

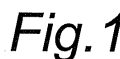
(22) Date of filing: **03.08.2015**

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The leakage detection device 4 enables fail-safe function independent of the installation position and the mounting orientation.



Description

[0001] The invention relates to a leakage detection device for a double walled fluid pipe having a drainage jacket surrounding a high pressure pipe, particularly for internal combustion engines, comprising at least one fluid inlet duct for connection to the drainage jacket of the fluid pipe, at least one fluid outlet duct for connection to a leakage conduit, and at least one valve device for control of the flow of leakage fluid through the fluid outlet, the valve device having a spring loaded valve body which can be shifted against a reset force of a reset spring by the pressure of the drainage fluid entering the fluid inlet duct, wherein a first position of the valve body corresponds to a minimal leakage amount and a second position corresponds to maximal leakage amount of the high pressure pipe.

[0002] Due to legal requirements high pressure fuel pipes in marine engines must be of a double-walled design. The inner pipe has a thick wall and carries the high pressure fuel from the fuel pump(s) to the injector(s). This thick wall pipe must be fully enclosed in an outer jacket over the whole length of the pipe. Such pipes are called double-walled pipes.

[0003] The purpose of the outer jacket is twofold:

- In case of a burst of the inner high pressure pipe the outer jacket will contain the excess fuel and prevent fire;
- In case of a smaller crack or damaged sealing of the high pressure pipe the volume between the inner and the outer pipes will be filled up with fuel, allowing a leakage detection device to trigger an alarm before a more severe damage of the high pressure pipe occurs.

[0004] All engines meant for marine applications must have a device for detecting the possible leakage of the high pressure fuel lines.

[0005] The document EP 2 297 448 B1 describes a fuel injection system for a piston engine wherein the supply pipes are provided with double walls, wherein an inner flow space of the supply pipe is for high pressure fuel and an outer flow space acts as a collecting channel for possibly leaking fuel. A leak detector with a control chamber for detecting a fuel leak is connected to the collecting channel. The control chamber is provided with an orifice through which fuel leakage occurring in normal operating conditions can be removed from the control chamber. In the upper part of the control chamber a leakage outlet is arranged through which excess fuel can be drained. Further the control chamber is provided with a fuel level detection means for detecting excess leakages. The function of the control chamber is dependent on the mounting orientation. The volume and design of the control chamber are assigned by the allowed leakage amount. Therefore relative installation space has to be available.

[0006] The publication WO 2009/003717 A1 discloses a fuel system for a combustion engine having a local leakage detection device for a double wall tubing. The pressure based local leakage detection senses piston movement by visual or sensor. The device comprises a check valve being arranged in a leakage passage and opening a fluid passage into a leakage conduit which is fluidly connected to a leakage fluid collecting container. The fluid collecting container is provided with a sensor for detecting a fluid in the container and for issuing a corresponding signal. The detection device described in WO 2009/003717 A1 doesn't consider any allowed leakage.

[0007] It is the object of the invention to provide a leakage detection device which can be used for different combustion engines and which requires only little available space, not requires special installation position and can be used as local leakage detection device as well.

[0008] According to the present invention this is achieved with a leakage detection device as described above where the valve body comprises at least one throttle passage for flow connection of the fluid inlet duct and the fluid outlet duct, wherein in each shifting position of the valve body the throttle passage is flow connected to the fluid inlet duct and to the fluid outlet duct. This allows for an efficient leakage detection: In normal engine operation small leakage amounts can flow through the throttle passage without triggering an alarm wherein in case of a more severe leakage the leaking fuel cannot be discharged through the throttle passage, the pressure above the valve body rises and causes it to move to a second end position to cope with the higher leakage amount.

[0009] The leakage detection device comprises at least one position detection sensor, wherein at least the second position of the valve body is detected by the position detection sensor. The position detection sensor can be designed as a proximity sensor, for example a Hall-sensor, or a contact sensor. No pressure sensors or level detection means are necessary to detect above-mentioned movement of the valve body and trigger a leakage alarm.

