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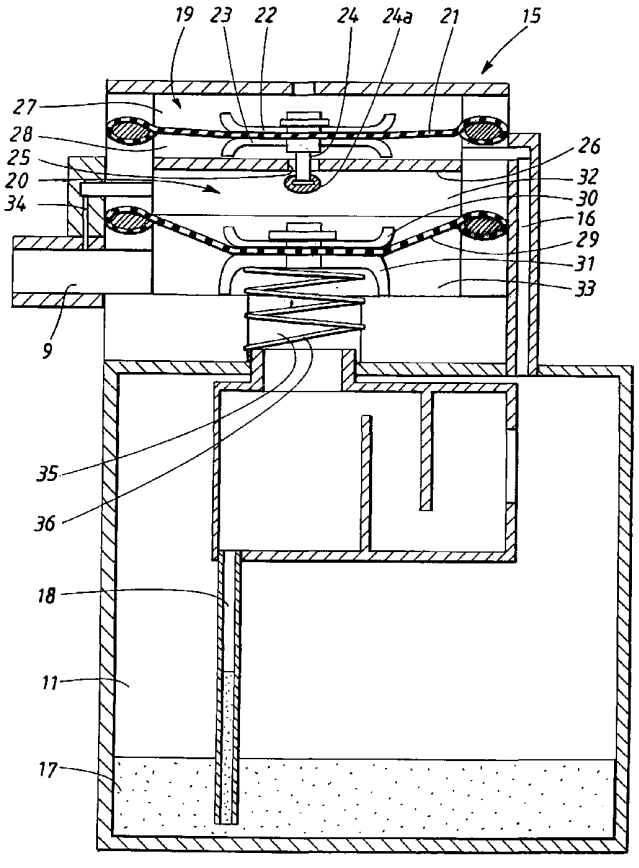
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(54) Title: VALVE DEVICE FOR PRESSURE CONTROL IN A COMBUSTION ENGINE, AND A METHOD FOR SUCH PRESSURE CONTROL



(57) Abstract: The invention relates to a valve device (15) for pressure control in a combustion engine (1) with a crankcase (11) to which crankcase gases are guided during operation of the engine, which valve device (15) is adapted for detecting the current pressure in said crankcase (11)and for opening and closing, respectively, a connection (35) between said crankcase (11) and a suction pipe (9) of the engine depending on said detected pressure. The invention is characterized in that the valve device (15) comprises a first valve (19) which is adapted for assuming a condition between a first, opened position and a second, closed position depending on said detected pressure in the crankcase (11), and a second valve (20) which is adapted for assuming a condition between a first, opened position and a second, closed position depending on the condition of said first valve (19). The invention also relates to a method for such pressure control. By means of the invention, an improved device for ventilating crankcase gases is provided, wherein in particular an accurate control of the pressure in the crankcase is provided.

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Valve device for pressure control in a combustion engine, and a method for such pressure control

TECHNICAL FIELD:

The present invention relates to a valve device for pressure control in a combustion engine with a crankcase to which crankcase gases are guided during operation of the engine, which valve device is adapted for detecting the current pressure in said crankcase and for opening and closing, respectively, a connection between said crankcase and a suction pipe of the engine depending on said detected pressure.

The invention also relates to a method for pressure control in a combustion engine, comprising feeding crankcase gases during operation of the engine from a crankcase forming part of the engine, detecting the current pressure in said crankcase, and opening and closing, respectively, a connection between said crankcase and a suction pipe of the engine depending on said detected pressure.

BACKGROUND OF THE INVENTION:

In the field of vehicles provided with a combustion engine, various methods are today utilized for treating the gases which are fed out from the vehicle's engine in connection with the combustion in the engine. In this case, such exhaust gas treatment takes place as a consequence of various reasons, e.g. demands regarding purification of harmful pollutants in the exhaust gases and requirements regarding the engine's fuel economy and service life.

In this connection, it is previously known to utilize arrangements for ventilating crankcase gases out from the engine's crankcase. The crankcase gases are generated during operation in the respective combustion chamber of the engine and comprise a comparatively high concentration of hydrocarbons which can be combusted. The crankcase gases are guided from the combustion chamber, between the respective cylinder foder and piston rings of the respective engine cylinder, and then further on to the engine's crankcase.

For environmental reasons, it is normally not acceptable to discharge the crankcase gases in the atmosphere. For this reason, it previously known to feed the crankcase gases from the engine's crankcase and back to a suitable point in connection with the engine's inlet side. By means of such a closed crankcase ventilation, the gases can once again be sucked into the engine's air admission for combustion in the engine. By means of this return of the crankcase gases back to the engine's inlet side, the discharges of harmful pollutants from the engine can be reduced.

