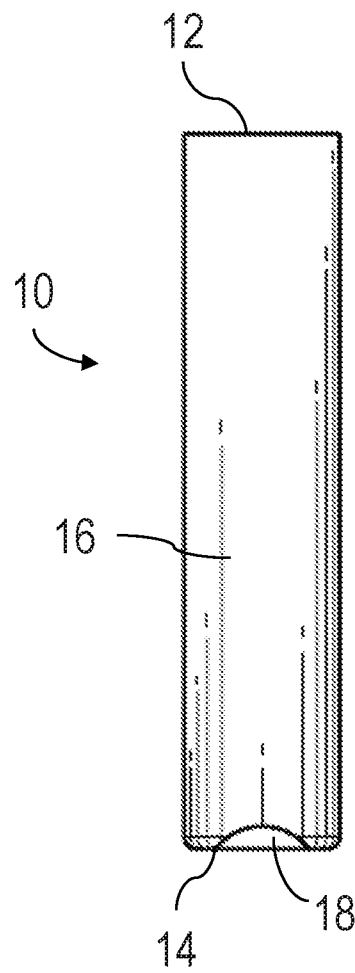
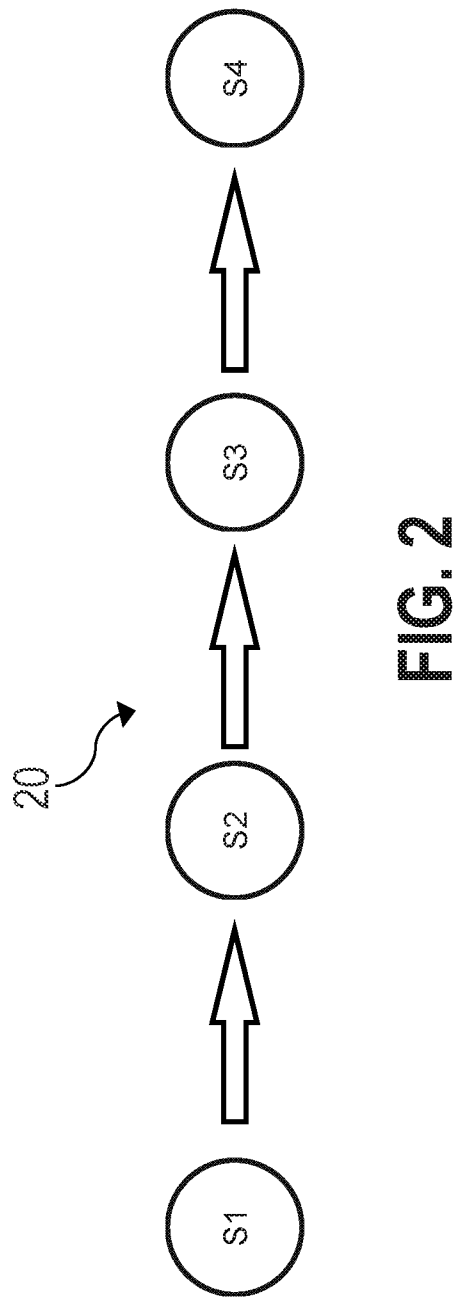


