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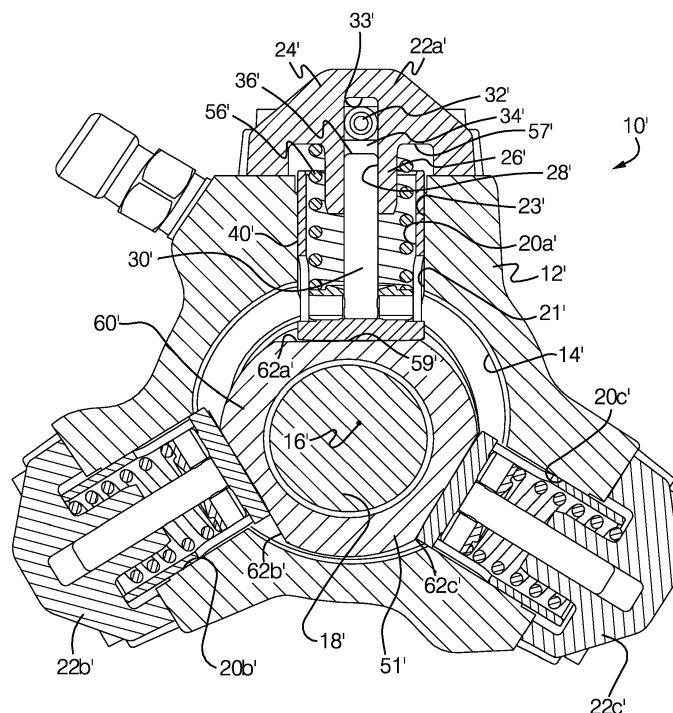
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(54) **HIGH TEMPERATURE FUEL DEFLECTOR FOR A FUEL PUMP DRIVE ASSEMBLY**

(57) During the operation of a high pressure fuel pump, it is normal to expect internal fuel leakage between a pumping plunger (30') and plunger bore (28'). Current pump designs position critical interfaces (55', 59') directly in-line with the leaking fuel. A fuel deflector surface (58') may be used to re-direct the flow of hot, leaking fuel away

from the critical interfaces (55', 59') and toward a lower cam box (51') where the fuel may be cooled with other resident fuel. The deflector surface (58') may be shaped and vents (52') positioned to channel (B) the hot fuel to flow toward a lower cam box (51').

**FIG. 5**

Description

FIELD OF THE INVENTION

[0001] This invention relates to a drive assembly for a fuel pump. In particular, the invention relates to a drive assembly for a high pressure fuel pump and more specifically to a drive assembly including a deflector configured to shield components of the fuel pump from unwanted exposure to hot, high pressure fuel.

BACKGROUND OF THE INVENTION

[0002] In a known common rail rider/tappet fuel pump, for example as described in European Patent No. EP 1184568, three pumping plungers are arranged at equi-angularly spaced locations around an engine driven cam shaft. A cam rider travels over the surface of a cam of the cam shaft. Each plunger is mounted within a respective plunger bore provided in a pump housing and, as the cam shaft is driven, each of the plungers is caused to reciprocate within its bore. As the plungers reciprocate, each causes pressurisation of fuel within an associated pumping chamber. The delivery of fuel from the pumping chambers to a common high pressure supply passage is controlled by means of respective delivery valves associated with each of the pumps. The high pressure supply passage supplies fuel to a common rail, or other accumulator volume, for delivery to the downstream injectors of the injection system.

[0003] In this arrangement it is typical for a tappet to be provided to transmit drive from the cam and a cam rider, to each of the plungers. As stated above, the pumping plunger is used to pressurise fluid in a pumping chamber for delivery to a desired location. For example, the fluid could be engine fuel of a diesel engine fuel injection system. Each tappet is located within a tappet bore provided in the pump housing and is arranged so that, as the cam is driven, each tappet is caused to reciprocate within its respective bore, resulting in reciprocating motion to the respective plunger. As the tappet is driven radially outward from the cam shaft by the cam rider, its respective plunger is driven to reduce the volume of the pumping chamber. This part of the pumping cycle is referred to as the pumping stroke of the plunger, during which fuel within the associated pumping chamber is pressurised to a relatively high level. During a return stroke of the plunger, the plunger is urged in a radially inward direction toward the cam under the influence of a plunger return spring.

[0004] A secondary function of the tappet is to reduce lateral forces applied to the plunger by transmitting transverse loads to the tappet bore so that generally the plunger is driven in a reciprocal motion by the tappet along a respective longitudinal axis of motion. A known tappet, which is slidably received in a tappet bore in the pump housing, is generally cup-shaped and has a cylindrical side wall portion to cooperate with the wall of the tappet

bore, and a base end portion opposing the cam rider, which together define an internal chamber. Vents or windows may be provided in the base portion and/or side wall portion of the tappet to allow a lubricating fluid to flow from a region around the cam mechanism (the "lower cam box") to a region within the tappet (the "upper cam box") so that hydraulic forces do not inhibit sliding movement of the tappet within the tappet bore.

[0005] A spring seat or plate is mounted to or otherwise engaged with the lower end of the plunger and is received in the upper cam box. A plunger return spring abuts the radially outer face of the spring seat and is compressed during a pumping stroke of the plunger, so that a return biasing force is applied to the plunger, via the spring seat, to help drive the plunger return stroke. In PCT Publication No. WO 2004/104409 for example, a coupling mechanism in the form of a circlip may be used to couple the bucket tappet to the lower portion of the pumping plunger, so that axial motion of one (e.g., the tappet) results in axial motion of the other (e.g., the plunger).