One problem which arises in connection with previously known arrangements of the above-mentioned type is that the crankcase gases normally contain a certain amount of oil in the form of small oil particles. This is due to the fact that the crankcase gases incide against the engine's oil sump, wherein a certain part of the lubricating oil is transformed into a liquid "mist" comprising small drops of oil. If these oil particles should be allowed to be returned to the engine's inlet, coatings could be formed in, for example, the engine's combustion chambers and on valves, which obviously is not desirable.

The above-mentioned problem particularly concerns engines provided with turbo aggregate. For example, today's diesel engines for commercial vehicles are often provided with systems for turbo charging, wherein an increased amount of air in a known manner can be compressed in a compressor and then be fed into the engine. Normally, such systems also comprise an intercooler, wherein the air which has been fed through the compressor can be cooled. If the crankcase gases are fed to the compressor, the oil particles in the crankcase gases may cause a coating in the compressor, which results in an impaired efficiency in the compressor. Furthermore, the oil particles may cause a coating in the intercooler, which results in an impaired efficiency in the intercooler. Furthermore, there is a risk of the oil drops being sucked into the engine.

In order to solve the above-mentioned problems and thereby to prevent oil particles from being carried along with the crankcase gases and to the engine's suction pipe, it is previously known to utilize various types of separation devices, which in that case are provided between the crankcase and the engine's inlet pipe. For example, so-called screen separators, baffle separators and fine separators are utilized for separating the oil particles from the crankcase gases in different manners.

Furthermore, it can be assumed that the pressure in the crankcase normally must be kept very close to the surrounding atmospheric pressure, since a too high overpressure in the crankcase may result in an oil leakage out of the engine. In a corresponding manner, an undesired underpressure may result in penetration of dirt via the engine's gaskets and further into the engine. Thus, there is a demand for accurate control of the pressure in the crankcase, so that this can be kept within a predetermined interval.

SUMMARY OF THE INVENTION:

One object of the present invention is to provide a valve device for efficient ventilation of crankcase gases in a combustion engine.

This object is achieved by means of a valve device of the above-mentioned type, the characterizing features of which will be apparent from appended claim 1 and which comprises a first valve which is adapted for assuming a condition between a first, opened position and a second, closed position depending on said detected pressure in the crankcase, and a second valve which is adapted for assuming a condition between a first, opened position and a second, closed position depending on the condition of said first valve.

The object is also achieved by means of a method of the above-mentioned type, the characterizing features of which will be apparent from appended claim 11 and which comprises controlling a first valve between a first, opened position and a second, closed position depending on said detected pressure in the crankcase, and controlling a second valve between a first, opened position and a second, closed position depending on the condition of said first valve.

Several advantages are attained by means of the invention. Primarily, it can be noted that the pressure in the crankcase can be controlled within a comparatively narrow interval which is defined beforehand. This control is provided by means of a servo-like functional manner of the two valves.

Preferably, the first valve comprises a flexible diaphragm which, depending on the detected pressure in the crankcase, causes a valve element to open and close,

respectively, an opening which connects the first valve with the second valve. Furthermore, the second valve preferably comprises a flexible diaphragm which, depending on the condition of the first valve, is adapted for opening and closing, respectively, said connection. In this manner, it is provided that the first valve can be formed so that the valve element only makes small movements during the pressure control. As a consequence of this, the diaphragm in the first valve can be made comparatively small, which thus corresponds to small diaphragm movements and a very insignificant undesired influence from disturbing factors, for example forces which act from the diaphragm itself. This creates conditions for an accurate control, at the same time as the valve device can be constructed in a compact manner.

Advantageous embodiments of the invention will be apparent from the appended dependent claims.

BRIEF DESCRIPTION OF THE DRAWINGS:
The invention will be further described in the following with reference to a preferred embodiment and to the annexed drawings, in which

Fig. 1 in principle shows an arrangement in connection with a combustion engine, in which the present invention can be utilized, and

Fig. 2 shows a schematic cross-sectional view of a valve device according to the invention, and

Figs. 3a-c in a schematic form show the functional manner of the invention.

PREFERRED EMBODIMENT:
Fig. 1 shows a principal view of an arrangement according to the present invention. According to a preferred

embodiment, the invention is provided in connection with an engine block 1 in a six-cylinder four-stroke diesel engine with a gear box 2 with clutch which is connected to the engine's crankshaft.

The engine is overloaded by means of a turbo compressor 3 of known type, which in turn comprises a turbine 4 which is connected to the engine's exhaust manifold 5 and a compressor 6 which is connected to the engine's induction manifold 7 via an intercooler 8. Via a suction pipe 9, the suction side of the compressor 6 is connected to an air filter 10.

