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[Continued on next page]

(54) Title: VALVE GATE DEVICE

(57) Abstract: A valve gate device (100) for regulating a flow of melt into one or more molding cavities of a mold in a molding system. The valve gate device includes a valve stem (110), a drive unit (120), a cam shaft (130), and a cam mechanism (140). The cam shaft (130) is coupled to the drive unit (120), and receives rotational motion from the drive unit (120). The cam shaft (130) has an axis of rotation that is parallel to the longitudinal axis of the valve stem (110). The cam mechanism (140) couples the valve stem (110) to the cam shaft (130), and is configured to drive reciprocating axial motion of the valve stem (110) with rotation of the cam shaft (130) in a single direction.

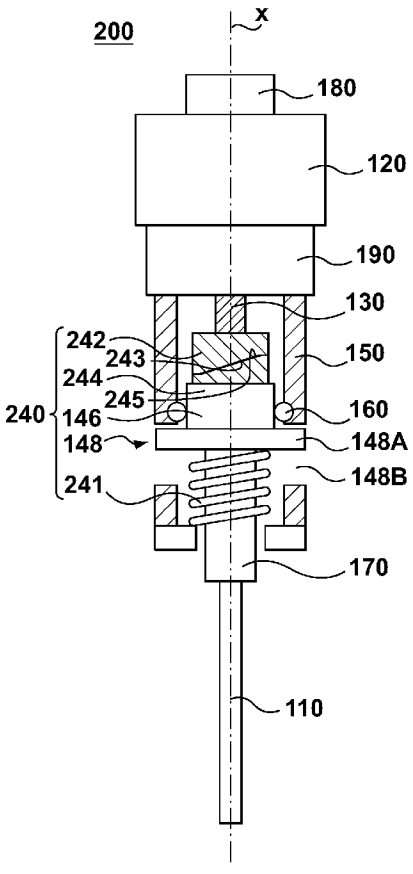

FIG. 2B

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KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

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Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

— *of inventorship (Rule 4.17(iv))*

Published:

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

VALVE GATE DEVICE

TECHNICAL FIELD

Non-limiting embodiments disclosed herein generally relate to, but are not limited to, a valve gate device, and more particularly a valve gate device for regulating a flow of melt into one or more molding cavities of a mold, and/or a melt distribution device of a molding system including a valve gate device.

BACKGROUND

Molding is a process by virtue of which a molded article can be formed from molding material by using a molding system. Various molded articles can be formed by using the molding process, such as an injection molding process. An example of a molded article that can be formed, for example, from polyethylene terephthalate (PET material) is a preform suitable for subsequent blow molding into a final shaped container.

A typical molding system includes inter alia an injection unit, a clamp assembly and a mold assembly. The injection unit can be, for example, a reciprocating screw type injection unit. Within the reciprocating screw type injection unit, raw material (such as PP, PET or the like) is fed through a hopper, which in turn feeds an inlet end of a plasticizing screw. The plasticizing screw is encapsulated in a barrel, which is heated by barrel heaters. Helical flights of the screw convey the raw material along an operational axis of the screw. Typically, a root diameter of the screw is progressively increased along the operational axis of the screw in a direction away from the inlet end.

As the raw material is being conveyed along the screw, it is sheared between the flights of the screw, the screw root and the inner surface of the barrel. The raw material is also subjected to some heat emitted by the barrel heaters and conducted through the barrel. As the shear level increases in line with the increasing root diameter, the raw material, gradually, turns into substantially homogenous melt. When a desired amount of the melt is accumulated in a space at discharge end of the screw (which is an opposite extreme of the screw vis-à-vis the inlet end), the screw stops. The screw is then forced forward (in a direction away from the inlet end thereof), forcing the desired amount of the melt into one or more molding cavities of a mold through a gate and runner system, such as a hot runner system.

A hot runner system is typically comprised of several components: a sprue to receive molten resin from the injection unit, a manifold to distribute the resin to several ports, and a plurality of nozzles to transfer the resin from the manifold ports to the receiving molding cavities. Usually, hot runner systems and mold assemblies are treated as tools that may be sold separately (or together) from molding systems.

