



- (51) International Patent Classification:
F16K 1/54 (2006.01) *F16K 1/42* (2006.01)
F04B 53/10 (2006.01) *F16K 17/04* (2006.01)
F16K 1/38 (2006.01)
- (21) International Application Number:
PCT/CA2011/000284
- (22) International Filing Date:
14 March 2011 (14.03.2011)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
61/313,888 15 March 2010 (15.03.2010) US
- (71) Applicant (for all designated States except US):
MAGNA POWERTRAIN INC. [CA/CA]; 50 Casmir Court, Concord, Ontario L4K 4J5 (CA).
- (72) Inventor; and
(75) Inventor/Applicant (for US only): **WILLIAMSON, Matthew** [CA/CA]; 243 Weldrick Road West, Richmond Hill, Ontario L4C 5J2 (CA).
- (74) Agents: **BRANDT, Kerstin, B.** et al.; Magna International Inc., 337 Magna Drive, Aurora, Ontario L4G 7K1 (CA).
- (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, RO, RS, RU, 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,

[Continued on next page]

(54) Title: LOW GAIN PRESSURE RELIEF VALVE

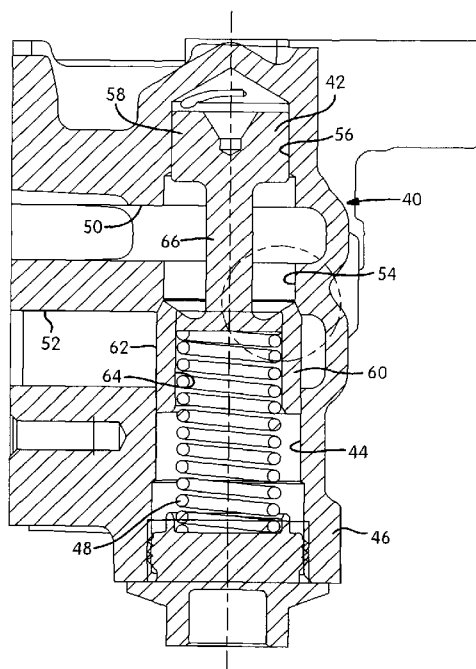


FIG. 2

(57) Abstract: A pressure relief valve for a pump pressurizing a fluid includes a housing having a first aperture in communication with high pressure fluid, a second aperture in communication with low pressure fluid, a bore extending between the first and second apertures, and a conical seat formed at the end of the bore. A plunger is slidable between a first position where fluid is prevented from passing between the first and second apertures and a second position where fluid is allowed to flow between the first and second apertures. The plunger includes a conical surface. A biasing member urges the plunger toward the first position and engages the conical surface with the conical seat when the plunger is in the first position.



GM, KE, LR, LS, MW, MZ, NA, 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).

Published:

- *with international search report (Art. 21(3))*
- *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

LOW GAIN PRESSURE RELIEF VALVE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional
5 Application No. 61/313,888 filed on March 15, 2010. The entire disclosure of the
above application is incorporated herein by reference.

FIELD

[0002] The present disclosure relates to a pressure relief valve for a
fluid pumping system. More specifically, the present disclosure relates to a low
10 gain pressure relief valve for use in automotive applications.

BACKGROUND

[0003] A number of automotive fluid pumping system include a
pressure relief valve to limit the downstream pressure output of the pump to
establish an equilibrium operating pressure for the fluid pumping system. In
15 some cases, the fluid pumping system and pressure relief valves are quite
simple in design and include a cylindrical plunger positioned within a bore of the
pump itself or the plunger may be externally mounted in a separate valve
housing. The plunger is in fluid communication with a high side pressure output
of the pump and is operable to open and close a waste passage that is in fluid
20 communication with the low pressure side of the pump, a low pressure gallery or
a sump. The plunger is biased by a spring to a first end of the bore
corresponding to a closed position. The waste passage is blocked when the
plunger is in the closed position. As the output pressure of the pump increases,
the pressure of the working fluid on the end of the plunger acts against the bias
25 of the spring and, when the pressure is sufficiently high, the plunger is moved
from the closed position to expose the waste passage and allow pressurized
working fluid from the high pressure side of the pump to enter the waste
passage, thus reducing the output pressure produced by the pump. As the
output pressure of the pump increases, the plunger is moved further into the
30 bore, allowing more working fluid to enter the waste passage. As the output
pressure of the pump decreases, the biasing force of the spring moves the
plunger toward the closed position. An equilibrium level is reached based on the

pump output, the geometry of the plunger, bore, and the mechanical characteristics of the spring.

[0004] Another more slightly complex lubrication system includes a pressure relief valve including a plunger having two spaced apart pistons of different diameters. Such configuration is the subject of patent application WO2006/032132, which is herein incorporated by reference in its entirety.

[0005] While the previously known relief valves have adequately performed in the past, they may suffer from certain disadvantages. For example, valve systems including moveable plungers in contact with pressurized fluid may be subject to receipt of feedback signals capable of sustaining the plunger in an undesirable oscillation. Furthermore, some pressure relief valves are more susceptible to jamming with debris that may be entrained in the working fluid and disrupting proper valve operation. In one instance, large particle contamination is a concern regarding restricting the plunger from returning to a completely closed position resulting in the pump producing insufficient output pressure and/or volume at a certain operating speed. In particular, the plunger may be restricted from completely closing the opening to the waste passage due to large particle contamination.

[0006] Other known pressure relief valves may include progressively shaped exit holes to vary the valve function. A progressively shaped exit hole includes one or more portions having a relatively small aperture through which pressurized fluid must pass. While these valves may function in certain environments, it is common for automotive components such as engine blocks to include residual casting sand retained within pockets or bores of the engine block. After the engine has been assembled and at initial engine operation, the casting sand or other small particle contaminants may break free and become entrained within the fluid to be pumped. The small particles may clog the progressively shaped exit hole and preclude proper operation. Accordingly, it may be desirable to provide a simple, inexpensive and improved pressure relief valve.