In accordance to what has been described above, crankcase gases will be generated in the engine, which gases will be guided from the respective combustion chamber of the engine and into its crankcase 11. This takes place mainly as a consequence of non-sealed piston rings between the engine's pistons and the walls in the respective cylinder. Crankcase gases contain small particles in the form of oil drops, and for reasons which have been mentioned above, there is a demand for separating these particles from the gases. To this end, the engine's crankcase 11 comprises a per se known and only schematically indicated screen separator 12 and a baffle separator 13. From the baffle separator 13, the crankcase gases are guided further onto a fine separator 14.

In accordance to what has been mentioned initially, there is a demand for controlling the current pressure in the crankcase 11. To this end, the arrangement according to the invention comprises a valve device 15, the construction and function of which will be described in detail below, and a connection in the form of a pipe 16 which connects the inside of the crankcase 11 with said valve device 15. In this manner, the valve device 15 is

adapted for continuous detection of the pressure in the crankcase 11.

The valve device 15 will now be described with reference to Fig. 2, which is a schematic cross-sectional view in which the crankcase 11 with the various separation devices is shown. The drawing also shows an oil sump 17 and a draining pipe 18 for draining the oil particles which have been separated by means of the separation devices, so that the oil particles are guided back to the oil sump 17.

When controlling the pressure in the crankcase 11, it is necessary that this pressure is kept very close to the surrounding atmospheric pressure, more precisely slightly above the atmospheric pressure. Otherwise, a too high overpressure would result in an undesired oil leakage and a too high underpressure would result in penetration of dirt into the engine via its gaskets (not shown). Suitably, the pressure in the crankcase 11 can be kept within in an interval of the order of 0-65 mm water column. Furthermore, an underpressure prevails in the suction pipe 9. This underpressure can vary during the operation of the engine, for example depending on the current load of the engine. An underpressure which corresponds to 0-650 mm water column is normal. In this connection, it can be assumed that the surrounding atmospheric pressure constitutes a reference with the pressure 0 mm water column.

The invention is not limited for utilization in engine arrangements in which the above-mentioned pressure intervals prevail, but may in principle be utilized in any arrangements where there is a demand for maintaining a pressure in the crankcase and the suction pipe, respectively, which is within predetermined intervals.

Thus, the invention is based on the demand for controlling the pressure in the crankcase 11 within a predetermined, comparatively narrow, permissible pressure interval. To this end, the valve device 15 according to the invention is utilized, which valve device now will be described in detail.

The valve device 15 comprises two separate valve units, more precisely a first valve 19 and a second valve 20. Both these valves 19, 20 are preferably of the type which is based on a surrounding gas pressure acting upon a flexible diaphragm, preferably of rubber, so that it is moved depending on the pressure which acts against the diaphragm. This movement of the diaphragm in turn affects a control mechanism for a gas flow. According to what is apparent from Fig. 2, the first valve 19 comprises a first rubber diaphragm 21, which via an upper and a lower valve disc 22, 23 is mounted in a displaceable valve rod 24. This valve rod 24 is provided with a valve element 24a which is adapted to sealingly co-operate with an opening 25 in an intermediate wall 26, which in turn separates the first valve 19 from the second valve 20. In this manner, the opening 25 constitutes a connection between the first and the second valve.

Furthermore, the diaphragm 21 in the first valve 19 is provided so that it separates a first chamber 27 from a second chamber 28. The first chamber 27 is connected with the surrounding atmosphere, while the second chamber is connected with the crankcase 11, via the pipe 16 which connects to the crankcase 11. Thus, the pressure in the second chamber 28 is just as high as the pressure in the crankcase 11.

The second valve 20 comprises a second rubber diaphragm 29 and two additional valve discs 30, 31. In a corresponding manner to the first valve 19, the second

rubber diaphragm 29 is adapted so that it separates a third chamber 32 from a fourth chamber 33. The third chamber 32 is connected with the suction pipe 9, via a narrow connection 34 which functions as a restrictor. According to the shown embodiment, the fourth chamber 33 is connected with the outlet of the fine separator 14 (cf. Fig. 1), i.e. the fourth chamber 33 is provided downstream of all separation devices, via an opening 35. The fourth chamber 33 is also connected with the suction pipe 9. Furthermore, the second valve 20 is connected with a spring element 35, which is adapted so that the second rubber diaphragm 29 is influenced towards the opening 35, i.e. so that the second valve 20 strives to seal against the opening 35. In this manner, this sealing function is provided by means of the fact that the lower valve disc 31 in the second valve 20 sealingly bears against a surface which surrounds the opening 35, according to what is apparent from Fig. 2.

According to what is apparent from Fig. 3a, which is a schematic cross-sectional view showing the function of the valve device 15 (and where certain details have been omitted in relation to what is shown in Fig. 2), the first valve 19 as well as the second valve 20 are in their closed positions when the pressure in the crankcase 11 and the suction pipe 9, respectively, lies within their desired intervals. To this end, the components forming part of the valves, and the spring element 36 (not apparent from Fig. 3a) and the restrictor 34, are formed and provided so that the first valve 19 seals against the first opening 25, while the second valve 20 seals against the second opening 35, which thus constitutes a connection between the crankcase 11 and the suction pipe 9.

