(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 2 115 276 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
15.07.2015 Bulletin 2015/29

(21) Application number: **08709311.8**

(22) Date of filing: **06.02.2008**

(51) Int Cl.:
F01L 11/02 *(2006.01)*

(86) International application number:
PCT/FI2008/050043

(87) International publication number:
WO 2008/107515 (12.09.2008 Gazette 2008/37)

(54) IMPROVED TWO-STROKE ENGINE

VERBESSERTER ZWEITAKTMOTOR

MOTEUR À DEUX TEMPS AMÉLIORÉ

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

(30) Priority: **08.03.2007 FI 20075162**

(43) Date of publication of application:
11.11.2009 Bulletin 2009/46

(73) Proprietor: **Wärtsilä Finland Oy**
65380 Vaasa (FI)

(72) Inventor: **NYNÄS, Håkan**
FI-65280 Vasa (FI)

(74) Representative: **Berggren Oy Ab**
P.O. Box 16
Antinkatu 3 C
00101 Helsinki (FI)

(56) References cited:
WO-A-00/77357
WO-A-90/15230
DE-A1- 3 940 826
DE-A1-102004 013 461
JP-A- 61 065 013
US-A1- 2004 099 228
US-A1- 2006 196 456

EP 2 115 276 B1

Description

Technical field

[0001] The invention relates to a two-stroke crosshead engine with at least one cylinder and a piston reciprocating therein and provided with a piston rod for transmission of power, said cylinder being provided with inlet means for supplying scavenge air into the cylinder, with means for providing for ignition and combustion during the combustion stroke, and with exhaust valve means in accordance with the preamble of claim 1.

Background art

[0002] In crosshead engines the piston reciprocating in a cylinder is not directly connected to a connecting rod but through a piston rod slidably supported to the engine. Hence, the piston rod together with the piston make only reciprocating movements in the cylinder. In two-stroke engines of this kind feeding of scavenge air is conventionally arranged through scavenge ports arranged in the lower part of the cylinder liner, whereby it is the piston itself that opens and closes these ports in a certain fixed phase of the combustion cycle. As a consequence the oil film lubricating the cylinder and the piston together with the piston rings is broken every time the piston moves past the port openings. This increases the wear of both the cylinder liner and the piston with the piston rings.

[0003] The document JP61065013 A shows an arrangement described above. In this case the piston is additionally provided with a scavenging displacer which, after the scavenging hole is opened is moved upward so that the residual gas in the cylinder is reliably discharged at the upper section, while the scavenging air is sucked at the lower section.

[0004] Document WO 2005/028820 A1 discloses a two-stroke engine according to the preamble of claim 1. In highly loaded crosshead engines the piston has a high thermal load. The cooling is normally arranged with cooling oil supplied and drained through drillings in the piston rod and the connecting rod making the system rather complicated.

[0005] In addition in a two-stroke crosshead engine the timing of the Inlet scavenging is fixed to the geometry and position of the scavenging ports, and is, thus, independent on the load of engine in each case.

[0006] An aim of the invention is to provide a new and improved two-stroke crosshead engine, which solves i. a. the above mentioned problems of the prior art

[0007] The aims of the invention can be met substantially as is disclosed in claim 1 and in the other claims.

Disclosure of the invention

[0008] The basic idea of the invention is to essentially change the way of feeding the scavenge air into the cylinder. According to the invention the inlet means include channel means for leading scavenge air through the piston into the cylinder and inlet valve means arranged on the piston for controlling the supply of scavenge air into the cylinder through the channel means.

[0009] The inlet valve means include a valve surface on the piston in association with the channel means and an inlet valve or the like cooperating with the valve surface and movably supported on the piston rod. The piston rod is provided with control valve means operatively connected with the inlet valve means for the control thereof. The control valve means are either hydraulically or pneumatically operated, and the piston rod is provided with a chamber with an auxiliary piston element movably arranged therein and fixed to the inlet valve. The chamber is arranged to communicate through the piston rod with a hydraulic fluid source for controlling the movements of the auxiliary piston element and, thus, the operation of the inlet valve means. A hydraulic control and a control logic are provided for timing of operation of the control valve such that the inlet valve is arranged to open when the piston is moving up.

[0010] This novel solution has a number of advantages. Since there are no longer inlet ports located at a fixed position in the cylinder liner effecting adversely on the film of lubrication oil, the scuffing and thus the wear of the piston with the piston rings and the cylinder liner can be reduced, which is prone to increase the life-time of the said components. The piston and the inlet valve means can be cooled by the scavenge air. This is particularly of advantage since the more air is needed for combustion the bigger is the cooling flow through the piston, since the amount of available cooling air follows the output of the engine. As a consequence the conventional oil cooling can be reduced or possibly even dispensed with regarding certain components. Further, the new solution makes it possible to affect the timing of the inlet valve means. By changing the exact opening and closing time of the inlet valve means the scavenge time can correspondingly be changed depending on the load situation to give optimum performance.

