

(19) World Intellectual Property
Organization
International Bureau



(43) International Publication Date
31 December 2003 (31.12.2003)

PCT

(10) International Publication Number
WO 2004/000488 A2

(51) International Patent Classification⁷: **B22D 18/02**

(21) International Application Number:
PCT/EP2003/005996

(22) International Filing Date: 6 June 2003 (06.06.2003)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
PD2002A000167 21 June 2002 (21.06.2002) IT

(71) Applicant (for all designated States except US): **BBS - RIVA S.P.A.** [IT/IT]; Via Collegio, 10, I-44030 RO (IT).

(72) Inventor; and

(75) Inventor/Applicant (for US only): **FRULLA, Claudio** [IT/IT]; Via Mazzini, 12/A, I-20084 Lacchiarella (IT).

(74) Agent: **MODIANO, Guido**; Modiano & Associati, Via Meravigli, 16, IT-20123 Milan (IT).

(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, NI, NO, NZ, OM, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

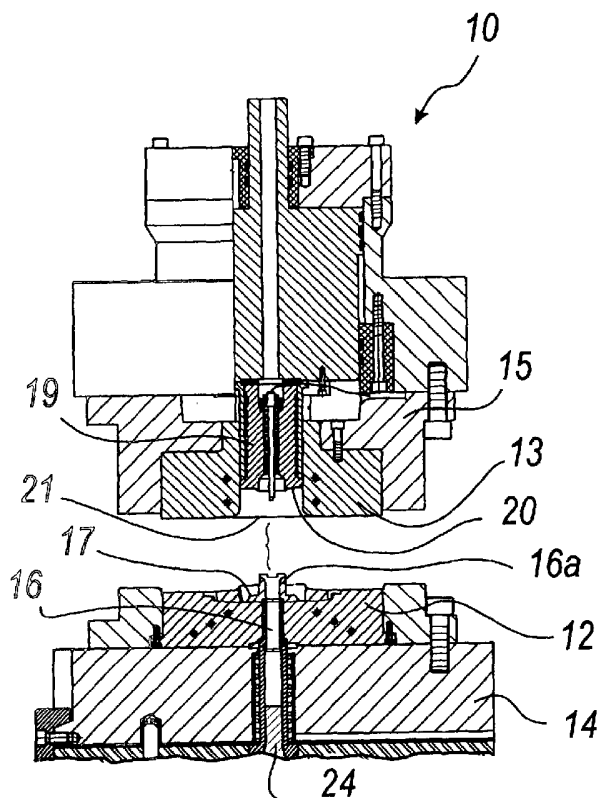
(84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— without international search report and to be republished upon receipt of that report

[Continued on next page]

(54) Title: APPARATUS FOR MANUFACTURING ARTICLES MADE OF ALUMINUM, ALUMINUM ALLOYS, LIGHT ALLOYS AND THE LIKE, AND METHOD PERFORMED BY THE APPARATUS



(57) Abstract: An apparatus and method for manufacturing articles made of aluminum, aluminum alloys, light alloys and the like, the apparatus comprising a lower die section (12) and at least one upper die section (13), associated with corresponding press platens (14, 15) for closure determining shape of the cast article, a vertically elongated duct (16) for introducing liquid metal, a to pressurized furnace that leads into the lower die section (13) that forms at least one lower impression (17) with at least one concave portion for introducing liquid metal through at least one corresponding inlet (18) formed at the upper portion of the duct (16), a male plug (19) associated with the upper die section (12), and movable with respect thereto.



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.

APPARATUS FOR MANUFACTURING ARTICLES MADE OF ALUMINUM, ALUMINUM ALLOYS, LIGHT ALLOYS AND THE LIKE, AND METHOD PERFORMED BY THE APPARATUS

Technical Field

5 The present invention relates to an apparatus for manufacturing articles made of aluminum, aluminum alloys, light alloys and the like, and to a method performed by said apparatus.

Background Art

10 It is known that the manufacture of articles made of aluminum, aluminum alloys, light alloys and the like, by casting, currently uses a casting method, known as low-pressure casting, in which the liquid metal is made to rise from a pressurized furnace through a liquid metal feed duct that leads upward into a die formed by two or more sections.

15 Once the filling of the impression of the closed die has ended, the liquid metal must solidify, and this usually occurs over a relatively long period of time, further producing, at the liquid metal feed channel, a relatively large sprue.

20 This type of casting has the drawback of having long casting times in addition to a waste of material produced by the sprue and to the fact that the cast article does not have a very compact structure, since casting occurs at low pressure.

25 Another known type of casting method allows to provide articles with a structure that is particularly compact due to the fact that the two sections of the die that form the impression of the cast article are closed together with an application of pressure after the impression has been filled with liquid metal, thus achieving a compaction of the material and a considerable structural uniformity, and further avoiding the formation of a sprue, with the consequent benefits related to casting time.

30 In this solution, however, it is necessary to provide a precise dosage of liquid metal and it is therefore necessary to have a dosage unit that allows to

feed dosed quantities of material, consequently increasing complexity of execution.

Disclosure of the invention

The aim of the present invention is to solve the above-mentioned
5 problems, by providing an apparatus for manufacturing articles made of aluminum, aluminum alloys, light alloys and the like, which allows to obtain articles that have a very compact structure, without sprue and with considerably shorter times to achieve the solidification step.

Another object is to provide an apparatus that does not require a dosage
10 unit in order to introduce the liquid metal in the impression of the die.

Another object is to provide an apparatus that allows, with a single casting process, both single parts having a complex geometry and a plurality of parts, possibly mutually different ones, obtaining a correct dosage for each part being cast.

15 Another object is to provide an apparatus in which the liquid metal is fed, during the solidification step, by a part of the die that applies pressure to the casting.

Another object of the present invention is to provide an apparatus that thanks to its particular constructive characteristics is capable of giving the
20 greatest assurances of reliability and safety in use.

Another object of the present invention is to provide an apparatus that can be obtained easily starting from commonly commercially available elements and materials and is further competitive from a merely economical standpoint.

