(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
9 August 2012 (09.08.2012)

WIPO | PCT

(10) International Publication Number
WO 2012/104850 A1

(51) International Patent Classification:
F16K 17/30 (2006.01)

(21) International Application Number:
PCT/IL2012/050032

(22) International Filing Date:
31 January 2012 (31.01.2012)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/437,816 31 January 2011 (31.01.2011) US

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, 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, 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.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

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

— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

[Continued on next page]

(54) Title: FUEL VALVE

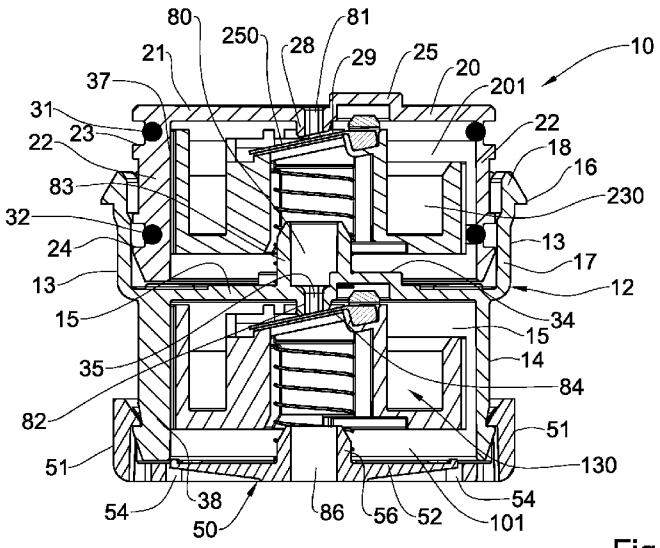


Fig. 2

(57) Abstract: A roll -over fuel valve configured with a float - sealable fluid path module (10) comprising a float member (130, 230) axially displaceable within a float housing, between an open position and a closed position. The float member is normally biased in direction of the closed position and the float member comprises an open liquid chamber for collecting liquid, thus taking part in the force equilibrium acting on the float member.

WO 2012/104850 A1

— *of inventorship (Rule 4.17(iv))*

Published:

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

FUEL VALVE

FIELD OF THE DISCLOSED SUBJECT MATTER

This disclosed subject matter relates to fuel valves and more particularly to a roll-over valve (ROV). Even more specifically the disclosed subject matter is concerned with a float configuration for such valves.

BACKGROUND OF THE DISCLOSED SUBJECT MATTER

A large variety of valves for use with vehicles' fuel tanks are known, among which are of more relevance with respect to the present invention those fitted with two or more valve assemblies, or those referred to as two stage valves.

A basic roll-over type fuel valve is disclosed in US Patent 5,7381,32 disclosing a roll over vent valve comprising: a housing having a fluid inlet and a fluid outlet, the latter comprising a substantially elongated slit-like outlet aperture of the housing bounded by a valve seating. There is furthermore provided a float member located in the housing and axially displaceable within the housing between the inlet and the outlet; an elongated flexible closure membrane strip anchored at one end thereof to an end of the float member adjacent the outlet and at a portion thereof offset with respect to the outlet; spring biasing means located within the housing and bearing on the float member so as to spring bias it in the direction of the outlet; whereby the spring biassing together with buoyancy forces acting on the float member tend to press the membrane strip into sealing engagement with the outlet aperture whilst gravity forces acting on the float member tend to displace the float member away from the outlet so as to progressively detach the strip from sealing engagement with the outlet.

For example, US Patent 7,207,347 t discloses an over filling interdiction, vapor venting and roll over multi-function valve comprising a housing defining a confined space formed with one or more fluid inlets to said confined space, a fluid outlet chamber at top end of said housing and being in flow communication with an outlet duct; a first outlet port extending between said confined space and said fluid outlet chamber, and a second outlet port extending between said confined space and said fluid outlet chamber; a valve assembly located within the confined space and comprising a first stage float member associated with said first outlet port, and a second stage float member associated with said second outlet port, said float members being axially displaceable by buoyancy forces within the confined space about parallel axes, from an open position in which said first and second outlet port is open to a closed position; in which said first and said second outlet port is respectively sealingly engaged by said first stage float member and by said second stage float member wherein said first stage float member at least partially overlaps over said second stage float member such that when said first stage float member is in its open position it is supported by the second stage float member, the arrangement being such that only displacement of the second stage float member from the open position into closed position the first stage float member can be displaced into its closed position and sealingly engage the first outlet port.

Yet another example of a multi sage float type-valve is disclosed in US Patent 6,701,952 directed to a valve fitted within a fluid tank, the valve comprising a housing fitted with one or more fluid inlet ports, and an outlet port, said housing accommodating a float-type valve member axially aligned within the housing, and is displaceable therealong between an open position in which the outlet port is open, and a closed position in which the outlet port is sealingly closed; the valve characterized in that the housing is integrally formed with a nozzle member, said nozzle member being in flow communication with the outlet port and having a main portion with an outlet thereof extending within the tank; said outlet port being formed in an upper portion of the housing, said upper portion having an upper end wall and said outlet port being defined by an aperture within the upper end wall said aperture being sloped with respect to the longitudinal axis of the valve, a top wall portion of the float-type valve member facing said aperture and being equally sloped with respect to the longitudinal axis of the valve, said top wall portion of the valve member being provided with a closure membrane strip

that is capable to sealingly engage the aperture within the upper end wall and to fully close the valve when the top wall portion of the float-type valve member approaches said outlet port

SUMMARY OF THE DISCLOSED SUBJECT MATTER

It is an object of the present disclosed subject matter to provide a roll-over fuel valve configured with a float-sealable fluid path module comprising a float member axially displaceable within a float housing, between an open position and a closed position; said float member being normally biased in direction of the closed position; and said float member comprises an open liquid chamber for collecting liquid, thus taking part in the force equilibrium acting on the float member.