[0010] According to a simple and small embodiment of the invention the valve body is a control piston which is slidably mounted in a control cylinder, wherein at least one outlet orifice of the fluid outlet duct is arranged in the cylinder barrel of the control cylinder. In a variant of the invention the control piston comprises at least one control edge sliding across the outlet orifice while the control piston travels from one shifting position to another shifting position.

[0011] The throttle passage may extend between a first face side and a second face side of the control piston, wherein the first face side is facing the fluid inlet duct, and wherein preferably the second face side is facing the reset spring. Therefore the first face side and the second face side of the control piston are flow connected by the throttle passage. Preferably the control piston comprises

a slot being formed in the barrel surface of the control piston between the control edge and the second face side of the control piston. The control piston comprises a groove being formed in the barrel face of the control piston below the control edge. The slot and the groove establishes flow connection between the second face side of the control piston and the outlet orifice.

[0012] In the following the invention is described by way of example with reference to the attached drawings in which:

Fig. 1 shows schematically a leakage detection device according to the invention with a valve body in a first end position;

Fig. 2 the leakage detection device of Fig. 1 with the valve body being in an intermediate position;

Fig. 3 the leakage detection device of Fig. 1 with the valve body being in a second end position;

Fig. 4 the valve body in a plan view;

Fig. 5 the valve body in a side view; and

Fig. 6 the valve body in a sectional view according to line VI - VI in Fig. 5.

[0013] Fig. 1 shows schematically a double walled fluid pipe 1, e.g. a fuel pipe of a marine engine, with a high pressure pipe 2 and a drainage jacket 3 surrounding the high pressure pipe 2. A leakage detection device 4 is attached to the drainage jacket 3 via a fluid inlet duct 5. Further the leakage detection device 4 is connected to a leakage conduit (not shown) via a fluid outlet duct 6.

[0014] The leakage detection device 4 comprises a valve device 7 for control of the flow of leakage fluid through the fluid outlet duct 6. The valve device 7 includes a spring loaded valve body 8 which can be shifted against a reset force of a reset spring 9 by the pressure of the drainage fluid entering the fluid inlet duct 5.

[0015] In the embodiment of the invention shown in Fig. 1 to Fig. 3 the valve body 8 is configured as a control piston 11, which is mounted slidably in a control cylinder 12. The control piston is shown in detail in Fig. 4 to Fig. 6. The cylinder barrel 13 of the control cylinder 12 comprises an outlet orifice 6a leading to the fluid outlet duct 6. The control piston 11 comprises a control edge 14 which is arranged in the barrel surface 15 of the control piston 11 in such a way that it is sliding across the outlet orifice 6a while the control piston 11 travels from one shifting position to another shifting position.

[0016] The valve body 8 comprises a throttle passage 10 for flow connection of the fluid inlet duct 5 and the fluid outlet duct 6. The throttle passage 10 extends between a first face side 11a (see Fig. 4) and a second face side 11b of the control piston 11, wherein the first face side 11a is facing the fluid inlet duct 5 and the second face

side 11b is facing the reset spring 9, which is arranged in a spring chamber 17 of the control cylinder 12. The throttle passage 10 is located in/parallel to the longitudinal axis of the control piston 11 (see Fig. 5) in the embodiment shown in the figures. Of course, other variants with inclined throttle passage or multiple passages or combinations of inclined and straight passages are possible.

[0017] Further the control piston 8 comprises a slot 18 being formed in the barrel surface 15 of the control piston 11 between the control edge 14 and the second face side 11b of the control piston and a groove 18a being formed in the barrel surface 15 of the control piston 11 below the control edge 14. The slot 18 and the groove 18a are adjacent to the control edge 14. The top edge of the groove 18a has to be the same as the lower edge of the control edge 14. The flow cross section areas of the slot 18 and the groove 18a have to be bigger than the cross section of the throttle passage 10. The height h1 of the outlet orifice 6a has to be bigger than the height h2 of the control edge 14. The slot 18 basically runs parallel to a longitudinal axis of the piston 11 (in the embodiment shown also parallel to the throttle passage 10). The groove 18a runs in a plane perpendicular to the longitudinal axis of the piston 11 around the circumference/barrel surface 15 of the control piston 11.