SUMMARY

[0007] This section provides a general summary of the disclosure, and is not a comprehensive disclosure of its full scope or all of its features.

[0008] A pressure relief valve for a pump pressurizing a fluid includes
5 a housing having a first aperture in communication with high pressure fluid, a second aperture in communication with low pressure fluid, a bore extending between the first and second apertures, and a conical seat formed at the end of the bore. A plunger is slidable between a first position where fluid is prevented from passing between the first and second apertures and a second position
10 where fluid is allowed to flow between the first and second apertures. The plunger includes a conical surface. A biasing member urges the plunger toward the first position and engages the conical surface with the conical seat when the plunger is in the first position.

[0009] Further areas of applicability will become apparent from the
15 description provided herein. The description and specific examples in this summary are intended for purposes of illustration only and are not intended to limit the scope of the present disclosure.

DRAWINGS

[0010] The drawings described herein are for illustrative purposes only
20 of selected embodiments and not all possible implementations, and are not intended to limit the scope of the present disclosure.

[0011] Figure 1 is a fragmentary cross-sectional view of a prior art pressure relief valve;

[0012] Figure 2 is a fragmentary cross-sectional view of a low gain
25 pressure relief valve constructed in accordance with the teachings of the present disclosure;

[0013] Figures 3a-3e depict enlarged fragmentary cross-sectional views of the valve shown in Figure 2 having a plunger at different axial positions;

[0014] Figure 4 is a graph depicting valve opening area versus valve
30 position for the prior art and the valve of the present disclosure;

[0015] Figure 5 is an enlarged fragmentary cross-sectional view of the valve opening for a prior art valve;

[0016] Figure 6 is an enlarged fragmentary cross-sectional view of the valve opening for a valve of the present disclosure;

[0017] Figure 7 is an enlarged fragmentary cross-sectional view depicting thin film fluid flow through an orifice of the prior art valve;

5 [0018] Figure 8 is an enlarged fragmentary cross-sectional view depicting thin film fluid flow through an orifice of the valve of the present disclosure;

[0019] Figure 9 is an enlarged fragmentary cross-sectional view depicting possible large particle jamming of the prior art valve;

10 [0020] Figure 10 is an enlarged fragmentary cross-sectional view depicting large particle retention within a recess of the valve of the present disclosure;

[0021] Figure 11 is a schematic of a fluid pumping system;

[0022] Figure 12 is a graph depicting discharge pressure versus
15 discharge flow rate comparing a prior art valve to the valve of the present disclosure;

[0023] Figure 13 provides pressure distribution graphs for the prior art valve at open and closed positions; and

[0024] Figure 14 provides pressure distribution graphs for the valve of
20 the present disclosure at open and closed positions.

[0025] Corresponding reference numerals indicate corresponding parts throughout the several views of the drawings.

DETAILED DESCRIPTION

[0026] Example embodiments will now be described more fully with
25 reference to the accompanying drawings.

[0027] Figure 1 depicts a prior art pressure relief valve generally indicated at reference numeral 10. Valve 10 includes a housing 12 defining a bore 14 in receipt of a plunger 16. A compression spring 18 biases plunger 16 into engagement with housing 12 to define a closed valve position. Plunger 16
30 includes a first piston portion 20 substantially shaped as a right circular cylinder having an outer cylindrical surface 22 and a substantially planar end face 24. A passageway 26 is in receipt of pressurized fluid output from a pump (not shown).

A waste passage 28 may be selectively placed in communication with passageway 26 when plunger 16 is moved away from its closed position and end face 24 translates past a lip 30 of bore 14.

5 **[0028]** Figure 2 depicts a pressure relief valve 40 constructed in accordance with the teachings of the present disclosure. Valve 40 includes a plunger 42 axially translatable within a bore 44 in a housing 46. A spring 48 urges plunger 42 toward a closed position shown in Figure 2. Housing 46 includes a high pressure passage 50 in receipt of fluid output from a pump (not shown). A waste passage 52 may be selectively placed in fluid communication
10 with passage 50 when plunger 42 is axially translated away from its closed position. Housing 46 also includes an intermediate bore 54 having an inner diameter smaller than bore 44. A further reduced diameter bore 56 is in receipt of a first piston portion 58 of plunger 42.

15 **[0029]** Plunger 42 also includes a second piston portion 60 having an outer cylindrical surface 62 sized to slide within bore 44. Second piston portion 60 also includes a pocket 64 in receipt of spring 48. A stem portion 66 interconnects first piston portion 58 and second piston portion 60.

20 **[0030]** Figures 3a-3e provide enlarged fragmentary cross-sectional views of a portion of pressure relief valve 40 having plunger 42 at a number of different positions including a closed position shown in Figure 3a and an open position shown at Figure 3e. A conical valve seat 70 is formed at one end of bore 54 in communication with passage 52. Conical seat 70 terminates at a wall 73 of housing 46 to define a circular opening having a first size. A mating conical surface 72 is formed at an end 74 of second piston 60. Outer cylindrical
25 surface 62 has a diameter greater than the size of the circular opening at wall 73. As shown in Figure 3a, when plunger 42 is at the closed position, conical surface 72 engages conical seat 70 along the majority of the length of conical seat 70.

30 **[0031]** A recess 78 is formed in second piston 60 at end 74 to retain debris therein. Recess 78 includes a conically shaped wall 80 intersecting conical surface 72 at an edge 82. Edge 82 defines a circle at the intersection of conical surface 72 and wall 80.