According to an example of the disclosed subject matter the valve comprises a multi-stage float-sealable fluid path module and according to a particular design the valve is a two-stage module configuration, comprising two in-line float-sealable fluid path modules, each module configured with an independent float member axially displaceable within a respective float housing, between an open position and a closed position; said float member being normally biased in direction of the closed position; and said float member comprises an open liquid chamber for collecting liquid, thus taking part in the force equilibrium acting on the float member.

Any one or more of the following features and designs can be incorporated in a fuel valve according to the present disclosed subject matter, independently or in combination, wherein modifications apply to a single or multiple stage valve:

- Where the valve is a two-stage float configuration the float members extend in series, above one another, wherein fluid flow from a one float-sealable fluid path module flows into a second float-sealable fluid path module extending there above;
- a two-stage float configuration the float member of each module are displaceable independently from one another and however are displaceable between at least a fully open position, i.e. where both modules are at their respective open position (facilitating airing a fuel tank and draining an associated liquid fuel trap), and a closed position wherein at least one, and optionally both modules are at their respective closed position, i.e. preventing fluid flow towards the liquid fuel trap;

- Where the valve is a two-stage float configuration the float members are displaceable within an integrated housing;
- The liquid chamber of the float member has a top opening;
- The float housing has a bottom inlet opening being in flow communication with the fuel tank, and a top outlet opening being in flow communication with a liquid fuel trap;
- The liquid chamber of the float member is configured to retain at least an amount of liquid also at considerable inclinations;
- The float member is displaceable within the float housing only in the axial direction (i.e. rotation of which is prevented);
- The float member has a diameter greater than its height;
- The float member is restricted for axial displacement within the housing, thus eliminating clamping at the event of tilt thereof;
- The liquid chamber of the float member is compartmented; according to one configuration the compartments are in fluid flow communication with one another. According to another configuration the compartments are not fluid flow communication with one another;
- According to one particular design the liquid chamber has an annular cross-section, or annular segmented; the annular or annular segmented liquid chamber can be symmetric or of an irregular cross-section;
- The float member is configured with an inclined top surface bearing a sealing member configured for sealing engagement against an outlet port of the float-sealable fluid path module; said outlet port being inclined in correspondence with the inclined top surface of the float member;
- A top edge of the liquid chamber extends below a lower edge of the sealing member of the float member;
- At a two-stage float configuration the outlet port of one float-sealable fluid path module extends into an inlet port of a consecutive, top float-sealable fluid path module;
- The housing of the float-sealable fluid path module is configured for snap-fitting within the valve housing.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to understand the disclosed subject matter and to see how it can be carried out in practice, embodiments will now be described, by way of non-limiting examples only, with reference to the accompanying drawings, in which:

Fig. 1A is a perspective view of a high performance leak prevention roll-over valve;

Fig. 1B is an isometric exploded view of the valve of Fig. 1A;

Fig. 2 is a longitudinal sectional view of the valve of Fig. 1, sectioned along II-II and shown in a fully closed position;

Fig. 3 is a perspective view of the section seen in Fig. 2;

Fig. 4 is a longitudinal sectional view of the valve of Fig. 2, the valve shown in a partially closed position;

Fig. 5 is a longitudinal sectional view of the valve of Fig. 2, the valve shown in an open position;

Fig. 6 is a longitudinal sectional view of the valve of Fig. 3, the valve shown inclined at an angle (i.e. tilted);

Fig. 7 is a perspective exploded view of interior parts of the roll-over valve showing a float member, flexible membrane and membrane;

Fig. 8 is a longitudinal sectional view of a single stage float-sealable fluid path module, the valve shown in an open position;

Fig. 9A is a longitudinal sectional view of a valve according to a modification of the disclosed subject matter; and

Fig. 9B is a longitudinal sectional view of a float member used in the configuration of Fig. 9A.

DETAILED DESCRIPTION OF EMBODIMENTS

Attention is first directed to Figs. 1 to 3 illustrating a high performance leak prevention two- stage float-sealable fluid path module generally designated **10** of a roll-over valve (not shown in the drawings), configured for assembly within a fuel tank (not shown in the drawings) and further for coupling to a canister (fuel liquid/vapor treating device).

The float-sealable fluid path module **10** comprises a central housing **12**, an upper housing **20**, and a bottom cover **50**. The central housing **12** comprises a central portion **15**, upper portion **13**, which is substantially cylindrical and projects up from the central partition portion **15**, and lower portion **14**, which is also cylindrical and projects down from the central partition portion **15**.

Upper portion **13** has a larger inner diameter than that of lower portion **14**, and comprises a lower wall portion **17**, an upper wall portion **18** that has a slightly larger diameter than that of the lower wall **17**, and lateral projections **16** projecting out from upper wall portion **18** for snapping engagement within corresponding openings of an above attachment e.g. within the fuel valve housing or directly within an opening configured in the fuel tank (not shown).

The lower portion **14** comprises a rib element **38** extending longitudinally along its inner surface and openings **19** for engagement with the bottom cover **50** as will hereinafter be described. The central partition portion **15** is disc shaped and comprises an orifice **35** positioned at its center, a spring support **83** projecting upward from the center of the central partition portion **15** and with a central space flow path **80** leading to the orifice **35**, and downward projecting walls **82** of a cylindrical shape and formed with an inclined bottom seating surface **84**. The central partition portion **15** further comprises a projection **34** upwardly projecting and of substantially rectangular shape.

The upper housing **20** is substantially cylindrical and comprises a top wall **21** and side wall **22** projecting downward from top wall **21**. Top wall **21** comprises a projection **25** identical in shape to that of projection **34** described above, an orifice **81** and downward projecting walls **28** formed with a inclined bottom sealing surface **29**, which are identical in shape to that of orifice **35**, projecting walls **82** and surface **84** described above. Side wall **22** comprises an upper annular groove **23** and a lower annular groove **24**, each configured for receiving O-ring **31** and O-ring **32** respectively. Additionally, Side wall **22** has an identical inner diameter to that of lower portion **14** of the central housing **12**, and further comprises a rib element **37** longitudinally extending along its inner surface and identical to that of notch element **38** described above. The upper housing **20** is snappingly engaged by several openings **65** (Fig. 1) formed in central housing **12** engageable by corresponding lateral projections **67** formed on the outer surface of side wall **22**. The upper housing **20** resides sealingly within the upper

portion **13** of central housing **12**, being sealed by O-ring **32** pressing against the inner surface of lower wall **17** and forming therein an upper chamber **201**.

