



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
26.01.2011 Bulletin 2011/04

(51) Int Cl.:
F02M 59/46 (2006.01) F02M 63/00 (2006.01)

(21) Application number: **09163595.3**

(22) Date of filing: **24.06.2009**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO SE SI SK TR
Designated Extension States:
AL BA RS

(72) Inventor: **Cheron, Antonin**
Bexleyheath, Kent DA7 6BJ (GB)

(74) Representative: **Gregory, John David Charles**
Delphi Diesel Systems
Patent Department
Courteney Road
Gillingham
Kent ME8 0RU (GB)

(71) Applicant: **Delphi Technologies Holding S.à.r.l.**
4940 Bascharage (LU)

(54) **Valve Arrangement**

(57) A valve arrangement (32) for controlling fluid flow comprising a valve housing (18) defining a chamber (28) and a conduit (24) wherein a seating region (26) is defined at a transition between the chamber (28) and the conduit (24), a valve member (34) engageable with the seating region (26) and a retaining member (44) received within the chamber (28). A stop member is also received

within the chamber (28) and defines a first surface (57) engageable with the retaining member (44) and a second surface (52) which is spaced a predetermined distance from the valve member (34) when the first surface (47) is engaged with the retaining member (44) thereby to provide a means to limit the maximum travel of the valve member (34) away from the seating region (26).

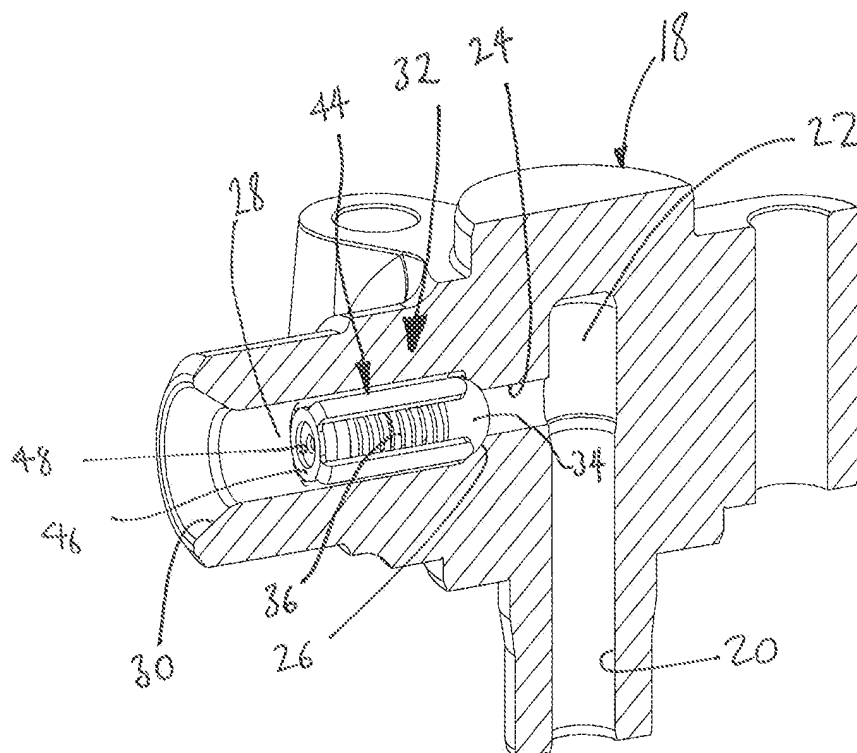


FIGURE 2

Description

Technical Field

[0001] The invention relates to a fluid valve arrangement and more particularly to a non-return valve or 'check valve' arrangement for use in a common rail fuel injection system for supplying high pressure fuel to a compression-ignition internal combustion engine.

Background of the Invention

[0002] In a common rail fuel injection system for a compression-ignition internal combustion engine (more commonly known as a 'diesel' engine), a fuel pump is used to pressurised fuel to a high pressure, typically between about 500 bar and 2000 bar, and to supply the pressurised fuel to a common rail fuel volume.

[0003] Such a fuel pump generally comprises a pumping plunger that is moveable back and forth within a plunger bore and defines a pumping chamber within the bore. The pumping plunger is associated with a drive arrangement which drives the plunger within the bore to perform an induction stroke, during which fuel at low pressure is drawn into the pumping chamber, and a pumping stroke, during which the fuel within the pumping chamber is compressed. An outlet valve arrangement controls the passage of fuel from the pumping chamber to a high pressure pipe that leads to the common rail. A typical outlet valve arrangement is shown in Figure 1.