[0032] As previously mentioned, one of the concerns with the prior art valve system is that certain feedback conditions existed that were capable of self sustaining unstable oscillations of plunger 16. The plunger oscillations may cause undesirable noise, vibration or harshness. To prevent this type of instability, it may be desirable to reduce the gain of critical components in the system. As part of the solution to the prior problem, the present disclosure provides a method to reduce the gain of a fluid pressure relief valve.

$$\text{Gain} = \frac{\text{Output}}{\text{Input}} = \frac{\text{Valve\_Flow}}{\text{Applied\_Pressure}} = \frac{1}{\text{Hydraulic\_Resistance}}$$

Accordingly, reduced gain is realized by increasing hydraulic resistance. The hydraulic resistance through pressure relief valve 40 is due to a combination of turbulent and laminar flow coefficients. These coefficients are non-linear functions of temperature, fluid properties and the three dimensional fluid path geometry. Fluid path geometry is a function of plunger shape, housing shape and plunger position. Plunger position is a function of fluid pressure, plunger effective area and biasing spring rate. It should be appreciated that this expression is simplified and intended only to illustrate the principle of valve gain and not necessarily to provide a numerical means for quantifying valve gain.

[0033] It is contemplated that hydraulic resistance is proportional to valve opening area. Figure 4 depicts a comparison of valve gain based on valve opening area for the prior art design of Figure 1 and the inventive design of Figure 2. As is evident from the graph, the rate of change of opening area per change in valve position is substantially lower for pressure relief valve 40 than pressure relief valve 10. Figures 5 and 6 depict plunger 16 and plunger 42 axially displaced the same amount. An opening area between housing 12 and plunger 16 is substantially greater than the opening area between housing 46 and plunger 42.

[0034] Figures 7 and 8 provide further explanation for a difference in hydraulic resistance between the prior art design of valve 10 and presently disclosed valve 40. As is shown in Figure 7, once plunger 16 is moved from the closed position to open a path to waste passage 28, fluid flows from passage 26 to waste passage 28. It should be noted that a relatively large open area exists

to either side of an orifice defined between end face 24 and a wall 88 of passage 28. Based on this geometrical configuration, the length of the orifice is very small.

[0035] Figure 8 depicts plunger 42 axially displaced from the closed position to provide an annular orifice between conical seat 70 and conical surface 72. As shown in Figure 4, for the same magnitude of axial displacement, not only is the opening area between plunger 42 and housing 46 less than the opening area between plunger 16 and housing 12, but the length of the orifice is substantially greater. Hydraulic resistance increases as the path length of a thin film of fluid increases. After valve 40 opens, a thin film of fluid has a significant path length through which the fluid must pass in valve 40 as compared to valve 10. A higher hydraulic resistance results.

[0036] Figures 9 and 10 illustrate a contamination resistance feature of valve 40. Figure 9 depicts prior art valve 10 while Figure 10 depicts valve 40. Based on the geometry of housing 12 and the interface of surfaces 24 and 22 with bore 14, large particles may collect at the opening between plunger 16 and housing 12. During a closing action of plunger 16, the large particles may jam the valve in the open position.

[0037] Based on the shape of conical seat 70, conical surface 72 and recess 78, large particles do not collect near the valve opening. Small particles are washed through the gap between conical seat 70 and conical surface 72 at relatively high velocity.

[0038] To evaluate the theoretical differences between valve 10 and valve 40, a test fluid pumping system 110 was constructed as shown in Figure 11. A fixed displacement pump 112 includes an inlet 114 in communication with a low pressure fluid reservoir 116. An outlet 118 of pump 112 discharges pressurized fluid to a variable hydraulic load 120. Fluid may exit variable hydraulic load 120 and enter a low pressure fluid reservoir 122. The pressure relief valve to be tested is plumbed in communication with outlet 118. Figure 11 depicts valve 40 where passage 50 is in receipt of pressurized fluid output from pump 112 and waste passage 52 is in communication with fluid reservoir 116. Plunger 42 is biased toward a closed position by spring 48.

[0039] To evaluate the gain of the different relief valves, variable hydraulic load 120 is first configured to provide a minimum load. At this time, fixed displacement pump 112 is driven at constant speed. Figure 12 depicts discharge pressure versus discharge flow rate for valve 10 and valve 40. At
5 minimum hydraulic load, the discharge flow rate is at a maximum and is substantially the same for both valves because both of the valves are in the closed position. As the hydraulic load 120 is increased, the discharge pressure increases. Initially, the effective surface area of plunger 16 and plunger 42 are the same. Similarly, the force applied by spring 18 and spring 48 is the same.
10 As such, the valve opening pressure for each valve is the same.

[0040] As the variable hydraulic load is further increased, the traces of discharge pressure versus discharge pressure flow rate for each pump diverge. Valve 10 exhibits a relatively high gradient due to a reduction of static pressure acting on the effective end surface of plunger 16 once the valve opens. This
15 phenomenon is illustrated at Figures 13 and 14 where the upper portions of Figures 13 and 14 relate to valves 10 and 40 being closed and where a uniform static pressure distribution is applied to each plunger.

[0041] An open position is shown at the lower portion of Figure 13 where relatively high fluid velocity exists near plunger face 24. A reduction in static pressure results and is depicted by the pressure distribution graph above
20 each plunger. The gradient of discharge pressure versus discharge flow rate for valve 40 is substantially less. The reduced gain or gradient is due at least in part to a less drastic change in pressure distribution acting on plunger 42 as the plunger moves from the closed position to the open position. The lower portion
25 of Figure 14 depicts this arrangement. When plunger 42 is in the open position, the zone of high fluid velocity is not directly adjacent to the upper surface of plunger 42. The shape of conical annulus between conical seat 70 and conical surface 72, as well as the shape of recess 78, define the flow path of fluid.

[0042] Furthermore, the effective area on which pressurized fluid may
30 act is increased by the provision of conical surface 72. By limiting the reduction in static pressure and increasing the surface area on which the pressure may

act, the discharge pressure versus discharge flow rate gradient of valve 40 is reduced.