FIG. 1



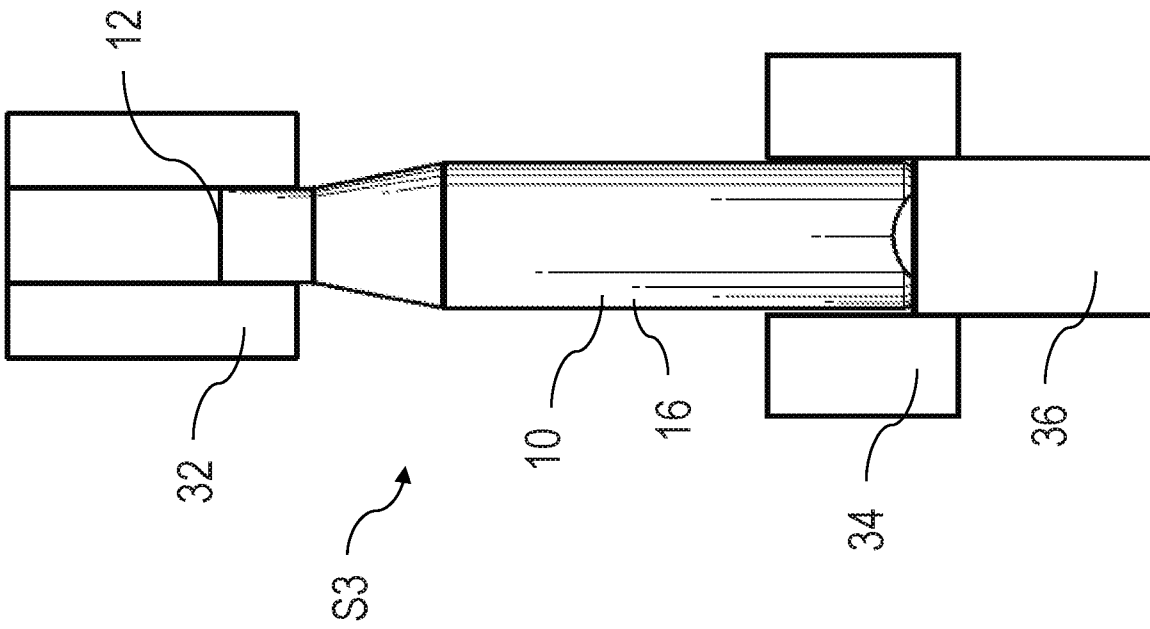


FIG. 4

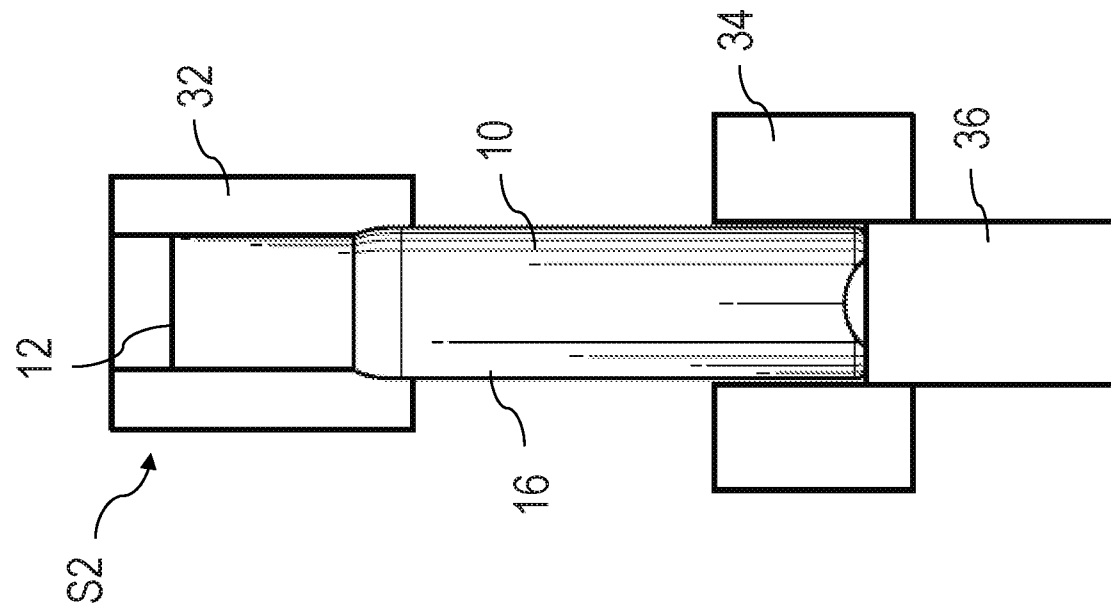
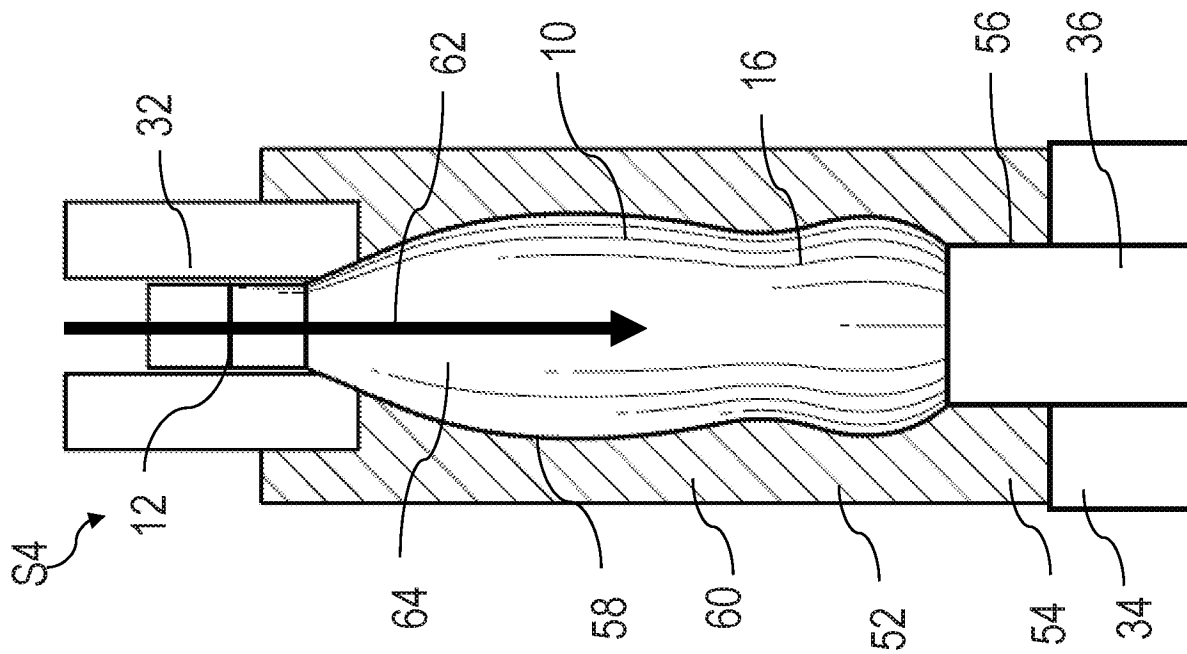