[0004] The outlet valve arrangement comprises a valve housing 2 that defines an internal chamber 4 having a flared outlet region 6. At the end of the internal chamber opposite the flared outlet region 6 is a narrow inlet conduit 8, wherein a valve seating region 10 is defined at the transition between the internal chamber 4 and the inlet conduit 8. A ball valve 12 is biased into engagement with the seating region 10 by a spring 14, which bears against a spring seat member 16, the spring seat member 16 being received in the internal chamber 4 in a fixed position by a press fit. The spring seat member 16 has a central aperture 11 to allow fluid to flow through it.

[0005] The position of the ball valve 12 is responsive to the pressure of fluid within the inlet conduit 8, as will now be explained. If the pressure of fuel within the inlet conduit 8 is high such that the force it exerts on the ball valve 12 is sufficient to move the ball valve 12 against the closing force of the spring 14, the ball valve 12 lifts away from the valve seating region 10 and fluid is permitted to flow through the inlet conduit, past the valve seating region 10, and to the outlet region 6. However, if fluid pressure in the inlet conduit 8 drops to a level where the seating force of the spring 14 is greater than the force acting on the ball valve 12 due to fluid pressure in the inlet conduit 8, then the ball valve 12 is forced to engage the valve seating region 10, thereby preventing a backflow of fluid from the outlet region 6 to the inlet conduit 8.

[0006] The valve arrangement in Figure 1 is sometimes known in the art as a non-return valve or, alternatively, a check valve and is in common use in many types of fluid pumps. Such a valve arrangement has a simple design and functions adequately and reliably to constrain the flow of fluid into a single direction. However, the valve design has associated drawbacks. For example, the valve arrangement is prone to excessive wear of the valve seating region 10 since the ball valve 12 is free to wobble laterally as it lifts away from the seating region 10 due to fluid flowing around the ball turbulently. This can result in the ball valve 12 impacting the valve seating region 10 which can wear the seating surface.

[0007] Furthermore, the ball valve 12 is permitted to travel a considerable distance along the internal chamber 4 against the force of the spring 14, which slows down the response of the valve arrangement to changes in pressure within the inlet conduit 8.

Summary of the Invention

[0008] It is against this background that the invention provides a valve arrangement for controlling fluid flow comprising a valve housing defining a chamber and a conduit wherein a seating region is defined at a transition between the chamber and the conduit. A valve member is received inside the chamber and is engageable with the seating region. A retaining member is also received inside the chamber and serves to hold the valve components in the chamber, including a stop member having a first surface engageable with the retaining member and a second surface which is spaced a predetermined distance from the valve member when the first surface is engaged with the retaining member thereby to provide a means to limit the maximum travel of the valve member away from the seating region.

[0009] The stop member limits the amount of travel permitted to the valve member which has the principal benefit of reducing the response speed of the valve, since the valve member must only move from a relatively low lift position to re-seat itself. Since the valve assembly can close more quickly, there is less backflow of fluid past the valve member into the conduit when the pressure of fuel in the conduit falls below the pressure needed to keep the valve member away from its seat.

[0010] Although the valve assembly will function acceptably in the configuration described above, the valve assembly may incorporate biasing means to bias the valve member into a closed position and, also, to bear against the stop member to ensure that it remains spaced from the valve member.

[0011] Although a number of biasing means are applicable, for example diaphragms and elastomeric members, preferably the biasing means is a helical compression spring since these are efficient to manufacture and readily available 'off-the-shelf' in a variety of spring strengths, in order to enable to opening pressure of the valve assembly to be varied. Furthermore, metallic com-

pression springs tend to exhibit high resistance to fatigue and chemical attack which makes them particularly useful in a fluid environment.

[0012] Preferably, the stop member includes a enlarged head portion which defines the first surface and which bears against the retaining member and an elongate projecting portion that defines the second surface. The spring is therefore receivable over the projecting portion which holds the spring in position.

[0013] The valve member may be in the form of a metallic ball, although the skilled person would understand that other forms of valve members would function adequately. However, a ball valve is preferred for availability, simplicity and cost.

[0014] The retaining member may take the form of a ring-like hub having a central aperture to provide access to the stop member, by an engineering press tool for example. Preferably, the retaining member may be shaped to include one or more arms extending from the hub in the direction of the valve member, to form a cage around the stop member and the valve member thereby guiding movement thereof.

[0015] Although the retaining member could be fixed in position within the chamber by numerous methods, by welding for example, it is preferred that the retaining member is dimensioned so as to define a press fit engagement with the chamber. Further retention techniques, such as welding, could be employed after the press fit operation to add strength to the fixing.