SUMMARY

In accordance with an aspect disclosed herein, there is provided a valve gate device. The valve gate device includes a valve stem, a drive unit, a cam shaft, and a cam mechanism. The cam shaft is coupled to the drive unit. The cam shaft receives rotational motion from the drive unit, has an axis of rotation that is parallel to a longitudinal axis of the valve stem. The cam mechanism couples the valve stem to the cam shaft and is configured to drive reciprocating axial motion of the valve stem with rotation of the cam shaft in a single direction.

These and other aspects and features of non-limiting embodiments will now become apparent to those skilled in the art upon review of the following description of specific non-limiting embodiments of the invention in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The non-limiting embodiments will be more fully appreciated by reference to the accompanying drawings, in which:

FIG. 1A depicts a cross-sectional view of a valve gate device, corresponding to a closed position, in accordance with a first non-limiting embodiment.

FIG. 1B depicts a cross-sectional view of the valve gate device, in accordance with the first non-limiting embodiment, corresponding to an open position.

FIG. 2A depicts a cross-sectional view of a valve gate device, corresponding to a closed position, in accordance with a second non-limiting embodiment.

FIG. 2B depicts a cross-sectional view of the valve gate device, in accordance with the second non-limiting embodiment, corresponding to an open position.

The drawings are not necessarily to scale and may be illustrated by phantom lines, diagrammatic representations and fragmentary views. In certain instances, details that are not necessary for an understanding of the embodiments or that render other details difficult to perceive may have been omitted.

DETAILED DESCRIPTION

Reference will now be made in detail to various non-limiting embodiment(s) of a valve gate device for use in a melt distribution device (e.g. a hot runner) of a molding system. It should be understood that other non-limiting embodiment(s), modifications and equivalents will be evident to one of ordinary skill in the art in view of the non-limiting embodiment(s) disclosed herein and that these variants should be considered to be within scope of the appended claims.

Furthermore, it will be recognized by one of ordinary skill in the art that certain structural and operational details of the non-limiting embodiment(s) discussed hereafter may be modified or omitted (i.e. non-essential) altogether. In other instances, well known methods, procedures, and components have not been described in detail.

In accordance with a first non-limiting embodiment, as depicted in FIGS. 1A and 1B, valve gate device 100 is shown. The valve gate device 100 includes a valve stem 110. In a melt distribution device (not shown) of a molding system having the valve gate device 100, reciprocating axial translation of the valve stem 110 corresponds to actuation between a closed position and an open position of a valve gate for regulating a flow of melt therethrough.

The valve gate device 100 also includes a drive unit 120. The drive unit 120 may be an electromechanical device such as, for example, an electric motor. The valve gate device 100 also includes a cam shaft 130 extending from the drive unit 120. The valve gate device 100 further includes a cam mechanism 140 located between the drive unit 120 and the valve stem 110. The cam shaft 130 is configured to couple the drive unit 120 to the cam mechanism 140. The cam mechanism 140 is configured to couple the cam shaft 130 to the valve stem 110. The cam shaft has a longitudinal axis that is substantially coincident with a longitudinal axis X of the valve stem 110. However, in another non-limiting embodiment (not shown) the longitudinal axis of the cam shaft 130 may be parallel to but offset from the longitudinal axis X of the valve stem 110.

The cam mechanism 140 includes a driving cam 142. The driving cam 142 is associated with the cam shaft 130. The cam mechanism 140 also includes a driven cam 144. The driven cam 144 is associated with a moving body 146. The moving body 146 is associated with the valve stem 110.

As depicted, the driving cam 142 includes a driving member 143 extending radially outward from the cam shaft 130. The driven cam 144 includes a cylindrical body that defines a profiled groove 145 in an inward facing surface and spanning the circumference thereof. The driving cam 142 is at least partially arranged within and cooperates with the profiled groove 145.

The profile of the profiled groove 145 is generally oriented at an angle with respect to the longitudinal axis X of the valve stem 110. Those skilled in the art will appreciate that the profile of the profiled groove 145 is not particularly limited and may be appropriately selected or adjusted to provide mechanical magnification between actuation in open position and actuation in the closed position according to the requirement of a molding process.