25 This aim and these and other objects that will become better apparent hereinafter are achieved by an apparatus for manufacturing articles made of aluminum, aluminum alloys, light alloys and the like, which comprises a lower die section and at least one upper die section, which are associated with corresponding press platens for their closure so as to determine the
30 shape of the article to be cast, a vertically elongated duct for introducing

liquid metal that arrives from an underlying pressurized furnace leading into the lower die section, characterized in that said lower die section forms at least one lower impression that has at least one concave portion for introducing liquid metal through at least one corresponding inlet formed at the upper portion of said duct that rises from the lower die section, a male plug being associated with the upper die section, the male plug being able to move with respect to the upper die section and forming an upper impression portion, said at least one upper die section being closable onto said lower die section, determining the shape of the article to be cast, and said male plug acting as a flow control element for said at least one inlet, whose overflow level determines the chosen quantity of liquid metal that is present inside said shape.

The apparatus performs a process that consists in:

- closing said die sections while the male plug is arranged at a higher level than the overflow level of said inlets;
- introducing liquid metal into the shape formed by said die sections, through said inlets, until it is completely full;
- lowering said male plug to the overflow level of said inlets, until said inlets are closed, determining a clean separation between the liquid metal contained in said duct and the liquid metal that is present within said shape,
- waiting for the casting to solidify;
- opening said die sections and extracting the manufactured article.

Brief description of the drawings

Further characteristics and advantages of the invention will become better apparent from the following detailed description of a preferred but not exclusive embodiment thereof, illustrated by way of non-limitative example in the accompanying drawings, wherein:

Figures 1 and 6 are views of an apparatus according to the invention in one of its embodiments, respectively in the two initial and final steps for forming the central portion of a wheel for road vehicles;

Figures 2 to 5 are views of a portion of the apparatus of Figure 1, in corresponding intermediate steps of operation;

Figures 7 and 12 are views of an apparatus according to the invention in another embodiment, respectively in the two initial and final steps for
5 producing a wheel for road vehicles;

Figures 8 to 11 are views of a portion of the apparatus of Figure 7, in corresponding intermediate operating steps.

Ways of carrying out the invention

With reference to Figures 1 to 6, an apparatus for manufacturing articles
10 made of aluminum, aluminum alloys, light alloys and the like, according to the invention, is generally designated by the reference numeral 10 in a first embodiment.

The apparatus 10 is designed to form central portions 11 of wheels for road vehicles, and comprises a lower die section 12 and an upper die section
15 13, which are respectively associated with a lower press platen 14 and an upper press platen 15.

The die sections 12 and 13 can be coupled by way of the movement of the upper press platen 15, forming a shape 23 of the article being cast.

A vertical duct 16 leads into the lower die section 12 in order to introduce
20 liquid metal 24 that arrives from an underlying pressurized furnace, provided in a way known in the art.

The lower die section 12 forms a lower impression 17, which has at least one concave portion for introducing liquid metal 24 through a plurality of contoured inlets 18 that are formed at the upper portion of the duct 16 that
25 rises through the lower die section 12.

A male plug 19 is associated with the upper die section 13, can move with respect to the upper die section 13 and forms a portion 20 of an upper impression 21.

The upper die section 13 can be closed onto the lower die section 12, determining the shape 23 of the article to be cast, i.e., of a central portion 11
30

of a wheel for road vehicles, and the male plug 19 acts as a flow control element for the inlets 18, whose overflow level determines the chosen quantity of liquid metal 24 that is present within the shape 23.

As shown in Figures 1 to 6, the duct 16 forms, at its upper end 16a that rises from the lower die section 12, a plurality of contoured and circumferentially equidistant inlets 18 for introducing liquid metal 24, whose lower portions 18a determine the corresponding overflow level.

The male plug 19 is arranged so as to be substantially coaxial to the duct 16 and is provided in a lower region with an axial hollow 22 whose cylindrical wall 22a is suitable to close the inlets 18, by arrangement thereof at their overflow level, and causing a clean separation between the liquid metal 24 that is present within the duct 16 and the liquid metal that is present within the shape 23.

Advantageously, the male plug 19 cooperates so as to form the shape 23 of the article being cast when it is arranged at a lower level than the overflow level of the inlets 18, improving the feeding of the casting during setting.

The various steps of the operation of the apparatus 10 are shown in succession from Figure 1 to Figure 6.

The apparatus 10 performs a process that consists in:

- closing the die sections 12 and 13, while the male plug 19 is arranged at a higher level than the overflow level of the inlets 18 (see Figure 2),
- introducing liquid metal 24 into the shape 23 formed by the die sections 12 and 13, through the inlets 18, until it is filled completely,
- lowering the male plug 19 to the overflow level of the inlets 18, until they are closed, causing a clean separation between the liquid metal that is present within the duct 16 and the liquid metal that is present within the shape 23 (see Figure 5),
- further lowering the male plug 19 until the intended shape 23 of the article being cast is obtained,

- waiting for the casting to solidify,
- opening the die sections 12 and 13 and removing the cast article.

In the case shown in Figures 1 to 6, in which the overflow level of the inlets 18 is arranged at a higher level than the highest point of the shape 23, the step for introducing liquid metal 24 into the shape 23 consists in:

- making liquid metal 24 rise from the pressurized furnace through the duct 16 to a level that is higher than the overflow level, until the shape 23 is completely filled (see Figure 3) and then
- lowering the level of the liquid metal 24 of the duct 16 (see Figure 4).

10 The male plug 19 improves the feeding of the casting during solidification.

One can in fact say that the male plug 19 acts as a "feeder" of liquid metal of the article being cast during solidification, even after the closure of the inlets 18.

15 This occurs because during the solidification of the article being cast, in the step for the further lowering of the male plug 19 after closing the inlets 18, the male plug applies a very high pressure to the article (on the order of 1200 kg/cm^2), particularly on its internal peripheral region, and is thus able to keep fluid the metal that in that region starts to become solid upon contact
20 with the central part of the die and "push" it into the furthest peripheral regions, where the liquid metal arrives with greater difficulty.

In this manner, the structure of the cast article is more compact by way of the great pressure applied by the male plug and is uniform in all its parts by way of the correct distribution of the liquid metal.

25 With reference to Figures 7 to 12, an apparatus for manufacturing articles made of aluminum, aluminum alloys, light alloys and the like, according to the invention, is generally designated by the reference numeral 110 in a second embodiment.

The apparatus 110 is designed to produce complete wheels 111 for road
30 vehicles and comprises a lower die section 112, an upper die section 113,

and lateral die sections 114, which are associated with corresponding press platens, generally designated by the reference numeral 115.