Brief Description of the Drawings

[0016] Reference has already been made to Figure 1 which shows a design of valve arrangement that is known in the art. In order for the invention to be more readily understood, embodiments of the invention will now be described with reference to the following drawings, in which:

Figure 2 is a perspective view, in cross-section, of a pumping head of an automotive fuel pump incorporating a valve arrangement in accordance with the invention;

Figure 3 is a perspective view, in cross section of the pumping head in Figure 2, but with the valve arrangement shown in exploded form; and

Figures 4A to 4F are a series of perspective views showing the assembly procedure for the valve arrangement in Figures 2 and 3.

Detailed Description of the Embodiments

[0017] Referring to Figures 2 and 3, a pumping head 18 comprises a metallic block having a centrally located blind bore 20 extending through the pumping head 18 longitudinally. Although not shown in Figures 2 and 3, in

use a pumping plunger would be arranged to reciprocate within the bore 20 and to define a pumping chamber 22 with the blind end of the bore 20.

[0018] Extending laterally from the pumping chamber 22 is an outlet conduit 24 having a relatively narrow bore. The outlet conduit 24 leads to a diverging conical transition region 26 into a relatively wide-bored chamber 28.

[0019] At the end of the chamber 28 opposite the conical region 26, the chamber 28 flares outwardly to define an outlet region 30. Although not shown in the figures, it should be appreciated that, in use, the outlet region 30 would be connected to a high pressure fluid pipe to convey pressurised fluid to a load device, such as a high pressure fluid accumulator volume. As such, the outlet region 30 is shaped appropriately to connect to a high pressure connection as would be known to a person skilled in the art.

[0020] The chamber 28 houses a non-return valve arrangement 32 in accordance with the invention. It should be noted that the term 'non-return valve' is known in the art to be equivalent to 'check valve', referring to a valve device that permits fluid to flow only in one direction.

[0021] The valve arrangement 32 comprises a valve member 34 in the form of a metallic ball that is biased into engagement with the conical transition region 30 which, thus, forms a seating surface for the ball valve member 34. The biasing means for the ball valve member 34 is a compression spring 36, one end of which bears against the surface of the ball valve member 34, the other end of which bears against a stop member 38.

[0022] The stop member 38 includes a relatively large annular head region 40 against which the spring abuts. The head region 40 defines a flat upper face having a chamfered edge. A relatively narrow projection 42 having a frustoconical mid-section and a cylindrical end section extends from the underside of the head region 40 and is received by the spring. It should be appreciated that the frustoconical-cylindrical configuration of the narrow projection 42 assists with manufacturing the stop member but is not essential to the functionality of the component.

[0023] The valve assembly 32 also includes a retaining member 44 in the form of a cage (hereafter 'cage member') that is received inside the chamber 28 in a press fit and serves to retain the individual components of the valve arrangement 32 inside the chamber 28 and, as such, the stop member 38 is located intermediate the cage member 44 and the valve member 34.

[0024] The cage member 44 is comprised of a metallic part that includes a ring-shaped hub 46 that defines a central aperture 48, the purpose of which will be described later. The cage member 44 also includes four arms 50 that are equi-angularly spaced around the periphery of the hub 46 and which extend within the chamber 28 in the direction of the ball valve member 34. Each one of the arms 50 therefore extends at a right-angle to the plane of the hub 46.

[0025] The cage member 44 may be manufactured by being stamped from a sheet of metal, for example steel,

after which the arms are bent back into position as shown in the Figures. Alternatively, the cage member 44 may be machined from a solid metal part. Although steel is the preferred material for the cage member 44, because it strikes the right balance between hardness, strength, weight and cost, it should be appreciated that the cage member could also be manufactured from other metals, or metal alloys.

[0026] The head region 40 of the stop member 38 is shaped so as to be slidable within the volume defined between the arms 50 of the cage member 44 and, since the spring 36 bears against the underside of the head region 40, an upper surface 47 of the head region 40 is biased into engagement with the hub 46. When in this position, an end surface 52 of the projection 42 is spaced from the ball valve member 34, thereby defining a means to limit the maximum distance it is permitted to lift from the seating region 26.

[0027] In operation, fluid is pumped from the pumping chamber 22 to the conduit 24, which establishes a force on the ball valve member 34 in the direction opposing the biasing force of the spring 36. If the force acting on the ball valve member 34 due to fluid pressure is greater than the spring closing force, the ball valve member 34 lifts away from the seating region 26 such that fluid in the conduit 24 is allowed to flow pass the ball valve member 34 and into the chamber 28. It should be appreciated that the arms 50 of the cage member 44 define flow passages between them to allow fluid to pass relatively unimpeded, as fluid is not forced to flow through the coils of the spring 36.