[0018] The throttle passage 10 and the groove 18 enable minimal fluid flow between the fluid inlet duct 5 and the fluid outlet duct 6 in each position of the control piston 11 other than the second end position shown in Fig. 3. A first end position of the valve body 8 (shown in Fig. 1) corresponds to a minimal leakage amount and a second end position (shown in Fig. 3) corresponds to maximal leakage amount of the high pressure pipe 2.

[0019] In the region of the second end position (i.e. the lower dead point shown in the Figs. 3) of the valve body 8 the leakage detection device 4 comprises a position detection sensor 19 which may be configured as proximity sensor, e.g. hall-sensor, or as a simple contact sensor.

[0020] The flow of leakage fluid is indicated by arrows 20. Leakage fluid is indicated as dashed areas.

[0021] Low amounts of leakage are allowed and can be drained through the throttle passage 10 and the fluid outlet duct 6 without any movement of the valve body 11, as shown in Fig. 1.

[0022] If leakage amount captured by the drainage jacket 3 comes to an extent, the throttle passage 10 cannot cope with, the pressure in the drainage jacket 3 and the fluid inlet duct 5 will increase until the control piston 11 starts moving - in the Figs. - downwardly against the retain spring's 9 resistance until the control edge 14 passes the outlet orifice 6a. This position is shown in Fig. 2. A first part 20a of the fluid inside the control cylinder 12 is drained from the fluid inlet duct 5 directly to the outlet orifice 6a, passing an upper region 16 of the control edge 14. A second part 20b of the fluid inside the control cylinder 12 flow from the fluid inlet duct 5 through the throttle

passage 10 into the spring chamber 17, and is drained via the groove 18a and the slot 18 to the outlet orifice 6a, as shown in Fig. 2. The position detection sensor 19 is arranged and configured in a way to detect this position of the control piston 11 shown in Fig. 2.

[0023] If the leakage and the pressure in the drainage jacket 3 further increases, the control piston 11 travels to the second end position shown in Fig. 3. In this position the flow conduit between the slot 18 and the groove 18a and the outlet orifice 6a is closed by the control edge 14 of the control piston 11, so the whole amount of leakage fluid which is feed through the fluid inlet duct 5 into the control cylinder 12 is drained directly to the outlet orifice 6a passing the upper region 16 of the control edge 14.

[0024] The described leakage detection device 4 enables fail-safe function independent of the installation position and the mounting orientation. Compared with state in the art devices the leakage detection device according to the invention is compact and requires only little installation space.

Claims

1. Leakage detection device (4) for a double walled fluid pipe (1) having a drainage jacket (3) surrounding a high pressure pipe (2), comprising:

- at least one fluid inlet duct (5) for connection to the drainage jacket (3) of the fluid pipe (1);
- at least one fluid outlet duct (6) for connection to a leakage conduit;
- at least one valve device (7) for control of the flow of leakage fluid through the fluid outlet duct (6), the valve device (7) having a spring loaded valve body (8) which can be shifted against a force of a reset spring (9) by the pressure of the drainage fluid entering the fluid inlet duct (5), wherein a first end position of the valve body (8) corresponds to a minimal leakage amount and a second end position corresponds to maximal leakage amount of the high pressure pipe, **characterised in that** the valve body (8) comprises at least one throttle passage (10) for flow connection of the fluid inlet duct (5) and the fluid outlet duct (6), wherein in each shifting position of the valve body (8) the throttle passage (11) is flow connected to the fluid inlet duct (5) and to the fluid outlet duct (6).

2. Leakage detection device (4) according to claim 1, **characterised in that** the leakage detection device (4) comprises at least one position detection sensor (19), wherein at least the second position of the valve body (8) is detectable by the position detection sensor (19).

3. Leakage detection device (4) according to claim 1

or 2, **characterised in that** the position detection sensor (19) is a proximity sensor, preferably a hall-sensor.