The die sections 112, 113 and 114 can be mated by way of the movement of the press platens 115, defining the shape 123 of the article being cast.

5 A vertically elongated duct 116 leads into the lower die section 112 in order to introduce liquid metal 124 that arrives from an underlying pressurized furnace, which is not shown for the sake of simplicity.

The lower die section 112 forms a lower impression 117, which has at least one concave portion for the introduction of liquid metal 124 through a
10 plurality of contoured inlets 118 which are formed at the upper portion of the duct 116 that rises through the lower die section 112.

A male plug 119 is associated with the upper die section 113, can move with respect to the upper die section 113 and forms a portion 120 of the upper impression 121.

15 The upper die section 113 and the lateral die sections 114 can be closed onto the lower die section 112, determining the shape 123 of the article to be cast, i.e., a wheel 111, and the male plug 119 acts as a flow control element for the inlets 118, whose overflow level determines the intended quantity of liquid metal 124 that is present within the shape 123.

20 As shown in Figures 7 to 12, the duct 116 forms, at its upper end 116a that rises from the lower die section 112, a plurality of contoured and circumferentially equidistant inlets 118 for introducing liquid metal 124, whose lower portions 118a determine the corresponding overflow level.

The male plug 119 is arranged substantially coaxially to the duct 116,
25 provided in a lower region with an axial hollow 122, whose cylindrical wall 122a is suitable to close the inlets 118, being arranged at their overflow level, causing a clean separation between the liquid metal 124 that is present within the duct 116 and the liquid metal that is present within the shape 123.

Advantageously, the male plug 119 cooperates so as to form the shape
30 123 of the article being cast when it is arranged at a lower level than the

overflow level of the inlets 118, improving the feeding of the casting during solidification.

The various steps of the operation of the apparatus 110 are shown in succession from Figure 7 to Figure 12.

5 The apparatus 110 performs a process that consists in:

- closing the die sections 112, 113 and 114 with a male plug 119, which is arranged at a higher level than the overflow level of the inlets 118 (see Figure 8),
- introducing liquid metal 124 into the shape 123 formed by the die sections 112, 113 and 114, through the inlets 118, until it is filled completely,
- 10 -- lowering the male plug 119 to the overflow level of the inlets 118 until they are closed, causing a clean separation between the liquid metal 124 that is present within the duct 116 and the liquid metal that is present within the shape 123 (see Figure 10),
- 15 -- further lowering the male plug 119 until the intended shape 123 of the article being cast is obtained (see Figure 11),
- waiting for the casting to solidify,
- opening the die sections 112, 113 and 114 and removing the cast article.

20 In the case shown in Figures 7 to 12, in which the overflow level of the inlets 118 is arranged at a lower height than the highest point of the shape 123, the step for introducing liquid metal 124 into the shape 123 consists in:

- making liquid metal 124 rise from the pressurized furnace through the duct 116, to a level that is higher than the overflow level, until the shape 123 is completely filled (see Figure 9),
- 25 -- keeping the liquid metal 124 under pressure.

In this case, therefore, in order to be able to fill the shape 123 completely it is necessary to feed the liquid metal 124 under pressure.

Once the shape 123 has been filled completely, the male plug 119 is lowered until the inlets 118 are closed (see Figure 10).

30 In the case shown in Figures 7 to 12, therefore, after the step for further

lowering of the male plug 119, a step is necessary which consists in -- removing the pressure of the furnace for the consequent lowering of the level of the liquid metal 124 that is present inside the duct 116 (see Figure 11).

5 Also in this case, as in the preceding one, the male plug 119 improves the feeding of the casting during solidification, since it applies a very high pressure to the article (on the order of 1200 kg/cm^2), particularly on its internal peripheral region, thus being able to keep fluid the metal that in that region starts to solidify upon contact with the central part of the die and to
10 "push" it into the furthest peripheral regions, where the liquid metal arrives with the greatest difficulty.

The structure of the article being cast is more compact by way of the great pressure applied by the male plug and is more uniform in all its parts by way of the correct distribution of the liquid metal.

15 Advantageously, in the lower die section there can be a plurality of lower impressions, which are distributed uniformly and circumferentially around the inlet duct.

Also in this case, the lower impressions have concave portions that allow to introduce quantities of liquid metal that are a direct function of their
20 geometry, so that by introducing the liquid metal, making said metal rise through the duct by way of a pressure application from the furnace, it is possible to fill the concave regions with an amount of liquid metal that in practice is dosed.

In any case, it is possible to provide level sensors 25 in order to stop the
25 rise of the liquid metal 24, or it is optionally possible to preset the time and the pressure applied to the liquid metal so as to obtain a dosed overflow of said liquid metal.

In this regard it is also possible to provide, particularly for the case shown in Figures 1 to 6, before the step for introducing liquid metal 24 in the lower
30 impression 17, a pre-dosage step that consists in making an amount of liquid

metal 24 dosed according to preset requirements rise from the pressurized furnace through the feed duct 16.

An important particularity of the invention is that when the inlets 18/118 are closed by the male plug 19/119, a clean separation is obtained between
5 the liquid metal 24/124 that is present within the shape 23/123 and the duct 16/116, with the possibility to make the level of liquid metal 24/124 present in the duct 16/116 fall again, preferably at a heated region.

The movement of the male plug 19/119 applies pressure to the liquid metal 24/124, compacting said metal and thus obtaining parts that have
10 considerable structural uniformity and improved mechanical strength.

The apparatus according to the invention therefore allows correct dosage of liquid metal within the shape, defined by the die parts, of one or more articles to be produced.

From the above description it is therefore evident that the invention
15 achieves the proposed aim and objects and in particular the fact is stressed that the male plug in practice provides a flow control element that closes the passages for connection to the duct for introducing the liquid metal, avoiding the formation of sprue and further applying a pressure to the solidifying liquid metal which helps to obtain a product that has high structural and
20 mechanical characteristics, with a reduction of the solidification time.

The present invention is susceptible of numerous modifications and variations, all of which are within the scope of the appended claims.

All the technical details may furthermore be replaced with other technically equivalent elements.

25 In practice, the materials used, as well as the contingent shapes and the dimensions, may be any according to requirements.

The disclosures in Italian Patent Application No. PD2002A000167 from which this application claims priority are incorporated herein by reference.

