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(71) Applicant: **Westport Power Inc.**
Vancouver, BC V6P 6GW (CA)

(72) Inventors:
- **Lefevre, Alexis**
  68510 Uffheim (FR)
- **Papirer, Pierre**
  68350 Reiningue (FR)

(74) Representative: **Gesthuysen, von Rohr & Eggert**
Patentanwälte
Postfach 10 13 54
45013 Essen (DE)

(54) Cryogenic pump

(57) A cryogenic pump 2 is typically used to supply high pressure natural gas to an engine. The pump 2 has a piston 6 operable to discharge cryogenic liquid from a pumping chamber 8 within a pump housing 4. The cryogenic liquid exits the chamber 8 through an outlet port 10 in which a check valve 12 is positioned. The check valve 12 has a valve member 14 which is loaded by a spring 28 and is retained by a retaining member 16 accessible from outside the housing 4. The check valve 12 has an inlet 18 which is axial with the valve member 14 and an outlet 20 which is transverse to the axis of the valve member 14.

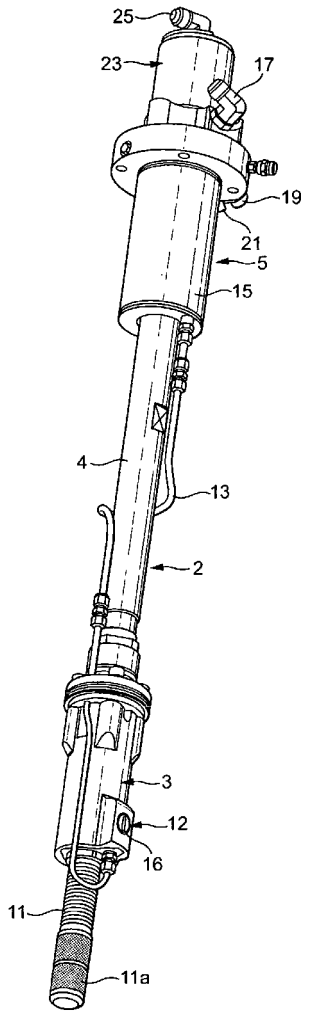


FIG. 1

EP 2 541 062 A1

Description

[0001] This invention relates to a cryogenic pump and particularly to a check valve for a cryogenic piston pump.

[0002] A cryogenic pump that utilises a piston as the pumping member has a pumping chamber with an outlet port from the pumping chamber communicating with a conduit for the pumped liquid. Typically, a check valve is located in the conduit to prevent backflow of liquid from the conduit to the pumping chamber. A check valve typically has its inlet and outlet in axial alignment with one another.

[0003] Cryogenic pumps are typically used in industrial plants for example, in plant for the separation or liquefaction of industrial gases. Cryogenic liquefied gases are becoming increasingly widely used. For example, liquefied natural g as (LNG) is now being used as an automotive fuel, particularly for heavy goods vehicles (HGVs). Piston pumps have been developed in order to transfer the LNG from a storage vessel on board the vehicle to the vehicle's engine. Such a pump needs to be quite compact and easy to maintain. The pump typically has a vaporiser associated with it.

[0004] An example of a cryogenic pump suitable for use with LNG on an HGV is given in US 7 293 418 B2,

[0005] According to the present invention there is provided a cryogenic pump for pumping LNG having a piston operable to discharge cryogenic liquid from a pumping chamber within a pump housing, an outlet port from the pumping chamber, the outlet port having its location in the pump housing, an a check valve in the outlet port, wherein the check valve has a valve member, a demountable retaining member accessible from the exterior of the pump housing, an inlet axial with the valve member, and an outlet transverse to the axis of the valve member.

[0006] In one embodiment of a cryogenic pump according to the invention, the retaining member has a sleeve for guiding the valve member. The sleeve is typically integral with the retaining member.

[0007] The valve member may have a cylindrical body an a frusto-conical head, which, when the check valve is in its closed position, makes sealing engagement under the bias of the spring with a complementary valve seat formed in the pump housing. The head is typically formed of plastics material, for example, PTFE. On the other hand the valve seat is typically formed of metal, for example, stainless steel.

