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(54) **Title**: NON-RETURN VALVE

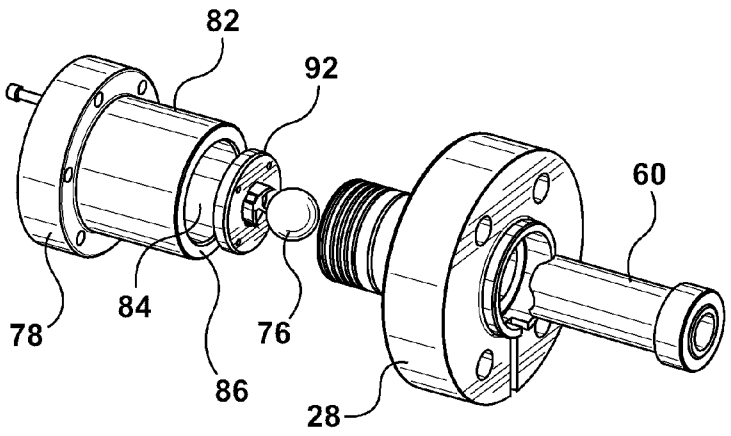


FIG. 4

(57) **Abstract**: A shutoff valve (36, 136) includes nozzle (28), adapted to be moved relative to a hot runner assembly (50), and operable to communicate with the hot runner assembly (50) when in a forward position. The nozzle (28) includes a melt channel (30) having a first narrow portion (70), a second narrow portion (72), and a wider portion (74) located therebetween. A ball (76) is located within the wider portion (74) of the melt channel (30), and adapted to close the shutoff valve (36, 136) when abutting against one of the first narrow portion (70) and the second narrow portion (72), and open the shutoff valve (136) when displaced away from the one of the first narrow portion (70) and the second narrow portion (72). An anvil (92, 192) is mounted to the molding assembly (50). The ball (76) is urged towards its closed position by melt pressure. Moving the nozzle (28) into the forward position causes the anvil (92, 192) to move the ball (76) from the closed position into its open position.

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NON-RETURN VALVE

FIELD

The present invention relates to injection molding machinery. More specifically, the present invention relates to the control of melt within an injection unit.

BACKGROUND

Some examples of known molding systems are: (i) the HyPET ™ Molding System, (ii) the Quadloc ™ Molding System, (iii) the Hylectric ™ Molding System, and (iv) the HyMet ™ Molding System, all manufactured by Husky Injection Molding Systems, Ltd..

The injection molding process typically comprises preparing a polymeric (or sometimes metal) material in an injection unit for melting, injecting the now-melted material under pressure into a closed and clamped mold, solidifying the material in its molded shape, opening the mold and ejecting the part before beginning the next cycle. The molding material typically is supplied to the injection unit from a hopper in the form of pellets or powder. The injection unit transforms the solid material into a molten material (sometimes called a "melt"), typically using a feed screw. The melt is then injected into a hot runner or other molding system under pressure from the feed screw or a plunger unit. A shut off valve assembly is often provided to stop and start the flow of molten material from the barrel to the molding system.

Many screws mount non-return valves at their distal end to prevent melt from flowing back during injection. A typical prior-art shutoff valve is shown in Fig. 1 at 5. Shutoff valve 5 is mounted to an end of barrel head 7. It includes a spool 9, rotatably mounted within the valve body. Beyond the shutoff-off valve 5 (relative to barrel head 7) is a nozzle extension 11 and plunger nozzle 13 that extends into the central opening 15 of a platen 17 into a hot or cold runner (not shown). Running through barrel head 7, nozzle extension 11 and plunger nozzle 15 is a melt channel 19. Actuation of spool 9 between an open position and a closed position permits or prevents expression of a melt material through melt channel 19.

SUMMARY

According to a first aspect of the invention, there is provided a shutoff valve for an injection unit, comprising a nozzle, adapted to be moved relative to a molding assembly, and operable to communicate with the molding assembly when in a forward position. A melt channel is defined within the nozzle, the melt channel including a first narrow portion, a second narrow portion, and a wider portion located therebetween. A ball is located within the wider portion of the melt channel, and adapted to close the shutoff valve when abutting against one of the first narrow portion and the second narrow portion, and open the shutoff valve when displaced away from the one of the first narrow portion and the second narrow portion. An anvil is adapted to be mounted to the molding assembly; and wherein the ball is urged towards its closed position by melt pressure, and moving the nozzle into the forward position causes the anvil to move the ball from the closed position into its open position.

According to a second embodiment of the invention, there is provided a molding system, comprising a molding assembly, adapted to produce molded articles; an injection unit, adapted to inject a melt into the molding assembly including; and a shutoff valve. The shutoff valve has a nozzle, adapted to be moved relative to the molding assembly, and operable to communicate with the molding assembly when in a forward position. A melt channel is defined within the nozzle, the melt channel including a first narrow portion, a second narrow portion, and a wider portion located therebetween. A ball is located within the wider portion of the melt channel, and adapted to close the shutoff valve when abutting against one of the first narrow portion and the second narrow portion, and open the shutoff valve when displaced away from the one of the first narrow portion and the second narrow portion. An anvil is adapted to be mounted to the molding assembly; and wherein the ball is urged towards its closed position by pressure generated by the melt within the melt channel, and moving the nozzle into the forward position causes the anvil to move the ball from the closed position into an open position.