In another non-limiting embodiment (not shown), the driving cam 142 may include a cylindrical body associated with the cam shaft 130 that defines a profiled groove spanning the circumference thereof, and the driven cam 144 may be associated with the moving body 146.

In other non-limiting embodiments (not shown), cam mechanism 140 may include a swash plate mechanism.

Referring back to the non-limiting embodiment depicted in FIGS. 1A and 1B, the valve gate device 100 includes a coupling structure 170 configured to couple the valve stem 110 to the moving body 146. However, it will be appreciated that the moving body 146 may be affixed, otherwise coupled to, or integrally formed with valve stem 110.

Persons skilled in the art will appreciate that that the driving cam 142 may be affixed, coupled to, or integrally formed with cam shaft 130. Persons skilled in the art will also appreciate that that the driven cam 144 may be affixed, coupled to, or integrally formed with moving body 146. Furthermore, it will be appreciated that the moving body 146 may be affixed, coupled to or integrally formed with valve stem 110.

The valve gate device 100 also includes a housing 150 configured to at least partially contain and support the cam mechanism 140. The housing 150 may be a cylindrically shaped casing. The valve gate device 100 further includes a seal 160. Seal 160 is configured to seal a lubricant, or a substance

to reduce friction between cooperating surfaces of the cam mechanism 140, within at least a portion of the housing 150. However, non-limiting embodiments (not show) that do not include a seal 160 are also contemplated herein.

The depicted cam mechanism 140 further includes an anti-rotation device 148. The anti-rotation device 148 includes a first anti-rotation structure 148A and a second anti-rotation structure 148B. The first anti-rotation structure 148A and the second anti-rotation structure 148B cooperate such that rotation of the moving body 146 is prevented, while reciprocating motion the moving body 146 is permitted.

More particularly, the first anti-rotation structure 148A includes an elongate member and the second anti-rotation structure 148B includes a slot defined in an inward facing surface of the housing 150. The slot extends in a direction parallel to the longitudinal axis X of the valve stem 110. The elongate member extends radially outward from the moving body 146. The elongate member is at least partially arranged within and cooperates with the slot to prevent rotation of the moving body 146, while permitting linear translation thereof in direction parallel to the longitudinal axis X of the valve stem 110.

In another non-limiting embodiment (not shown), the first anti-rotation structure 148A may include a slot extending in a direction parallel to the longitudinal axis X of the valve stem 110, and the second anti-rotation structure 148B may include an elongate member.

The depicted valve gate device 100 includes a position sensor 180. The position sensor 180 is adapted to sense an angular position of a rotating part, e.g. the cam shaft 130, or a linear position of a linearly moving part, e.g. the moving body 146, of the valve gate device 100. In use, closed loop feedback from the position sensor 180 may allow for profiling of the position and/or velocity of the valve stem 110.

As depicted in FIGS. 1A and 1B, the position sensor 180 is configured as an encoder associated with the drive unit 120. However, the location of the position sensor 180 is not particularly limited and may be appropriately selected by a person skilled in the art.

In some non-limiting embodiments, the position sensor 180 may be configured as rotary encoder coupled to a controller unit. Examples of rotary encoders contemplated include (but are not limited to): mechanical absolute encoders, optical absolute encoders, standard binary encoders, gray encoders, single-track gray encoders, incremental rotary encoders, and sine wave encoders.

In another non-limiting embodiment (not shown), the position sensor 180 may be configured as at least one switch. The at least one switch may be actuated with the rotation of a rotating part of the valve gate device 100, or with the linear movement of a linearly moving part of the valve gate device 100.

In still another non-limiting embodiment (not shown), operation without position sensor 180 can also be performed by configuring the anti-rotation device 148 to include a mechanical stop, thereby stalling the motor. For example, the anti-rotation device 148 may be configured such that the elongate member bottoms out against the slot, causing a stall condition. Current draw by the drive unit 120 may be monitored to provide visibility to the stall condition.