[0028] As mentioned, the extent of linear movement of the ball valve member 34 is limited by the position of the stop member 38, and more specifically the distance between the ball valve member 34 and the end surface 52 of the projection 42. Since the ball valve member 34 is only permitted to lift a relatively small distance away from the seating region 26, this ensures that the valve arrangement 32 is highly responsive to pressure drops across the ball valve member 34 which limits the flow of fluid back across the seating region 26.

[0029] The arms 50 of the cage member 44 serve as guiding means which inhibit lateral movement of the ball valve member 34 within the chamber 28, in particular when the ball valve member 34 lifts away from the seating region 26. Without such guidance, it is possible for the ball valve member 34 to shift laterally as it lifts which can increase the wear on the seating region and, thus, reduce the serviceable life of the valve arrangement.

[0030] The configuration of the valve arrangement 32 lends itself to efficient assembly. Furthermore, the height of the maximum permissible ball valve lift can be set accurately, and reliably from part-to-part, as will now be described.

[0031] Figures 4A to 4F show the valve assembly of Figures 2 and 3 assembled step-by-step.

[0032] In a first assembly step, as shown in Figure 4A, the ball valve member 34 is inserted into the chamber 28

through the outlet region 30 and is seated against the seating region 26.

[0033] As shown in Figure 4B, the spring 36 is then received onto the projection 42 of the stop member 38 until the spring 36 abuts the head region 40, following which the stop member 38 and compression spring 36 sub-assembly is inserted into the chamber 28 such that the spring 36 abuts up against the ball valve member 34. This is the position shown in Figure 4C. Since the ball valve member 34, compression spring 36 and stop member 38 define a clearance fit with the chamber 28, the insertion of the components may either be completed as a manual operation or by an automated process.

[0034] In a third assembly step, the cage member 44 is press fit into the chamber 28. Since the outer dimension of the cage member 44 is substantially equal to the internal diameter of the chamber 28, it is necessary to use a press to install the cage member 44.

[0035] Initially, the cage member 44 is offered up to the outlet region 30 of the chamber 28, as shown in Figure 4C, and then a press-tool 60 drives the cage member 38 further into the chamber 28, as shown in Figure 4D. The press-tool 60 comprises a generally cylindrical rod 61 having a first end 62 (the end remote from the conduit 24) adapted for use with a engineering press and a second end 64 adapted for engagement with the outer end of the cage member 44 and the head region 40 of the stop member 38.

[0036] More specifically, the second end 64 of the press-tool 60 includes a circular projection 66 which has a predetermined height based on the required maximum lift height of the ball valve member. As can be seen in Figures 4E and 4F, the second end 64 of the press-tool 60 abuts the hub 46 of the cage member 44 and the projection 66 extends through the aperture 48 so as to contact the upper face of the head region 40 of the stop member 38.

[0037] As the press-tool 60 drives the cage member 44 into the chamber 28, eventually the end surface 52 of the stop member 38 will contact the ball valve member 34 which terminates the action of the press. This position is shown in Figure 4E and it should be appreciated that the spring 36 is not shown for clarity.

[0038] In this position, the press-tool 60 urges the end surface 52 of the stop member 38 into contact with the ball valve member 34, against the force of the spring 36 and such that the head region 40 of the stop member 38 is spaced from the underside of the hub 46 of the cage member 44. When the press-tool 60 is retracted from the chamber 28, as shown in Figure 4F, the head region 40 of the stop member 38 is urged against the hub 46 by the spring 36. Consequently, the end surface 52 of the stop member 38 retracts away from the ball valve member 34 by a corresponding amount, thereby defining the maximum permissible lift height for the ball valve member. It should therefore be appreciated that the maximum lift height is defined by the depth of the projection 66 of the press-tool 60 minus the thickness of the hub 46 of

the cage member 44.

[0039] It should be appreciated that variations on the embodiment described above are possible without departing from the inventive concept, as defined by the claims.

[0040] For example, the valve arrangement is described above with reference to a specific design of pumping unit. However, it should be noted that the pumping unit is exemplary only and is not intended to limit the scope of the invention as defined by the claims since the valve arrangement could also be used with other pumping devices.

[0041] In terms of the components of the valve arrangement, the skilled person would realise that various modifications could be made without affecting their essential functionality. For instance, although the arms 50 of the cage member 44 are useful to guide movement of the ball valve member 34, they are not essential to the inventive concept and they may be omitted. On the other hand, the cage member 44 may be formed with much shorter arms so no guiding is provided and such that the arms merely serve to grip the bore of the chamber 28 so as to fix the cage member in place. Furthermore, although the cage member has been described as having four arms, the cage could also be constructed with three arms, which may be a benefit in terms of manufacturing simplicity and material costs. Alternatively, the cage member may include more than four arms to provide closer guidance to the ball valve member and if there is sufficient clearance in the chamber.

