



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
21.01.2015 Bulletin 2015/04

(51) Int Cl.:
F01M 13/04 (2006.01)

(21) Application number: **13176549.7**

(22) Date of filing: **15.07.2013**

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

(71) Applicant: **Caterpillar Energy Solutions GmbH**
68167 Mannheim (DE)

(72) Inventor: **Berger, Olaf**
67373 Dudenhofen (DE)

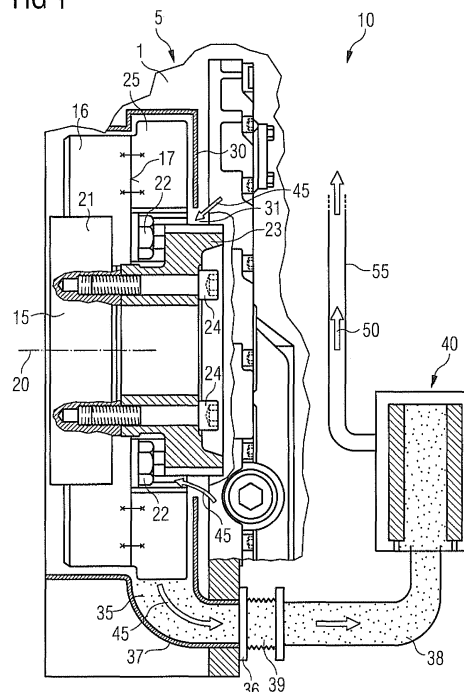
(74) Representative: **Kramer Barske Schmidtchen**
Patentanwälte PartG mbB
European Patent Attorneys
Landsberger Strasse 300
80687 München (DE)

(54) **Removing of blow-by gas out of crankcase without auxiliary drive**

(57) The present disclosure refers to a blow-by gas removing device (5) for an internal combustion engine (10) having a crankcase (1). The blow-by removing device (5) may comprise an engine component (15; 16) rotatably driven about a longitudinal axis (20). A fan wheel (25) may be fixed to the engine component (15; 16) such that the fan wheel (25) rotates together with the engine component (15; 16). A housing (30) may cover at least partially the fan wheel (25). The housing (30) may be

provided with an outlet (35) configured to be connected to an oil separating device (40). The fan wheel (25) and the housing (30) may be configured in a manner that blow-by gas (45) saturated with oil is being sucked off from the crankcase (1) and discharged through the outlet (35). Further, the present disclosure refers to a method for removing blow-by gas of an internal combustion engine without an auxiliary drive for a fan.

FIG 1



Description

Technical Field

[0001] The present disclosure generally refers to a blow-by gas removing device for an internal combustion engine. In particular, the disclosure refers to a blow-by gas removing device for removing blow-by gas including oil or oil mist present in a crankcase of the internal combustion engine and for discharging it to an oil separating device.

[0002] Further, the present disclosure in general relates to a method for removing blow-by gas including oil of an internal combustion engine. In particular, the method disclosed comprises the use of rotating power of a rotating engine component of the internal combustion engine for driving a fan wheel configured to remove the blow-by gas, particularly to suck off the blow-by gas out of the crankcase.

Background

[0003] Internal combustion engines, especially gas engines, may have the problem that unburned and partially burned fuel gas, known as hydrocarbons, blow past the engine's piston rings into the crankcase. These gases are also known as blow-by gas or blow-by exhaust gas.

[0004] In an open venting system, a blow-by tube emits unburned oil and soot into the environment. Accordingly, if such a blow-by gas mixture pollutes the environment, a controlling crankcase venting of internal combustion engines, gas engines, by retro-fitting the engines with crankcase control equipment is an accepted practice. There are several systems available on the market which clean the crankcase vapours. Other technologies use a process to separate and capture these by-pass gases, also known as contaminants, while allowing "organic fuel" to enter back into the engine's combustion chamber

[0005] For removing the blow-by gas including oil it is known to use a fan sucking in the blow-by gas saturated with oil and discharging the blow-by gas to an oil-separating device, for example a filter cartridge, or in general an oil separator. However, a separate auxiliary drive is necessary for driving the fan. The overall costs of an internal combustion engine might be relatively high resulting from the separate auxiliary drive and the necessary powering of the auxiliary drive.