CLAIMS

1. An apparatus for manufacturing articles made of aluminum, aluminum alloys, light alloys and the like, comprising a lower die section (12) and at least one upper die section (13), which are associated with corresponding
5 press platens (14,15) for their closure so as to determine the shape (23) of the article to be cast, a vertically elongated duct (16) for introducing liquid metal (24) that arrives from an underlying pressurized furnace leading into said lower die section (12), characterized in that said lower die section (12) forms at least one lower impression (17) that has at least one concave
10 portion for introducing liquid metal (24) through at least one corresponding inlet (18) formed at the upper portion of said duct (16) that rises from said lower die section (12), a male plug (19) being associated with said upper die section (13), said male plug (19) being movable with respect to said upper die section (13) and forming an upper impression portion (20), said at least
15 one upper die section (13) being closable onto said lower die section (12), determining the shape (23) of the article to be cast, and said male plug (19) acting as a flow control element for said at least one inlet (18), whose overflow level determines the chosen quantity of liquid metal (24) that is present inside said shape (23).
- 20 2. The apparatus according to claim 1, characterized in that said duct (16) forms at its upper end (16a), which rises from said lower die section (12), a plurality of contoured inlets (18) for introducing liquid metal (24) into one or more impressions (17) whose lower portions (18a) define the corresponding overflow level.
- 25 3. The apparatus according to the preceding claims, characterized in that said male plug (19) is arranged substantially coaxially to said duct (16) and is provided in a lower region with an axial hollow (22) whose cylindrical wall (22a) is suitable to close said inlets (18), by arrangement thereof at their overflow level, to cause a clean separation between the liquid metal that is
30 present within said duct (16) and the metal that is present within said shape

(23).

4. The apparatus according to one or more of the preceding claims, characterized in that said male plug (19) cooperates to form the shape (23) of the article being cast when it is arranged at a height that is lower than the
5 overflow level of said inlets (18).

5. A method for manufacturing articles made of aluminum, aluminum alloys, light alloys and the like, performed by an apparatus according to one or more of the preceding claims, which consists in:

- closing said die sections (12,13) while the male plug (19) is arranged at a
10 higher level than the overflow level of said inlets (18),
- introducing liquid metal (24) into the shape (23) formed by said die sections (12,13), through said inlets (18), until it is filled completely,
- lowering said male plug (19) to the overflow level of said inlets (18) until they are closed, causing a clean separation between the liquid metal that is
15 present within said duct (16) and the metal that is present within said shape (23),
- waiting for the casting to solidify,
- opening said die sections (12,13) and removing the cast article.

6. The method according to claim 5, characterized in that it comprises,
20 after the step for lowering said male plug (19) to the overflow level of said inlets (18), a step for the further lowering of said male plug (19) until the intended shape of the article being cast is obtained.

7. The method according to at least one of claims 5 and 6, characterized in that said step for introducing liquid metal in the impression (17) while the
25 overflow level of said inlets (18) is arranged at a higher level than the highest point of said shape, consists in

- making liquid metal rise from said pressurized furnace through said duct (16) to a higher level than said overflow level until said shape is completely filled,
- 30 -- lowering the level of liquid metal of said duct (16).

8. The method according to at least one of claims 5 and 6, characterized in that said step for introducing liquid metal into the impression (17) while the overflow level of said inlets is arranged at a lower level than the highest point of said shape (23), consists in

- 5 -- making liquid metal rise from said pressurized furnace through said duct (16) to a higher level than said overflow level until said shape is completely filled,
-- keeping said liquid metal pressurized.

9. The method according to claims 6 and 8, characterized in that it
10 comprises, after the step for further lowering of said male plug (19) until the intended shape of the article being cast is obtained, a step that consists in:

- removing pressure from said pressurized furnace,
-- lowering the level of liquid metal of said duct (16).

10. The method according to one or more of the preceding claims,
15 characterized in that it comprises, before said step for introducing liquid metal in the impression (17), a pre-dosage step that consists in

- making an amount of liquid metal (24), dosed according to preset requirements, rise from said pressurized furnace through said duct (16).