[0043] The foregoing description of the embodiments has been provided for purposes of illustration and description. It is not intended to be
5 exhaustive or to limit the disclosure. Individual elements or features of a particular embodiment are generally not limited to that particular embodiment, but, where applicable, are interchangeable and can be used in a selected embodiment, even if not specifically shown or described. The same may also be
varied in many ways. Such variations are not to be regarded as a departure from
10 the disclosure, and all such modifications are intended to be included within the scope of the disclosure.

CLAIMS

What is claimed is:

1. A pressure relief valve for a pump pressurizing a fluid, the valve comprising:
 - 5 a housing having a first aperture in communication with high pressure fluid, a second aperture in communication with low pressure fluid, a bore extending between the first and second apertures, and a conical seat formed at the end of the bore;
 - a plunger slidable between a first position where fluid is prevented from
10 passing between the first and second apertures and a second position where fluid is allowed to flow between the first and second apertures, the plunger including a conical surface; and
 - a biasing member urging the plunger toward the first position and engaging the conical surface with the conical seat when the plunger is in the first
15 position.
2. The pressure relief valve of claim 1, wherein the plunger includes a recess positioned adjacent to and radially inward from the conical surface.
- 20 3. The pressure relief valve of claim 2, wherein the conical surface of the plunger radially outwardly extends beyond the radial outward extent of the conical seat.
4. The pressure relief valve of claim 3, wherein the biasing member is
25 positioned with a pocket formed in the plunger.
5. The pressure relief valve of claim 4, wherein the plunger is guided within a cylindrical passage having an inner diameter large than the inner diameter of the bore.

6. A pressure relief valve for a pump pressurizing a fluid, the valve comprising:

a housing including a bore extending between first and second apertures, and a conical seat formed at the end of the bore;

5 a plunger slidable between a first position where fluid is prevented from passing between the first and second apertures and a second position where fluid is allowed to flow between the first and second apertures, the plunger including a conical surface; and

a biasing member urging the plunger toward the first position and
10 engaging the conical surface with the conical seat when the plunger is in the first position, wherein the conical seat and the conical surface define an annular orifice through which the fluid flows when the plunger is moved from the first position, the annular orifice having a predetermined length defining a hydraulic resistance of the valve.

15

7. The pressure relief valve of claim 6, wherein the predetermined length of the orifice is based on the geometry of the conical surface and the conical seat as well as the relative axial position of the plunger and the conical seat.

20

8. The pressure relief valve of claim 7, wherein an increase in the predetermined length reduces the gradient of a valve discharge pressure to a valve discharge flow rate.

25

9. The pressure relief valve of claim 6, wherein the conical surface of the plunger radially outwardly extends beyond the radial outward extent of the conical seat.

10. The pressure relief valve of claim 6, wherein the plunger is guided
30 within a cylindrical passage having an inner diameter large than the inner diameter of the bore.

11. The pressure relief valve of claim 6, wherein the hydraulic resistance of the valve with the annular orifice having a predetermined length is greater than a hydraulic resistance of a valve without an annular orifice defined by conical surfaces.

5

12. The pressure relief valve of claim 11, wherein the valve having a greater hydraulic resistance includes a valve gain less than a valve gain of the valve having a lesser hydraulic resistance.