It can be noted that the slight overpressure which during the normal condition prevails in the crankcase 11, and

thus also in the pipe 16, affects the first rubber diaphragm 21 in a manner which results in that the valve rod 24, with the valve element 24a associated therewith, is transferred towards its corresponding opening 25, wherein the valve element 24a sealingly bears against its corresponding opening 25. Furthermore, the second valve 20 is affected by means of the spring element 36 in a direction so that the opening 35 between the crankcase and the suction pipe 9 is blocked. During this normal condition which is shown in Fig. 3a, the pressure in the third chamber 32 is just as large as in the suction pipe 9.

If the pressure in the crankcase 11 should drop below a minimum permissible limiting value, this low pressure will result in that the first diaphragm 21 is influenced in a direction which results in that the valve element 24a no longer seals against its corresponding opening 25. This condition is shown in Fig. 3b. Thus, a passage of crankcase gases from the crankcase 11 is in this case allowed, via the pipe 16 and the second chamber 28, to the third chamber 32. In this manner, the pressure of the crankcase gases in the third chamber 32 will be towards a value which corresponds to the pressure in the crankcase 11. In this condition, the second valve 20 is closed and allows no passage of crankcase gases to the suction pipe 9 via the opening 35. This in turn results in that the pressure in the crankcase 11 increases. During this course of events, there will be a certain flow of crankcase gases from the third chamber 32, via the restrictor 34, and further on to the suction pipe 9. However, the restrictor 34 is so dimensioned that the building up of pressure in the crankcase 11 is not affected to any considerable extent.

If the pressure in the crankcase 11 should exceed a maximum permissible limiting value, the valve device 15

will assume the condition which is shown in Fig. 3c. In this regard, the first valve 19 will be influenced towards its closed condition as a consequence of the prevailing high pressure in the crankcase 11 (and thus also in the pipe 16) affecting the first diaphragm 21 in a direction so that the valve element 24a finally sealingly bears against corresponding opening 25. In this case, the pressure in the third chamber 32 will gradually drop towards a value which corresponds to the pressure in the suction pipe 9, due to the fact that gas is allowed to flow to the suction pipe 9 via the restrictor 34.

Finally, the pressure in the third chamber 32 will have dropped to a value at which the pressure in the crankcase 11 is capable of opening the second valve 20, wherein passage of crankcase gases via the opening 35 is allowed. This in turn implies that the pressure in the crankcase 11 decreases. When the pressure has dropped so much that it once again falls within its permissible interval, the second valve 20 will once again be closed, due to influence from the spring element 36.

Thus, it can be established that the first valve 19 can assume an opened position or a closed position depending on the detected pressure in the crankcase 11. Furthermore, the second valve 20 can assume an opened position or a closed position (i.e. for opening and closing, respectively, the opening 35) depending on the condition of the first valve 19. Thus, by means of the invention, a servo function is provided where the condition of the first valve 19 affects the adjustment of the second valve 20. In this case, the control of the second valve 20 takes place by means of the movement of the first valve 19. This movement can be made very small, which is an advantage since the first valve 19 in this manner can be formed with a small and light rubber diaphragm which in this case not affects the control by

means of factors which are due to the rubber diaphragm's own movements and the forces that it generates.

The invention is not limited to the fact that the respective valve 19, 20 is controlled so that they only assume two extreme positions. In other words, the valves 19, 20 can assume positions which lie between the extreme positions which are defined by means of the completely closed and the completely opened condition, respectively, of the respective valve. For example, during normal operation of the engine in question, both valves 19, 20 can be half opened or adjusted within a control area which is constituted by a restricted interval between the completely opened and the completely closed position of the respective valve.

By means of the fact that the valve device 15 comprises two valves 19, 20 with the above-mentioned servo function, it can be formed as a compact unit which easily can be mounted in connection with a combustion engine, i.e. in an area of the vehicle where the available space already is considerably limited.

According to the shown embodiment, the valve device 15 is provided after (i.e. downstream of) all the three separation devices 12, 13, 14 (cf. Fig. 1). This implies that the separation devices are not exposed to the high underpressure which can occur on the engine's suction side during operation. This is an advantage, as it implies that for example no nonreturn valve needs to be utilized in connection with the draining pipe 18 in order to stop oil from being sucked into the suction pipe 9.

In spite of the fact that the valve device 15 is situated downstream of the separation devices 12, 13, 14, the measuring of the crankcase pressure nevertheless takes place in the crankcase 11, via the pipe 16. This implies

that the control of the pressure in the crankcase takes place independently of the fall of pressure in the separation devices 12, 13, 14.