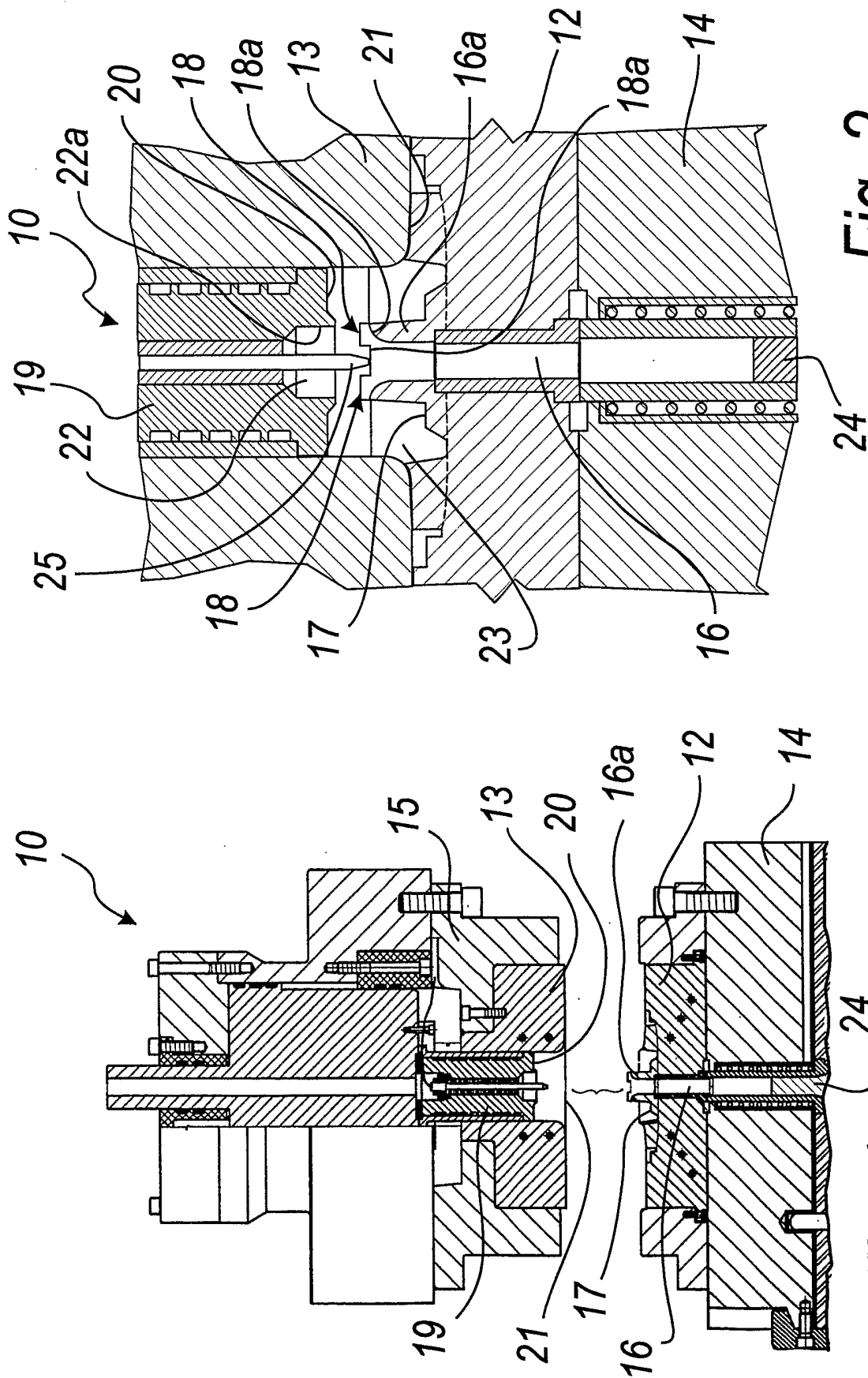


Fig. 2

Fig. 1

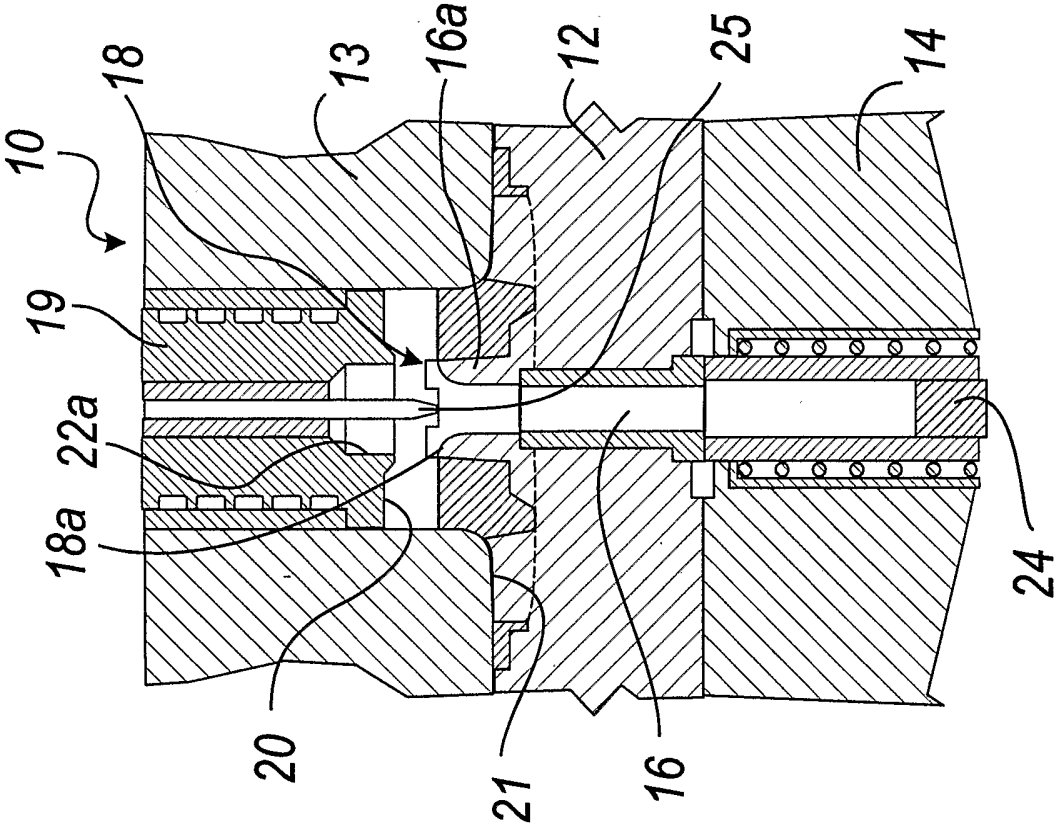


Fig. 4