[0008] The spring is typically a compression spring. The compression spring may seat in a detent in the retaining member.

[0009] A cryogenic pump according to the invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a schematic perspective view of the pump;

Figure 2 is a sectional side elevation of the warm end of the pump shown in Figure 1;

Figure 3 is a sectional elevation of the pumping chamber of the pump shown in Figure 1; and

Figure 4 is an enlarged sectional elevation of part of the pumping chamber shown in Figure 3 illustrating the check valve in the outlet part of the pumping chamber.

[0010] The drawings are not to scale.

[0011] Referring to the drawings, there is shown generally a cryogenic pump 2 of the kind having a cold end 3 adapted to be immersed in a volume of cryogenic liquid, not shown, to be supplied to, for example, a combustion engine. The pump 2 is generally of the same kind as that disclosed in US 7 293 418 B2, save that it does not include an accumulator. Instead the pump 2 has a pumping chamber communicating directly with a vaporiser or like heater. The disclosure of US 7 293 418 B2 is incorporated herein by way of reference. The cryogenic pump 2 has a warm end 5 opposite the cold end 3. The warm end 5 is not intended for immersion in the cryogenic liquid. The pump 2 has a housing 4 of generally elongate configuration with an axial piston 6 and piston shaft 7. The piston 6 is able, in operation, to draw cryogenic liquid into, and force cryogenic liquid out of, a pumping chamber 8 defined within the housing 4. The pumping chamber 8 has an inlet 9 for cryogenic liquid communicating with a hollow cylindrical cryogenic liquid intake member 11 typically fitted with a filter 11 a effective to prevent small solid particles from entering the pump.

[0012] The pumping chamber 8 has an outlet port 10 for the discharge of cryogenic liquid. With particular reference to Figures 3 and 4, the outlet port 10 houses a check valve 12. The outlet port 10 is connected to a relatively small diameter conduit 13 which extends from the cold end 3 to the warm end 5 of the pump 2. The conduit 13 terminates in an annular heat exchange device 15, in which the cryogenic liquid is vaporised by indirect heat exchange with a relatively high temperature heat exchange fluid. (if, for example, the cryogenic liquid is LNG, and the pump 2 is intended to supply the natural gas to an engine (not shown), the heat exchange fluid can be the aqueous liquid that is used to cool the engine.) The heat exchange device 15 is provided with an outlet 99 (see Figure 2) for vaporised natural gas and an inlet 19 and outlet 21 for the heat exchange fluid. Typically, there is within the heat exchange device a passage (not shown) for the cryogenic liquid in heat exchange relationship with another passage (not shown) for the heat exchange fluid. Flow of the cryogenic liquid through its passage causes it to vaporise.

[0013] At the warm end 5 of the pump 2 there is provided a drive chamber 23 for the piston 6. Typically, a hydraulic drive is employed, there being an inlet port 25 and an outlet port 17 for hydraulic liquid, but an electrical, pneumatic or mechanical drive could alternatively be used. The drive arrangements may in general be similar to those disclosed in US 7 293 418 B2 for the pump de-

scribed and shown therein. The piston 6 has two strokes. In its upward stroke (that is in its stroke away from the cold end 3, a flow of cryogenic liquid through the inlet 9 is induced. In its downward stroke (that is in its stroke away from the warm end 5) a flow of cryogenic liquid through the outlet port 10 is provided. The pump 2 is capable of generating a high delivery pressure, typically in the order of 300 bar, or higher.

[0014] The check valve 12 is best viewed in Figure 4. The check valve 12 is located in the pump housing 4 at the outlet port 10. The check valve 12 has a spring-loaded valve member 14 which is retained within the housing 4 by a demountable retaining member 16 accessible from the exterior of the pump housing 4. The retaining member 16 may make a screw-threaded engagement with the pump housing 4 and may have a configuration such that access can be gained to the valve member 14 from outside the housing 4 by means of a specific tool (not shown) to dismantle the part, in association with a standard wrench. In its normal position the retaining member 16 comprises a resilient O-ring seal 40 to prevent leakage of fluid out of the pump 16 via the screw-threads of the retaining member 16. The retaining member 16 has a sleeve 22 for guiding the valve member 14. The sleeve 22 is typically integral with the retaining member.