[0006] High pressure fuel pumps using a rider/tappet arrangement may allow hot fuel to leak between the plunger and plunger bore and toward the plunger-tappet interfaces, particularly during the pumping stroke. At very high pressures, despite plunger-to-bore clearances being only a few microns, the leakage can be considerable. Because the plunger-tappet and cam rider cam interfaces are disposed in line with the longitudinal axis of motion of the plunger, hot fuel, under pressure, may be directed at the interfaces during the pumping stroke, transferring additional heat from the hot fuel to the interfaces and/or promoting wear to occur at the interfaces.

[0007] Accordingly, the present invention seeks to address at least one of the aforementioned problems in the art.

SUMMARY OF THE INVENTION

[0008] In general, the invention provides a spring seat including a fuel deflector surface for a fuel pump assembly configured to shield sensitive parts from high pressure, high temperature leakage fuel generated during a pumping stroke. The fuel deflector surface is configured to cause the leaked fuel to take a longer flow path from the upper cam box to the lower cam box and thereby increase mixing and cooling of the leaked fuel with that resident within the lower cam box.

[0009] Thus, in accordance with an aspect of the invention, there is provided a spring seat for use in a high pressure fuel pump assembly. The fuel pump assembly further includes a pump housing, a pump head, a tappet, a plunger, and a return spring. The pump housing includes at least one bore for receiving a corresponding number of tappets. The pump head includes a plunger bore, the plunger is driven in a reciprocal manner within the plunger bore by a drive arrangement to pressurise fuel disposed within a pumping chamber defined by the pump head and the plunger. The tappet includes at least

one vent and is operably disposed between the drive arrangement and the plunger. The spring seat is coupled with the plunger. The plunger may be positioned within an aperture formed in the spring seat. The spring seat is disposed within an upper cam box defined within the tappet. The return spring is disposed between the spring seat and the pump head to bias the plunger against the tappet at an interface. The spring seat is characterised by a deflector surface configured to direct high temperature fuel outwardly through the at least one vent from the upper cam box to a lower cam box, wherein the spring seat is coupled with the plunger at a distance from the interface between the plunger and the tappet along a longitudinal axis of the plunger to thereby limit the effects of high pressure fuel within the fuel pump assembly. In one aspect of the invention, the spring seat may be coupled with the plunger at a distance of approximately 3.0mm to 4.0mm from the interface between the plunger and the tappet.

[0010] In addition, the deflector surface on the spring seat may further include an annularly tapered portion that is directed toward the upper cam box and inwardly toward the plunger to form an acute angle relative to a longitudinal axis of the plunger. Further, the spring seat may include an outer diameter, the tappet includes an inner diameter, and wherein the outer diameter of the spring seat is less than the inner diameter of the tappet and closely matched with the inner diameter of the tappet.

[0011] The tappet may include a base portion and a side wall portion. The base portion includes a perimeter, the side wall portion is connected with the base portion so as to be upstanding from a perimeter of the base portion. The side wall portion is slidably disposed within the bore, and the side wall portion and the base portion defines the upper cam box. The base portion is configured for cooperating with the drive arrangement for driving the plunger in the reciprocal manner. At least one of the base portion or the side wall portion are provided with of the at least one vent for allowing the passage of fuel from the upper cam box to the lower cam box. The fuel pump assembly may further comprise a cam rider, wherein the cam rider is operationally disposed between the drive arrangement and the tappet.

[0012] In another aspect of the invention, a method for protecting components within a high pressure fuel pump is provided. The fuel pump assembly includes a pump housing, a pump head, a tappet, a plunger, a spring seat, and a return spring. The pump housing includes a bore for receiving the tappet. The pump head includes a plunger bore. The plunger is configured for being driven in a reciprocal manner within the plunger bore by a drive arrangement to pressurise fuel disposed within a pumping chamber defined by the pump head and the plunger. The tappet includes at least one vent and is operably disposed between the drive arrangement and the plunger. The spring seat is coupled with the plunger and disposed within an upper cam box defined within the tappet. The return spring is disposed between the spring seat and the pump

head to bias the plunger against the tappet at an interface. The method is characterised by: providing a deflector surface on the spring seat that is configured to direct high temperature fuel outwardly through the at least one vent from the upper cam box to a lower cam box as the plunger is driven in the reciprocal manner, and positioning the spring seat with respect to the plunger at a distance from the interface between the plunger and the tappet along a longitudinal axis of the plunger to thereby limit the effects of high pressure fuel within the fuel pump assembly.

[0013] It will be appreciated by the skilled person how any embodiment or feature of one aspect of the invention may optionally be combined with any embodiment or feature of any other aspect of the invention and *vice versa*. It is particularly beneficial that the spring seat comprises a deflector surface configured to force the high pressure leakage to take a longer flow path (and therefore provide more cooling/mixing time) before reaching sensitive moving parts and the interfaces between them.

[0014] These and other aspects, objects and benefits of this invention will become clear and apparent on studying the details of this invention and the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] The invention will further be described, by way of example, with reference to the accompanying drawings:

Figure 1 is a cross-sectional view of a prior art fuel pump assembly having a tappet/rider type arrangement;

Figure 2 is a cross-sectional view showing a prior art pump head and tappet/rider arrangement;

Figure 3 is an enlarged view of a portion of the prior art tappet/rider arrangement shown in Figure 2;

Figure 4 is an enlarged view of a tappet/rider arrangement in accordance with an aspect of the present invention; and

Figure 5 is a cross-sectional view of a fuel pump assembly in accordance with the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0016] Referring now to the drawings, and initially to Figure 5, a fuel pump assembly 10' having a rider/tappet arrangement is shown. The fuel pump assembly 10' includes a pump housing 12' provided with an axially extending opening 14'. Opening 14' extends in a direction into the page shown in Figure 5. A cam shaft (not shown) having an axis of rotation 16' drives a drive arrangement such as an eccentrically mounted cam 18' mounted in opening 14'.