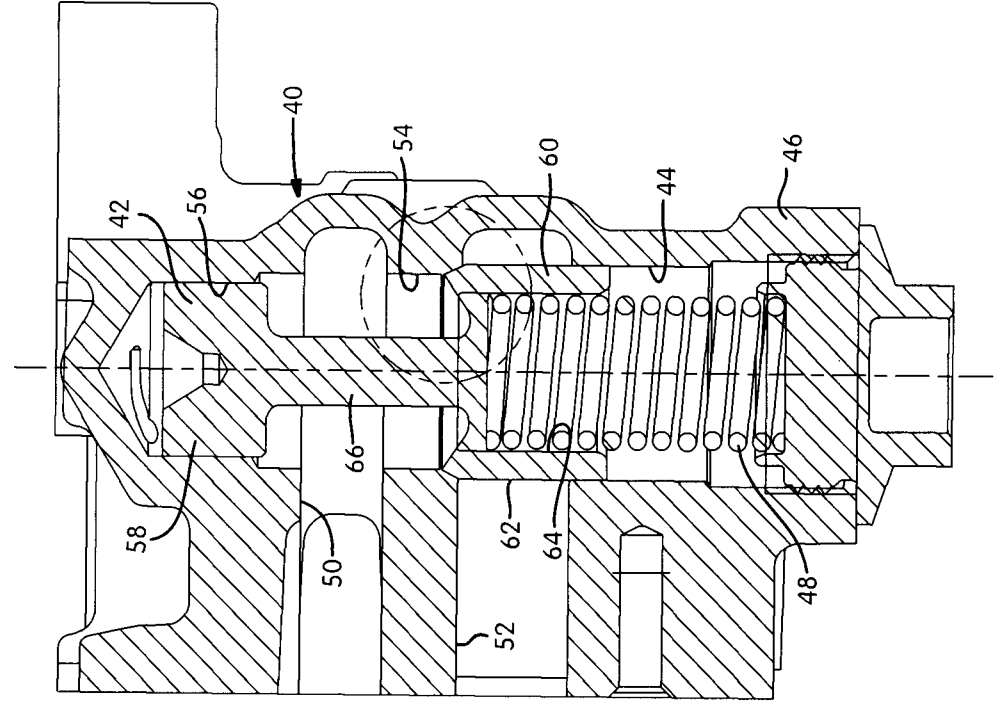


FIG. 2

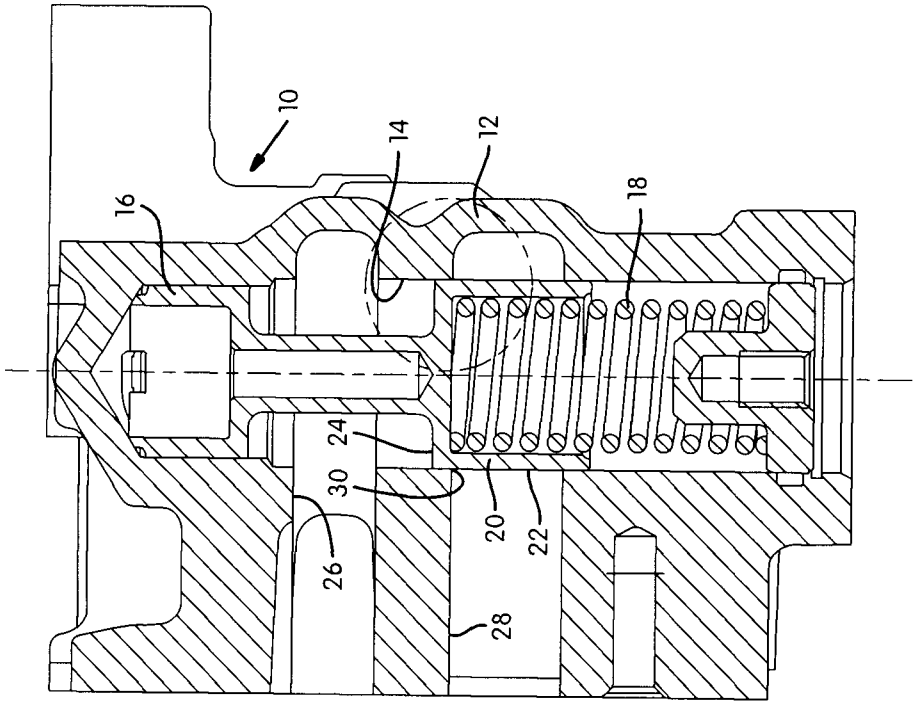


FIG. 1
Prior Art

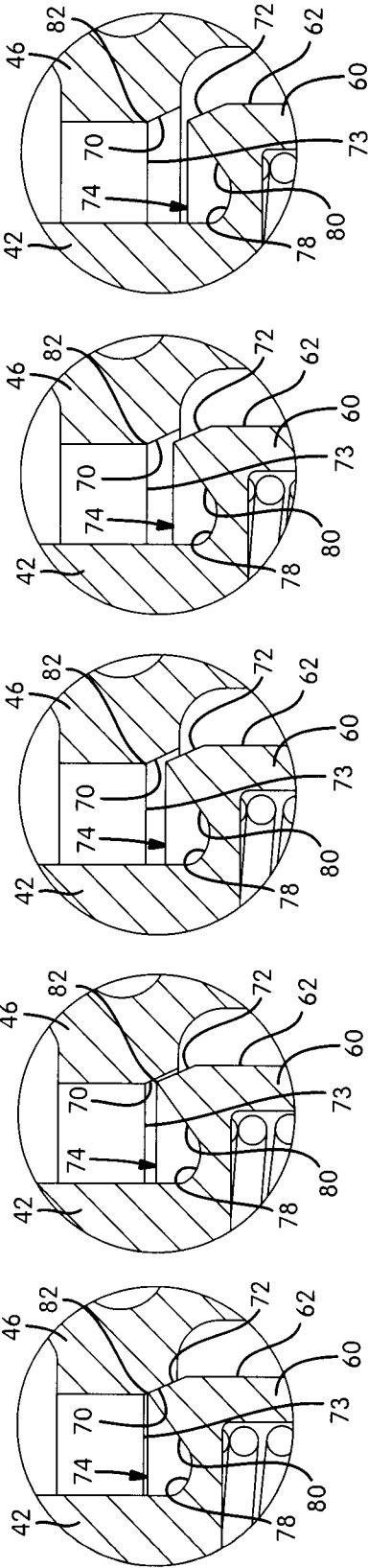


FIG. 3a

FIG. 3b

FIG. 3c

FIG. 3d

FIG. 3e

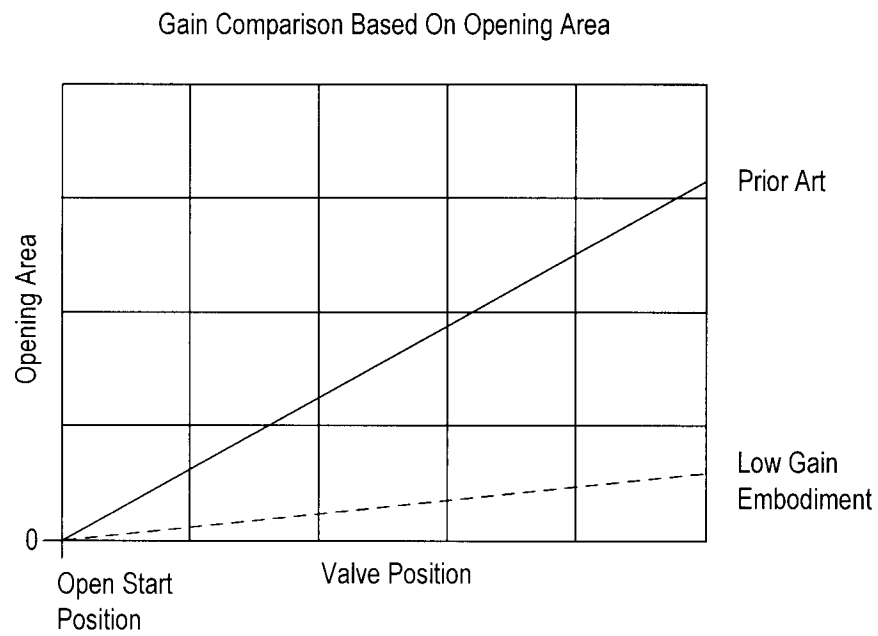