[0015] The valve member 14 has a cylindrical body 24 and a frusto-conical head 26. During the delivery stroke the check valve 12 remains open but it closes for the intake stroke of the piston 6. If the pump is idle, the check valve 12 remains closed. When the check valve 12 is in its closed position, the head 26 makes a sealing engagement, under the bias of a compression spring 28 and any fluid pressure in the outlet 20, with a complementary valve seat 30 formed in the pump housing 4. Typically, the head 26 and the rest of the valve member 14 are formed of a plastics material which is able to be used at cryogenic temperatures. PTFE is one such plastics material. Similarly, the housing 4 and, in particular, the valve seat 30 is made of a material that in addition to being a metallic engineering material is suitable for use at cryogenic temperatures. Stainless steel is one such material. The compression spring 28 is seated in a detent 32 in the retaining member 16. The bias of the compression spring 28 acts in a valve-closing direction. Thus, when there is no cryogenic liquid pressure acting in the opposite direction, the valve 12 remains in a closed position preventing back flow of fluid from the conduit 13 into the pumping chamber 8. Moreover, the basis of the spring is effective to keep the check valve closed 12 when there is no cryogenic liquid pressure acting on the valve member 14 irrespective of he attitude of the cryogenic pump 2. (in practice, the cryogenic pump is typically positioned with its axis at angle to the vertical.)

[0016] The valve 12 has an inlet 18 which is axial with the valve member 14 and a radial outlet 20 which is transverse to the axis of the valve member 14. The check valve 12, when open, permits cryogenic liquid to flow from the inlet 18 to the outlet 20. The flow path has an axial element being defined between the sleeve 22 and a complementary portion of the housing 4 and a transverse radial element through the outlet 20, there being a transverse radial passage 41 through the sleeve 22 of the retaining member 16 to aid flow of the cryogenic liquid.

[0017] The position of the check valve 12 in the housing 4 of the cryogenic pump 2 keeps down the dead volume between the piston 6 at the end of the downward stroke, i.e. the stroke away from the worn end 5, and the sealing area of the check valve 12, and thereby avoids loss of pump efficiency.

[0018] Typically, the valve member 14 undergoes wear in use, so is exchanged for an identical such member after a chosen period of time. In order to exchange the valve member 14, the pump 2 is withdrawn from the tank (not shown) containing cryogenic liquid in which it is typically located, the pump 2 allowed to return to ambient temperature, and the retaining member 16 removed.

Claims

1. A cryogenic pump (2) for pumping LNG having a piston (6) operable to discharge cryogenic liquid from a pumping chamber (8) within a pump housing (4), an outlet port (10) from the pumping chamber (8), the outlet port (10) having its location in the pump housing (4), and a check valve (12) in the outlet port (10), wherein the check valve (12) has a valve member (14), a demountable retaining member (16) accessible from the exterior of the pump housing (4), an inlet (18) axial with the valve member (14), and an outlet (20) transverse to the axis of the valve member (14).

2. A cryogenic pump (2) according to claim 1, wherein the retaining member (16) has a sleeve (22) for guiding the valve member (14).

3. A cryogenic pump (2) according to claim 2, wherein the sleeve (22) is integral with the retaining member (16).

4. A cryogenic pump (2) according to any one of claims 1 to 3,
wherein the valve member is spring (28) - loaded.

5. A cryogenic pump according to claim 4, wherein the valve member (14) has a cylindrical body (24) and a frustro-conical head (26), which, when the check valve (12) is in its closed position, makes sealing engagement under the bias of the spring (28) with a complementary valve seat (30) formed in the pump housing (4).

6. A cryogenic pump according to claim 5, wherein the head (26) is of plastics material.

7. A cryogenic pump according to claim 5 or claim 6, wherein the head (26) is of PTFE.

8. A cryogenic pump according to any one of claims 5 to 7, wherein the valve seat (30) is of metal.

9. A cryogenic pump according to claim 7, wherein the valve seat (30) is of stainless steel.

10. A cryogenic pump according to any one of the preceding claims,
wherein the spring (28) is a compression spring.

11. A cryogenic pump (2) according to claim 9, wherein the compression spring (28) seats in a detent (32) in the retaining member (16).