[0042] The configuration of the stop member may also take different forms to that described above. For example, in another embodiment (not shown) the stop member takes the form of a solid cylinder having a substantially uniform diameter along its length.

[0043] In addition, although the valve member has been described as a ball, other forms are also applicable to the invention. For example, the valve member could take the form of a part-hemispherical member having a cylindrical section blended thereon. Other geometrical prisms that could be spring biased into engagement with the seating region to block fluid flow are also applicable.

Claims

1. A valve arrangement (32) for controlling fluid flow comprising:

a valve housing (18) defining a chamber (28) and a conduit (24) wherein a seating region (26) is defined at a transition between the chamber (28) and the conduit (24);
 a valve member (34) engageable with the seating region (26);
 a retaining member (44) received within the chamber (28);
 a stop member (38) having a first surface (57)

engageable with the retaining member (44) and a second surface (52) which is spaced a predetermined distance from the valve member (34) when the first surface (47) is engaged with the retaining member (44) thereby to provide a means to limit the maximum travel of the valve member (34) away from the seating region (26).

2. The valve arrangement of Claim 1, wherein the stop member (38) includes an enlarged head portion (40) defining the first surface (47) and an elongate projecting portion (42) defining the second surface (52).
3. The valve arrangement of Claim 1 or Claim 2, further including biasing means (36) arranged to bias the stop member (38) into engagement with the retaining member (44) and to bias the valve member (34) into engagement with the seating region (26).
4. The valve arrangement of Claim 3, when dependent on Claim 2, wherein the biasing means (36) is received over the projecting portion (42) of the stop member (38).
5. The valve arrangement of Claim 3 or Claim 4, wherein the biasing means (36) is a compression spring.
6. The valve arrangement of any of Claims 1 to 5, wherein the valve member is a ball valve member.
7. The valve arrangement of any one of Claims 1 to 6, wherein the retaining member (44) includes a hub (46) having a central aperture to provide access to the stop member (38).
8. The valve arrangement of Claim 7, wherein the retaining member (44) is in a press fit engagement with the chamber (28).
9. The valve arrangement of Claim 7 or Claim 8, wherein one or more arms (50) extend from the hub (46) in the direction of the valve member (34), to form a cage around the stop member (38) and the valve member (34) thereby guiding movement thereof.