[0017] Pump housing 12' is provided with first, second and third radially extending openings or through bores 20a', 20b', 20c', each of which communicates at a radially inner end 21' thereof with axially extending opening 14' which extends through housing 12'. Other numbers of through bores can of course be utilised according to certain other embodiments of the present invention. A radially outer end 23' of each housing bore 20a', 20b', 20c' receives a respective pump head 22a', 22b', 22c'. Each pump head 22a', 22b', 22c' may be substantially identical and therefore for illustrative purposes, reference will be made hereinafter only to pump head 22a' shown in Figure 5.

[0018] Pump head 22a' includes a head portion 24' and a radially inwardly extending head turret 26' which projects into outer end 23' of opening 14' in pump housing 12'. Head turret 26' is provided with a plunger bore 28' that is configured for slidably receiving a pumping plunger 30'. A blind end 32' of plunger bore 28' is located within head portion 24' of pump head 22a' where at least one valve 33' is located to allow fluid communication into and out of a pumping chamber 34'. Blind end 32' of plunger bore 28' defines, together with a radially outer end face 36' of plunger 30', pumping chamber 34'. Pumping plunger 30' is an elongate shaft-like member that slides within plunger bore 28' inward toward and outward away from blind end 32' of pumping chamber 34' (the "pumping cycle"). As outer end face 36' of plunger 30' moves toward blind end 32' of pumping chamber 34' in the direction shown by arrow A in Figure 2 (the "pumping stroke"), the volume of pumping chamber 34' reduces. As plunger 30' moves away from blind end 32' of pumping chamber 34' in the direction along the axis of movement opposite to the direction shown by arrow A in Figure 2 (the "return stroke"), the volume of pumping chamber 34' increases. Thus, fuel at relatively low pressure is received during the return stroke of the plunger 30', and pressurisation of fuel to a relatively high level suitable for injection takes place as plunger 30' is driven to perform the pumping stroke upon rotation of the cam shaft.

[0019] Referring in addition to Figure 4, radially inner end 21' of axially extending opening 14' receives a tappet 40', a spring seat 54' and a return spring 56'. Tappet 40' is a substantially hollow body including a side wall portion 42' and a base portion 44'. Side wall portion 42' is generally cylindrical and extends upwardly from base portion 44' at the perimeter 45' of base portion 44' so as to define a generally bucket-shaped member. Base portion 44' and side wall portion 42' may be separately or integrally formed. An upper lip 48' of side wall portion 42' forms the circular surface which is urged upwards towards head portion 24' during the pumping stroke. Base portion 44' provides a blind end of an internal chamber or upper cam box 50' defined within tappet 40'. Tappet 40' is located within radially inner end 21' of housing bore 20a' so that an internal surface of housing bore 20a' is in sliding contact with cylindrical side wall portion 42' and serves to guide longitudinal movement and constrain lateral move-

ment of tappet 40'. Tappet 40' is shaped in the form of a bucket and may be referred to as a "bucket tappet."

[0020] Tappet 40' is coupled to plunger 30' by suitable means so that relative longitudinal movement is transferred between plunger 30' and tappet 40'. Accordingly, spring seat 54' in the form of a plate is received by a lower end of plunger 30' in an interference fit. While spring seat 54' is described as being secured to the end of plunger 30' by an interference fit, it will be appreciated that spring seat 54' could alternatively be integrally formed with the shaft-like plunger 30' or could be secured thereto via other ways. Spring seat 54' and plunger 30' move together as one unit.

[0021] Spring seat 54' locates one end of return spring 56' and the other end of plunger return spring 56' abuts a radially inner surface 57' of head portion 24' of pump head 22a', so that return spring 56' serves to apply a return biasing force to spring seat 54' and plunger 30' (and hence also to the tappet), to drive the plunger return stroke.

[0022] As shown in Figure 4, one or more vents or through holes 52' are formed circumferentially around side wall portion 42' and/or base portion 44' of tappet 40' to enable fluid, such as engine fuel, to flow between an outer region surrounding tappet 40' and an inner region within upper cam box 50'. Vents 52' reduce the pressure differential between upper cam box 50' and opening 14' within lower cam box 51' and therefore prevent excessive hydraulic force on tappet 40' during reciprocating motion. Vents 52' may be, for example, circular or church window style or the like.

[0023] Referring to Figure 5, the cam shaft co-operates with the eccentrically mounted cam 18' and a generally tubular cam rider 60' which extends coaxially with cam 18'. On the outer surface of cam rider 60' is provided first 62a', second 62b' and third 62c' flattened surfaces referred to as flats. Each one of flats 62a', 62b', 62c' co-operates with base portion 44' of tappet 40' for a respective one of plungers 30'. As respective tappets 40' are operably coupled to respective plungers 30', rotation of the cam shaft causes cam rider 60' to ride over the surface of eccentrically mounted cam 18' thereby imparting drive to both each respective tappet 40' and plunger 30' combination.

[0024] As the tappet 40' and plunger 30' are driven through the pumping stroke, low pressure fuel within pumping chamber 34' is compressed by plunger 30'. Compression of the fuel within pumping chamber 34' causes the fuel to increase in fluid pressure as well as increase in temperature. Because plunger 30' is slidably engaged within plunger bore 28', at least some gap is present between plunger 30' and plunger bore 28'. As a result, high temperature fuel, under pressure, is able to leak around plunger 30' and is directed toward spring seat 54' and base portion 44', and an interface 55' between plunger 30' and base portion 44' and an interface 59' between tappet 40' and cam rider 60' (Figure 5), before passing through vents 52' and into lower cam box

51'. As tappet 40' and plunger 30' perform the return stroke, fuel is drawn back into upper cam box 50' from lower cam box 51' through vents 52'. Thus, the flow of fuel between cam boxes 50', 51' serves to lubricate interfaces 55', 59'. However, during the pumping stroke, high temperature fuel, under pressure, is directed toward interfaces 55' and 59', thereby elevating the temperature of interfaces 55', 59' and potentially increasing wear at interfaces 55', 59' and of other surrounding components.