FIG. 4

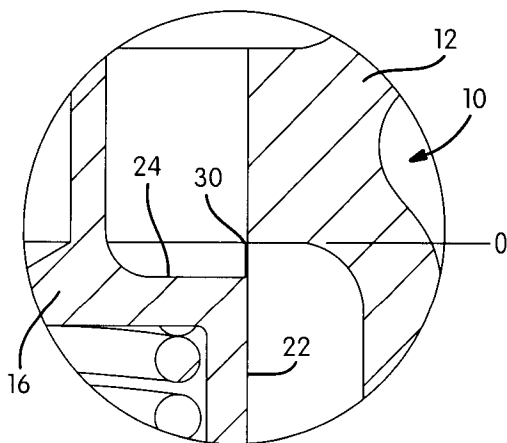


FIG. 5
Prior Art

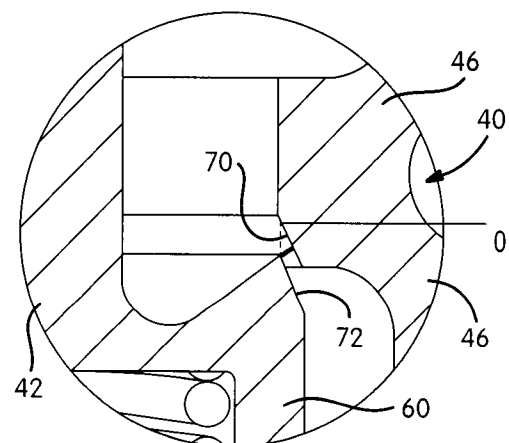


FIG. 6

4/8

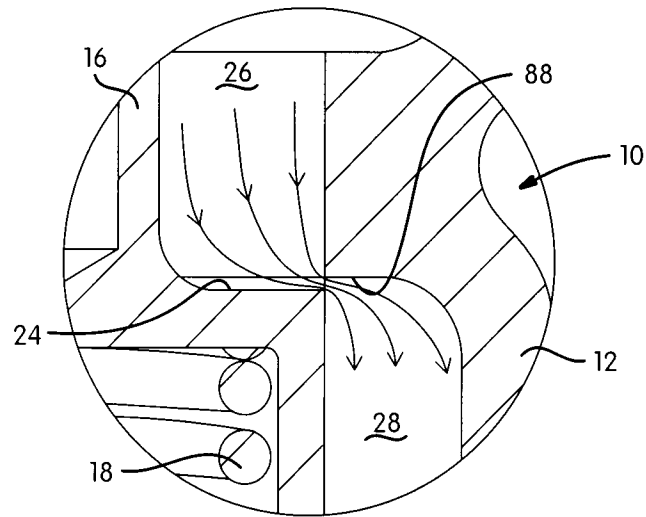


FIG. 7
Prior Art