[0006] The present disclosure is directed, at least in part, to improving or overcoming one or more aspects of prior systems.

Summary of the Disclosure

[0007] A first aspect of the present disclosure refers to a blow-by gas removing device for an internal combustion engine. The blow-by removing device may comprise an engine component configured to be driven and to rotate about a longitudinal axis. A fan wheel may be fixed to the

engine component such that the fan wheel rotates together with the engine component. A housing may cover at least partially the fan wheel. The housing may be provided with an outlet configured to be connected to an oil separating device. The fan wheel and the housing may be configured in a manner that blow-by gas is sucked off a crankcase of the internal combustion engine and discharged through the outlet.

[0008] Another aspect of the present disclosure refers to a method for removing blow-by gas of an internal combustion engine without an auxiliary drive for a fan. The method disclosed herein may comprise the step of rotating together an engine component, as, for example, a crank shaft, and a fan wheel fixed to the engine component, for example a crank shaft or torsional vibration damper. According to the method blow-by gas may be sucked in and compressed by the aid of the fan wheel. Then, the blow-gas may be delivered to an oil separating device.

Other features and aspects of this disclosure will be apparent from the following description and the accompanying drawings.

Brief Description of the Drawings

[0009] Fig. 1 shows a schematic cross-sectional view of a part of an internal combustion engine provided with a blow-by gas removing device.

Detailed Description

[0010] As shown in Fig. 1, an internal combustion engine 10 comprises a crank shaft 15. The crank shaft 15 rotates about a longitudinal axis 20. Here, a gear wheel 23 is attached to the crank shaft 15. The gear wheel 23 is fitted on an end of the crank shaft 15 by a plurality of bolts 24. The gear wheel 23 is used to drive an oil pump. Further, the crank shaft 15 and all engine components attached can be enclosed by a crankcase 1. As commonly known, crankcase 1 is a housing for the crank shaft 15 and forms a cavity below cylinders in the internal combustion engine 10.

[0011] In the embodiment shown in Fig. 1 a torsional vibration damper 16 is attached to the crank shaft 15 in a non-rotatable manner. And, if the crank shaft 15 rotates during operation of the internal combustion engine, the torsional vibration damper 16 also rotates. Here, the torsional vibration damper 16 is mounted on a shoulder 21 of the crank shaft 15 by means of a plurality of bolts 22.

[0012] According to the exemplary embodiment shown in Fig. 1 a fan wheel 25 is attached or mounted to a face 17 of the torsional vibration damper 16. The fan wheel 25 is bolted to the face 17 of the torsional vibration damper 16 by means of bolts 22. However, there are various alternatives for mounting the fan wheel 25 on the torsional vibration damper 16. For example, the fan wheel 25 may be attached to the face 17 by means of an adhesive. In another alternative the fan wheel 25 may be integrally

formed on the face 17 of the torsional vibration damper 16, in particular formed in one piece with the torsional vibration damper 16.

[0013] As an alternative to the shown arrangement of a fan wheel 25 on the face 17 of the torsional vibration damper 16, the fan wheel 25 may be fitted on a part of the gear wheel 23 or directly on the crank shaft 15. In all cases, the fan wheel 25 has to be mounted non-rotatably on the crank shaft 15 or any other driven engine component which is non-rotatably mounted on the crank shaft 15. As a result, the fan wheel 25 rotates due to rotation of the crank shaft 15.

[0014] A casing or housing 30 is stationary arranged and encloses the fan wheel 25 and, for example, other rotating components like the torsional vibration damper 16 at least partially. In the shown exemplary embodiment of the present disclosure the housing 30 surrounds the gear wheel 23 in such a manner that blow-by gas including oil can be sucked in through a gap 31 provided between the gear wheel's outer circumference and an inner edge of the housing 30.