[0025] As shown in Figure 4, in accordance with an aspect of the invention, alleviation of the adverse effects of high temperature fuel under pressure may be accomplished via a high temperature fuel deflector surface and a modified fuel flow path generally comprising a tappet 40', spring seat 54' and return spring 56'. Spring seat 54' has a larger outer diameter 70' than the prior art spring seat 54, to more closely match an inner diameter 72' of tappet 40' (i.e. the outer diameter 70' of the spring seat 54' is marginally smaller than the inner diameter 72' of the tappet 40'), so as to limit the passage of leaked, high temperature fuel between the diameters 70', 72' during the pumping stroke. Spring seat 54' is also positioned on plunger 30' an extended distance 74' from interface 55', as opposed to the spring seat 54 of the prior art (Figure 3) which is essentially flush with interface 55. For example, in one aspect of the invention, distance 74' may be approximately 3.0mm to 4.0mm. Also, spring seat 54' may include deflector surface 58' proximate return spring 56'. Deflector surface 58' may further include an annularly tapered portion 64' which may be used to direct high temperature fuel outwardly through plunger tappet vents 52' and the lower cam box 51' during the pumping stroke. Annularly tapered portion 64' may be directed toward upper cam box 50' and inwardly toward plunger 30' so as to form an acute angle relative to a longitudinal axis 76' of plunger 30'. Vents 52' may be elongated from base portion 44' toward pumping chamber 34' to receive the redirected high temperature fuel for passage there-through. The elevated spring seat 54', in combination with deflector surface 58', operate to shield or limit the interfaces 55' and 59' from exposure to high temperature fuel. That is, instead of being directed toward interfaces 55' and 59', leaked high temperature fuel will first impact deflector surface 58' and then be redirected through vents 52' (described below) to be mixed and cooled in lower cam box 51' before returning to upper cam box 50' during the return stroke, as generally shown by arrow B.

[0026] The modified tappet 40' of the present invention is a substantially hollow body including a side wall portion 42' and a base portion 44'. Side wall portion 42' is generally cylindrical and extends upwardly from base portion 44' at the perimeter 45' of base portion 44' so as to define a generally bucket-shaped member. Side wall portion 42' includes one or more vents or through holes 52'. As compared to the prior art vents 52 as shown in Figure 1, the openings formed by vents 52' are extended toward upper lip 48' of side wall portion 42', so as to be essentially in alignment with deflector surface 58', or even extend fur-

ther upward toward upper lip 48', when the pumping plunger 30' reaches the terminal point of the pumping stroke, so as to form a direct path for the fuel to flow from the angled portion 64' of the deflector surface 58, through the extended vent(s) 52' and to the lower cam box 51'. In this manner, the high pressure, high temperature fuel may be directed through vents 52' by deflector surface 58' to provide for additional cooling and mixing of the leaking fuel with that fuel resident within lower cam box 51'. As a result, cooler fuel may then lubricate and cool interfaces 55' and 59', and other surrounding components.

[0027] Although particular embodiments of the invention have been disclosed herein in detail, this has been done by way of example and for the purposes of illustration only. The aforementioned embodiments are not intended to be limiting, and it should be appreciated that various modifications may be made to the embodiments described above without departing from the scope of the invention as defined by the appended claims.

Claims

1. A fuel pump assembly (10') comprising a spring seat (54'), the fuel pump assembly (10') further including a pump housing (12'), a pump head (22a', 22b', 22c'), a tappet (40), a plunger (30'), and a return spring (56'), the pump housing (12') including a bore (20a', 20b', 20c') for receiving the tappet (40'), the pump head (22a', 22b', 22c') including a plunger bore (28'), the plunger (30') being driven in a reciprocal manner within the plunger bore (28') by a drive arrangement (18') to pressurise fuel disposed within a pumping chamber (34') defined by the pump head (22a', 22b', 22c') and the plunger (30'), the tappet (40') including at least one vent (52') and being operably disposed between the drive arrangement (18') and the plunger (30'), the spring seat (54') is coupled with the plunger (30') and disposed within an upper cam box (50') defined within the tappet (40'), the return spring (56') disposed between the spring seat (54') and the pump head (22a', 22b', 22c') to bias the plunger (30') against the tappet (40') at an interface (55'), the spring seat (54')

characterised by the spring seat (54') comprising a deflector surface (58') configured to direct high temperature fuel outwardly through the at least one vent (52') from the upper cam box (50') to a lower cam box (51'), and

wherein the spring seat (54') is coupled with the plunger (30') at a distance (74') from the interface (55') between the plunger (30') and the tappet (40') along a longitudinal axis (76') of the plunger (30') to thereby limit the effects of high pressure fuel within the fuel pump assembly (10').