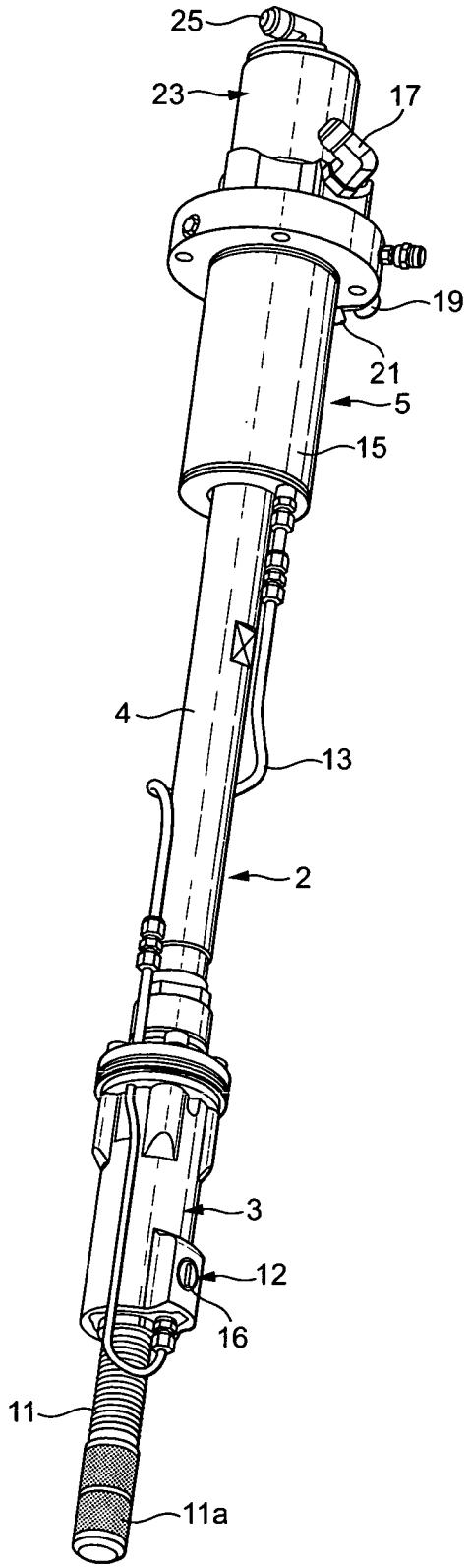


FIG. 1

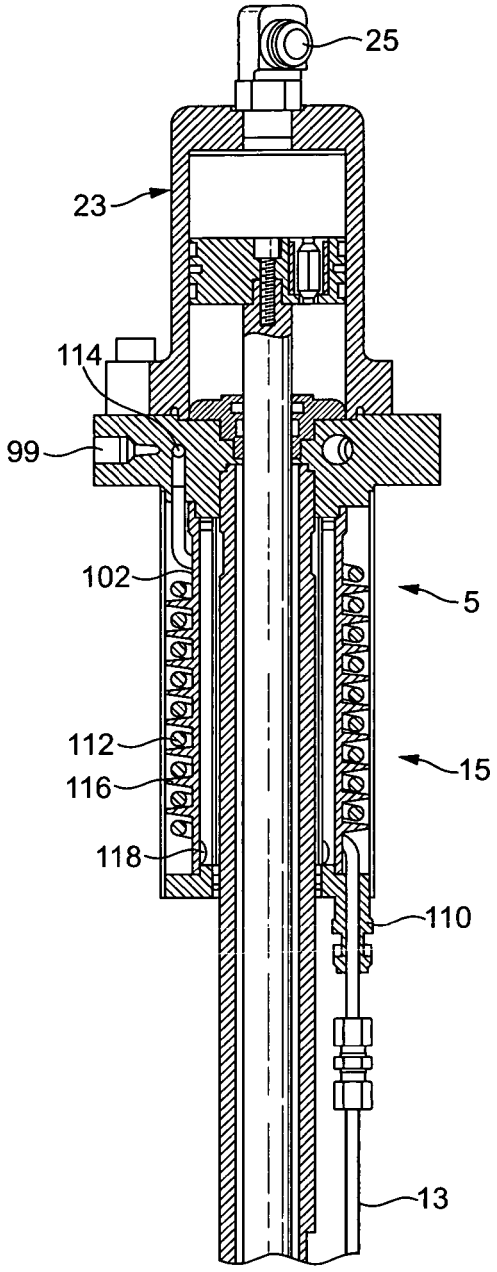


FIG. 2

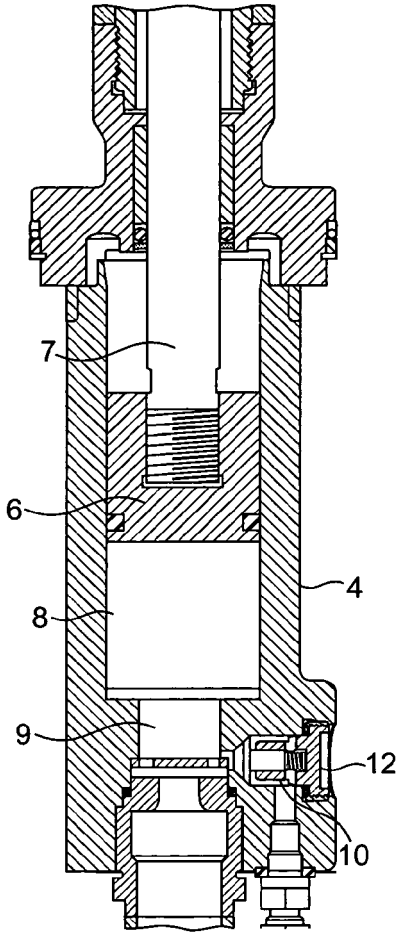


FIG. 3

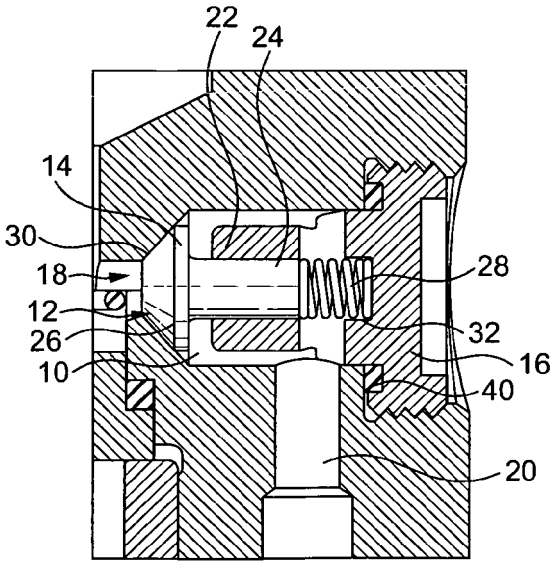


FIG. 4

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EUROPEAN SEARCH REPORT

Application Number
EP 11 35 2008

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 1 937 859 A (THOMAS ROSSWELL W) 5 December 1933 (1933-12-05) * page 1, line 1 - page 3, line 144; figure 3 * -----	1-11	INV. F04B15/08 F04B39/10 F04B53/10 F17C7/00
X	US 2 292 617 A (DANA LEO I) 11 August 1942 (1942-08-11) * page 1, column 1, line 1 - page 2, column 2, line 21; figure 1 * -----	1-11	
X	US 2 447 741 A (DE BAUFRE WILLIAM LANE) 24 August 1948 (1948-08-24) * column 1, line 1 - column 4, line 8; figure 1 * -----	1-11	

TECHNICAL FIELDS SEARCHED (IPC)
F04B F17C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	14 November 2011	Jurado Orenes, A

CATEGORY OF CITED DOCUMENTS

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 11 35 2008

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14-11-2011

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 1937859 A	05-12-1933	NONE	
US 2292617 A	11-08-1942	NONE	
US 2447741 A	24-08-1948	NONE	

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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Patent documents cited in the description

- US 7293418 B2 **[0004] [0011] [0013]**