The bottom cover **50** is substantially cylindrical and comprises a bottom lateral wall **52** and a side wall **51** projecting upward from the lateral wall **52** and grooves **53** within the side wall **51**. Lateral wall **52** comprises apertures **54**, central port **86**, and a spring support **83**. The bottom cover **50** has a slightly larger diameter that that of the lower portion **14** of central housing **12**, the lower portion **14** resides within bottom cover **50** forming a lower chamber **205**. Apertures **54** facilitate fluid flow between the lower float module **205** and a fuel tank (not shown) of a vehicle in which the valve resides.

Residing within the lower chamber **101** of the lower module of the float-sealable fluid path module **10**, there is a float member **130** substantially cylindrically shaped, an elongated strip-like flexible membrane **150**, secured at one end by a membrane holder **160,** and a coiled spring **170**. The float member **130** is axially displaceable and being spring biased in an upward direction by means of a coiled lower spring **170** and comprises a disc shaped base **135**, vertically projecting wall **132** projecting up from base **135** and forming a annular cup-like structure collecting chamber **137**.

lower chamber **101** further comprises a Lower spring housing chamber **140**, spring bearing surface **139**, and inclined upper wall **138,** whose inclination with respect to the longitudinal axis of the roll-over valve **10** and respectively of the float member **130** corresponds to the inclination of the bottom seating surface **84** or the central housing **12**.

As can be seen in the figures, each of the float members has a diameter greater than its height. This feature provides increased flotation of the float member, resulting in essentially improved sealing force, i.e. the force vector in direction urging each of the floats into its upwards, sealed position, is increased.

Furthermore, noting that the float members have a liquid collecting chamber with a top opening. This results in that at the event of inclination of the vehicle and the associated fuel tank, e.g. at significant steep inclination (ascending/descending), or at a roll-over or near to roll-over situation, some of the liquid spills out from the chambers **101** and **201,** whereby the resultant force acting on the float member is favorable in direction of urging the float members into their sealing positions under biasing effect of the spring, and further owing to the force vector now acting in the opposite direction (cosine of the angle α of inclination; Fig. 6).

As can be best seen in Figs. 7 and 8 float member **130** further comprises a groove **142** formed within vertically projecting wall **132**, and notch **145** of generally rectangular shape within the bottom surface of base **135**. The groove **142** mates with rib element **38** formed on the inner wall of central housing **12** thus restricting motion of the float member **130** only in a longitudinal (axial) direction i.e. restricted to up-down displacement while preventing any rotational displacement of the float member about its longitudinal axis.

Membrane **150** comprises a flat membrane portion **152** and is anchored at one extremity via an anchoring stud **154** to upper wall **138** of the float member **130**, and is secured by the membrane holder residing above the stud **154** and residing above the top edge vertically projecting wall **132**.

Similarly within the upper float-sealable fluid path module **201** comprises identical parts to those described within lower float-sealable fluid path module **101**, and designated with numeral in the **200**'s corresponding to like features of the parts labeled in the **100**'s described within chamber **101**. Upper chamber **201** and lower chamber **101** are selectively in flow communication with each other via flow path **80** and orifice **35** as will be discussed hereinafter.

Operation and functioning of the valve and the associated float-sealable fluid path module **10** will now be discussed with further reference being made to the remaining figures.

At an initial state, as seen in Figs. 2 and 3, before any liquid fuel **300** is introduced into the fuel tank, or when the fuel level is low and at regular pressure conditions and with the vehicle being level, both the lower float member **130** and the upper float member **230** reside in the open position i.e. at their bottom position with the weight of the float members **130** and **230** being greater than the opposed biasing spring force from spring coils **170** and **270** respectively.

When fuel **300** is introduced into the fuel tank (not shown) in which the fuel valve resides, it fills the fuel tank to the fuel limit line which corresponds to the line **301** seen in Fig. 4. The liquid **300** is free to enter through apertures **54** and fill lower chamber **101** of the lower float-sealable fluid path module. As the chamber **101** fills, the buoyancy of the float member **130** relative to the liquid **300** causes the float member **130** to axially displace in the vertical direction until membrane **150** sealingly engages inclined bottom seating surface **84** restricting any additional displacement and bringing

the lower float member **130** into a closed position. In reaching the fuel fill line **301**, fuel liquid **300** also fills the collecting chamber **137**. The force of spring coil **170** along with the buoyancy force is thus preset to counter the weight of the filled lower float member **130** residing within a fluid filled lower chamber **101**.

Any leakage that occurs through orifice **35** while lower float member **130** resides is in a closed position will cause collection of fuel liquid **300** in upper chamber **201**. As liquid level of chamber **201** of the upper float-sealable fluid path module, the buoyancy force acting on upper float member **230** will axially displace the float member **230** vertically to a closed position wherein membrane **250** sealingly engages inclined bottom sealing surface **29** thus providing a second level of sealing against leakage for the high performance roll-over valve.

In a condition of a vehicle roll-over both upper float member **230** and lower float member **130** reach their respective closed positions as shown in Fig. 2 and 3, wherein the float members **130** and **230** are in a closed position due to gravitational forces and the biasing springs **170** and **270**, both acting now in direction same as gravitational forces, to thereby displace the float members **120** and **230** into their respective sealed positions (though upside down), thus preventing fuel liquid from escaping the fuel tank towards the liquid trap.