[0011] The inlet valve means include a valve surface on the piston in association with the channel means and an inlet valve or the like, preferably in the form of a disc valve, cooperating with the valve surface and movably supported on the piston rod.

[0012] Timing of the inlet valve means can with advantage be arranged by providing the piston rod with control valve means operatively connected with the inlet valve means for the control thereof. The control valve means are with advantage either hydraulically or pneumatically operated.

[0013] In a practical embodiment the piston rod is provided with a chamber with an auxiliary piston element movably arranged therein and fixed to the disc valve. This chamber can be arranged to communicate through the piston rod with a hydraulic fluid source for controlling the movements of the auxiliary piston element and, thus,

the operation of the inlet valve means.

[0014] In order to secure proper function the control valve means are urged by spring means towards the closing position of the inlet valve means.

[0015] The channel means may comprise a number of separate channels arranged to be continuously in connection with a scavenge air supply source.

[0016] The invention may with advantage be applied independent on the actual way of operation of the two-stroke engine. Hence it may be an engine working on the diesel principle, whereby the means for providing for ignition and combustion include injection valve means for feeding fuel into the cylinder. In this case, in practice, the engine is provided with a turbocharger for compressing the scavenge air to be fed into the cylinder. Alternatively it may be a gasoline engine, whereby the means for providing for ignition and combustion include spark plug means. In this case the fuel is arranged to be mixed with the scavenge air before feeding it into the cylinder as is well known in the art as such.

Brief Description of Drawings

[0017] In the following the invention will be described, as a way of example only, with reference to the accompanying schematic drawings, in which

- Figure 1 illustrates a cross-section of a cylinder of a two-stroke crosshead engine in accordance with an embodiment of the invention, at the intake and scavenge strokes both the inlet valve and the exhaust valve open,
- Figure 2 illustrates the cylinder of figure 1, at the end phase of the compression stroke at the moment of ignition,
- Figure 3 illustrates the cylinder of figure 1 after the power stroke at the exhaust stroke the exhaust valve open,
- Figure 4 illustrates an embodiment of a piston according to the invention, and
- Figure 5 illustrates sections VA-VA and VB-VB of figure 4.

Detailed Description of Drawings

[0018] In the drawings reference numeral 1 indicates a part of an engine block including a cylinder 2 defined mainly by a cylinder liner 3. The cylinder 2 is provided with a piston 4 arranged to move in a reciprocating manner therein. Since the engine is a crosshead engine, the piston 4 is fixed to a piston rod 5, which is slidably supported to the cylinder block 1, or to some part fixed thereto, so that also the piston rod 5 moves reciprocatingly. The mutual fixing of the piston 4 and the piston rod 5 can be arranged in a way known as such e.g. by means of bolts 20 as is shown in figures 4 and 5. Power transmission from the piston 4 and the piston rod 5 occurs via a connecting rod (not disclosed) in a manner as is generally known in the art.

[0019] The engine block 1 is provided with a chamber 6 for feeding of scavenge air into the cylinder 2. The chamber 6 is for its part in connection with an inlet pipe or duct (not shown). In order to feed scavenge air into the cylinder 2 the piston 4, and possibly the upper part of the piston rod 5 depending on their design and mutual fixing, is provided with a number of channels 10 opening at the head part of the piston 4 toward the cylinder 2 and forming a common inlet opening arranged to form a valve surface 11. Arranged in cooperation with this valve surface 11 there is provided an inlet valve 12 with a stem 12a. The inlet valve 12 is by means of its stem 12a slidably mounted within and guided by the piston rod 5.

[0020] The upper end of the cylinder 2 includes an exhaust valve 9 arranged in a cylinder head 7 of the engine and controlling an exhaust duct 8. The cylinder head 7 is also provided with means 18 for providing for ignition and combustion. Depending on the way of operation of the engine the means 18 may be injection means arranged to inject fuel for ignition of the scavenge air at the end phase of the compression stroke. In this case the question is about a diesel engine. Alternatively the means 18 may be spark plug means igniting a mixture of scavenge air and fuel supplied into the cylinder 2 through the chamber 6.

[0021] In figure 1, depicting intake and scavenge strokes, the piston 4 is moving up and the inlet valve 12 is opened for allowing scavenge air into the cylinder 2. Simultaneously the exhaust gases are removed through the exhaust valve 9. Thereafter at a certain phase the exhaust valve 9 as well as the inlet valve 12 are closed and compression stroke follows. In accordance with figure 2, as a consequence, the scavenge air is compressed and at the end phase of the compression stroke the gases in the cylinder 2 are ignited, whichever is the way of operation of the engine. Power stroke follows. At the end of the power stroke the piston 4 still moving downwards the exhaust valve 9 is opened. The inlet valve 12 still being in its closed position the pressure is relieved and the exhaust gases rush out of the cylinder into the exhaust duct 8 as is depicted in figure 3. After the lower dead centre the cycle starts again so that during the first phase of the intake and scavenge strokes, as depicted in figure 1, the exhaust valve 9 still being open the intake air presses the rest of the exhaust gases into the exhaust duct 8 until the exhaust valve 9 is again closed.