The invention is not limited to the embodiments described above, but may be varied within the scope of the appended claims. For example, the invention can be utilized in various types of vehicles, e.g. passenger cars, lorries, loaders and buses, which comprise an engine being adapted for closed crankcase ventilation.

The invention can be utilized in turbo charged engines as well as engines without turbo charging.

The invention can be realized by means of various types of separation devices. In principle, the invention can be utilized even if no separation device is being utilized.

Furthermore, the above-mentioned spring element 35 can in principle be omitted, which may be relevant in those applications where the pressure difference between the crankcase and the suction pipe is comparatively small.

The above-mentioned diaphragms 21, 29 are preferably constructed by an elastic and oil-resistant material. For example, they can be constituted by rubber, but other materials with these characteristics may also be utilized for this purpose.

CLAIMS:

1. Valve device (15) for pressure control in a combustion engine (1) with a crankcase (11) to which crankcase gases are guided during operation of the engine, which valve device (15) is adapted for detecting the current pressure in said crankcase (11) and for opening and closing, respectively, a connection (35) between said crankcase (11) and a suction pipe (9) of the engine depending on said detected pressure,
c h a r a c t e r i z e d i n that the valve device (15) comprises a first valve (19) which is adapted for assuming a condition between a first, opened position and a second, closed position depending on said detected pressure in the crankcase (11), and a second valve (20) which is adapted for assuming a condition between a first, opened position and a second, closed position depending on the condition of said first valve (19).

2. Valve device (15) according to claim 1,
c h a r a c t e r i z e d i n that said second valve (20) is adapted for opening said connection (35) when the first valve (19) assumes its closed position, and that said second valve (20) is adapted for closing said connection (35) when the first valve (19) assumes its opened position.

3. Valve device (15) according to claim 1 or 2,
c h a r a c t e r i z e d i n that said first valve (19) is adapted for assuming its closed position when the pressure in the crankcase (11) exceeds a predetermined maximum permissible value, and that said first valve (19) is adapted for assuming its opened position when the

pressure in the crankcase (11) falls below a predetermined minimum permissible value.

4. Valve device (15) according to any one of the preceding claims, characterized in that the first valve (19) comprises a flexible diaphragm (21) which, depending on said detected pressure, causes a valve element (24a) to open and close, respectively, an opening (25) which connects the first valve (19) with the second valve (20), and that the second valve (20) comprises a flexible diaphragm (29) which, depending on the condition of the first valve (19), is adapted for causing opening and closing, respectively, of said connection (35).

5. Valve device (15) according to claim 4, characterized in that the flexible diaphragms (21, 29) are constituted by rubber diaphragms.

6. Valve device (15) according to any one of the preceding claims, characterized in that the second valve (20) comprises a spring element (36) which influences the second valve (20) with a force which strives to close said connection (35).

7. Valve device (15) according to any one of the preceding claims, characterized in that the valve device (15) is adapted for detecting said pressure in the crankcase (11) via a pipe (16) which connects from the crankcase (11) and to the first valve (19).

8. Valve device (15) according to any one of claims 4-7, characterized in that the diaphragm (21) in the first valve (19) separates a first chamber (27) from a second chamber (28), wherein the first chamber (27) is connected to the surrounding atmosphere and the

second chamber (28) is connected to the crankcase (11), and that the diaphragm (29) in the second valve (20) separates a third chamber (32) from a fourth chamber (33), wherein the third chamber (32) is connected with the suction pipe (9) via a restrictor connection (34) and the fourth chamber (33) is connected with the suction pipe (9) and the crankcase (11), via said connection (35), and wherein the valve element (24a) in the first element (19) co-operates with a connection (25) between the second chamber (28) and the third chamber (32) which can be opened.

9. Valve device (15) according to any one of the preceding claims, wherein said engine comprises at least one separation device (12, 13, 14) for separating small particles from said crankcase gases, which separation device (13, 14, 15) is provided between the crankcase (11) and the suction pipe (9),
c h a r a c t e r i z e d i n that said connection (35) is provided downstream of said separation device (12, 13, 14).

10. Engine arrangement comprising engine with crankcase (11) and a connection for ventilating crankcase gases from the crankcase (11) to a suction pipe (9) via a connection (35) which can be opened, wherein the engine arrangement comprises a valve device (15) according to any one of the preceding claims.

11. Method for pressure control in a combustion engine (1), comprising:

feeding crankcase gases during operation of the engine from a crankcase (11) forming part of the engine,

detecting the current pressure in said crankcase (11), and

opening and closing, respectively, a connection (35) between said crankcase (11) and a suction pipe (9) of the engine depending on said detected pressure,

c h a r a c t e r i z e d i n that the method comprises:

controlling a first valve (19) between a first, opened position and a second, closed position depending on said detected pressure in the crankcase(11), and

controlling a second valve (20) between a first, opened position and a second, closed position depending on the condition of said first valve (19).