Fig. 5 shows a condition of the float-sealable fluid path module **10** of the roll-over valve wherein upper float member **230** and lower float member **130** are in an open position. In this condition, liquid from a liquid trap (not shown) is free to flow back into the fuel tank along flow path marked by arrowed line **400**. The liquid flows by gravity and enters the valve via orifice **81** collecting in upper collecting chamber **237** and upper chamber **201**. As the chamber **201** fills and the buoyancy force lifts the upper float member **230**, the fluid drains via flow path **80** and orifice **82** collecting within the lower float member **130** in collecting chamber **137** and lower chamber **130** and finally flowing through apertures **54** and into the fuel tank below.

Fig. 8 illustrates a single stage float-sealable fluid path module generally designated **250** and being substantially similar to that disclosed in connection with the upper module disclosed in the two-stage float-sealable fluid path module disclosed in connection with Figs. 1 to 7, however with the exception that the base member **254** is configured with apertures **256** to facilitate liquid fuel inlet into the float accommodating housing **258**, whereby the flow path is indicated by arrowed line **262**. Operation of the

single stage float-sealable fluid path module is as disclosed herein above in connection with Figs. 1 to 7.

As can be seen in figures 7 and 9A and 9B, each of the float members is movable substantially only in an axial direction, i.e. substantially free of clamping arresting during tilting and displacement thereof, that owing to leading cylindrical studs **239** downwardly extending from the central partition **15** and the upper housing wall **20**, and slidingly displaceable within a pair of corresponding receptacles **241** formed in each of the float members **130** and **230.** It is noted that the receptacles **241** are configured with a tapering (widened) opening **243**, facilitating easy positioning of the cylindrical studs **239** into the receptacles **241**.

Those skilled in the art to which this disclosed subject matter pertains will readily appreciate that numerous changes, variations, and modifications can be made without departing from the scope of the invention, *mutatis mutandis*.

CLAIMS:

1. A roll-over fuel valve configured with a float-sealable fluid path module comprising a float member axially displaceable within a float housing, between an open position and a closed position; said float member being normally biased in direction of the closed position; and said float member comprises an open liquid chamber for collecting liquid, thus taking part in the force equilibrium acting on the float member.

2. A roll-over fuel valve according to claim 1, wherein the valve comprises a multi-stage float-sealable fluid path module and according to a particular design the valve is a two-stage module configuration, comprising two in-line float-sealable fluid path modules, each module configured with an independent float member axially displaceable within a respective float housing, between an open position and a closed position; said float member being normally biased in direction of the closed position; and said float member comprises an open liquid chamber for collecting liquid, thus taking part in the force equilibrium acting on the float member.

3. A roll-over fuel valve according to claim 1, wherein the valve is a two-stage float configuration the float members extend in series, above one another, wherein fluid flow from a one float-sealable fluid path module flows into a second float-sealable fluid path module extending there-above.

4. A roll-over fuel valve according to claim 2, wherein a two-stage float configuration of the float member of each module are displaceable independently from one another and however are displaceable between at least a fully open position, where both modules are at their respective open position, facilitating airing a fuel tank and draining an associated liquid fuel trap, and a closed position wherein at least one, and optionally both modules are at their respective closed position, preventing fluid flow towards the liquid fuel trap.

5. A roll-over fuel valve according to claim 1, wherein the valve is a two-stage float configuration the float members are displaceable within an integrated housing.

6. A roll-over fuel valve according to claim 1, wherein the liquid chamber of the float member has a top opening.

7. A roll-over fuel valve according to claim 1, wherein the float housing has a bottom inlet opening being in flow communication with a fuel tank, and a top outlet opening being in flow communication with a liquid fuel trap.

8. A roll-over fuel valve according to claim 1, wherein the liquid chamber of the float member is configured to retain at least an amount of liquid also at considerable inclinations.

9. A roll-over fuel valve according to claim 1, wherein the float member is displaceable within the float housing only in the axial direction whereby rotation of which is prevented.

10. A roll-over fuel valve according to claim 1, wherein the float member has a diameter greater than its height.

11. A roll-over fuel valve according to claim 1, wherein the float member is restricted for axial displacement within the housing, thus eliminating clamping at the event of tilt thereof.

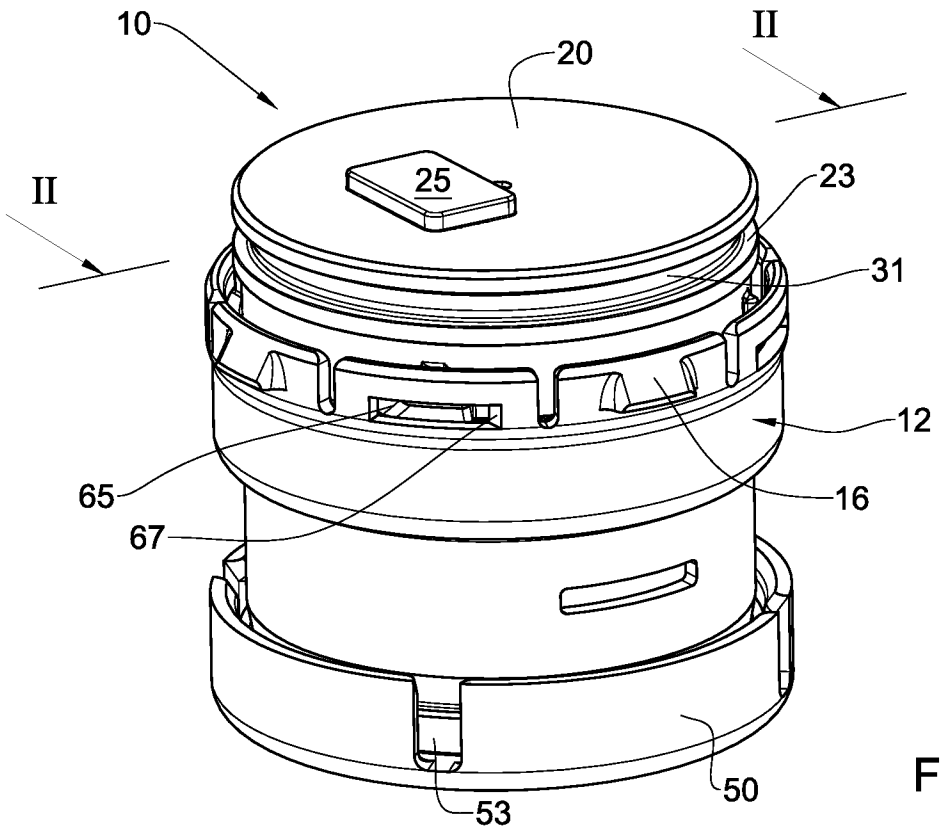
12. A roll-over fuel valve according to claim 1, wherein the liquid chamber of the float member is compartmented.