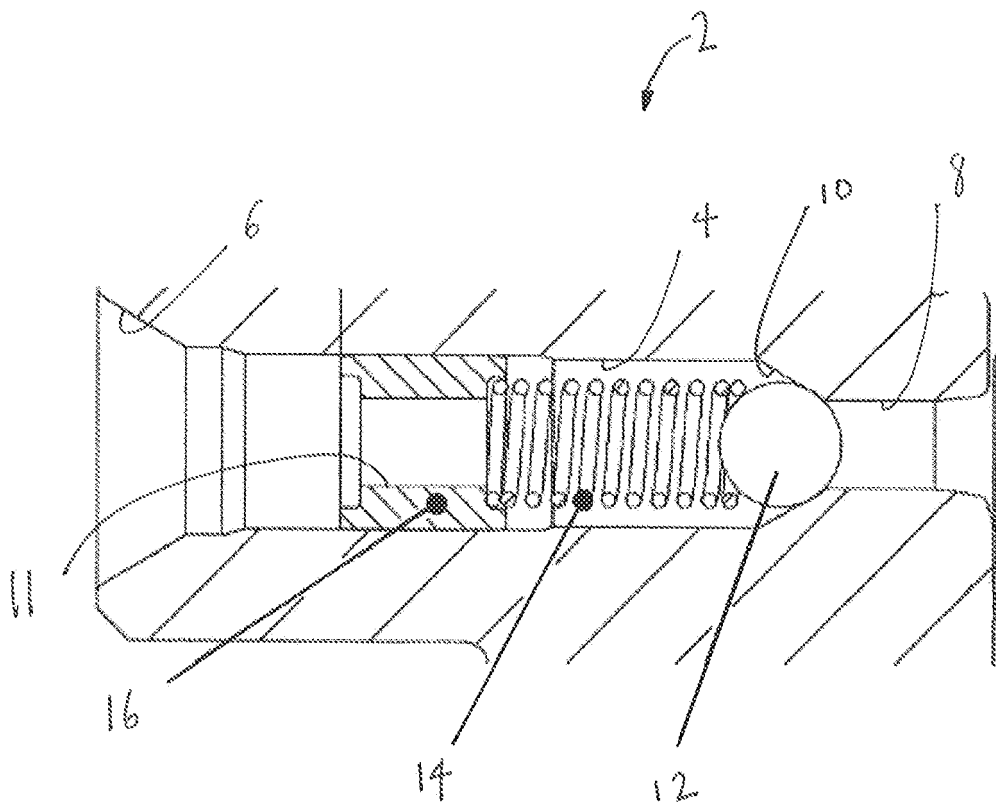


FIGURE 1

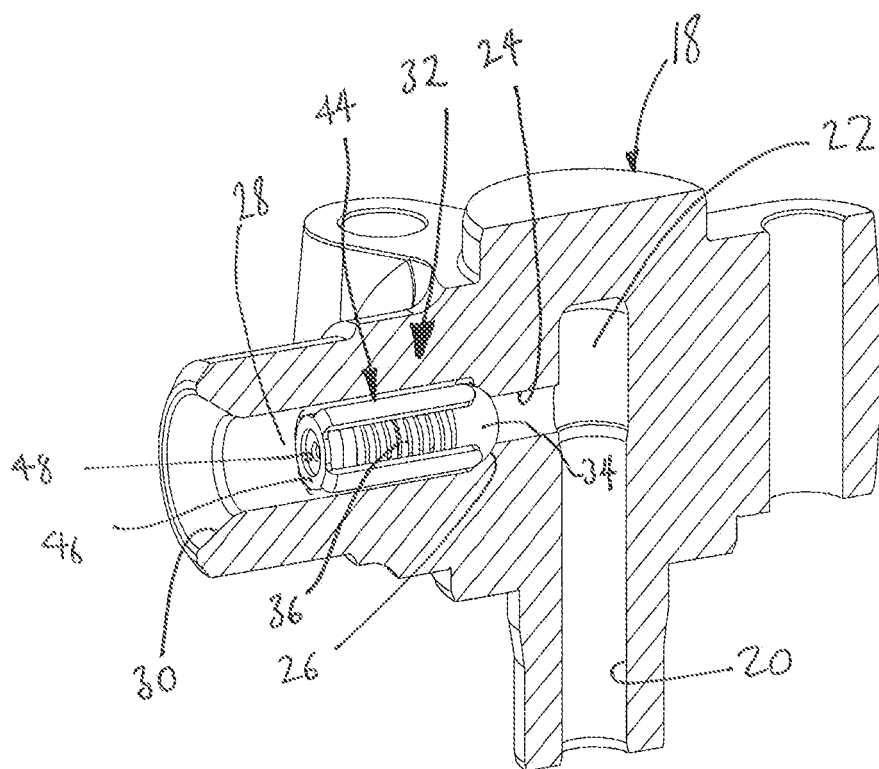


FIGURE 2

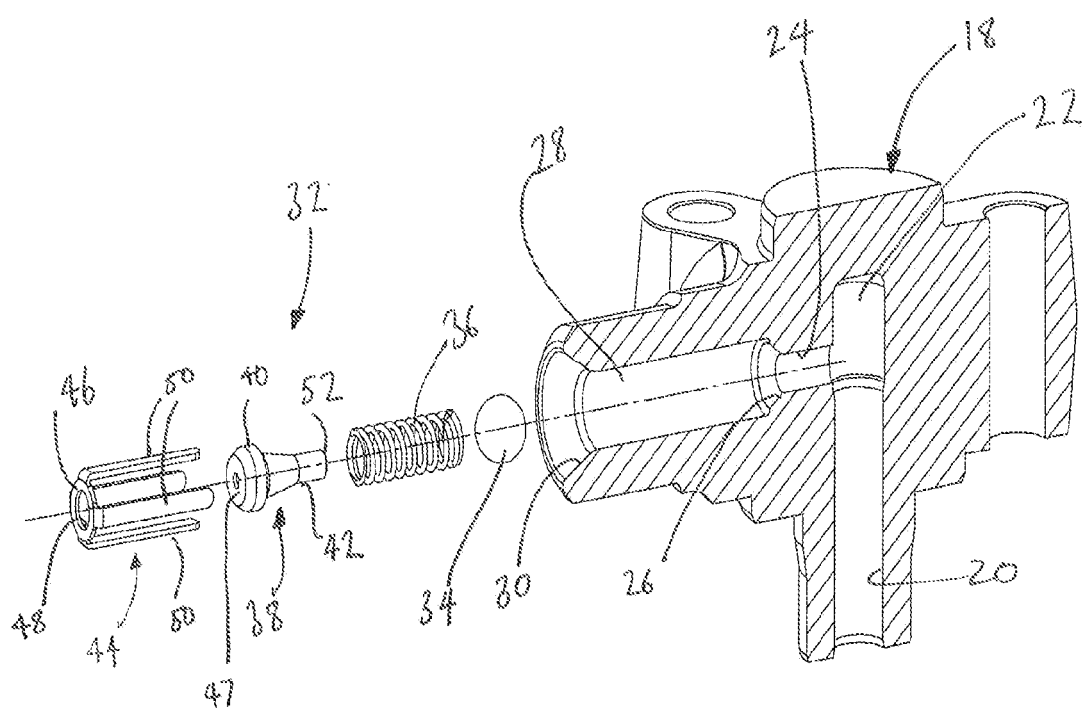


FIGURE 3

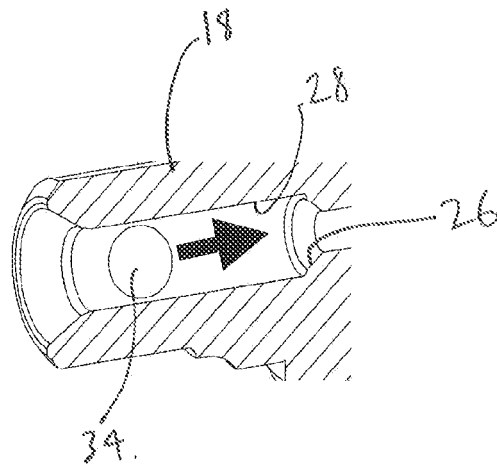


FIGURE 4A

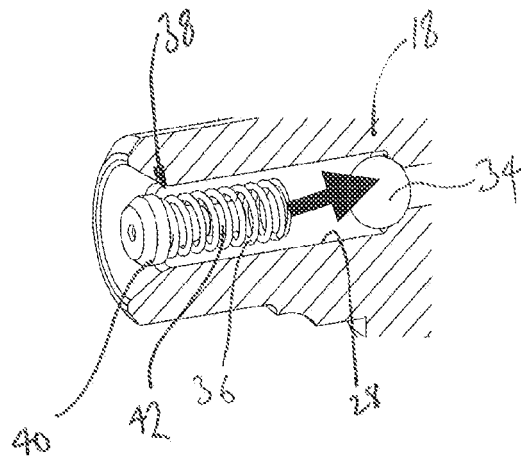


FIGURE 4B

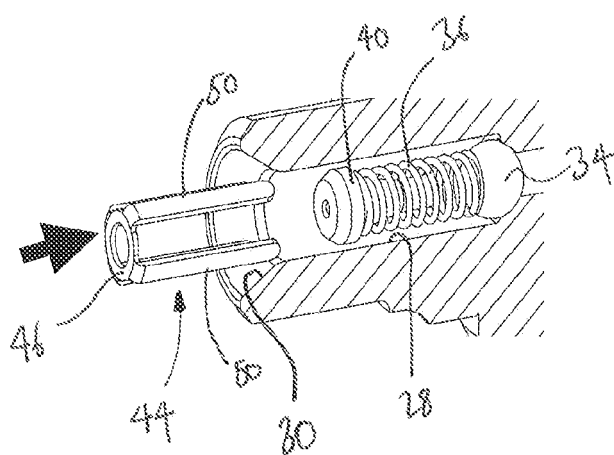
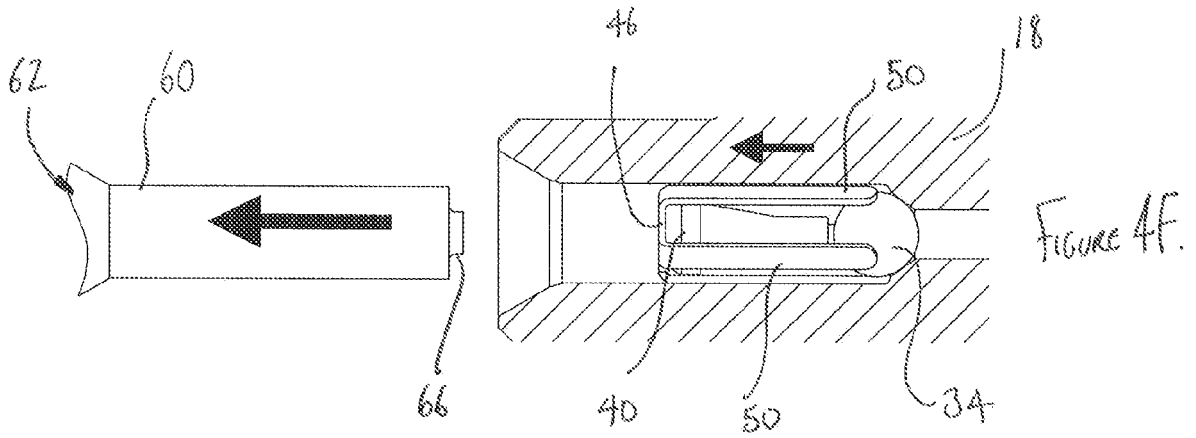
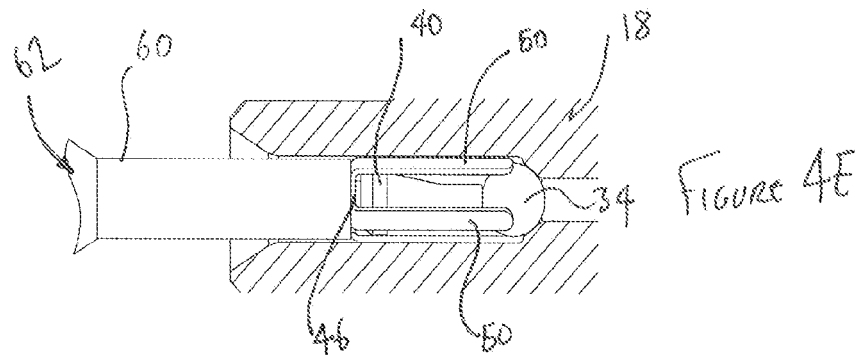
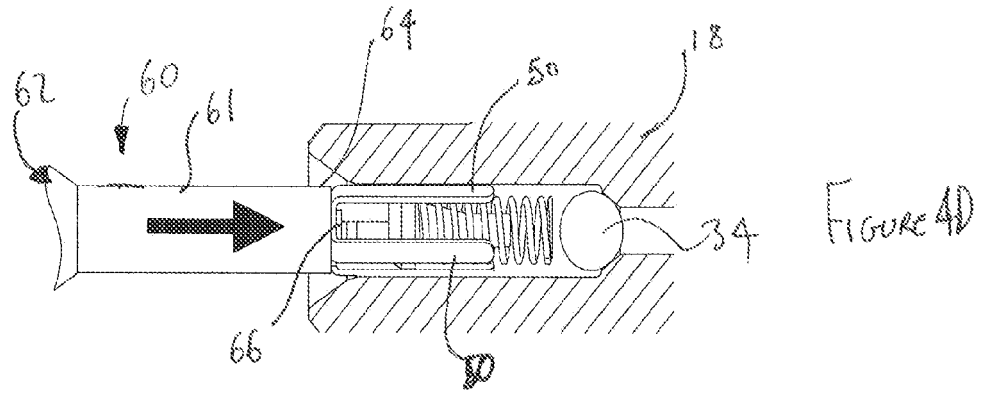


FIGURE 4C





EUROPEAN SEARCH REPORT

Application Number
EP 09 16 3595

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	DE 10 2005 061886 A1 (BOSCH GMBH ROBERT [DE]) 5 July 2007 (2007-07-05) * paragraphs [0011] - [0013]; figures 4,5 *	1-9	INV. F02M59/46 F02M63/00