2. A fuel pump assembly (10') as claimed in Claim 1,

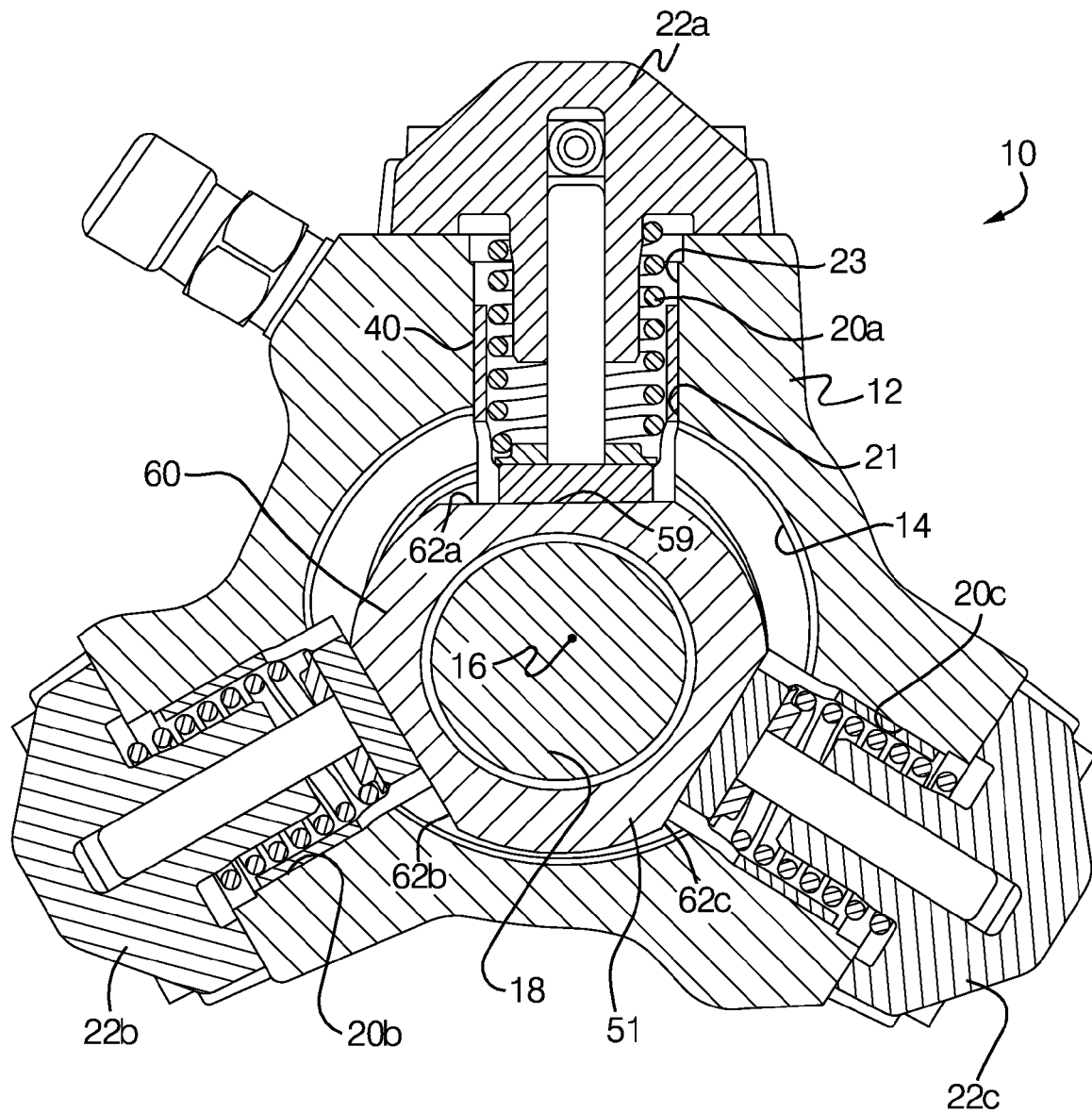
wherein the deflector surface (58') of the spring seat (54') includes an annularly tapered portion (64').

3. A fuel pump assembly (10') as claimed in Claim 2, wherein the annularly tapered portion (64') is directed toward the upper cam box (50') and inwardly toward the plunger (30') to form an acute angle relative to a longitudinal axis (76') of the plunger (30'). 5
4. A fuel pump assembly (10') as claimed in any of the preceding claims, wherein the spring seat (54') includes an outer diameter (70'), wherein the tappet (40') includes an inner diameter (72'), wherein the outer diameter (70') of the spring seat (54') is less than the inner diameter (72') of the tappet (40'). 10 15
5. A fuel pump assembly (10') as claimed in Claim 4, wherein the outer diameter (70') of the spring seat (54') is closely matched with inner diameter (72') of the tappet (40'). 20
6. A fuel pump assembly (10') as claimed in any one of the preceding claims, wherein the spring seat (54') is provided with an aperture for receiving the plunger (30'). 25
7. A fuel pump assembly (10') as claimed in any one of the preceding claims, wherein the pump housing (12') is provided with a plurality of bores (20a', 20b', 20c'), and wherein a corresponding number of tappets (40') are disposed in the respective bores (20a', 20b', 20c'). 30
8. A fuel pump assembly (10') as claimed in any one of the preceding claims, wherein the spring seat (54') is coupled with the plunger (30') at a distance of approximately 3.0mm to 4.0 mm from the interface between the plunger (30') and the tappet (40'). 35
9. A fuel pump assembly (10') as claimed in any one of the preceding claims, wherein the tappet (40') includes a base portion (44') and a side wall portion (42'), the base portion (44') including a perimeter (45'), the side wall portion (42') connected with the base portion (44') so as to be upstanding from a perimeter (45') of the base portion (44'), the side wall portion (42') is slidably disposed within the bore (22a', 22b', 22c'), the side wall portion (42') and the base portion (44') defining the upper cam box (50'), the base portion (44') configured for cooperating with the drive arrangement (18') for driving the plunger (30') in the reciprocal manner. 40 45 50
10. A fuel pump assembly (10') as claimed in Claim 9, wherein at least one of the base portion (44') or the side wall portion (42') are provided with at least one vent (52') for allowing the passage of fuel from the upper cam box (50') to the lower cam box (51'). 55