BRIEF DESCRIPTION OF THE DRAWINGS

Exemplary embodiments of the present invention will now be described with reference to the accompanying drawings, in which:

Fig. 1 is a cross sectional view of a prior art shutoff valve for an injection unit;

Fig. 2 is a side view of an injection unit and molding assembly according to a first embodiment;

Fig. 3 is a cross-sectional view of a shutoff valve for the injection unit of Fig. 2;

Fig 4 is an exploded view of portions of the shutoff valve of Fig. 3;

Fig. 5 is a perspective view of an anvil plate for the shutoff valve shown in Figs 3-4;

Fig. 6A to 6D are cross section views of the shutoff valve shown in Figs 3-4 during different phases of an injection cycle; and

Fig. 7 is a cross-sectional view of a shutoff valve according to another embodiment.

DETAILED DESCRIPTION OF THE NON-LIMITING EMBODIMENTS

Referring now to Fig. 2, an injection unit for a molding system 18 in accordance with a first non-limiting embodiment is shown generally at 20. The injection unit 20 includes a barrel 22 adapted to receive a screw 24. Barrel 22 may include an optional protective liner (not shown). A barrel head 26 closes off the end of barrel 22, and mounts a coaxially-aligned nozzle 28. A melt channel 30 is defined between them, extending through barrel 22, barrel head 26 and nozzle 28.

Resin material (typically thermoset or thermoplastic pellets) is fed from a hopper 32, through a feed throat 34 into melt channel 30. The rotational movement of screw 24 plasticizes the material prior to it exiting through nozzle 28. Typically, screw 24 may include a plurality of specialized zones (not shown). For example, a first zone might include screw flights adapted for conveying solid material from the hopper 32, a latter zone for shearing and plasticizing the material, and a final zone for mixing the now-molten material prior to exiting through nozzle 28. Screw 24 may also include weirs or channels to separate out unmelted material from the melted material for further processing. Other adaptations to the screw will occur to those of skill in the art.

In addition to rotating, screw 24 is typically operable to reciprocate back and forth to express the melted material out through nozzle 28 and pack the material between mold halves 44. Screw 24 may also include a check valve proximate its distal end (not shown). A shutoff valve 36, which will be described in greater detail later on, is provided near the tip of screw 24 to prevent the accidental exit of melt from or reentry of melt into barrel 22 when the injection unit 20 is not injecting. The rotational movements of screw 24 is provided by a motor 52, which may be an electric motor, a hydraulic motor, or a combination thereof (the embodiment depicted in Fig. 1 shows an electric version of motor 52). The rotational movement of screw 24 helps to melt and mix the molten material. In the presently-illustrated embodiment, screw 24 is

also translatable within barrel 22 via piston 38, in order to apply injection and hold pressure during the molding process.

Heater bands 54 are provided along a portion of the length of barrel 22 (though away from the feed throat 34) to assist in the melting of the material (in addition to the heat generated by the shearing action of screw 24) and then maintain the temperature of the molten material as it approaches the nozzle 28. Typically, heater bands 54 are covered with an insulating barrel cover 56 to minimize heat loss). Thermocouples 58 are provided along the barrel 22 to provide indicia of the material's temperature.

The injection unit 20 is slidably mounted to a base 40 along rails 42, and is operable to be translated between a forward position, where it is adapted to be in communication with a molding assembly 46 and a rearward position, where it is not in communication with the molding assembly 46. Translation of the injection unit 20 is typically provided by carriage cylinders (not shown) which move injection unit 20 relative to base 40 along rails 42. In addition, the injection unit 20 may be operable to pivot away from the molding assembly 46 when translated to its rearward position for servicing.

The molding assembly 46, as illustrated, includes a pair of mold halves 44, retained by platens 48, which in the present embodiment, include a stationary platen 48a and a movable platen 48b. Typically, the mold halves 44 include a plurality of molding cavities and cores for the concurrent molding of multiple molded articles. A hot runner assembly 50 is mounted between one of the mold halves 44 and the stationary platen 48a, that would provide distribution of the melt from the injection unit 20 to the plurality of molding cavities within mold halves 44.

Referring now to Figs. 3 and 4, shutoff valve 36 is described in greater detail. Shutoff valve 36 includes the nozzle 28, which is mounted at the end of the barrel head 26 that closes off the end of barrel 22 (Fig. 2). Nozzle 28 defines a nozzle chamber 64, which itself defines a portion of melt channel 30. Nozzle chamber 64 is open at a first end 66 (proximate the barrel head 62) and a second end 68 (proximate the molding assembly 46) .

Nozzle chamber 64 includes a first narrow portion 70 proximate the first end 66, and a second narrow portion 72 proximate the second end 68. Between the first narrow portion 70 and the second narrow portion 72 is a wider portion 74. The first narrow portion 70 and the second narrow portion 72 can be integrally formed by the body of nozzle 28 (such as is shown with second narrow portion 72 in Fig. 3), or it can be narrowed using an insert 60(such as is shown

with first narrow portion 70 in Fig. 3). In the presently-illustrated embodiment, insert 60 is a hollow cylinder adapted to fit against the interior sidewalls of nozzle 28. A ball 76 is located within the wider portion 74, and is sized as to be retained within the wider portion 74 by the sidewalls of first narrow portion 70 and second narrow portion 72, but to provide a clearance gap for the melt in the wider portion 74.