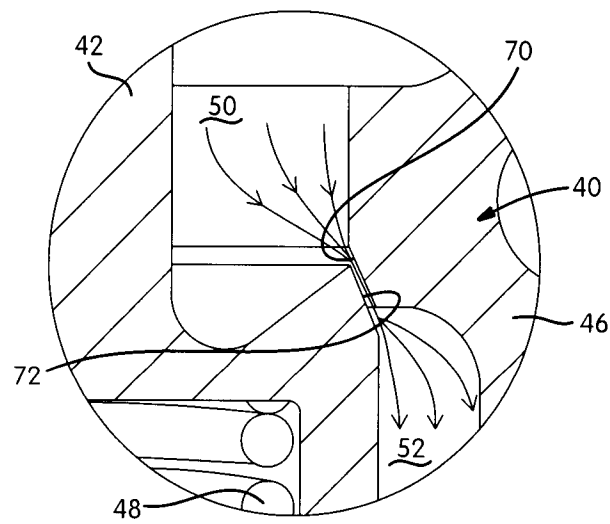


FIG. 8

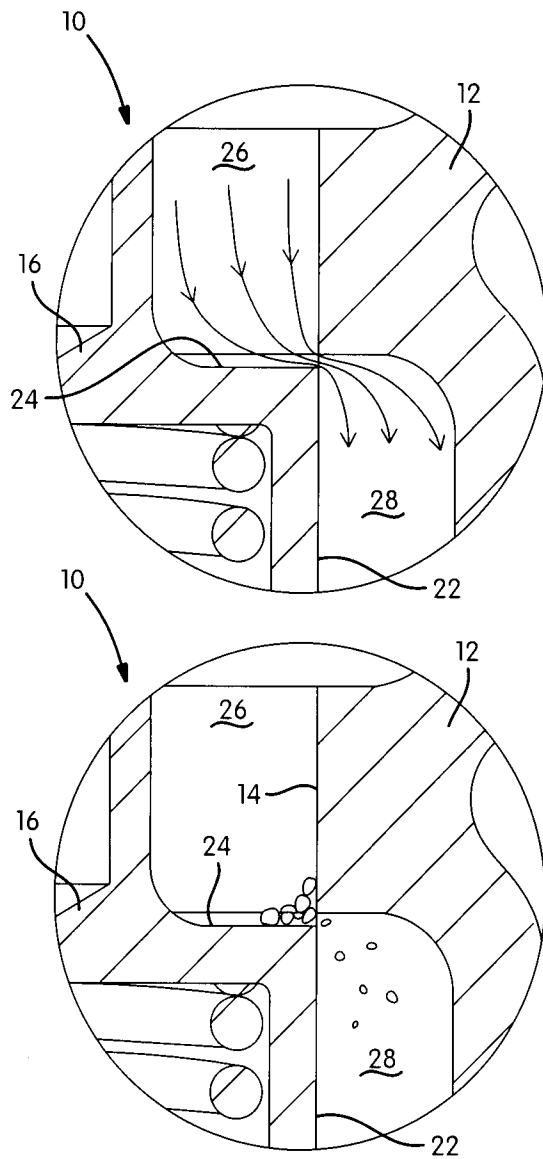


FIG. 9
Prior Art

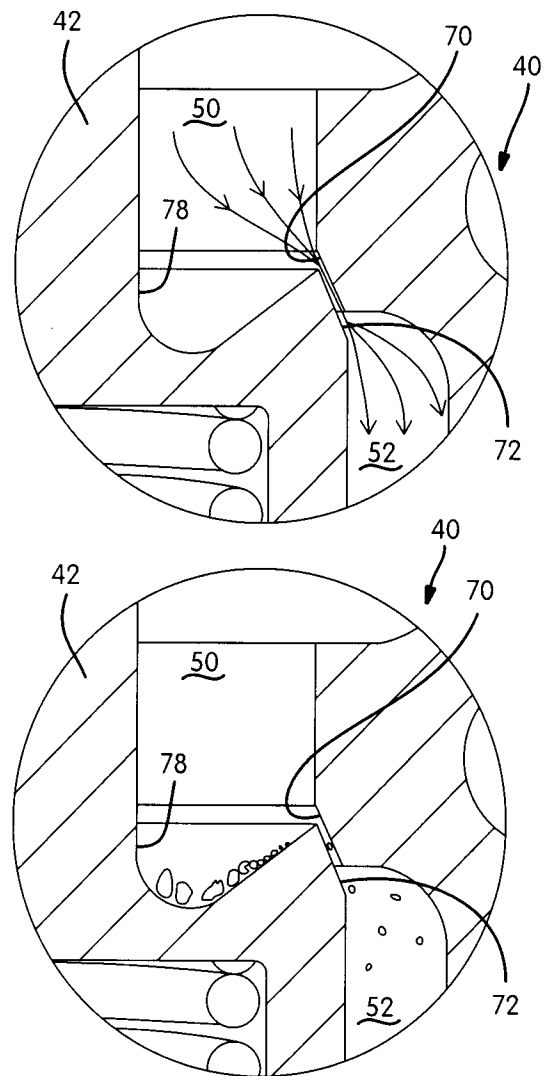
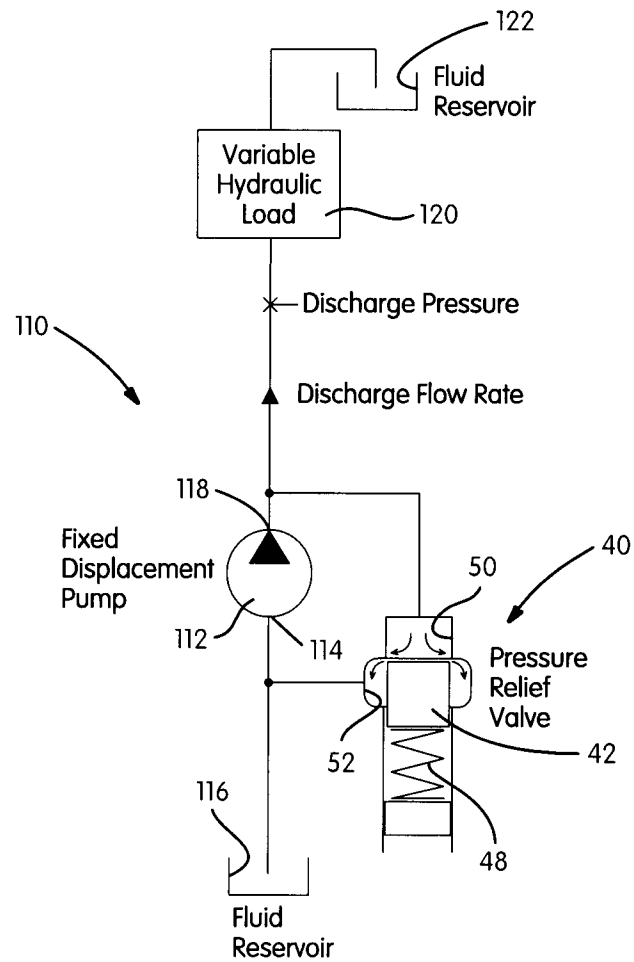
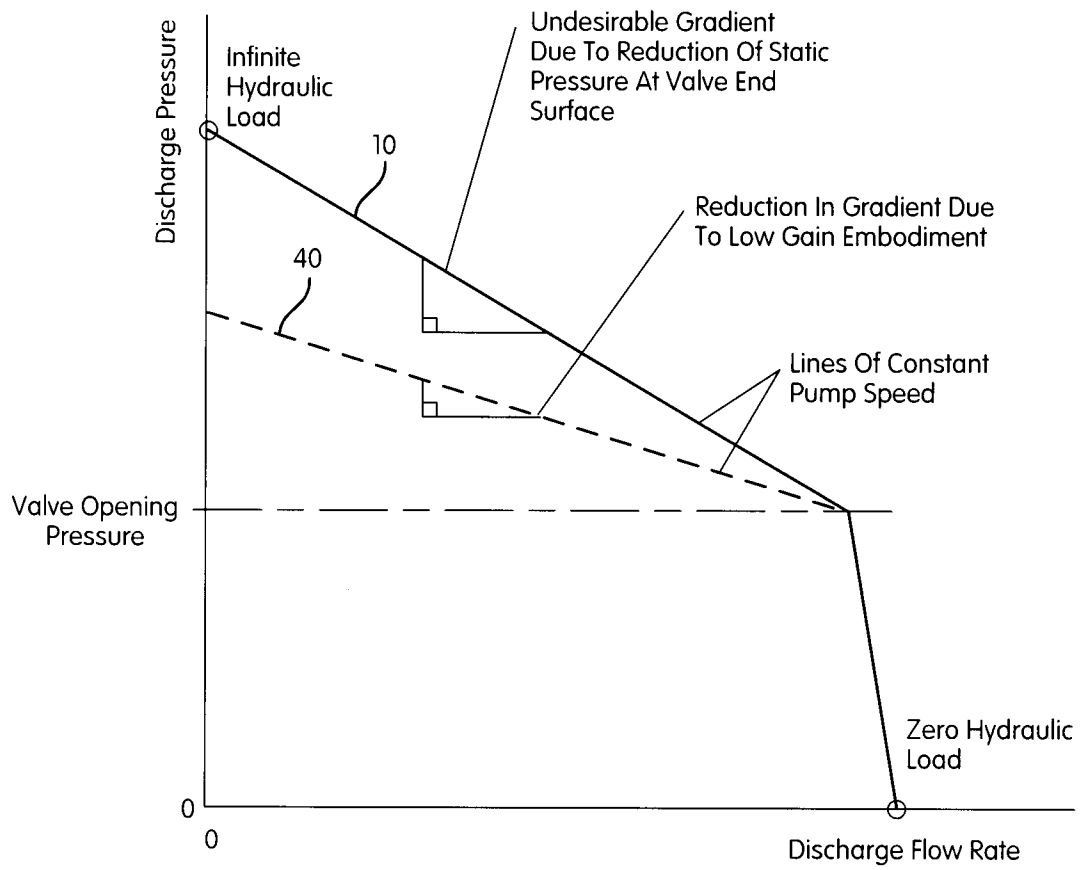