The depicted valve gate device 100 further includes a gearbox 190. The gearbox 190 is associated with the drive unit 120 and couples the drive unit 120 to the cam shaft 130. The gearbox 190 may be configured to provide an increase or decrease of rotational speed and torque transferred from the drive unit 120 to the cam shaft 130. In another non-limiting embodiment (not shown), the gearbox 190 may not be included or may be integrated as a single unit with the drive unit 120.

In operation, the drive unit 120 imparts a rotational motion to the cam shaft 130 causing the cam shaft 130 to rotate about its axis, i.e. the cam shaft 130 turns about its own longitudinal axis. Cam mechanism 140 translates rotation of the cam shaft 130 to axial translation of the valve stem 110 along longitudinal axis X. Cam mechanism 140 is capable of driving reciprocating axial motion of the valve stem with rotation of the cam shaft 130 in a single direction. More specifically, rotation of the cam shaft 130 causes rotation of the driving cam 142. The driven cam 144 cooperates with the driving cam 142 to translate rotation of the driving cam 142 into a reciprocating axial motion of the moving body 146, in direction parallel to longitudinal axis X, thereby driving reciprocating axial motion of the valve stem 110 with rotation of the cam shaft 130 in a single direction.

FIGs 2A and 2B depict a second non-limiting embodiment, which is substantially similar to the first non-limiting embodiment depicted in FIGS. 1A and 1B, other than: the driving cam 242 includes a first plate cam defining a first profiled surface 243; the driven cam 244 includes a second plate cam defining a second profiled surface 245; and the cam mechanism 240 further includes a biasing device 241 configured to urge together the first profiled surface 243 and the second profiled surface 245.

The profiles of the first and second profiled surfaces are generally oriented at an angle with respect to the longitudinal axis X of the valve stem 110. Those skilled in the art will appreciate that the profiles

of the first and second profiled surfaces can be appropriately selected or adjusted to provide mechanical magnification between actuation in open position and actuation in the closed position according to the requirement of a molding process.

The biasing device 241 as depicted in FIGs 2A and 2B is a spring member. However, persons skilled in the art would understand that other biasing devices are also contemplated, non-limiting examples of which may include: a compressed gas device, a bladder device, or an elastomeric body. The biasing device 241 is arranged to engage with both the moving body 146 and housing 150.

In non-limiting embodiments having biasing device 241, a thrust bearing feature (not shown) may also be included. The thrust bearing feature may be configured to at least partially isolate the gearbox 190 and/or the drive unit 120 from receiving stress and strain transmitted thereto by the biasing device 241.

In operation, the drive unit 120 imparts a rotational motion to the cam shaft 130 causing the cam shaft 130 to rotate about its axis, i.e. the cam shaft 130 turns about its own longitudinal axis. Cam mechanism 240 translates rotation of the cam shaft 130 to axial translation of the valve stem 110 along longitudinal axis X. Cam mechanism 240 is capable of driving reciprocating axial motion of the valve stem with rotation of the cam shaft 130 in a single direction. More specifically, rotation of the cam shaft 130 causes rotation of the driving cam 242. The driven cam 244 cooperates with the driving cam 242 to translate rotation of the driving cam 242 into an axial motion of the moving body 146, in direction parallel to longitudinal axis X. The biasing device 241 urges the moving body 146 in a direction opposite the direction of axial motion of the moving body 146 as caused by cooperation of the driven cam 244 with the driving cam 242, thereby driving reciprocating axial motion of the valve stem 110 with rotation of the cam shaft 130 in a single direction.

In a non-limiting embodiment (not shown), the profiles of the first profiled surface 243 and the second profiled surface 245 may include flat (i.e. non-angled) portions. The flat portions may engage with each other when the driving cam 242 and the driven cam 244 have an engagement corresponding to either the fully opened or fully closed positions of the valve stem 110. The engaged flat portions may be configured to improve stability at the fully opened and fully closed states.