Nozzle 28 is adapted to be removably located within a sprue bushing 78 that is not part of injection unit 20, but rather is mounted directly to the hot runner assembly 50 on the molding assembly 46 (Fig. 2). Alternatively, sprue bushing 78 could be adapted to be mounted to the stationary platen 48a. Sprue bushing 78 includes a base 80 that is adapted to be mounted directly to the hot runner, and a generally cylindrical body 82. Cylindrical body 82 is hollow and defines a bushing chamber 84 (see Fig. 4). Bushing chamber 84 includes openings at both ends. A first opening 86 is adapted to receive the nozzle 28 (a process described in greater detail later). A second opening 88 is located around a central melt inlet 89 on the hot runner assembly 50.

Mounted to a ledge 90 defined by the sprue bushing 78 is an anvil 92 which is operable to extend into the nozzle 28 and displace ball 76. Seen additionally in Fig. 5, the anvil 92 is adapted to receive fasteners 93 which secure the anvil 92 to the ledge 90. In the presently-illustrated embodiment, the anvil 92 extends across second opening 88, but permits melt flow through a plurality of melt apertures 94. Referring additionally to Fig. 5, the anvil 92 also includes a seat 96, which is adapted to receive and retain the ball 76 and thereby block melt apertures 94, preventing melt flow. In the presently-illustrated embodiment, the seat 96 is a raised cruciform crossbar, and the melt apertures 94 are open sectors defined between the bars of seat 96. In the presently-illustrated embodiment, the bars of seat 96 are concave (relative to the direction of melt flow) so as to properly seat ball 76. The shape of seat 96 and melt apertures 94 is not particularly limited and other shapes and configurations can be used. For example, seat 96 could be defined by a single crossbar, or by a pair of parallel crossbars. Alternatively, seat 96 could be defined by a spherical section and the melt apertures 94 be defined as a plurality of holes distributed across the spherical section. Other configurations will occur to those of skill in the art.

Referring now to Figs. 6A-6D, an injection cycle is shown for shutoff valve 36. Fig. 6A shows the shutoff valve 36 during the injection and hold phases of the injection cycle. During the injection and hold phases, injection unit 20 is located its fully-forward position along rails 42

(Fig. 2). Nozzle 28 is fully located within bushing chamber 84 of sprue bushing 78 so that the distal end of nozzle 28 abuts against the anvil 92. The anvil 92 extends into the second end 68 of the nozzle 28, displacing ball 76 back away from second narrow portions 72. Pressure from the melt forces ball 76 onto the seat 96 of anvil 92. Shutoff valve 36 is now held in the open position. The melt (as shown by the arrows) can flow around ball 76 and be expressed out of the second end 68 of nozzle 28 and into the molding assembly 46 through second opening 98 on the sprue bushing 78.

Fig. 6B shows the injection molding machine during the start of its recovery phase. Carriage cylinders (not shown) move the injection unit 20 towards its rearward position on rails 42. Barrel 22 is thus retracted so that nozzle 28 is no longer bottomed out against the anvil 92, and the seat 96 no longer extends into the second end of nozzle 28. Melt pressure forces ball 76 against the sidewalls of second narrow portion 72, thereby sealing the tip (i.e., moving shutoff valve 36 into the closed position). With shutoff valve 36 in the closed position, injection unit 20 can begin recovery (i.e., processing melt materials for the next injection cycle) by rotating screw 24.

In Fig. 6C, injection unit 20 has moved into its rearward position along rails 42. 92. No longer subjected to injection forces, the molding assembly 46 can begin to decompress, with melt located in hot runner assembly 50 flowing back into bushing chamber 84. As the pressure of the melt flowing back into bushing chamber 84 remains lower than the pressure of the melt within barrel 22, ball 76 remains seated against the sidewalls of second narrow portion 72 so that shutoff valve 36 remains in the closed position. During normal operation, injection unit 20 is not retracted so far from molding assembly 46 as to remove nozzle 28 from contact with sprue bushing 78.However, even when injection unit 20 is fully retracted so as to remove nozzle 28 from contact with sprue bushing 78, ball 76 mains a pressure seal due to the pressure of the melt within barrel 22.

In Fig. 6D, injection unit 20 begins to move towards its forward position to initiate the next injection cycle (as is shown in Figs. 6A-6C). The nozzle 28 moves towards the anvil 92 within sprue bushing 78, Shutoff valve 36 remains in the closed positions the melt pressure in barrel 22 is greater than the melt pressure within bushing chamber 84. Ball 76 abuts against the sidewalls of the first narrow portion 70 (formed by insert 60). Any melt that has accumulated in the bushing chamber 84 is pushed back into the hot runner by the forward motion of the nozzle 28.

Referring now to Fig. 7, a second embodiment of the invention is shown generally at 136. Shutoff valve 136 includes a nozzle 28 mounted to the end of a barrel head 26. The nozzle 28 is substantially similar to the nozzle depicted in Figs. 3-6, and includes a first narrow portion 70, a second narrow portion 72, and a wider portion 74 located therebetween. The second narrow portion 72 is typically formed by an insert 60. A ball 76 is located within the wider portion 74. Nozzle 28 is adapted to be slidably located within a sprue bushing 178.