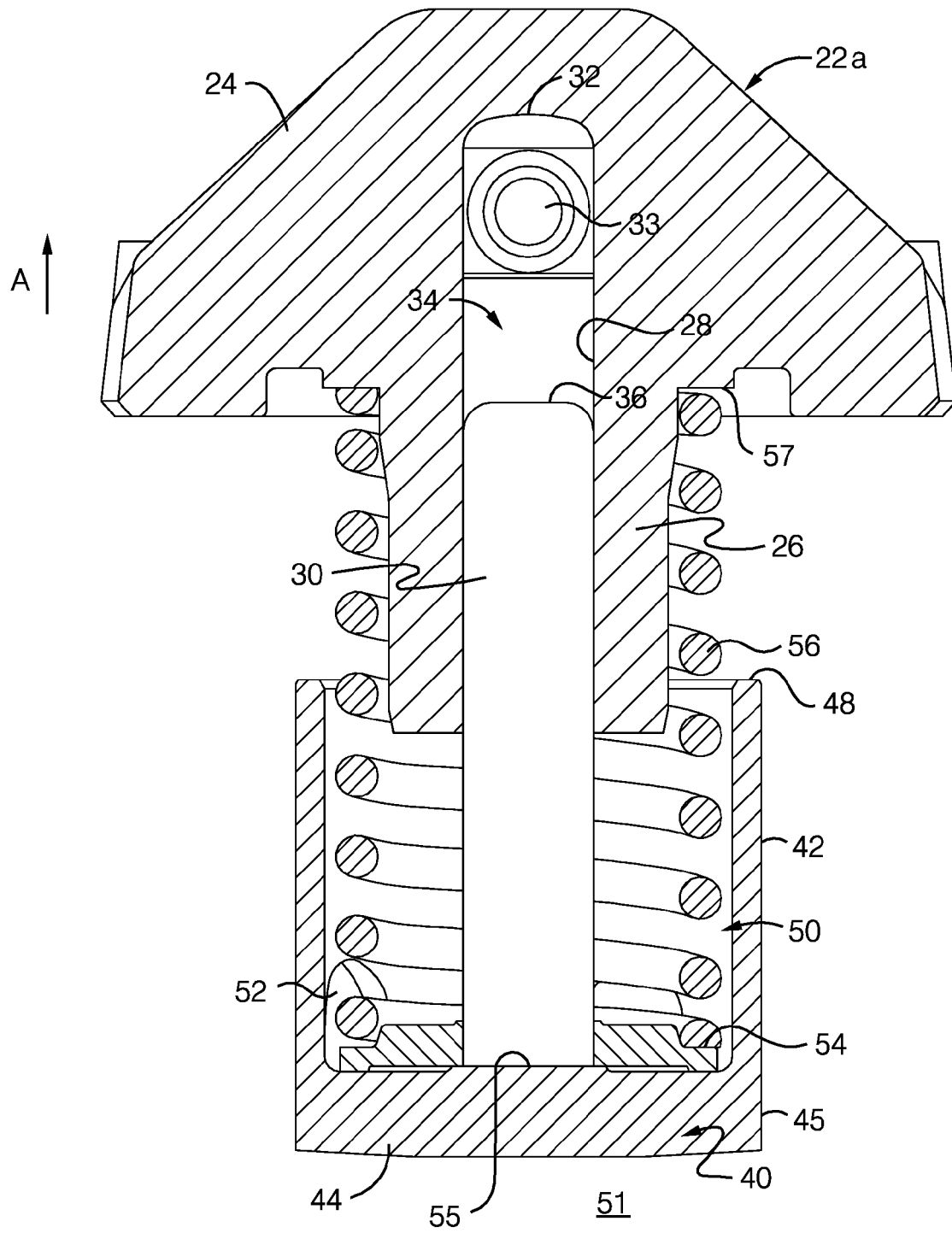
11. A fuel pump assembly (10') as claimed in any one of the preceding claims, wherein the fuel pump assembly (10') further includes a cam rider (60') operationally disposed between the plunger (30') and the tappet (40').

12. A method for protecting components within a high pressure fuel pump (10'), the fuel pump assembly (10') including a pump housing (12'), a pump head (22a', 22b', 22c'), a tappet (40'), a plunger (30'), a spring seat (54'), and a return spring (56'), the pump housing (12') including a bore (20a', 20b', 20c') for receiving the tappet (40'), the pump head (22a', 22b', 22c') including a plunger bore (28'), the plunger (30') configured for being driven in a reciprocal manner within the plunger bore (28') by a drive arrangement (18') to pressurise fuel disposed within a pumping chamber (34') defined by the pump head (22a', 22b', 22c') and the plunger (30'), the tappet (40') including at least one vent (52') and being operably disposed between the drive arrangement (18') and the plunger (30'), the spring seat (54') is coupled with the plunger (30') and disposed within an upper cam box (50') defined within the tappet (40'), the return spring (56') disposed between the spring seat (54') and the pump head (22a', 22b', 22c') to bias the plunger (30') against the tappet (40') at an interface (55); the method **characterised by:**

providing a deflector surface (58') on said spring seat (54') that is configured to direct high temperature fuel outwardly through the at least one vent (52') from the upper cam box (50') to a lower cam box (51') as the plunger (30') is driven in the reciprocal manner, and positioning the spring seat (54') with respect to the plunger (30') at a distance (74') from the interface (55') between the plunger (30') and the tappet (40') along a longitudinal axis (76') of the plunger (30') to thereby limit the effects of high pressure fuel within the fuel pump assembly (10').