It is noted that the foregoing has outlined some of the more pertinent non-limiting embodiments. It will be clear to those skilled in the art that modifications to the disclosed non-embodiment(s) can be effected without departing from the spirit and scope thereof. As such, the described non-limiting embodiment(s) ought to be considered to be merely illustrative of some of the more prominent

features and applications. Other beneficial results can be realized by applying the non-limiting embodiments in a different manner or modifying them in ways known to those familiar with the art. This includes the mixing and matching of features, elements and/or functions between various non-limiting embodiment(s) is expressly contemplated herein so that one of ordinary skill in the art would appreciate from this disclosure that features, elements and/or functions of one embodiment may be incorporated into another embodiment as skill in the art would appreciate from this disclosure that features, elements and/or functions of one embodiment may be incorporated into another embodiment as appropriate, unless described otherwise, above. Although the description is made for particular arrangements and methods, the intent and concept thereof may be suitable and applicable to other arrangements and applications.

WHAT IS CLAIMED IS:

1. A valve gate device, comprising:

a valve stem (110);

a drive unit (120);

a cam shaft (130), the cam shaft (130) being coupled to, and configured to receive rotational motion from, the drive unit (120), the cam shaft (130) having an axis of rotation parallel to a longitudinal axis (X) of the valve stem (110); and

a cam mechanism (140, 240), the cam mechanism (140, 240) coupling the valve stem (110) to the cam shaft (130), the cam mechanism (140, 240) being configured to drive reciprocating axial motion of the valve stem (110) with rotation of the cam shaft (130) in a single direction.

2. The valve gate device according to claim 1, wherein the cam mechanism (140, 240) includes:

a driving cam (142, 242), the driving cam (142, 242) being associated with the cam shaft (130).

3. The valve gate device according to claim 1, wherein:

the cam shaft (130) is axially aligned with the valve stem (110).

4. The valve gate device according to claim 1, further comprising:

a position sensor (180), the position sensor (180) being configured to sense an angular position of a rotating part, or a linear position of a linearly moving part of the valve gate device.

5. The valve gate device according to claim 1, further comprising:

a gearbox (190), the gearbox (190) being associated with the drive unit (120) and coupling the drive unit (120) to the cam shaft (130).

6. The valve gate device according to claim 2, wherein the cam mechanism (140, 240) further includes:

a driven cam (144, 244), the driven cam (144, 244) engaging with the driving cam (142, 242);

a moving body (146), the moving body (146) located between and being associated with the driven cam (144, 244) and the valve stem (110); and

an anti-rotation device (148), the anti-rotation device (148) configured to prevent rotation of the moving body (146) while allowing for axial motion thereof.

7. The valve gate device according to claim 6, wherein the anti-rotation device (148) includes:

a first anti-rotation structure (148A); and

a second anti-rotation structure (148B), the first anti-rotation structure (148A) and the second the anti-rotation structure (148B) being cooperating together to prevent rotation of the moving body (146) while allowing for axial motion thereof.

8. The valve gate device according to claim 6, wherein:

the driving cam (142) includes:

a driving member (143), the driving member (143) extending radially outward from the cam shaft (130); and

the driven cam (144) includes:

a cylindrical body that defines a profiled groove (145) in an inward facing surface and spanning a circumference thereof, the driving member (143) cooperating with the profiled groove (145) such that rotation of the cam shaft (130) is converted to reciprocating motion of the valve stem (110).

9. The valve gate device according to claim 6, wherein:

the driving cam (242) includes:

a first plate cam defining a first profiled surface (243); and

the driven cam (244) includes:

a second plate cam defining a second profiled surface (245), the first profiled surface (243) and the second profiled surface (245) cooperating such that rotation of the driving cam (242) causes axial translation of the valve stem (110).

10. The valve gate device according to claim 6, wherein the cam mechanism (240) further includes:

a biasing device (241), the biasing device (241) configured to urge together the first profiled surface (243) and the second profiled surface (245).