Like the sprue bushing of the previous embodiment, sprue bushing 178 is adapted to be mounted directly to a hot runner assembly 50 over the central melt channel 89. An anvil pin 192 is mounted directly to hot runner assembly 50 extends through the central melt inlet 89 into the sprue bushing 178. While nozzle 28 is seated fully within the sprue bushing 178, the anvil pin 192 extends through the first end 66 into the wider portion 74. The end of anvil pin 192 defines a seat 196 adapted to abut ball 76 and dislodge the ball 76 away from the first narrow portion 70. Thus, when nozzle 28 is located fully forward within sprue bushing 178, anvil pin 192 extends into the wider portion 74, thereby moving shutoff valve 136 is in the open position. When nozzle 28 is retracted rearwards, anvil pin 192 does not extend into wider portion 74, so that melt pressure forces ball 76 against the first narrow portion 70, moving shutoff valve 136 into the closed position. Optionally, anvil pin 192 includes external mixing threads 194 for the mixing of the melt is it flows into the hot runner assembly 50.

The description of the non-limiting embodiments provides examples of the present invention, and these examples do not limit the scope of the present invention. It is understood that the scope of the present invention is limited by the claims. The concepts described above may be adapted for specific conditions and/or functions, and may be further extended to a variety of other applications that are within the scope of the present invention. Having thus described the non-limiting embodiments, it will be apparent that modifications and enhancements are possible without departing from the concepts as described. Therefore, what is to be protected by way of letters patent are limited only by the scope of the following claims.

WHAT IS CLAIMED IS:

1. A shutoff valve (36, 136) for an injection unit (20), comprising

a nozzle (28) for expressing a melt, adapted to be moved relative to a molding assembly (46) between a forward position and a rearward position, and operable to communicate with the molding assembly (46) when in the forward position;

a melt channel (30), defined within the nozzle (28), the melt channel (30) including a first narrow portion (70), a second narrow portion (72), and a wider portion (74) located therebetween;

a ball (76), located within the wider portion (74) of the melt channel (30), and adapted to close the shutoff valve (36, 136) when abutting against one of the first narrow portion (70) and the second narrow portion (72), and open the shutoff valve (36, 136) when displaced away from the one of the first narrow portion (70) and the second narrow portion (72);

an anvil (92, 192), adapted to be mounted to the molding assembly (46) and to extend into the melt channel (30) when the nozzle is in the forward position; and

wherein the anvil (92, 192) is located so as to displace the ball (76) away from one of the first narrow portion (70) and the second narrow portion (72) to open the shutoff valve 936, 136) when the nozzle is in the forward position.

2. The shutoff valve (36, 136) of claim 1, wherein the molding assembly (46) further includes a sprue bushing (178) located around a central melt inlet, and the nozzle (28) is adapted to be slidably located within the sprue bushing (178).

3. The shutoff valve (36) of claim 2, wherein the anvil (92) is a crossbar mounted over the central melt inlet.

4. The shutoff valve (36) of claim 1, wherein the anvil (192) is an anvil pin (192) mounted to the molding assembly (46).

5. The shutoff valve (136) of claim 4, wherein the anvil pin (192) includes mixing threads for mixing of the melt flowing along its body.

6. The shutoff valve (36, 136) of claim 2, wherein the nozzle (28) remains slidably located within the sprue bushing (178) when moved into the rearward position.

7. The shutoff valve (36, 136) of claim 1, wherein the anvil (92, 192) is mounted directly to a hot runner assembly (50) located on the molding assembly (46).

8. A molding system (18), comprising

a molding assembly (46), adapted to produce molded articles;

an injection unit (20), adapted to inject a melt into the molding assembly (46) including; and

a shutoff valve (36, 136) having

a nozzle (28), adapted to be moved relative to the molding assembly (46), and operable to communicate with the molding assembly (46) when in a forward position;

a melt channel (30), defined within the nozzle (28), the melt channel (30) including a first narrow portion (70), a second narrow portion (72), and a wider portion (74) located therebetween;

a ball (76), located within the wider portion (74) of the melt channel (30), and adapted to close the shutoff valve (36, 136) when abutting against one of the first narrow portion (70) and the second narrow portion (72), and open the shutoff valve (36, 136) when displaced away from the one of the first narrow portion (70) and the second narrow portion (72);

an anvil (92, 192), adapted to be mounted to the molding assembly (46) and to extend into the melt channel (30) when the nozzle is in the forward position ; and

wherein the anvil (92, 192) is located so as to displace the ball (76) away from one of the first narrow portion (70) and the second narrow portion (72) to open the shutoff valve 936, 136) when the nozzle is in the forward position.

9. The molding system (18) of claim 8, wherein the molding assembly (46) further includes a sprue bushing (178) located around a central melt inlet, and the nozzle (28) is adapted to be slidably located within the sprue bushing (178).

10. The molding system (18) of claim 9, wherein the anvil (92) is a crossbar mounted across a bushing chamber (84) defined by the sprue bushing (178).

11. The molding system (18) of claim 9, wherein the anvil (192) is an anvil pin (192) mounted to the molding assembly (46).

12. The molding system (18) of claim 11, wherein the anvil pin (192) includes mixing threads for mixing of the melt flowing along its body.