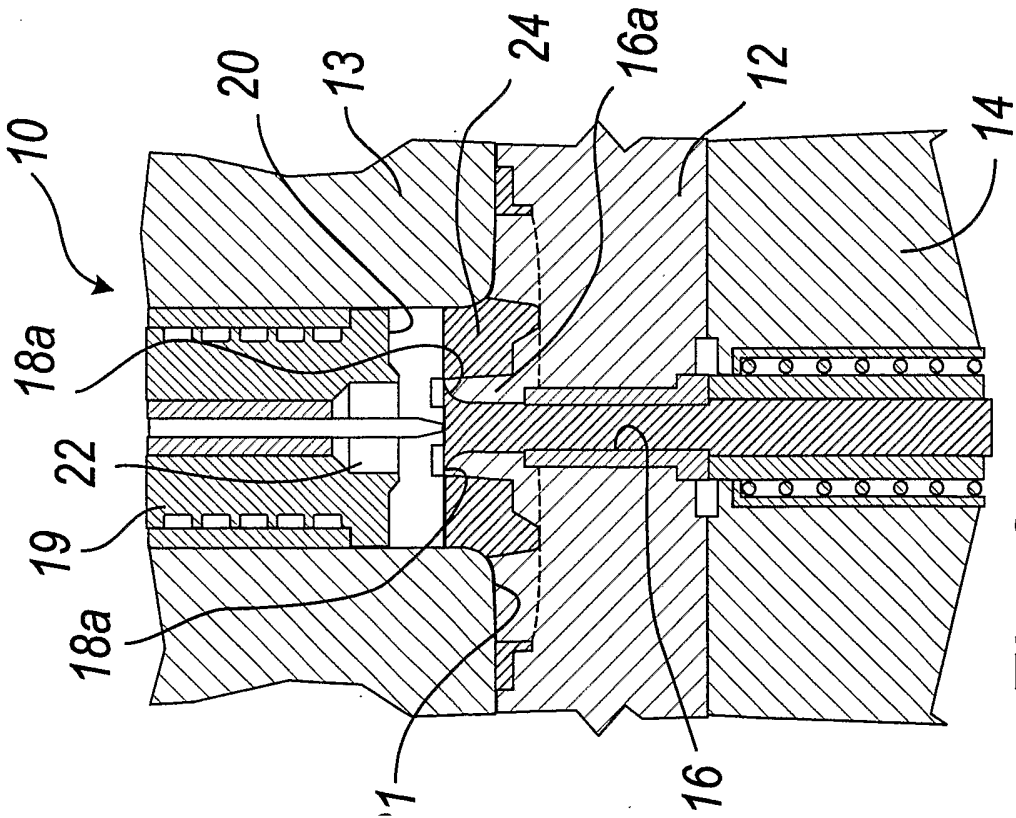


Fig. 3

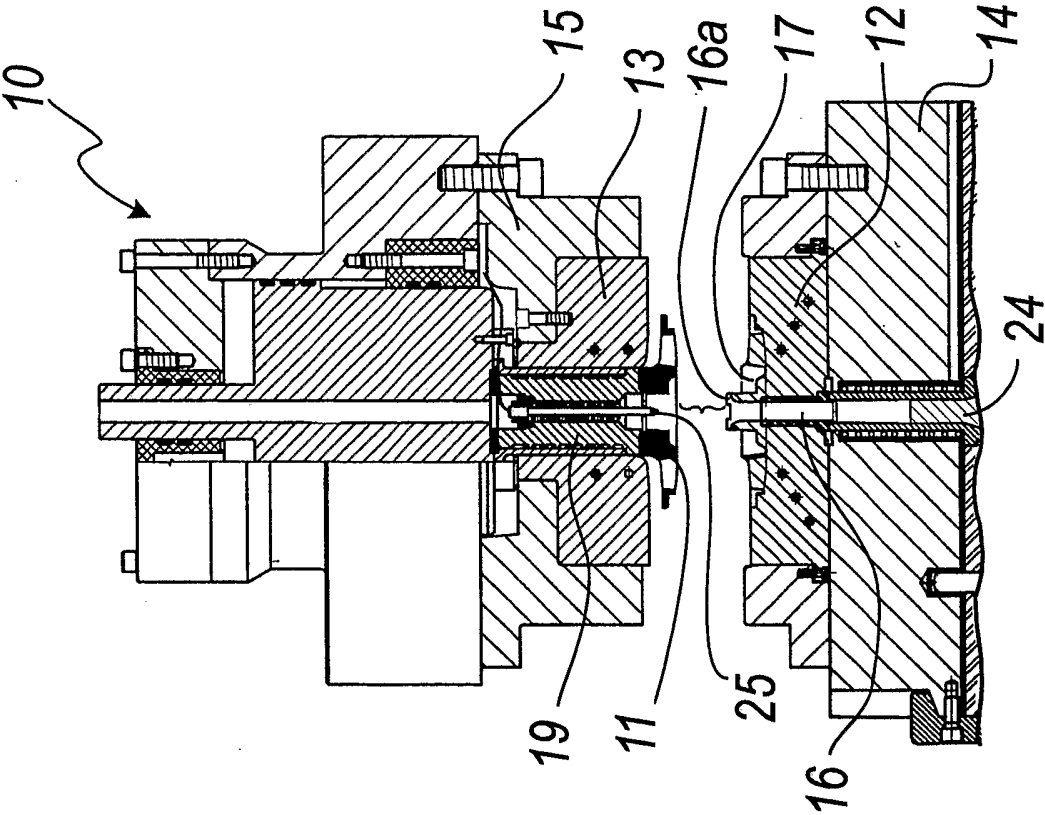


Fig. 6

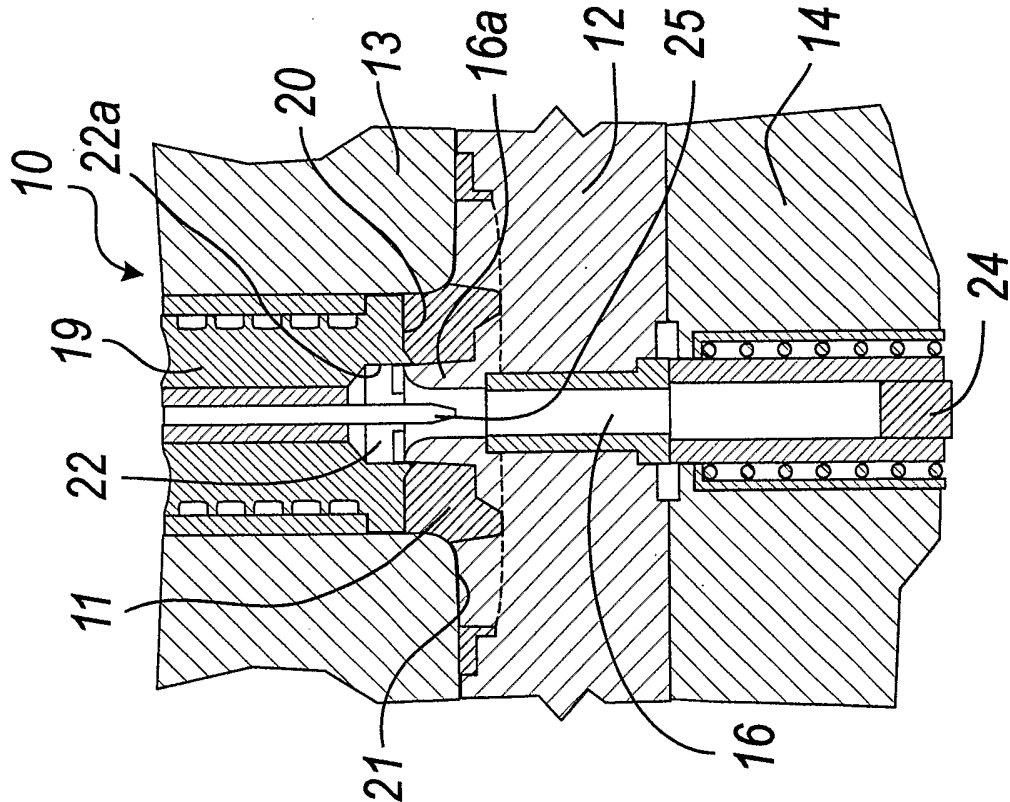