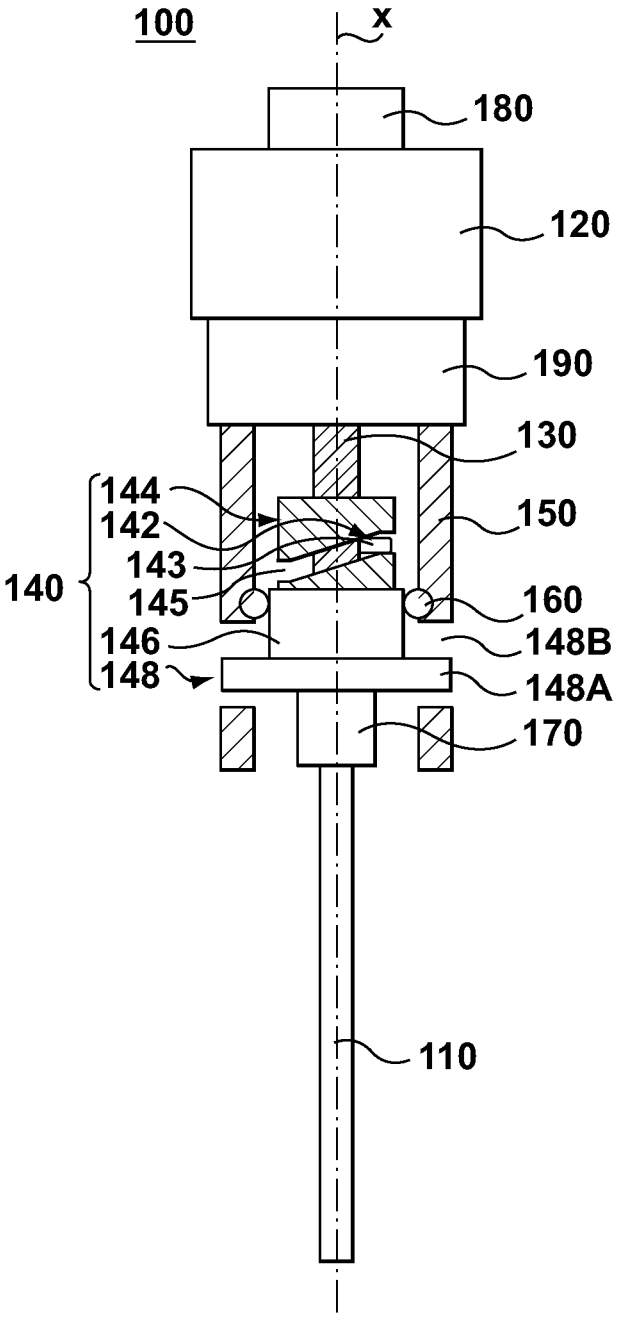
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FIG. 1A

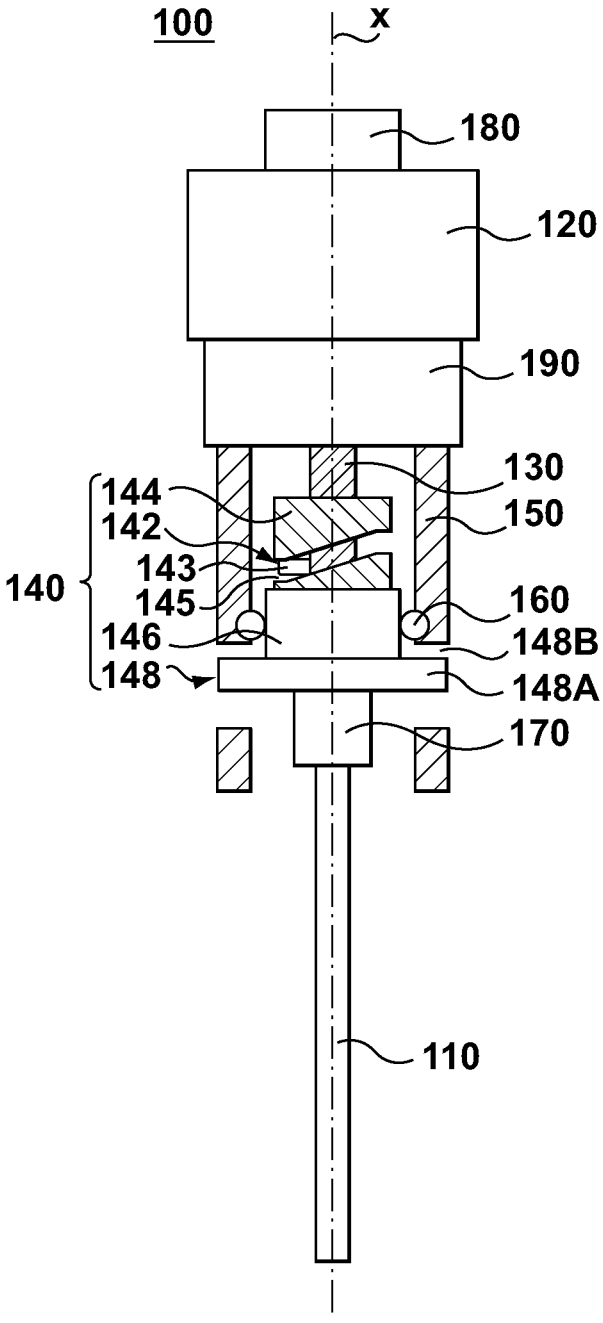
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FIG. 1B