13. The molding system (18) of claim 10, wherein the nozzle (28) remains slidably located within the sprue bushing (178) when moved into a rearward position.

14. The molding system (18) of claim 8, wherein the anvil (92, 192) is mounted directly to a hot runner assembly (50) located on the molding assembly (46).

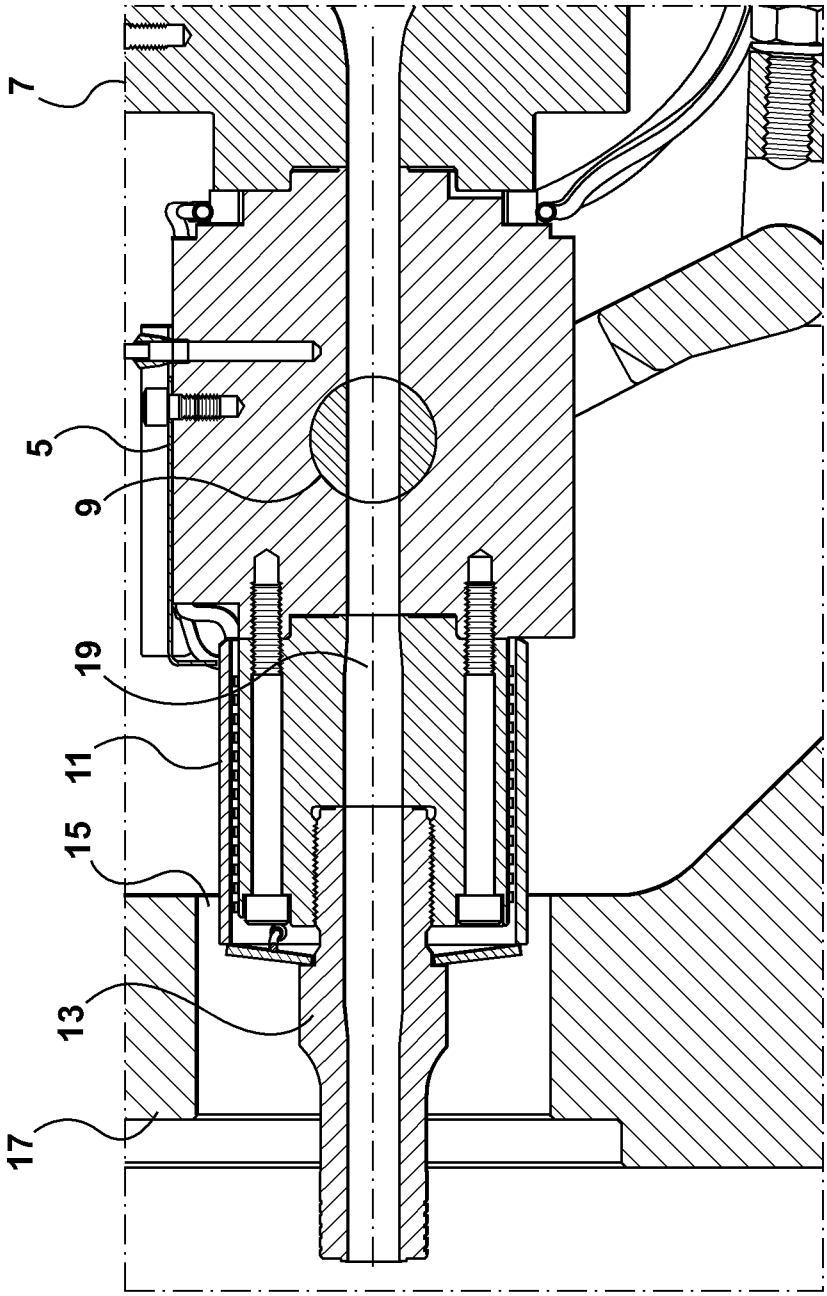


FIG. 1 (PRIOR ART)