4. Leakage detection device (4) according to claim 1 or 2, **characterised in that** the position detection sensor (19) is a contact sensor.

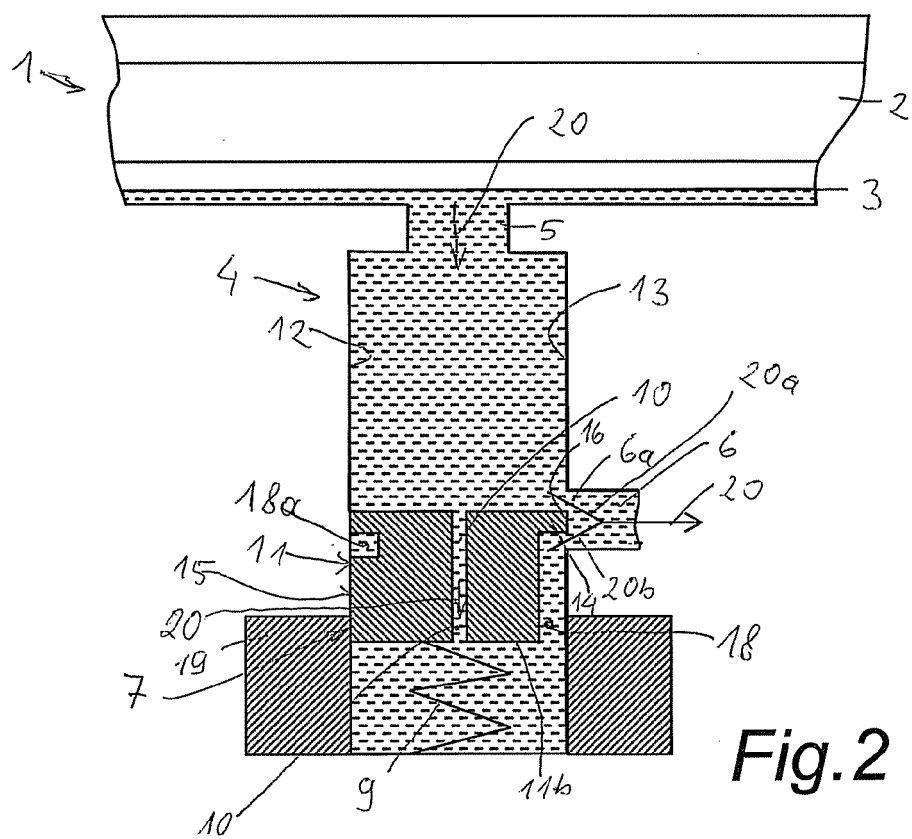
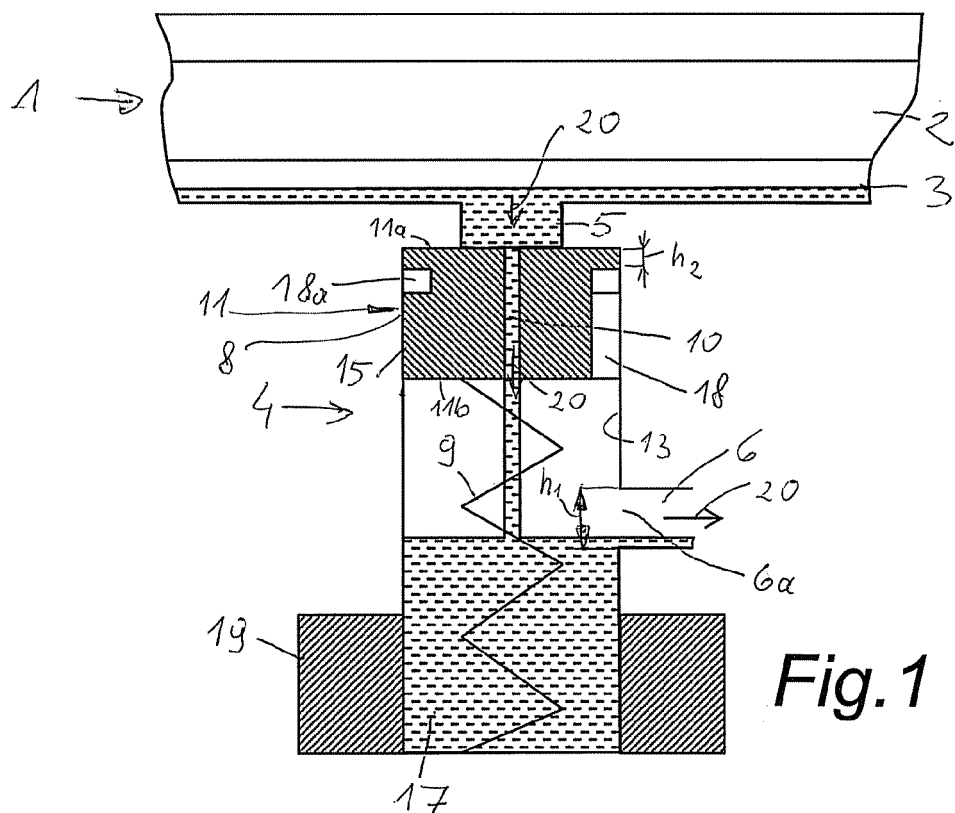
5. Leakage detection device (4) according to one the claims 1 to 4, **characterised in that** the valve body (8) is a control piston (11) being slidably mounted in a control cylinder (12), wherein at least one outlet orifice (6a) of the fluid outlet duct (6) is arranged in the cylinder barrel (13) of the control cylinder (12).