FIG. 10

6/8

**FIG. 11**

**FIG. 12**

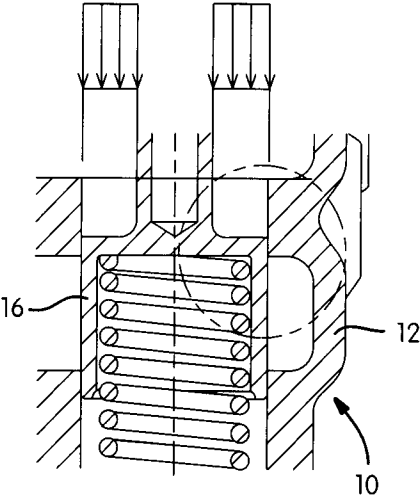


FIG. 13
Prior Art

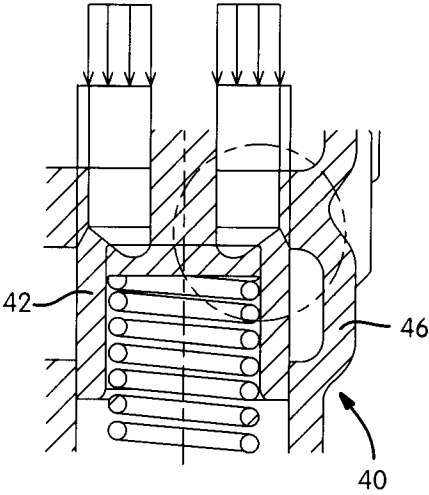


FIG. 14

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CA2011/000284

A. CLASSIFICATION OF SUBJECT MATTER IPC: F16K 1/54 (2006.01) , F04B 53/10 (2006.01) , F16K 1/38 (2006.01) , F16K 1/42 (2006.01) , F16K 17/04 (2006.01) According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) F16K 1/54 (2006.01) , F04B 53/10 (2006.01) , F16K 1/38 (2006.01) , F16K 1/42 (2006.01) , F16K 17/04 (2006.01) Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Electronic database(s) consulted during the international search (name of database(s) and, where practicable, search terms used) Epodoc; Search terms used in combination: pump; relief; valve; seat; conical; plunger; biased		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3972345 A; (COURT); 03 August 1976 (03-08-1976) Figure 1; Column 1, line 58 to column 2, line 13	Claims 1, 6, 11 and 12
X	GB 711606; (Bendix Aviation Corp.); 07 July 1954 (07-07-1954) Figure 1; Page 1, line 50 to page 2, line 55	Claims 1, 6, 11 and 12
Y	JP 5-272462 A; (); 19 September 1993 (19-09-1993) Figure 1; Abstract	Claims 1, 6, 11 and 12
Y	US 4021152 A; (TOYODA); 03 May 1977 (03-05-1977) Figure 1; Column 3, lines 14 to 63	Claims 1, 6, 11 and 12
Y	US 5249600 A; (BLUME); 05 October 1993 (05-10-1993) Figures 1 and 2	Claims 1, 6, 11 and 12
☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
* Special categories of cited documents : "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family	
Date of the actual completion of the international search 12 July 2011 (12-07-2011)	Date of mailing of the international search report 22 August 2011 (22-08-2011)	
Name and mailing address of the ISA/CA Canadian Intellectual Property Office Place du Portage I, C114 - 1st Floor, Box PCT 50 Victoria Street Gatineau, Quebec K1A 0C9 Facsimile No.: 001-819-953-2476	Authorized officer Steven A. Menyhart (819) 994-5348	

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CA2011/000284

Patent Document Cited in Search Report	Publication Date	Patent Family Member(s)	Publication Date
US3972345A	03 August 1976 (03-08-1976)	AU1367976A CA1029272A1 DE2623109A1 FR2312701A1 FR2312701B3	10 November 1977 (10-11-1977) 11 April 1978 (11-04-1978) 02 December 1976 (02-12-1976) 24 December 1976 (24-12-1976) 16 February 1979 (16-02-1979)
GB711606A	07 July 1954 (07-07-1954)	None	
JP5272462A	19 October 1993 (19-10-1993)	None	
US4021152A	03 May 1977 (03-05-1977)	SE7510875A SE7510875L	08 June 1976 (08-06-1976) 08 June 1976 (08-06-1976)
US5249600A	05 October 1993 (05-10-1993)	None	