PRIOR ART
FIG. 1



PRIOR ART
FIG. 2

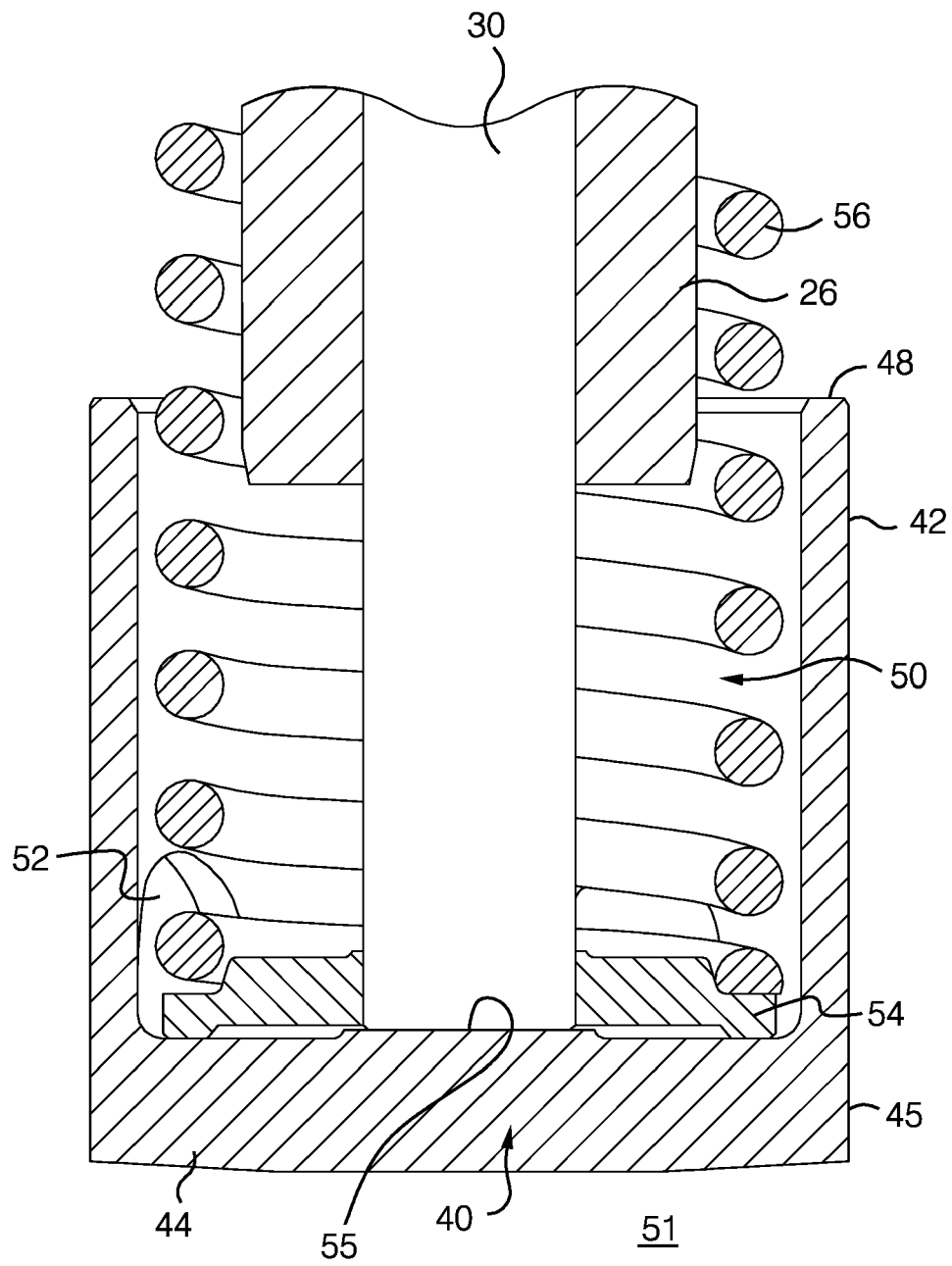


FIG. 3

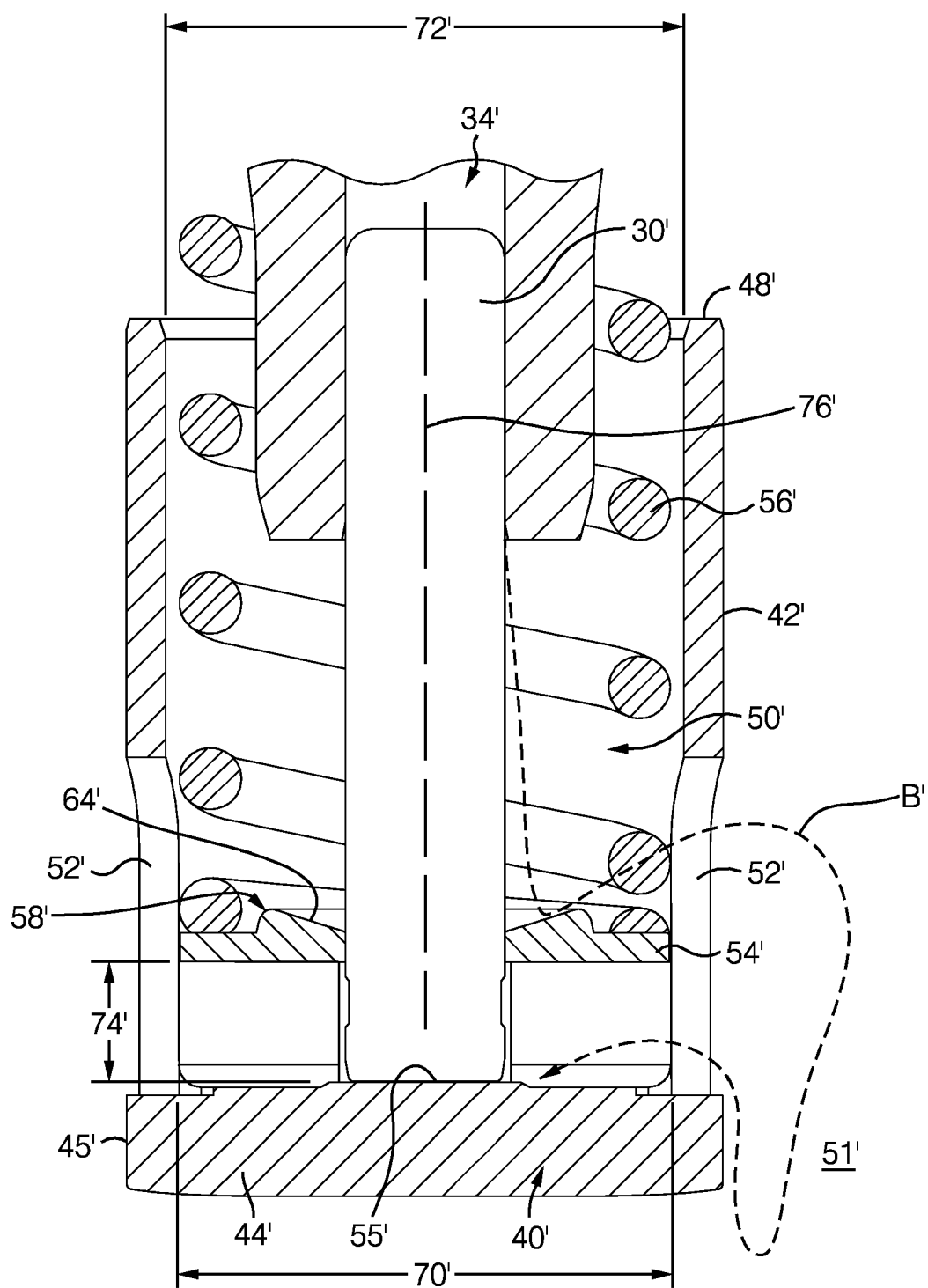


FIG. 4

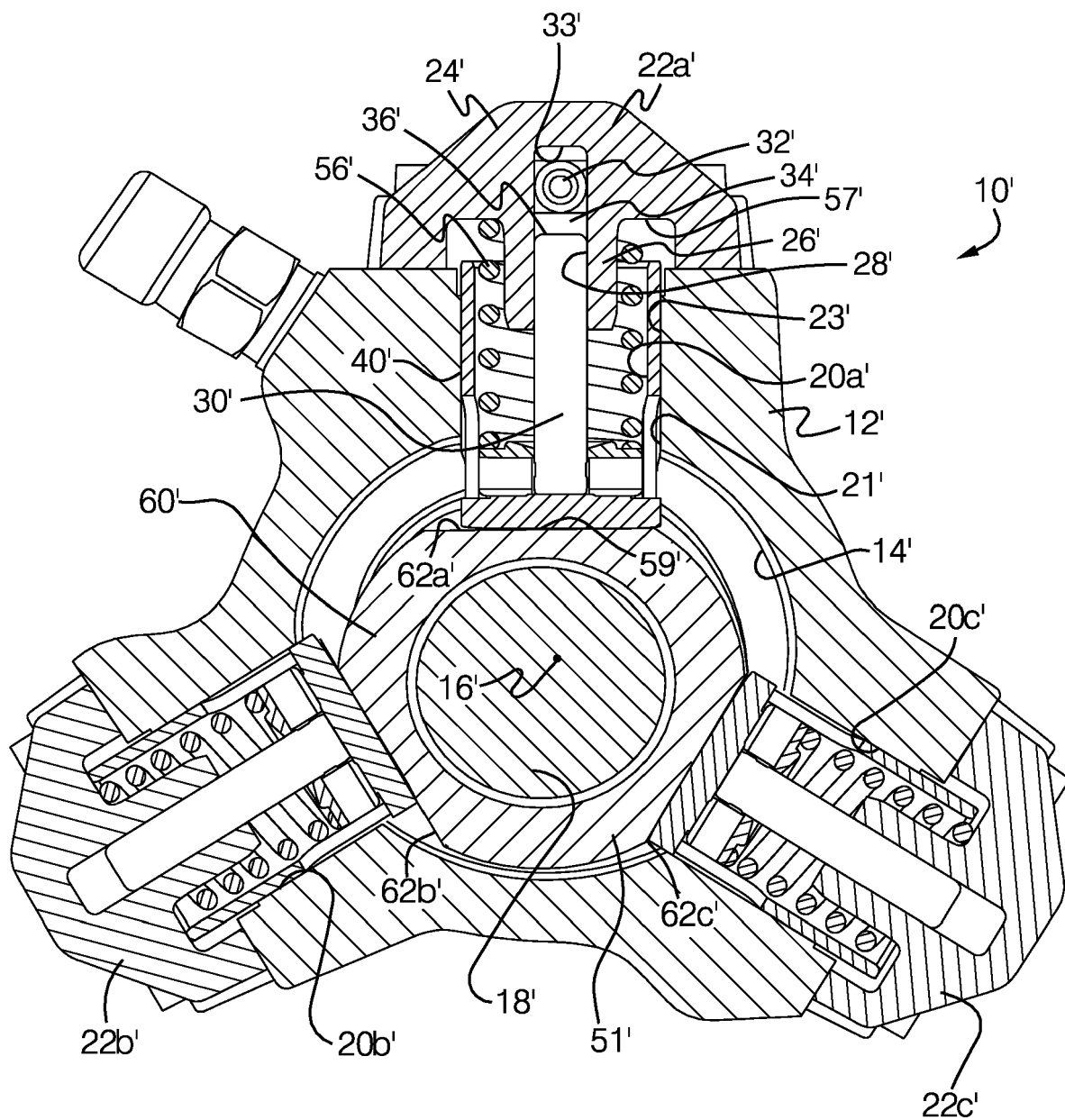


FIG. 5



EUROPEAN SEARCH REPORT

Application Number
EP 16 15 3708

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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	US 6 250 893 B1 (STREICHER BERND [DE]) 26 June 2001 (2001-06-26) * column 3, line 59 - column 5, line 10; figure 6 * * abstract *	1,4-12	INV. F02M59/10 F02M59/36 F04B1/04
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X	DE 10 2012 210199 A1 (BOSCH GMBH ROBERT [DE]) 19 December 2013 (2013-12-19) * paragraph [0027] - paragraph [0028]; figure 2 * * abstract *	1,6	TECHNICAL FIELDS SEARCHED (IPC) F02M F04B
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 24 May 2016	Examiner Hermens, Sjoerd
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			

EPO FORM 1503 03.82 (P04C01)

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

EP 16 15 3708

5 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
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