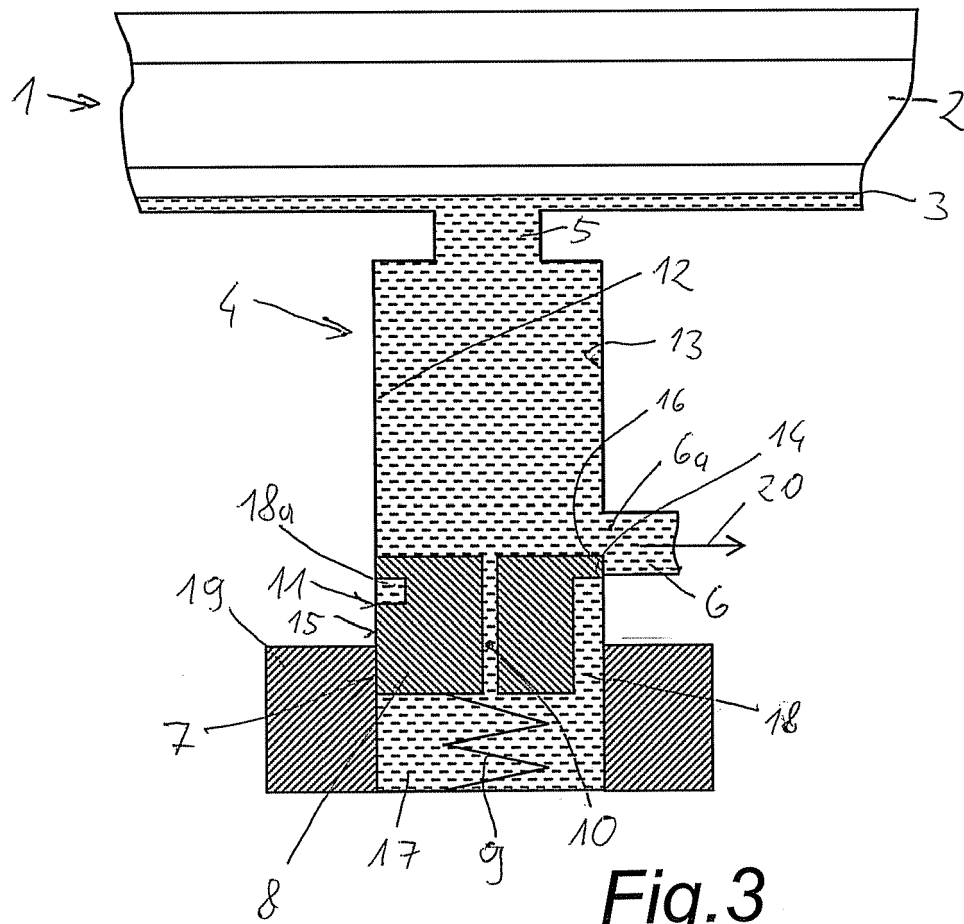
6. Leakage detection device (4) according to claim 5, **characterised in that**, the control piston (11) comprises at least one control edge (14) sliding across the outlet orifice (6a) while the control piston (11) is traveling from one shifting position to another shifting position.