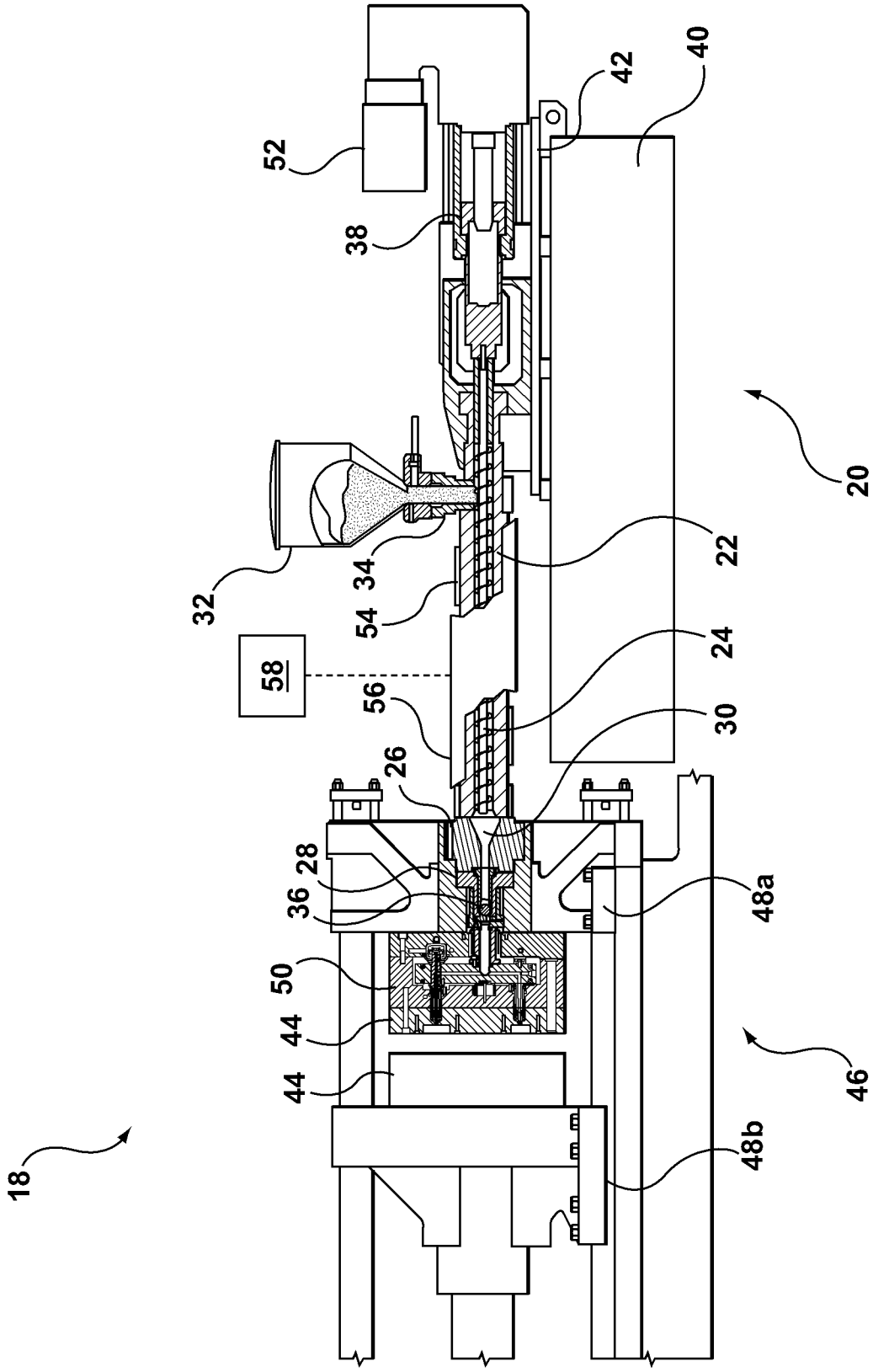


FIG. 2

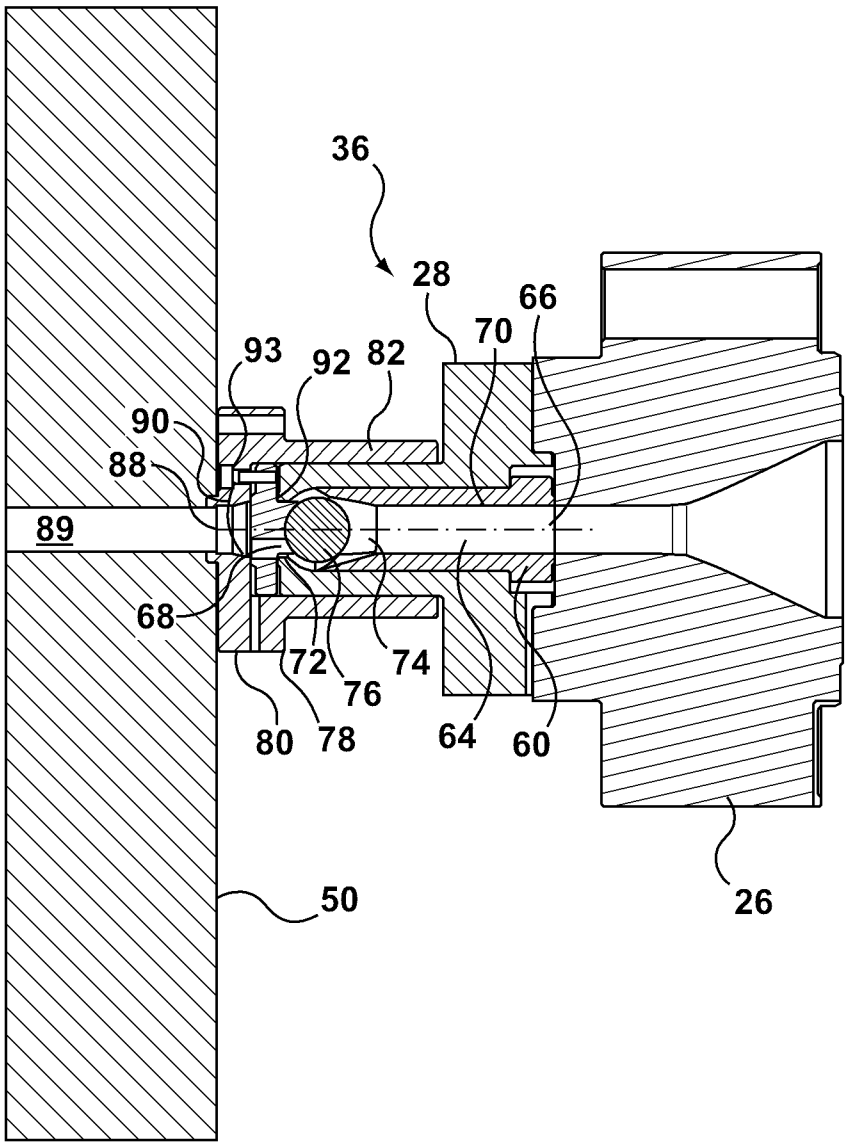


FIG. 3

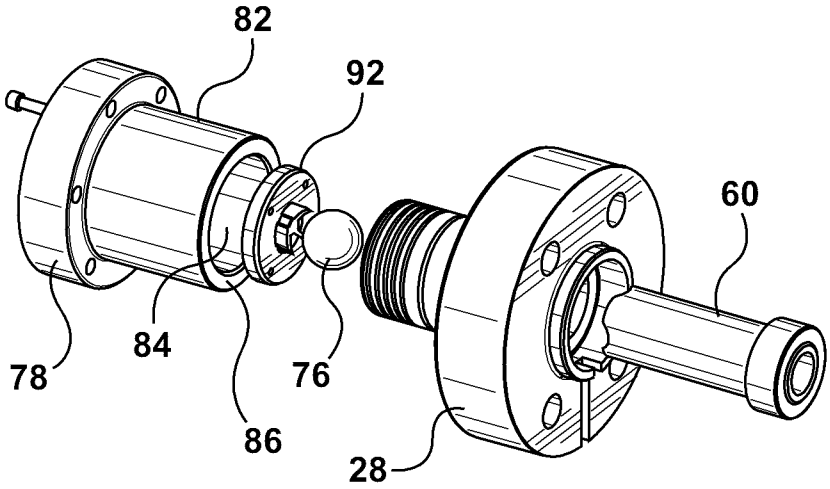


FIG. 4

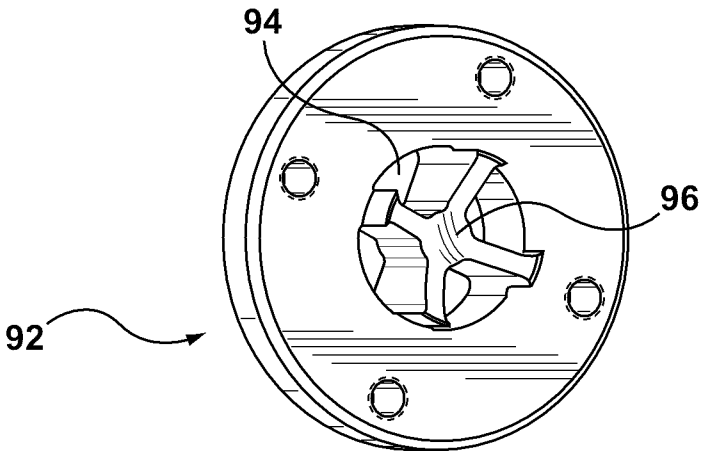


FIG. 5

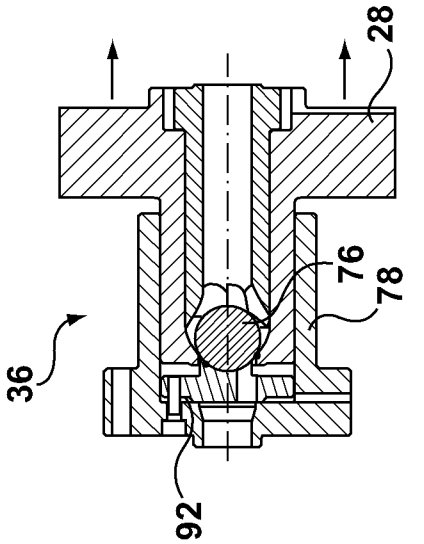


FIG. 6B

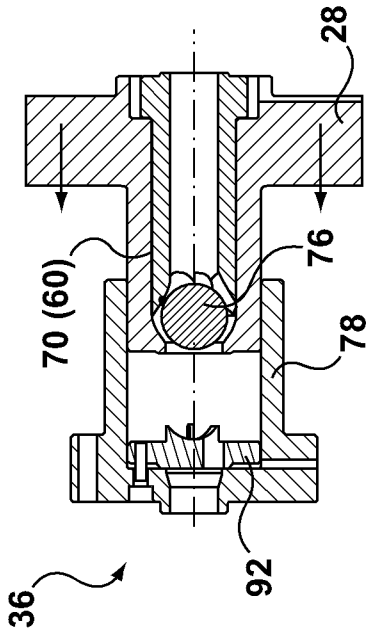


FIG. 6D

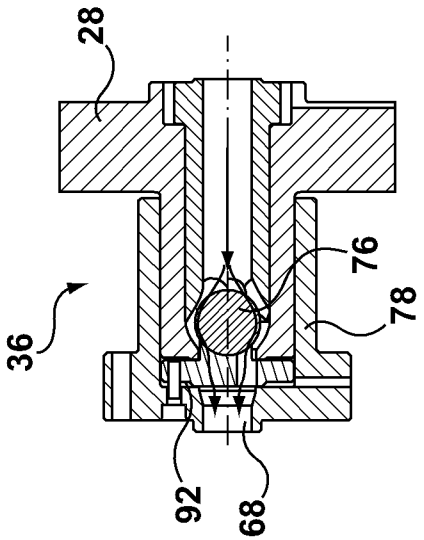


FIG. 6A

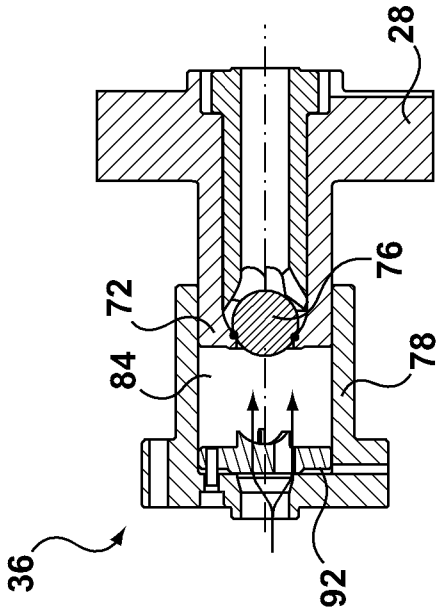


FIG. 6C

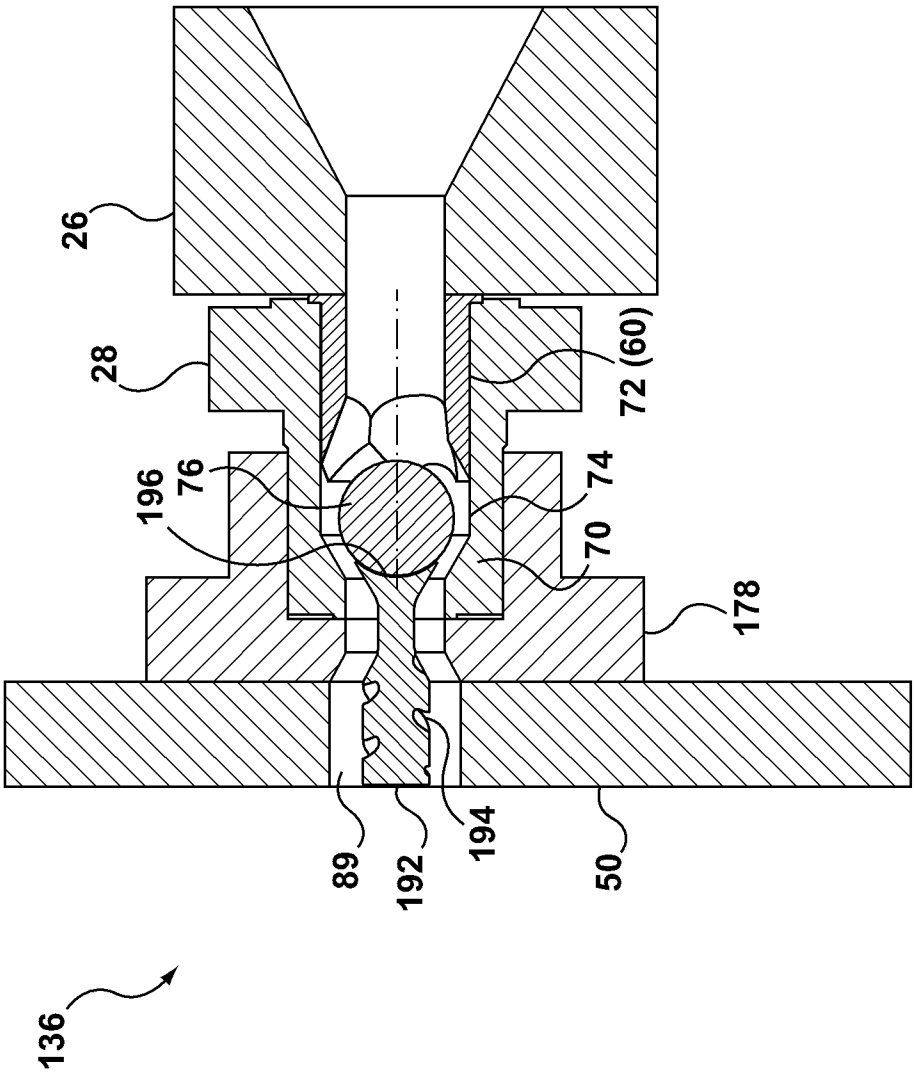


FIG. 7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CA2010/001699

A. CLASSIFICATION OF SUBJECT MATTER
IPC: ***B29C 45/23*** (2006.01)
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: ***B29C 45/**** (2006.01)

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

Electronic database(s) consulted during the international search (name of database(s) and, where practicable, search terms used)
EPOQUE (EPODOC and X-FULL), CPD with key words, such as: valve, mold/mould, inject* unit, shoot* pot, screw , nozzle, check*, non-return, ball, melt chamber, bushing, drool*, decompress, cross-over and anvil

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 1522396 A2 (SCHMIDT, H. H.) 13 April 2005 (13-04-2005) *whole document*	1-14
A	CA 2266306 C (MARUYAMA, K. et al.) 11 September 2000 (11-09-2000) *whole document*	1-14

[ ] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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

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Date of the actual completion of the international search	Date of mailing of the international search report
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