FIG. 3



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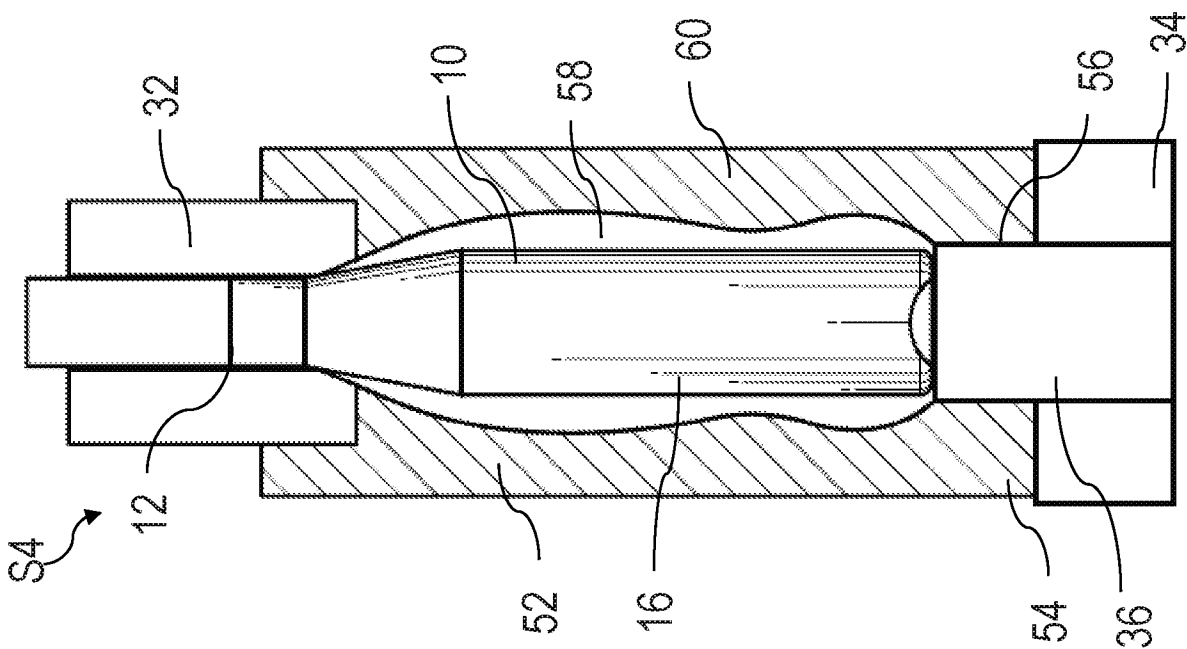


FIG. 5A

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2016/036961

A. CLASSIFICATION OF SUBJECT MATTER

INV. B21D51/26 B21D26/049 B21D26/033
ADD.

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)

B21D

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)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 2 859 966 A1 (ARDAGH MP GROUP NETHERLANDS BV [NL]) 15 April 2015 (2015-04-15) paragraph [0037] - paragraph [0051]; claims 1,2; figures 4A-4J,5A-5J,6A-6D -----	1-20
A	JP H08 90117 A (HOKKAI CAN; NITTO SEIKI KK) 9 April 1996 (1996-04-09) figures 1a,1b-5a,5b -----	1-20
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A	US 6 182 487 B1 (KOMIYA YASUHIKO [JP] ET AL) 6 February 2001 (2001-02-06) figures 1-10 -----	1-20



Further documents are listed in the continuation of Box C.



See patent family annex.

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"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

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Date of the actual completion of the international search

5 September 2016

Date of mailing of the international search report

15/09/2016

Name and mailing address of the ISA/

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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