7. Leakage detection device (4) according to claim 5 or 6, **characterised in that** the throttle passage (10) extends between a first face side (11a) and a second face side (11b) of the control piston (11), wherein the first face side is facing the fluid inlet duct (5), and wherein preferably the second face side (11b) is facing the reset spring (9).

8. Leakage detection device (4) according to claim 6 or 7, **characterised in that** the control piston (11) comprises a slot (18) being formed in a barrel surface (15) of the control piston (11) between the control edge (14) and the second face side (11b) of the control piston (11).

9. Leakage detection device (4) according to claim 7 or 8, **characterised in that** the control piston (11) comprises a groove (18a) being formed in a barrel surface (15) of the control piston (11) below the control edge (14) of the control piston (11).





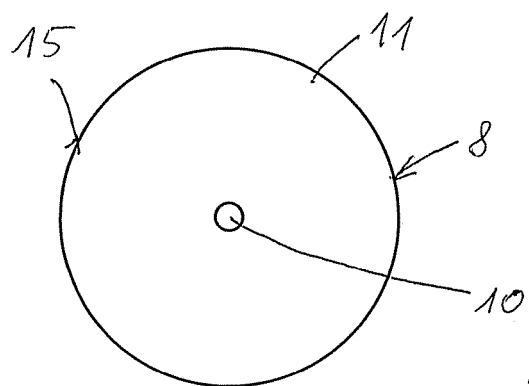


Fig. 4

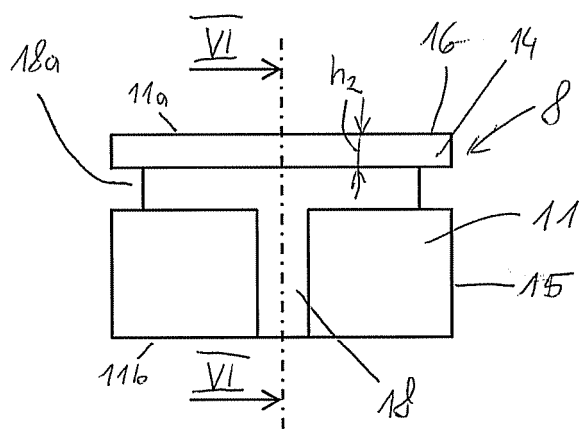


Fig. 5

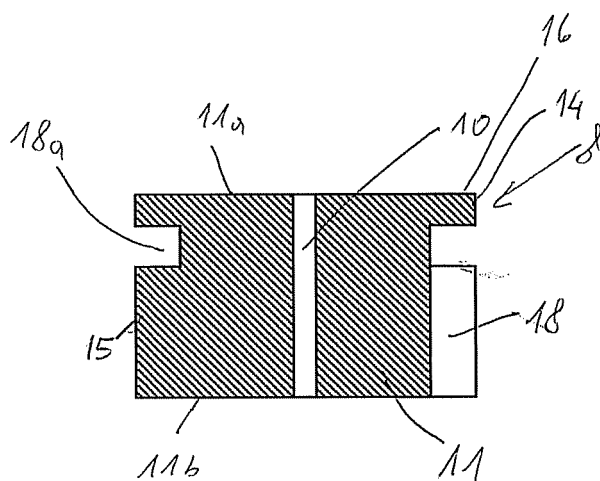


Fig. 6



EUROPEAN SEARCH REPORT

Application Number
EP 15 17 9456

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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 18 January 2016	Examiner Godrie, Pierre
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	

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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