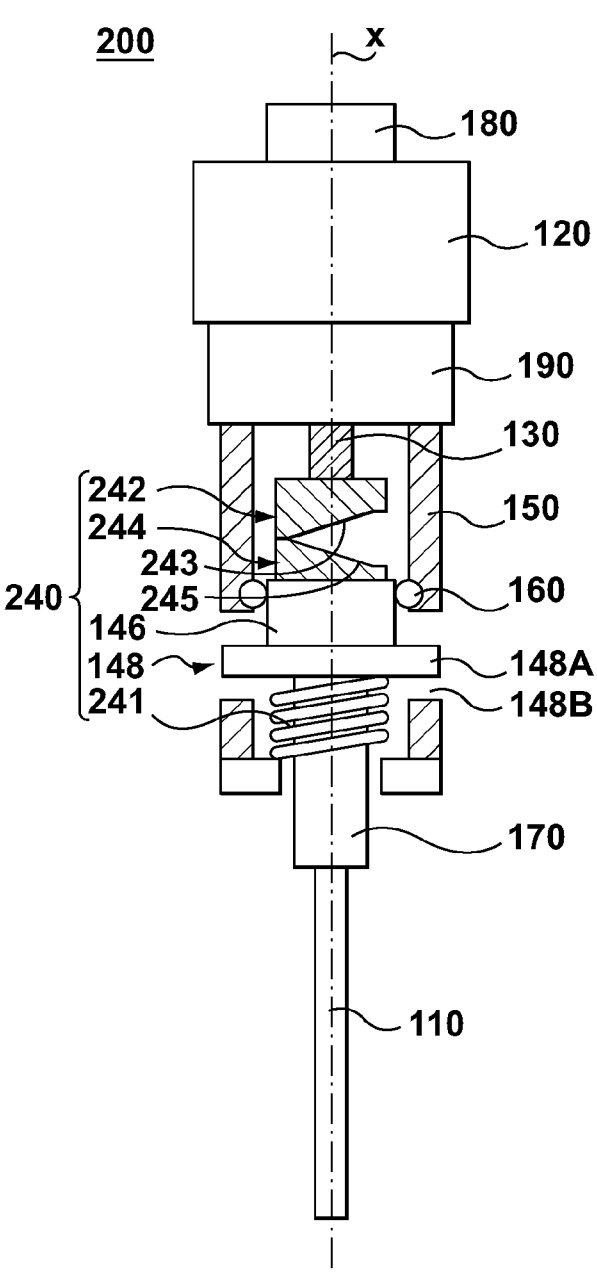
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FIG. 2A