X	US 6 347 815 B1 (KARGULA CHRISTOPHER J [US] ET AL) 19 February 2002 (2002-02-19) * column 3; figures 1,2 *	1-9	
X	US 6 360 721 B1 (SCHURICHT SCOTT R [US] ET AL) 26 March 2002 (2002-03-26) * abstract; figures 2,5 *	1,3-8	
X	WO 2007/088106 A1 (BOSCH GMBH ROBERT [DE]; MARINO GIUSEPPE [IT]; DE LUCA ALESSANDRO [IT];) 9 August 2007 (2007-08-09) * page 5; figure 1 *	1,3-6	
			TECHNICAL FIELDS SEARCHED (IPC)
			F02M
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 14 December 2009	Examiner Blanc, Sébastien
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

 1
EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 09 16 3595

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

14-12-2009

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 102005061886 A1	05-07-2007	CN 101341329 A	07-01-2009
		EP 1966481 A1	10-09-2008
		WO 2007073985 A1	05-07-2007
		JP 2009520908 T	28-05-2009
		KR 20080075888 A	19-08-2008
		US 2008279707 A1	13-11-2008

US 6347815 B1	19-02-2002	NONE	

US 6360721 B1	26-03-2002	NONE	

WO 2007088106 A1	09-08-2007	EP 1982100 A1	22-10-2008
		JP 2009531577 T	03-09-2009
		KR 20080094016 A	22-10-2008
		US 2008292473 A1	27-11-2008