[0022] Figures 4 and 5 illustrate one embodiment of the piston with the piston rod attached thereto by means of bolts 20. As can be seen the channels 10 are arranged through both the piston rod 5 and the piston 4 and form a uniform chamber in connection with the valve surface 11 in the piston 4. A possible alternative solution for the one shown could be an arrangement involving integration

of the piston rod to the piston to form one piece. This, however, would not allow utilising different materials for the piston and the piston rod.

[0023] In order to be able to control timing of the inlet valve 12 so as to better comply with the load situation of the engine in each case there is provided a control valve 13 operatively connected with the inlet valve 12 and comprising a chamber 14 arranged in the piston rod 5. Movably arranged in said chamber 14 there is an auxiliary piston element 15 fixed to the inlet valve 12 at the stem 12a thereof. The chamber 14 communicates through a duct 16 in the piston rod 5 with a hydraulic fluid source 19 (shown only schematically in figure 1) for controlling the movements of the auxiliary piston element 15 and, thus, the operation of the whole inlet valve 12. The control valve 13 is urged by a spring 17 towards the closing position of the inlet valve12. It should be noted that the force to open the inlet valve is assisted by the pressure of the scavenge air at the opening phase thereof and closing is assisted by inertia respectively. If required, instead of only one spring 17 a number of springs could be utilised for ensuring proper closing of the valve 13.

[0024] The hydraulic control can be arranged in a way known as such in the field of hydraulics. Instead of hydraulics also pneumatics may with advantage be utilised for the purpose. Control logic is needed for proper operation and timing of the operation of the control valve 13 so as to adjust the supply of scavenge air into the cylinder to the loading situation of the engine in each case.

[0025] It is clear that the invention is not limited to the examples mentioned above but can be implemented in many other different embodiments within the scope of the inventive idea defined in the attached claims. Thus the application of the invention is independent on the exact number of cylinders in the engine, each cylinder may be provided with more than one exhaust valve, the exact way of fixing of the piston to the piston rod may be selected as is convenient in each case etc. Also the operation of the control valve may be arranged in different ways, mechanical operation included.

Claims

1. A two-stroke crosshead engine with at least one cylinder (2) and a piston (4) reciprocating therein and provided with a piston rod (5) for transmission of power, said cylinder (2) being provided with inlet means for supplying scavenge air into the cylinder (2), with means (18) for providing for ignition and combustion during the combustion stroke, and with exhaust valve means (9), the inlet means including channel means (10) for leading scavenge air through the piston into the cylinder (2) and inlet valve means (11,12) arranged on the piston for controlling the supply of scavenge air into the cylinder (2) through the channel means (10), said inlet valve means (11,12) including a valve surface (11) on the piston in association with the channel means (10) and an inlet valve (12) or the like cooperating with the valve surface (11) and movably supported on the piston rod (5), wherein the piston rod (5) is provided with control valve means (13) operatively connected with the inlet valve means (11,12) for the control thereof, said control valve means (13) being either hydraulically or pneumatically operated, and that the piston rod (5) is provided with a chamber (14) with an auxiliary piston element (15) movably arranged therein and fixed to the inlet valve (12), said chamber (14) is arranged to communicate through the piston rod (5) with a hydraulic fluid source (19) for controlling the movements of the auxiliary piston element (15) and, thus, the operation of the inlet valve means (11,12), and **characterised in that** a hydraulic control and a control logic are provided for timing of operation of the control valve (13) such that the inlet valve (12) is arranged to open when the piston (4) is moving up.

2. A two-stroke crosshead engine according to claim 1, **characterised in that** the control valve means (13) are urged by spring means (17) towards the closing position of the inlet valve means (11,12).

3. A two-stroke crosshead engine according to claim 1 or 2, **characterised in that** the channel means (10) comprise a number of separate channels (10) arranged to be continuously in connection with a scavenge air supply source (6).

4. A two-stroke crosshead engine according to any one of the preceding claims, **characterised in that** the means (18) for providing for ignition and combustion include injection valve means for feeding fuel into the cylinder

5. A two-stroke crosshead engine according to any one of the preceding claims 1 to 3, **characterised in that** the means (18) for providing for ignition and combustion include spark plug means and **in that** fuel is arranged to be mixed with the scavenge air before feeding it into the cylinder.