12. Method according to claim 11,

c h a r a c t e r i z e d i n that it comprises:

opening said connection (35) when the first valve (19) assumes its closed position,

closing said connection (35) when the first valve (19) assumes its opened position,

closing the first valve (19) when the pressure in the crankcase (11) exceeds a predetermined maximum permissible value, and

opening the first valve (19) when the pressure in the crankcase (11) falls below a predetermined minimum permissible value.

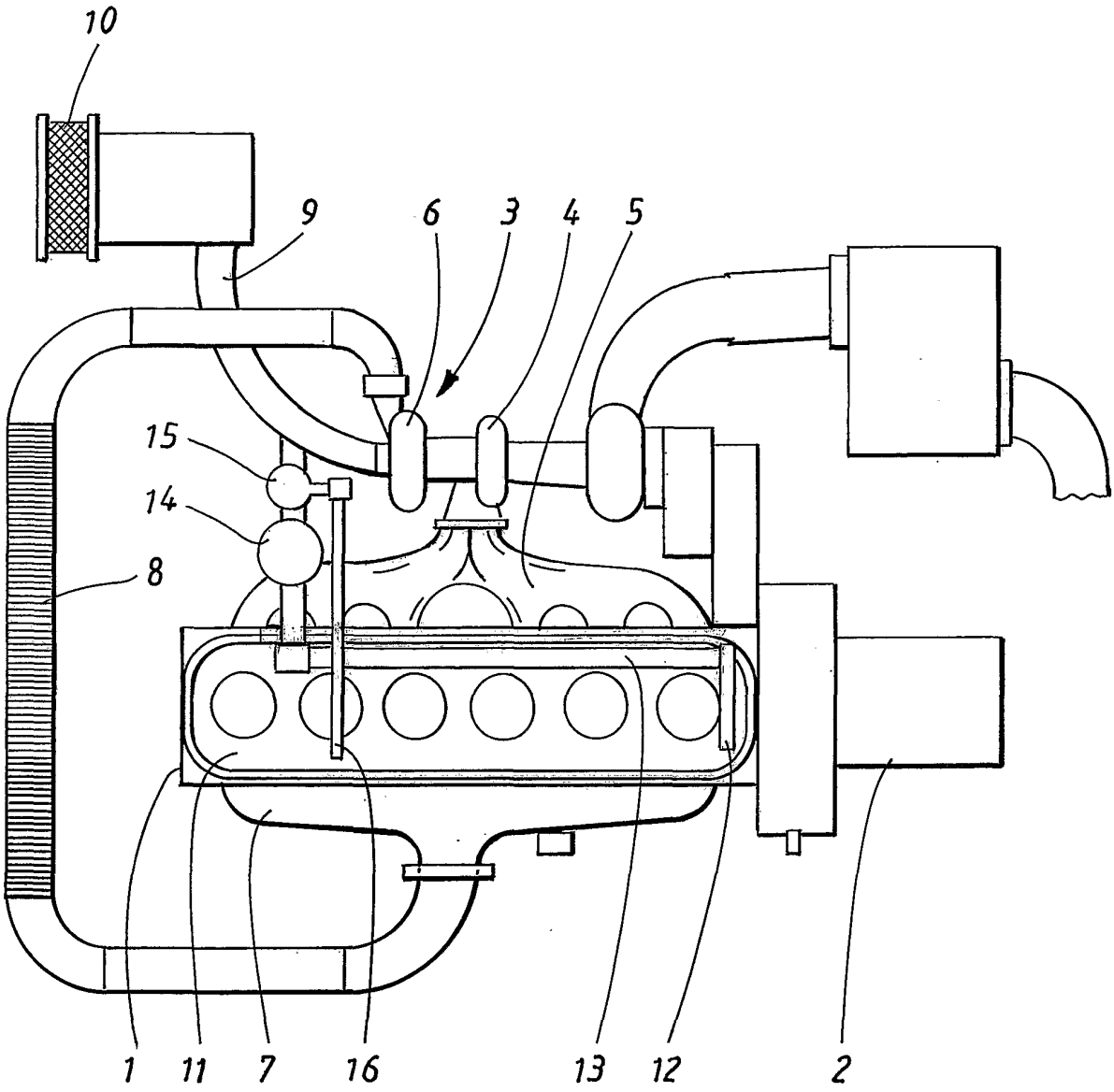