13. A roll-over fuel valve according to claim 1, wherein the liquid chamber has an annular cross-section, or annular segmented; the annular or annular segmented liquid chamber can be symmetric or of an irregular cross-section.

14. A roll-over fuel valve according to claim 1, wherein the float member is configured with an inclined top surface bearing a sealing member configured for sealing engagement against an outlet port of the float-sealable fluid path module; said outlet port being inclined in correspondence with the inclined top surface of the float member.

15. A roll-over fuel valve according to claim 1, wherein a top edge of the liquid chamber extends below a lower edge of the sealing member of the float member.

16. A roll-over fuel valve according to claim 2, wherein at a two-stage float configuration the outlet port of one float-sealable fluid path module extends into an inlet port of a consecutive, top float-sealable fluid path module.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31
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16
50
53

Fig. 1A

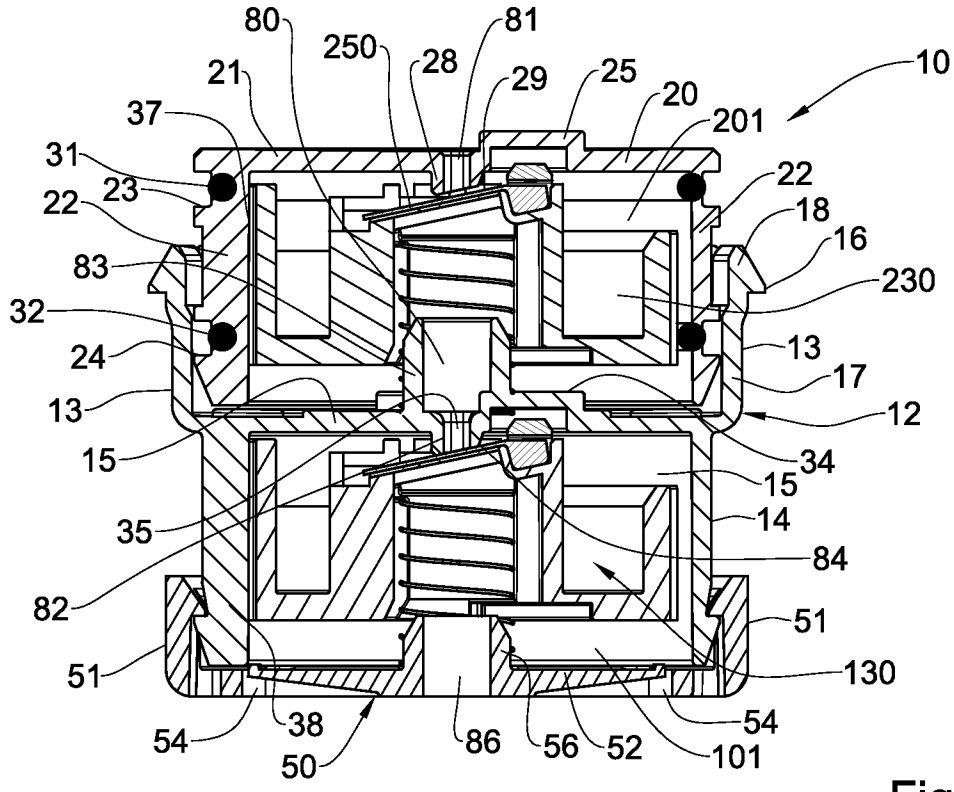
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Fig. 2