Fig. 5

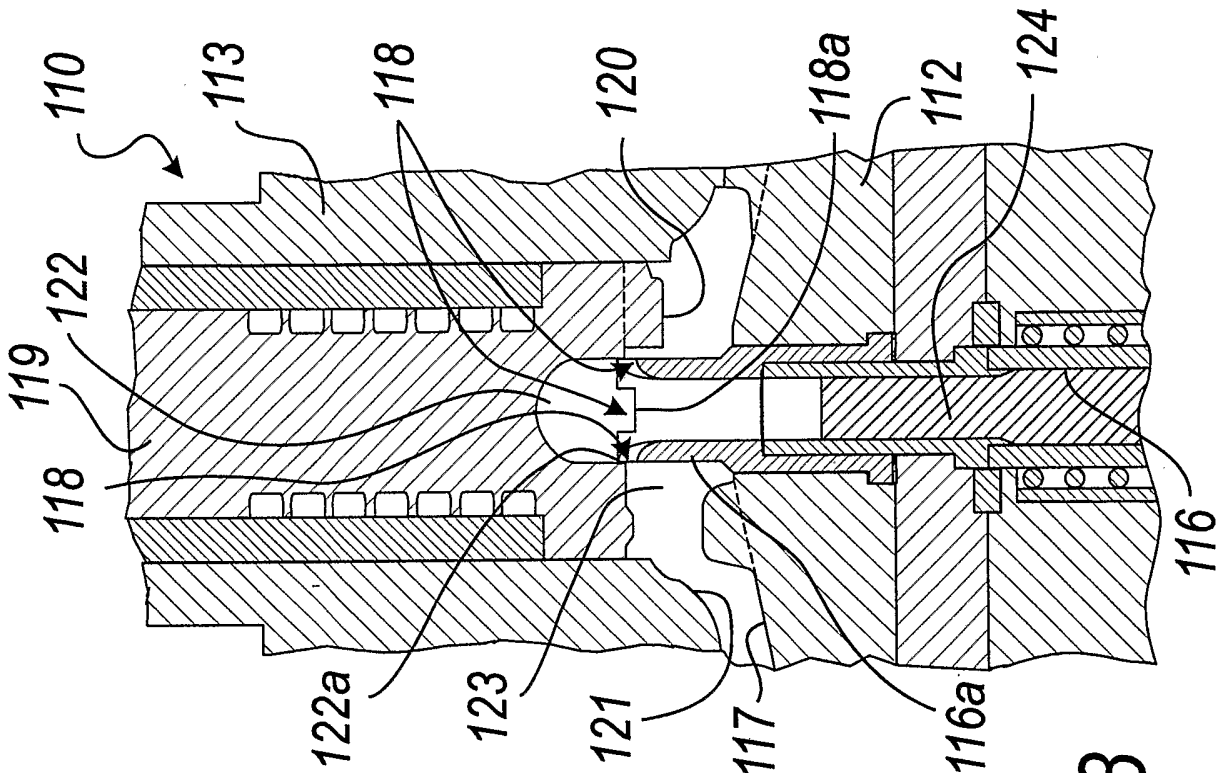


Fig. 8

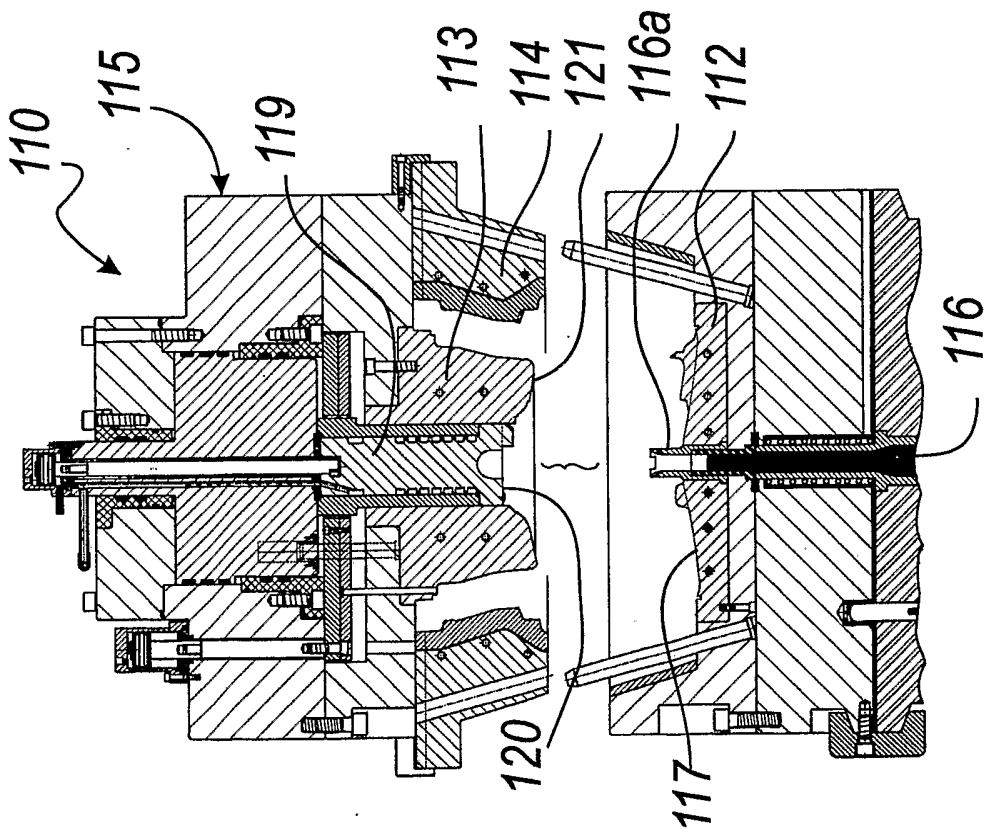