FIG.1

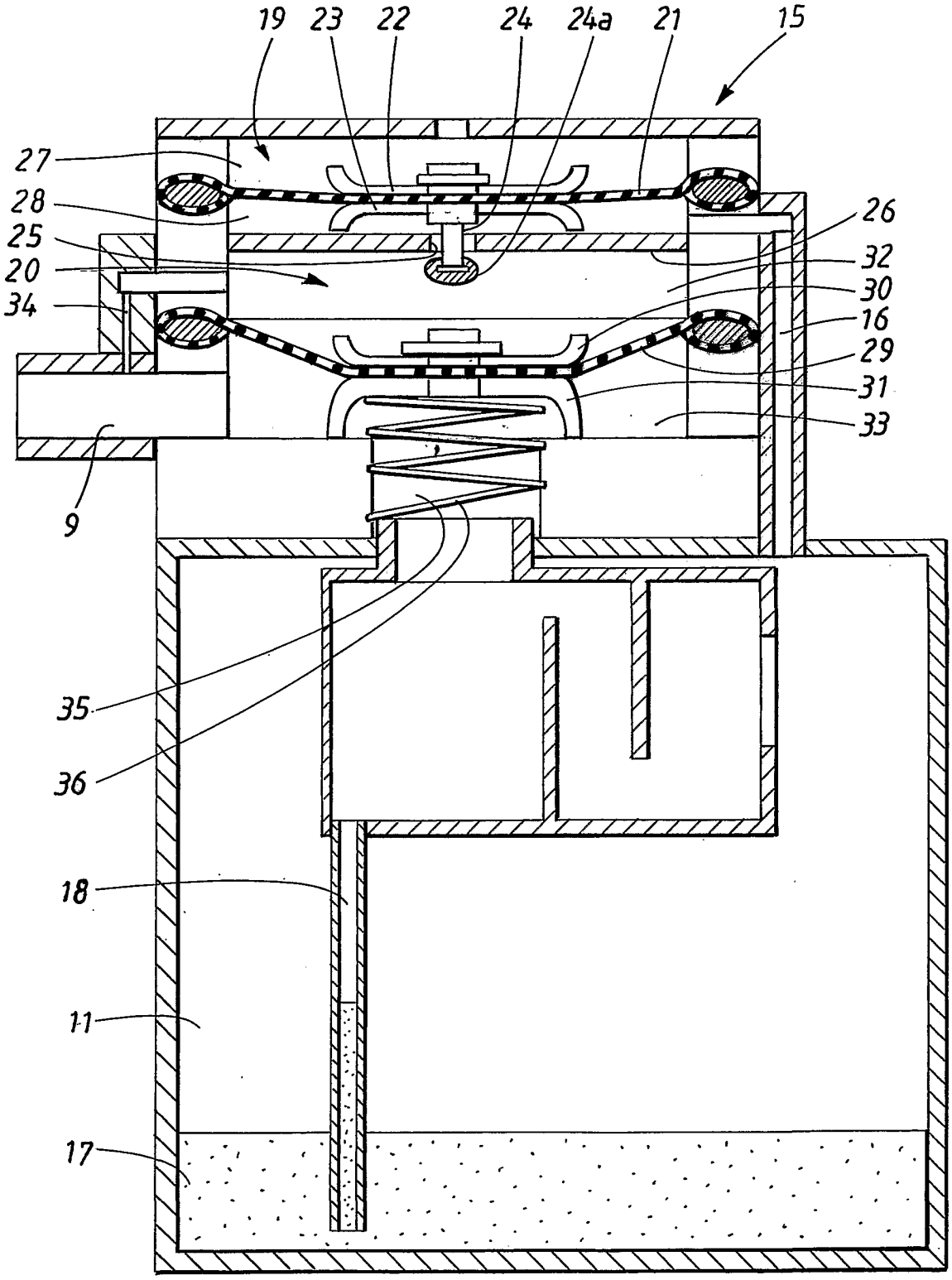

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FIG. 2

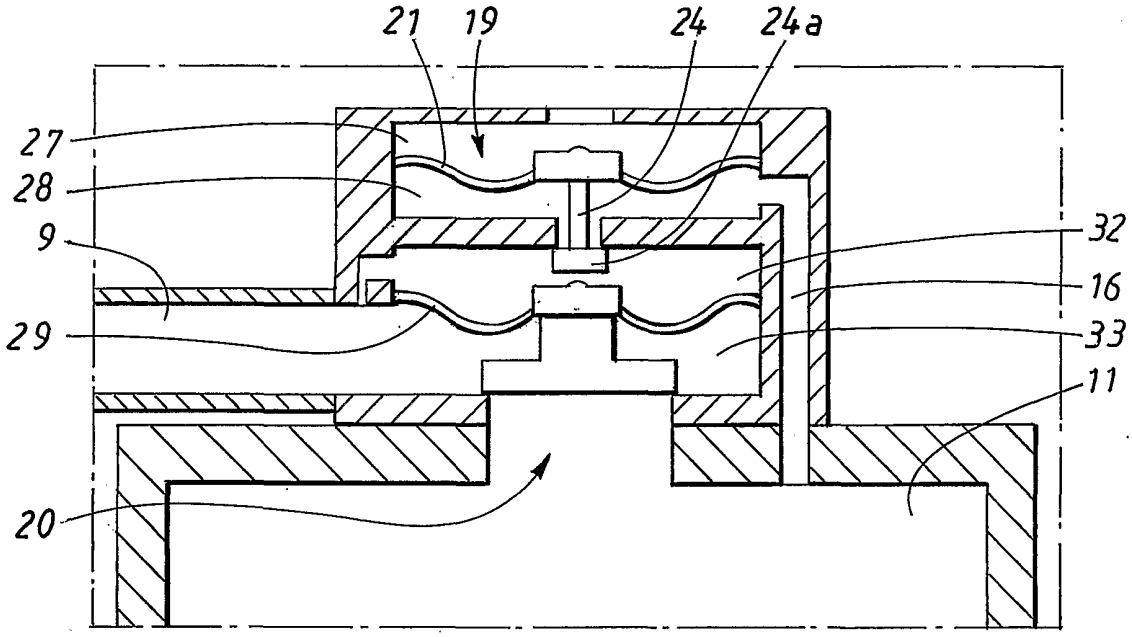


FIG. 3a

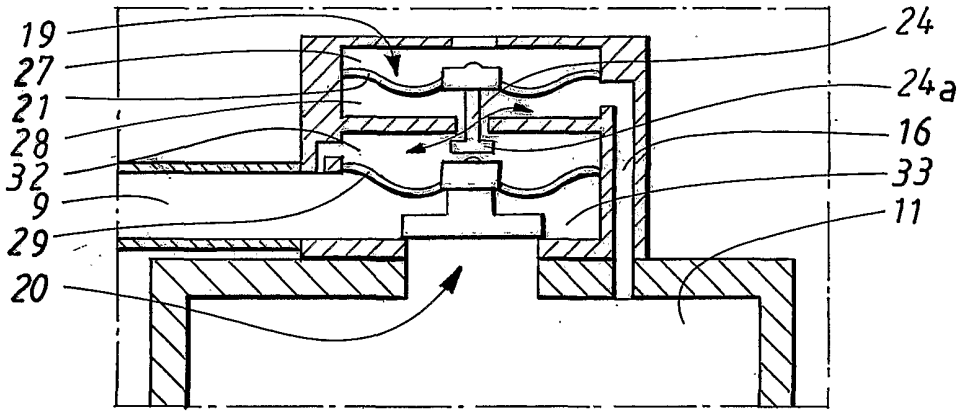


FIG. 3b

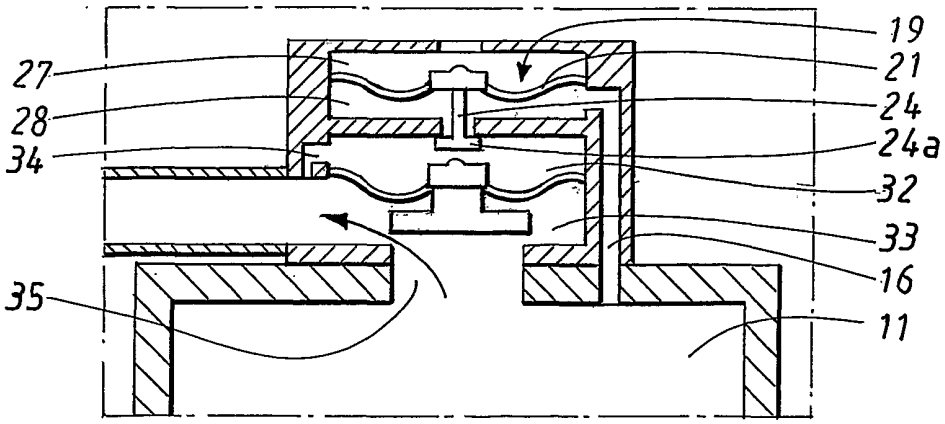


FIG. 3c

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 02/00332

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: F01M 13/02, F16K 7/17
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)

IPC7: F01M, F16K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5090393 A (HOLCH), 25 February 1992 (25.02.92), figures 1-3, abstract ---	1,7,9-11
A	GB 1358797 A (FORD MOTOR COMPANY LIMITED), 3 July 1974 (03.07.74), page 1, line 9 - line 50, figures 1-3 ---	
A	EP 0896133 A1 (ADAM OPEL AG), 10 February 1999 (10.02.99), figure 1, abstract ---	
A	EP 0724206 A2 (ROBERT BOSCH GMBH), 31 July 1996 (31.07.96), figure 1, abstract ---	

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
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PCT/SE 02/00332

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