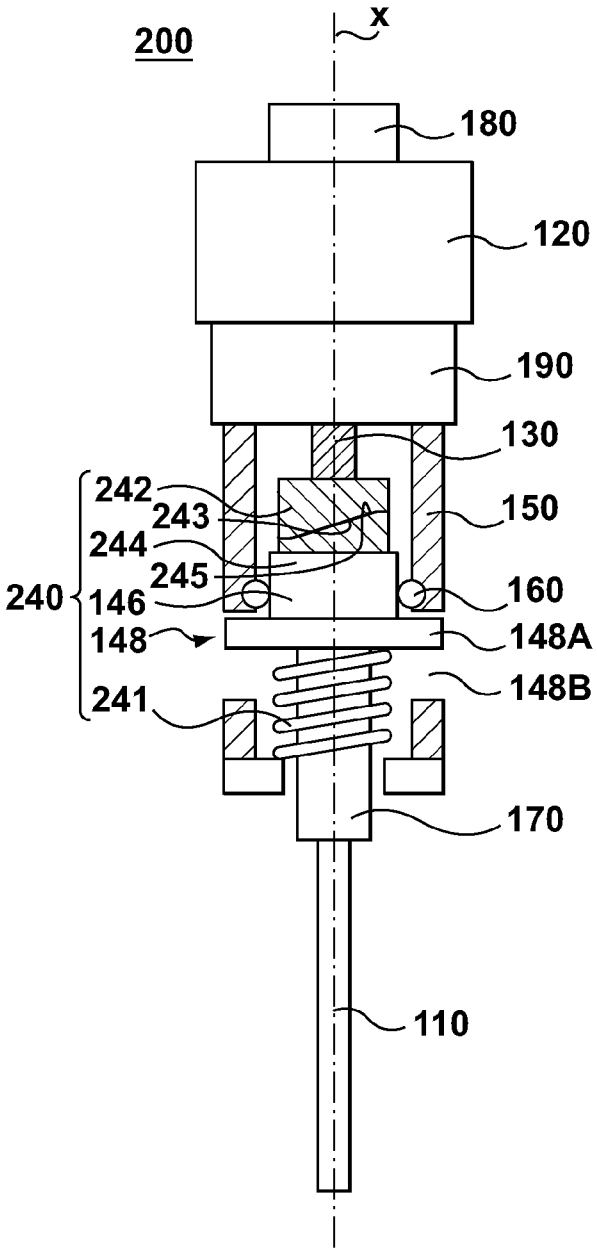
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FIG. 2B

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CA2013/050573

A. CLASSIFICATION OF SUBJECT MATTER

IPC: ***F16K 31/524*** (2006.01) , ***B29C 49/42*** (2006.01) , ***F16K 31/04*** (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: ***F16K 31/524*** (2006.01) , ***B29C 49/42*** (2006.01) , ***F16K 31/04*** (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)

Epodoc; IPCs F16K and B29C; and

Keywords: molding; injection; blow; cam; drive; plate; swash; reciprocating; axial; translation; cylindrical; valve; stem; gear; box

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 3872203A; (YOSHIKAWA et al.); 18 March 1975 (18-03-1975) Figure 3; Entire document	Claims 1 to 10
A	JP 2010084847 A; (SASAO et al.); 15 April 2010 (15-04-2010) Entire document	Claims 1 to 10
A	US 4368018 A; (REES et al.); 11 January 1983 (11-01-1983) Entire document	Claims 1 to 10

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

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

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

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
19 September 2013 (19-09-2013)	02 October 2013 (02-10-2013)

Name and mailing address of the ISA/CA
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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CA2013/050573

Patent Document Cited in Search Report	Publication Date	Patent Family Member(s)	Publication Date
US3872203A	18 March 1975 (18-03-1975)	AU6036273A	20 March 1975 (20-03-1975)
		AU465885B2	09 October 1975 (09-10-1975)
		BE800610A1	01 October 1973 (01-10-1973)
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		IT985349B	30 November 1974 (30-11-1974)
		JPS4917459A	15 February 1974 (15-02-1974)
		JPS5325855B2	29 July 1978 (29-07-1978)
		US3901638A	26 August 1975 (26-08-1975)
JP2010084847A	15 April 2010 (15-04-2010)	None	
US4368018A	11 January 1983 (11-01-1983)	None	