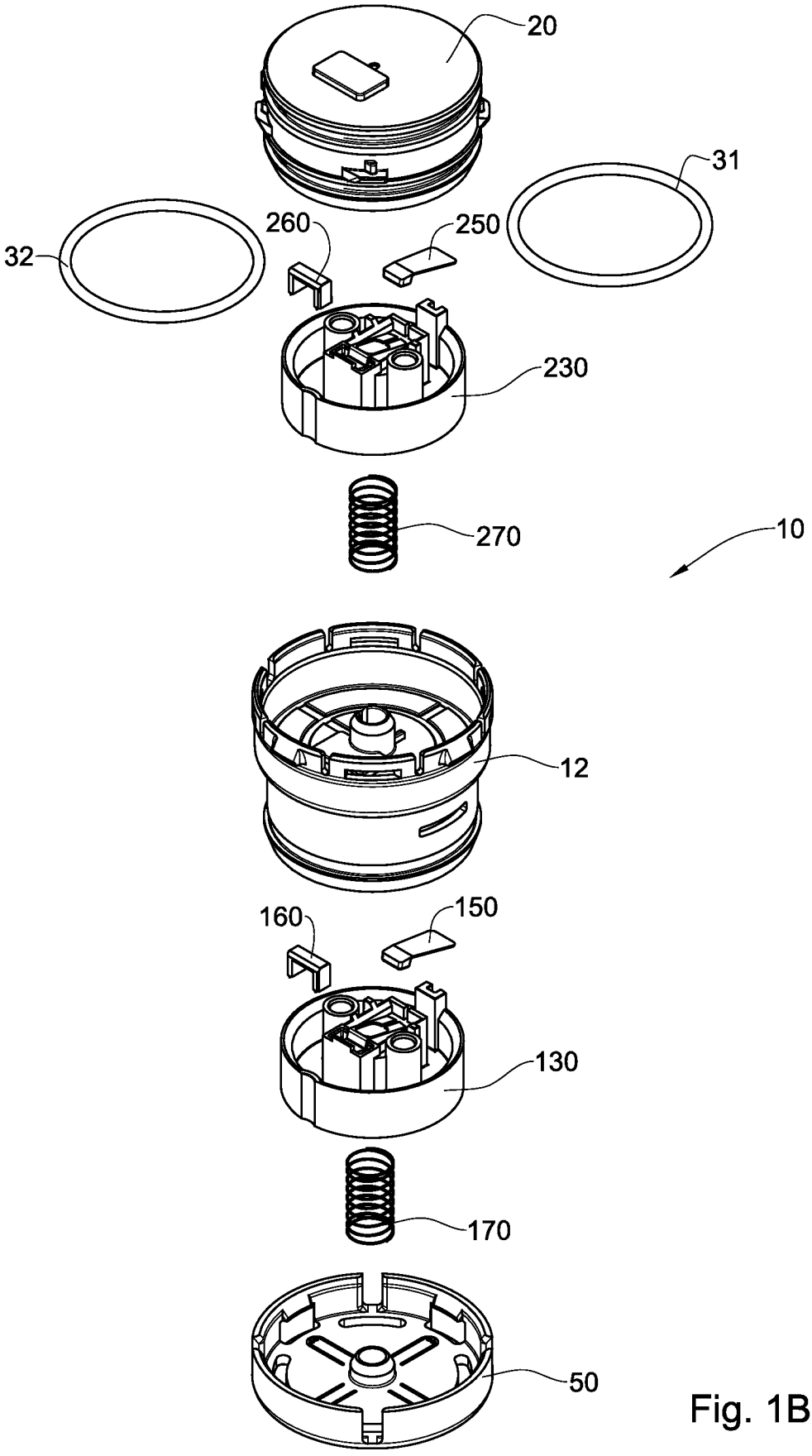
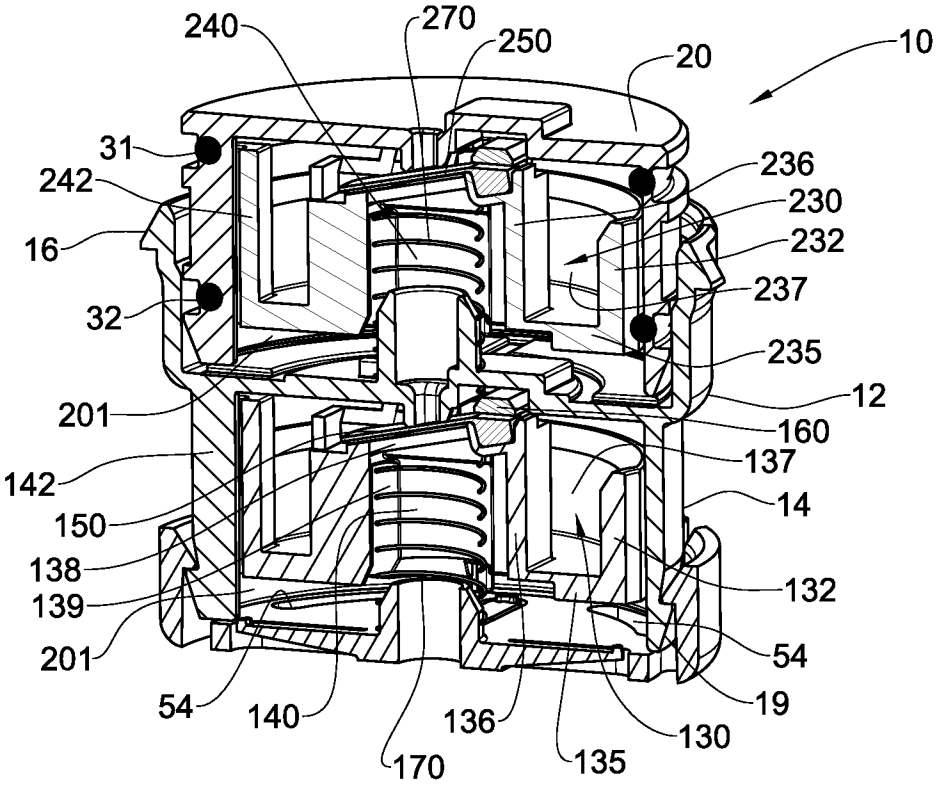


Fig. 1B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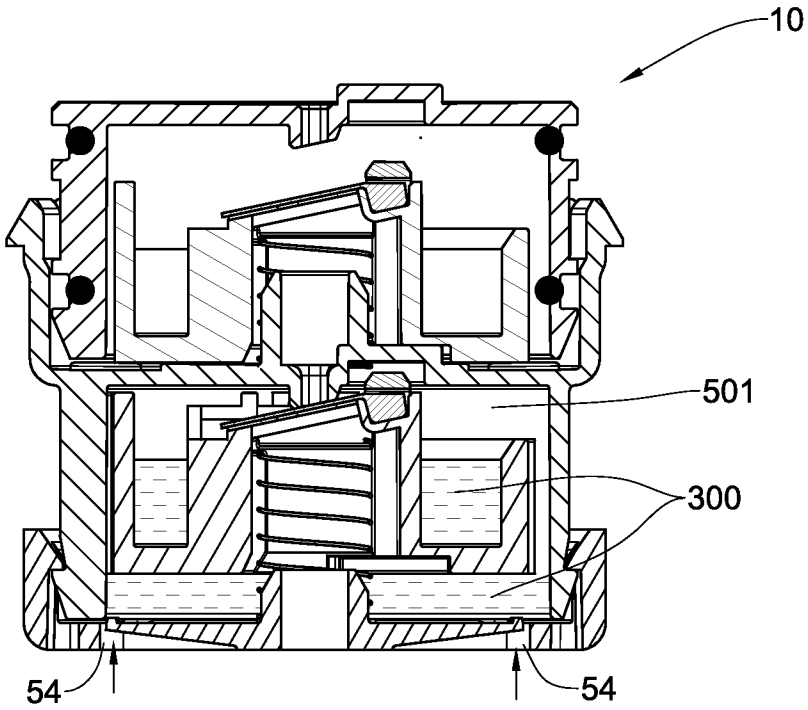
135