Patentansprüche

1. Zweitakt-Kreuzkopfmotor mit wenigstens einem Zylinder (2) und einem Kolben (4), der in demselben hin- und hergeht und mit einer Kolbenstange (5) zur Kraftübertragung versehen ist, wobei der Zylinder (2) mit Einlassmitteln zum Zuführen von Spülluft in den Zylinder (2), mit Mitteln (18) zum Sorgen für Zündung und Verbrennung während des Verbrennungstaktes und mit Auslassventilmitteln (9) versehen ist, wobei die Einlassmittel Kanalmittel (10) zum Leiten von Spülluft durch den Kolben in den Zylinder (2) und Einlassventilmittel (11, 12), die an dem Kolben

zum Steuern der Zufuhr von Spülluft in den Zylinder (2) durch die Kanalmittel (10) angeordnet sind, einschließen, wobei die Einlassventilmittel (11, 12) eine Ventilfläche (11) an dem Kolben in Verknüpfung mit den Kanalmitteln (10) und ein Einlassventil (12) oder dergleichen, das mit der Ventilfläche (11) zusammenwirkt und beweglich an der Kolbenstange (5) getragen wird, einschließen, wobei die Kolbenstange (5) mit Steuerventilmitteln (13) versehen ist, die für eine Steuerung derselben wirksam mit den Einlassventilmitteln (11, 12) verbunden sind, wobei die Steuerventilmittel (13) entweder hydraulisch oder pneumatisch betätigt werden, und wobei die Kolbenstange (5) mit einer Kammer (14) mit einem Hilfskolbenelement (15) versehen ist, das in derselben angeordnet und an dem Einlassventil (12) befestigt ist, wobei die Kammer (14) dafür angeordnet ist, durch die Kolbenstange (5) mit einer Hydraulikfluidquelle (19) in Verbindung zu stehen, um die Bewegungen des Hilfskolbenelements (15) und folglich die Betätigung der Einlassventilmittel (11, 12) zu steuern, und **dadurch gekennzeichnet, dass** eine Hydrauliksteuerung und eine Steuerlogik bereitgestellt werden, für die Zeitsteuerung des Betriebs des Steuerventils (13) derart, dass das Einlassventil (12) dafür angeordnet ist, zu öffnen, wenn sich der Kolben (4) nach oben bewegt.

2. Zweitakt-Kreuzkopfmotor nach Anspruch 1, **dadurch gekennzeichnet, dass** die Steuerventilmittel (13) durch Federmittel (17) zu der Schließstellung der Einlassventilmittel (11, 12) hin gedrängt werden.

3. Zweitakt-Kreuzkopfmotor nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** die Kanalmittel (10) eine Anzahl von gesonderten Kanälen (10) umfassen, die dafür angeordnet sind, kontinuierlich in Verbindung mit einer Spülluft-Zufuhrquelle (6) zu stehen.

4. Zweitakt-Kreuzkopfmotor nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die Mittel (18) zum Sorgen für Zündung und Verbrennung Einspritzventilmittel zum Einspeisen von Kraftstoff in den Zylinder einschließen.

5. Zweitakt-Kreuzkopfmotor nach einem der vorhergehenden Ansprüche 1 bis 3, **dadurch gekennzeichnet, dass** die Mittel (18) zum Sorgen für Zündung und Verbrennung Zündkerzenmittel einschließen, und dadurch, dass der Kraftstoff dafür eingerichtet ist, mit der Spülluft gemischt zu werden, bevor er in den Zylinder eingespeist wird.

Revendications

1. Moteur à crosse à deux temps avec au moins un cylindre (2) et un piston (4) effectuant un mouvement alternatif dans celui-ci et muni d'une tige de piston (5) pour la transmission de la puissance, ledit cylindre (2) étant muni d'un moyen d'admission pour fournir de l'air de balayage dans le cylindre (2), d'un moyen (18) pour pourvoir à l'allumage et à la combustion pendant la course de combustion et d'un moyen de soupape d'échappement (9), le moyen d'admission comprenant un moyen de conduit (10) pour guider l'air de balayage à travers le piston dans le cylindre (2) et un moyen de soupape d'admission (11, 12) disposé sur le piston pour contrôler l'alimentation d'air de balayage dans le cylindre (2) à travers le moyen de conduit (10), ledit moyen de soupape d'admission (11, 12) comprenant une surface de soupape (11) sur le piston en association avec le moyen de conduit (10) et une soupape d'admission (12) ou un élément analogue, coopérant avec la surface de soupape (11) et supporté de façon mobile sur la tige de piston (5), dans lequel la tige de piston (5) est muni d'un moyen de soupape de régulation (13) raccordé en fonctionnement avec le moyen de soupape d'admission (11, 12) pour le contrôle de celle-ci, ledit moyen de soupape de régulation (13) étant actionné soit hydrauliquement, soit pneumatiquement, et, la tige de piston (5) est munie d'une chambre (14) avec un élément de piston auxiliaire (15) disposé de façon mobile dans celui-ci et fixé à la soupape, d'admission (12), ladite chambre (14) est disposée pour communiquer à travers la tige de piston (5) avec une source de fluide hydraulique (19) pour contrôler les mouvements de l'élément de piston auxiliaire (15) et, de ce fait, le fonctionnement des moyens de soupape d'admission (11, 12) et **caractérisé en ce qu'**une commande hydraulique et une logique de commande sont prévues pour le réglage du fonctionnement de la soupape de régulation (13) de telle sorte que la soupape d'admission (12) est agencée pour s'ouvrir lorsque le piston (4) monte.