Fig. 7

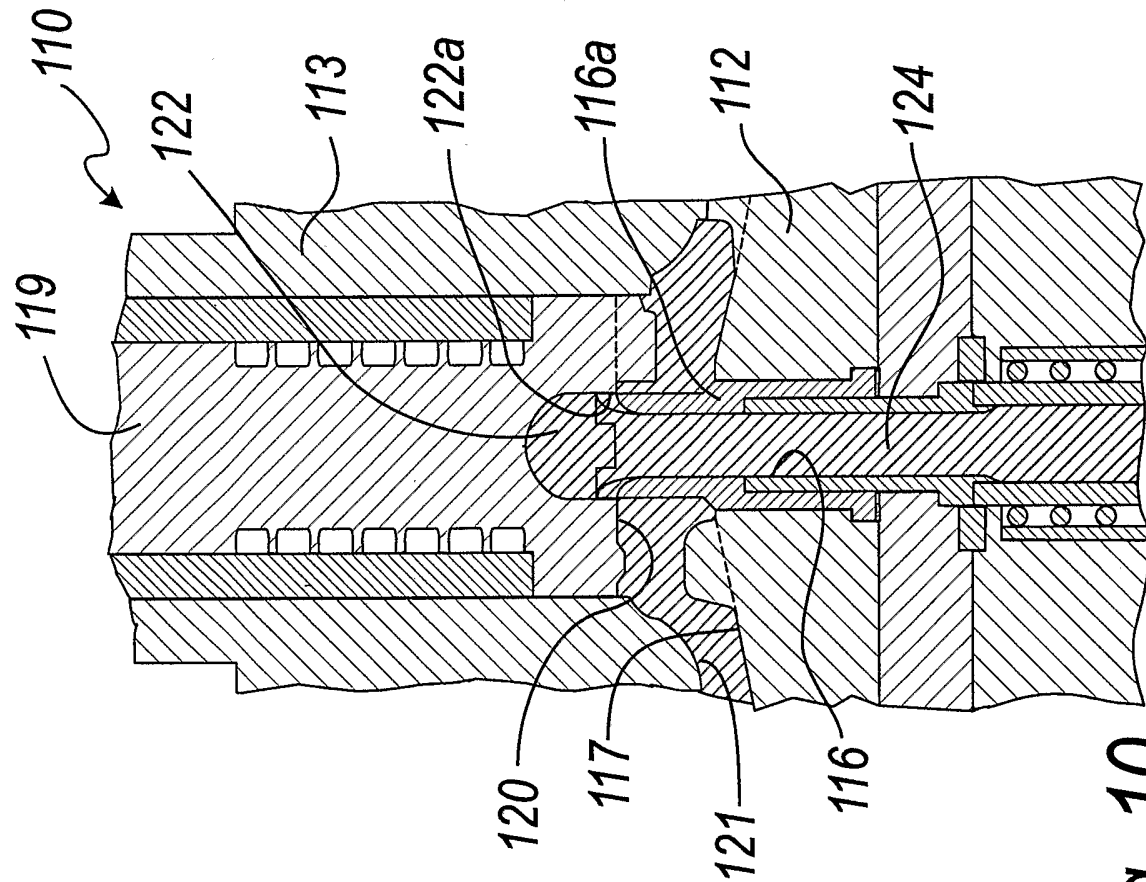


Fig. 10

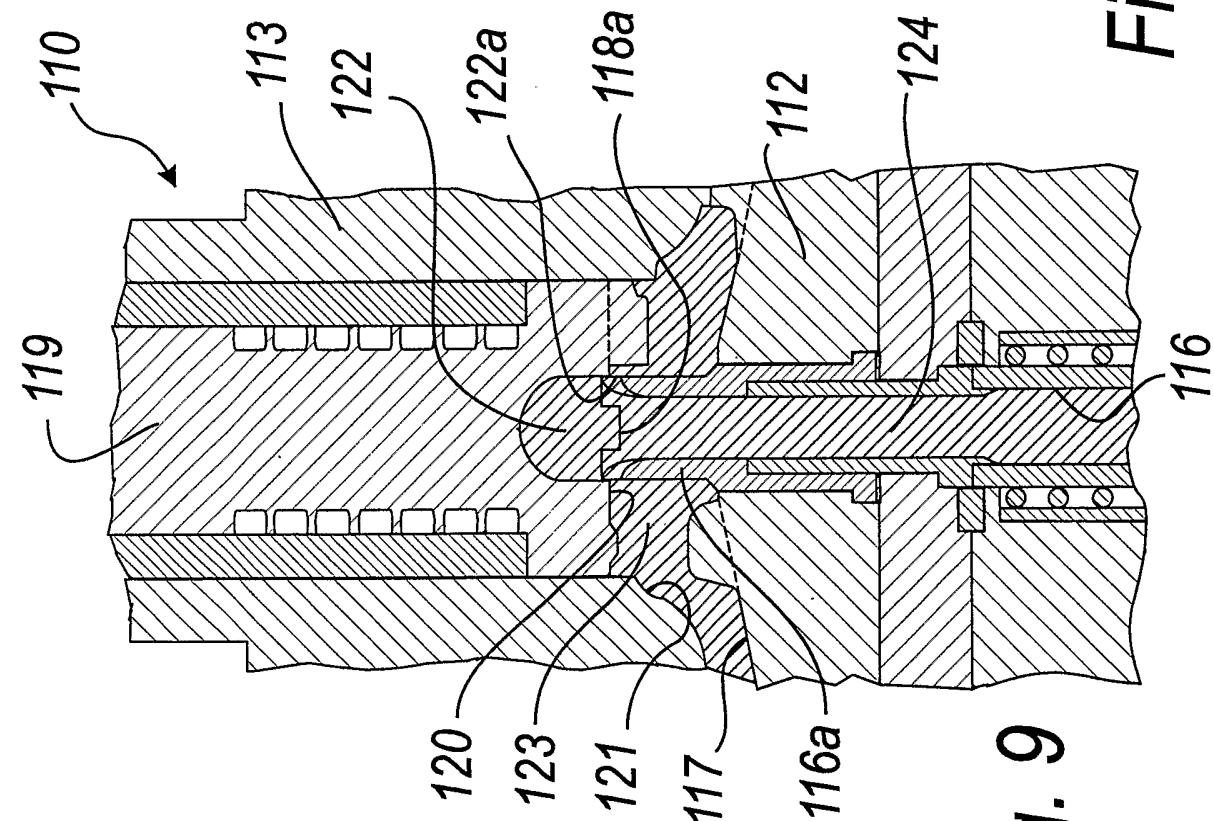


Fig. 9