Fig. 3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300
54
54

Fig. 4

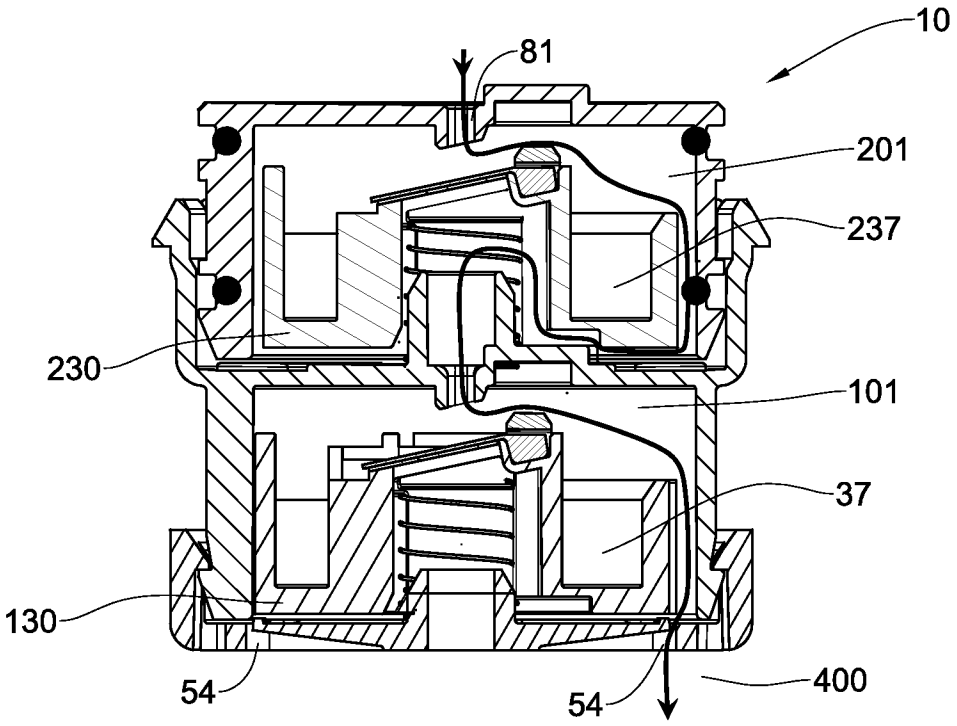

Fig. 5

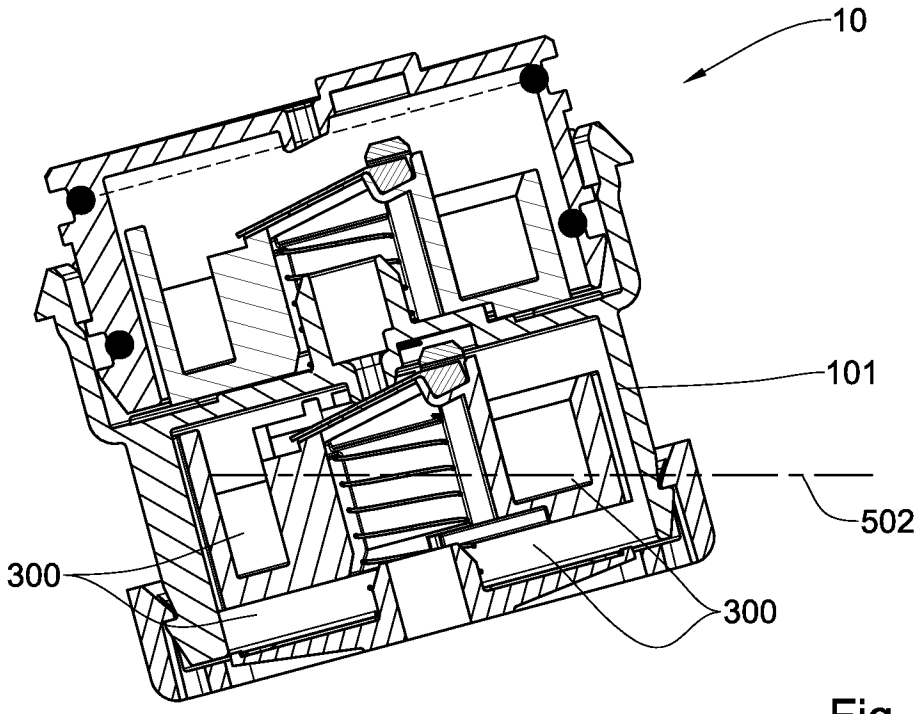

Fig. 6

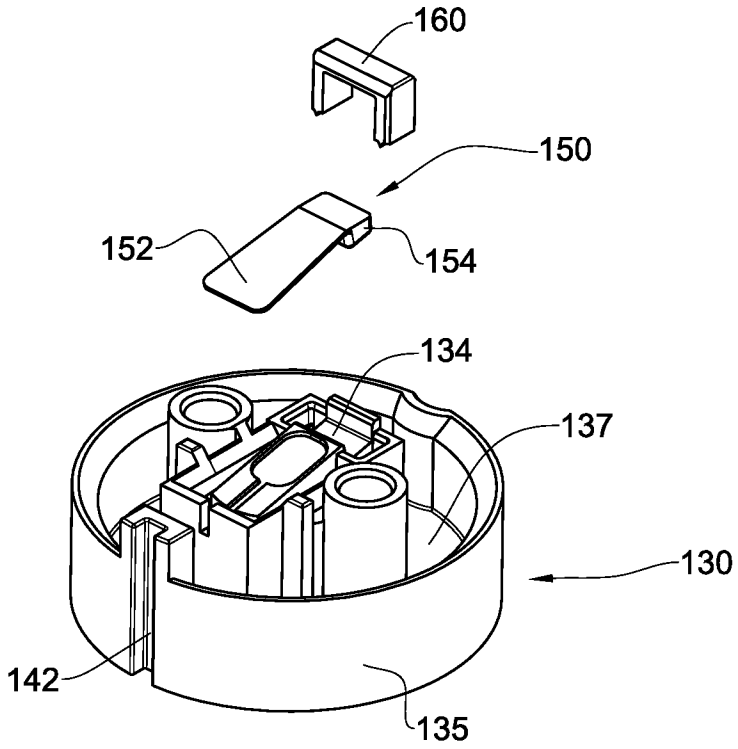

Fig. 7

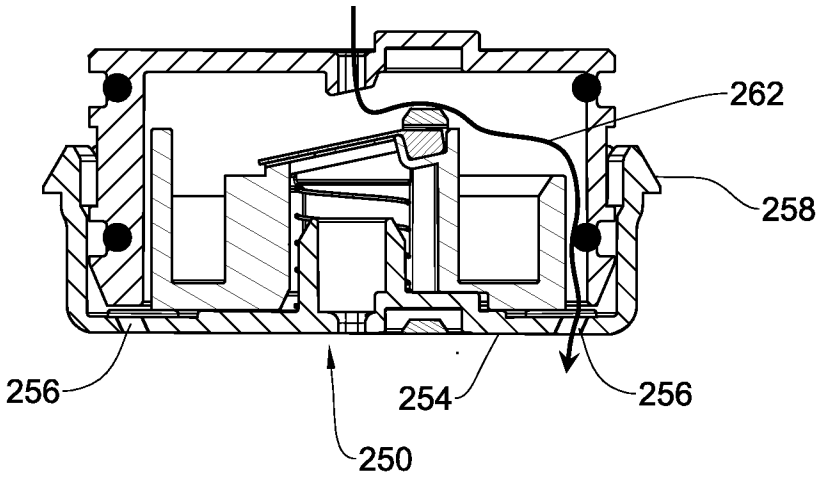

Fig. 8

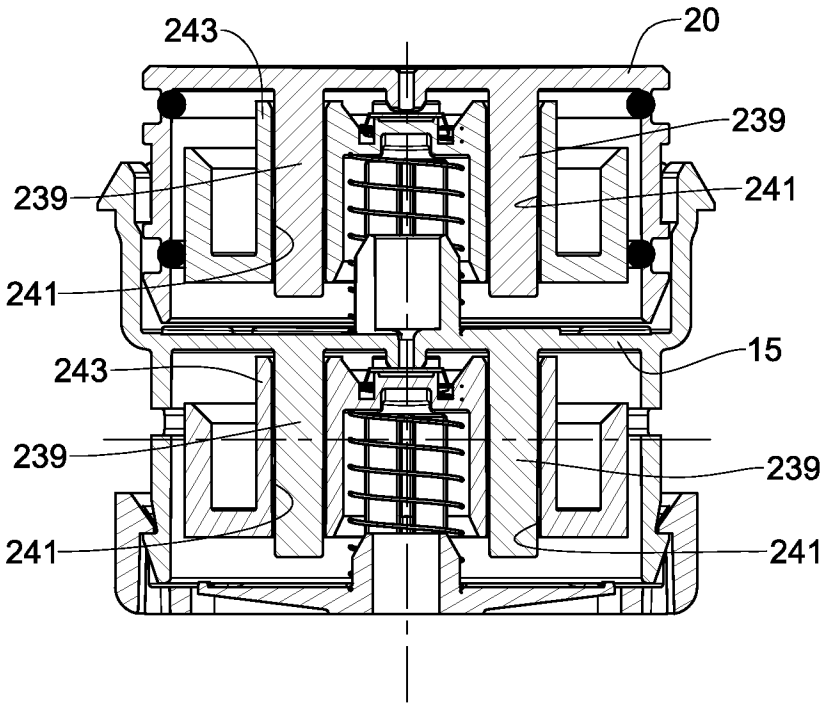

Fig. 9A

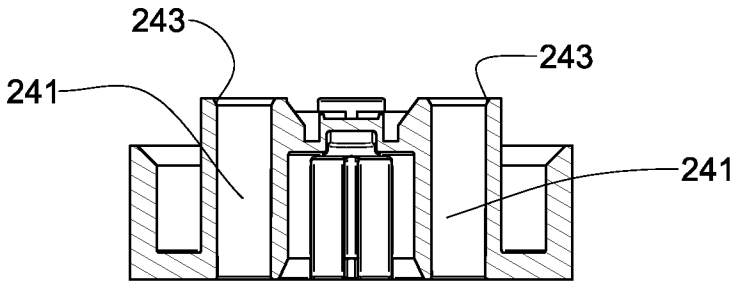

Fig. 9B

INTERNATIONAL SEARCH REPORT

International application No
PCT/IL2012/050032

A. CLASSIFICATION OF SUBJECT MATTER
INV. F16K17/30
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)
F16K B60K

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 practical, 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	US 5 738 132 A (ZAKAI AVI [IL] ET AL) 14 April 1998 (1998-04-14) cited in the application column 2, line 55 - column 4, line 45; figures	1-16
A	EP 0 773 128 A2 (BORG WARNER AUTOMOTIVE [US]) 14 May 1997 (1997-05-14) column 11, line 15 - line 51; figure 6	1-16
A	US 5 944 044 A (KING TIMOTHY J [US] ET AL) 31 August 1999 (1999-08-31) column 4, line 55 - column 16, line 53; figures	1-16

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
23 April 2012	02/05/2012

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Rusanu, Irina

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IL2012/050032

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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