2. Moteur à crosse à deux temps selon la revendication 1, **caractérisé en ce que** le moyen de soupape de régulation (13) est poussé par un moyen de ressort (17) vers la position de fermeture du moyen de soupape d'admission (11, 12).

3. Moteur à crosse à deux temps selon la revendication 1 ou 2, **caractérisé en ce que** le moyen de conduit (10) comprend un nombre de conduits séparés (10) agencés pour être continuellement en raccord avec une source d'alimentation d'air de balayage (6).

4. Moteur à crosse à deux temps selon l'une quelconque des revendications précédentes, **caractérisé en ce que** le moyen (18) pour pourvoir à l'allumage et à la combustion comprend un moyen de soupape d'injection pour amener du carburant dans le cylin-

dre.

5. Moteur à crosse à deux temps selon l'une quelconque des revendications 1 à 3, **caractérisé en ce que** le moyen (18) pour pourvoir à l'allumage et à la combustion comprend un moyen de bougie d'allumage et **en ce que** le carburant est configuré pour être mélangé avec l'air de balayage avant de l'amener dans le cylindre.

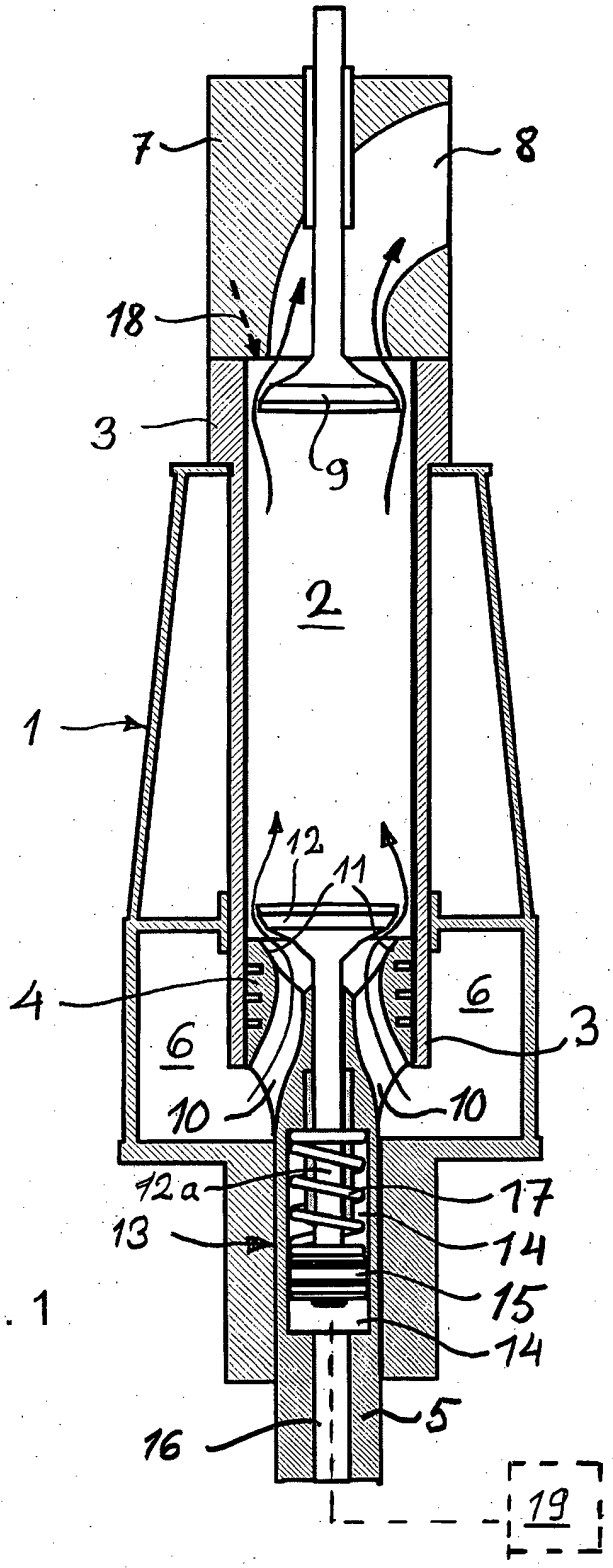

Fig. 1

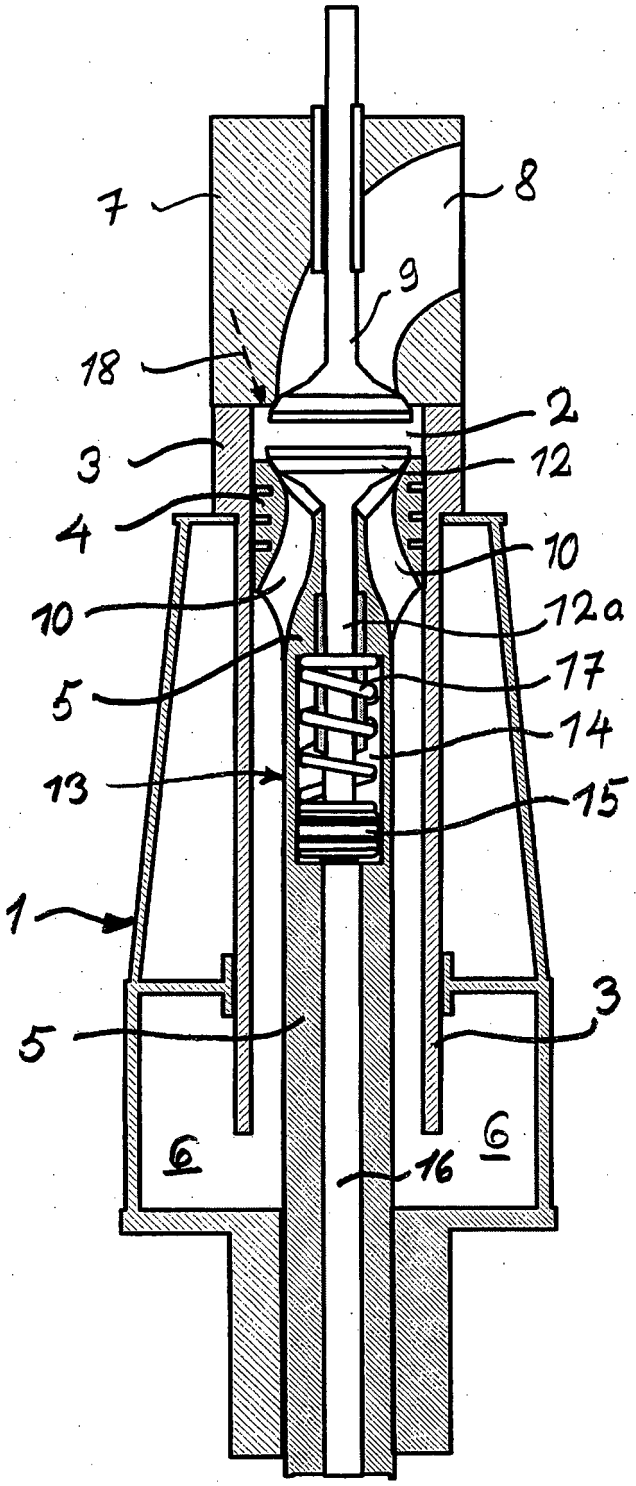

Fig. 2

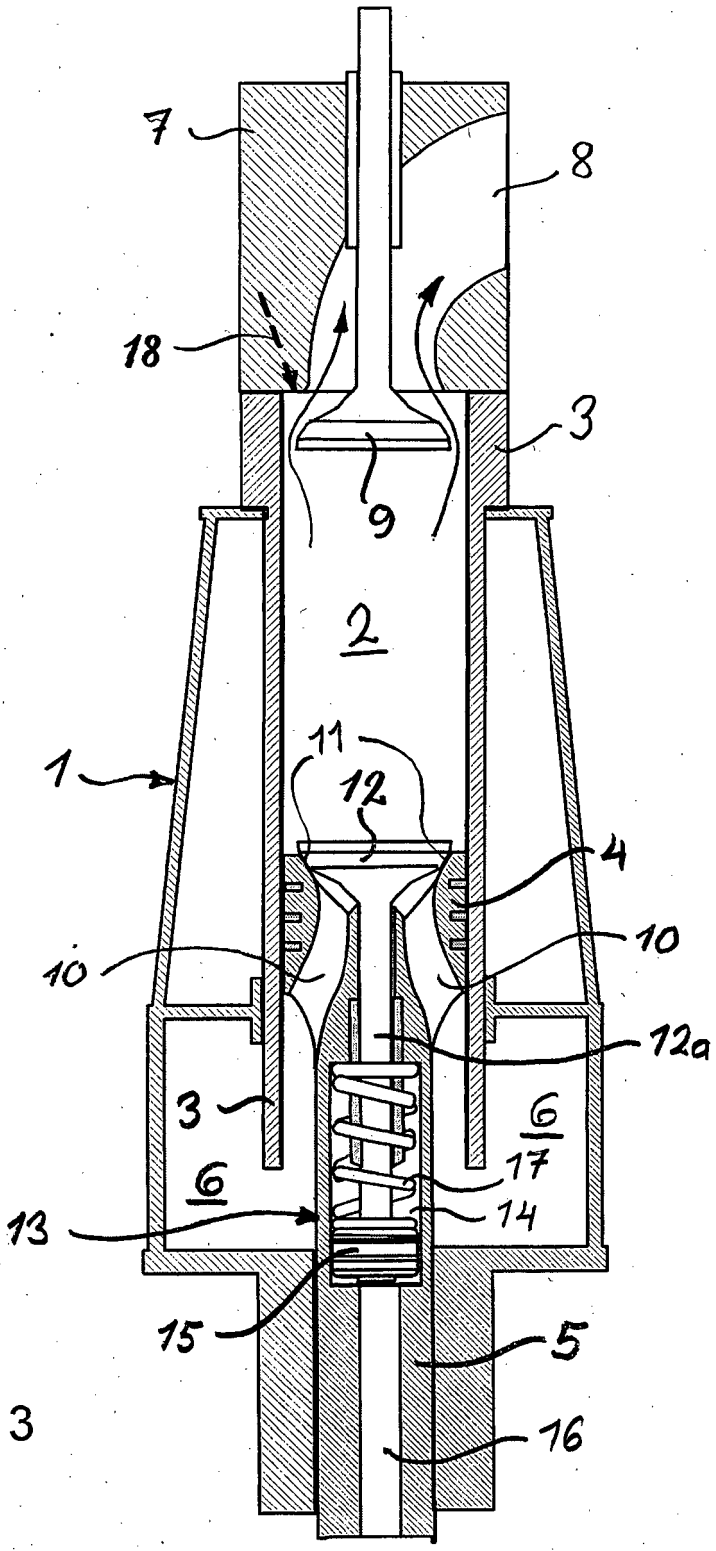

Fig. 3

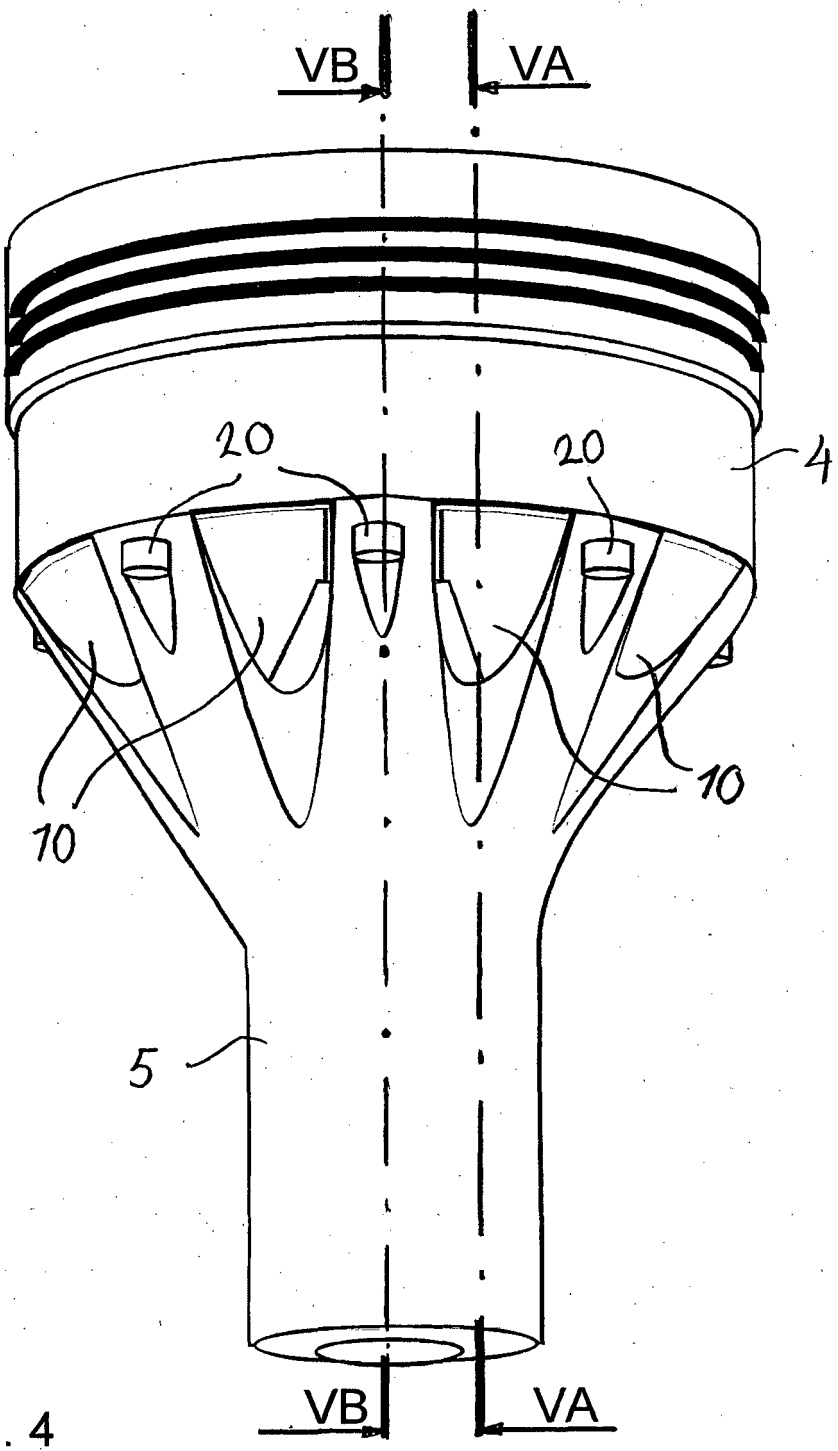

Fig. 4

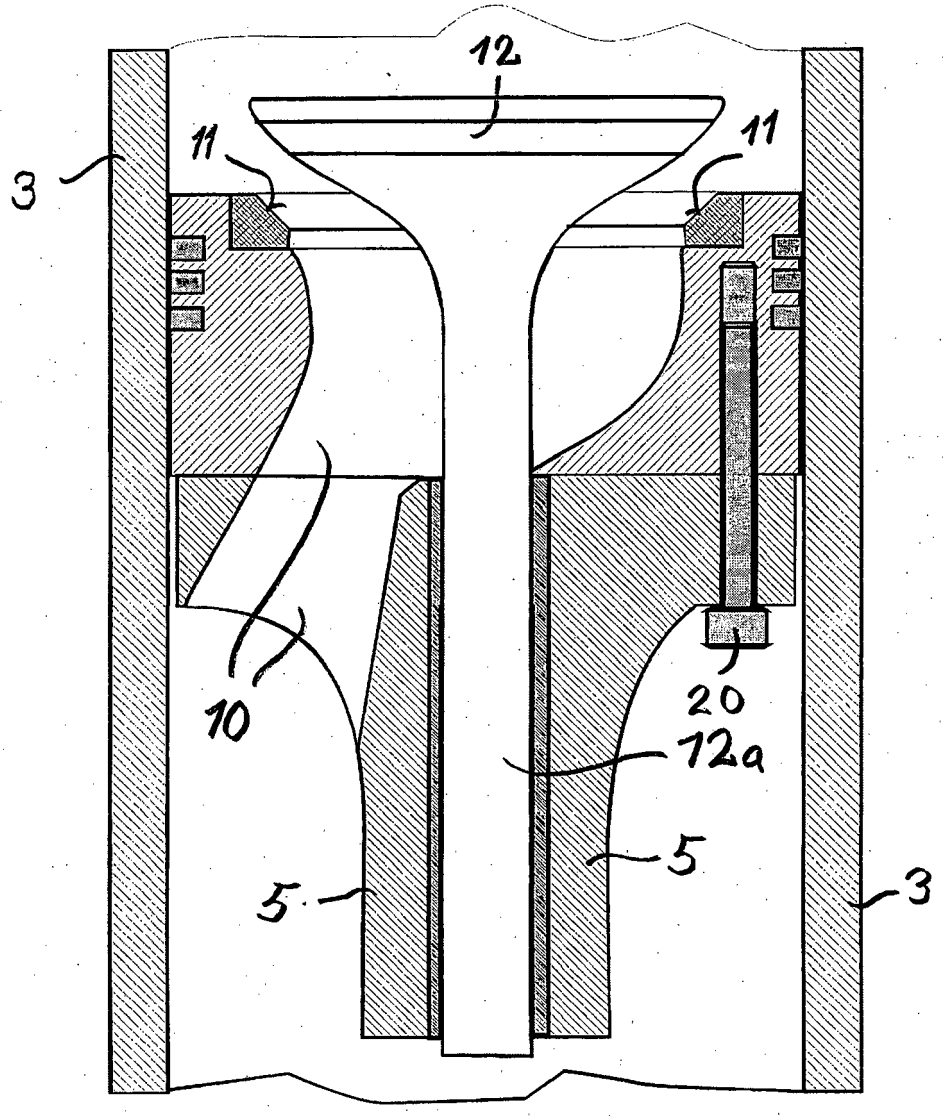

Fig. 5

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 61065013 A **[0003]**
- WO 2005028820 A1 **[0004]**