[0015] The housing 30 is provided with an outlet or opening 35 at the radial outer side of the housing 30. Here, in the exemplary embodiment of the housing 30, the opening 35 opens to the outer radial circumference of the fan wheel 25. (The opening 35 is part of a connection flange 36 of a connection part 37)? The connection part 37 is connected to a pipe 38 by means of a bellow 39 configured to compensate length variations due to thermal conditions during operation of the internal combustion engine.

[0016] The pipe 38 connects to an oil separating device 40 comprising one or more filter elements known in the prior art. The oil separating device 40 is connected to an inlet pipe 55, in which the purified blow-by gas 50 is guided to the entrance site, normally an inlet pipe of the internal combustion engine. In an alternative embodiment, inlet pipe 55 connected to the oil separating device 40 is already part of an inlet manifold of the internal combustion engine 10.

Industrial Applicability

[0017] During operation of the internal combustion engine, blow-by gas including oil and/or other particles accumulates in the crankcase 1 of the internal combustion engine 10. Normally, a separate fan is provided to remove the blow-by gas 45 from the crankcase 1 and to supply the same to an external oil separating device 40.

[0018] According to the present disclosure, the fan wheel 25 non-rotatably mounted on the torsional vibration damper 16 rotates together with the torsional vibration damper 16 due to rotation of the crank shaft 15. As a combination of the shape of fan wheel 25 and housing 30, made, for example, of metal sheet or cast iron, the blow-by gas 45 is being sucked in, inter alia, through the gap 31 at the radial inner side of the fan wheel 25. Due to the rotation of the fan wheel 25 and the shape of that

fan wheel 25, the blow-by gas 45 travels to the radial outer side of the fan wheel 25 and is compressed.

[0019] Subsequently, the, for example, slightly compressed blow-by gas 45 is discharged through outlet or opening 35 and guided into oil separating device 40. In the oil separating device 40, the blow-by gas is purified, and particularly the oil in the blow-gas is separated. After this separation process, the purified blow-by gas 50 is supplied to the environment or to an inlet pipe 55 of the internal combustion engine 10. Alternatively, the purified blow-by gas 50 may be routed back to an intake manifold.

[0020] It must be noted that the casing may be a separate housing made of sheet metal or a contoured crankcase contour. As already mentioned, the fan wheel may be directly integrated into the torsional vibration damper and/or other components rotating together with the crank shaft of the internal combustion engine. Alternatively, any other driven engine component may be used as a rotating support for the fan wheel.

[0021] According to the present disclosure the removing of blow-by gas including oil is performed without using a separate auxiliary drive for a common fan configured to suck in the blow-by gas and discharge it to an oil removing device comprising, for example, a filter. To the contrary, the power of a rotating engine component is used the first time for driving a fan wheel sucking off the blow-by gas. Consequently, no extra drive is necessary for the blow-by gas removing device.

[0022] As mentioned above, the present disclosure can be implemented in internal combustion engines, in particular in gas engines. Here, a gas engine is an internal combustion engine which runs on a gas fuel, such as coal gas, producer gas, biogas, landfill gas or natural gas. In the UK, the term is unambiguous. In the US, due to the widespread use of "gas" as an abbreviation for gasoline, such an engine might also be called a gaseous-fueled engine or natural gas engine.

[0023] Finally, it should be noted that the terms "blow-by gas", and "blow-by gas including oil" mean the same, namely blow-by gas as it is present in an internal combustion engine during operation, in particular blow-by gas present in a crankcase.

[0024] Last but not least, attention should be paid to the fact that a device and method as disclosed herein particularly refer to a blow-by recirculation system and a blow-by recirculation method if the blow-by gas removing as disclosed herein is combined with supplying the blow-by gas in the inlet or suction part of the engine.

[0025] Although the preferred embodiments of this invention have been described herein, improvements and modifications may be incorporated without departing from the scope of the following claims.

Claims

1. A blow-by gas removing device (5) for an internal combustion engine (10) having a crankcase (1),

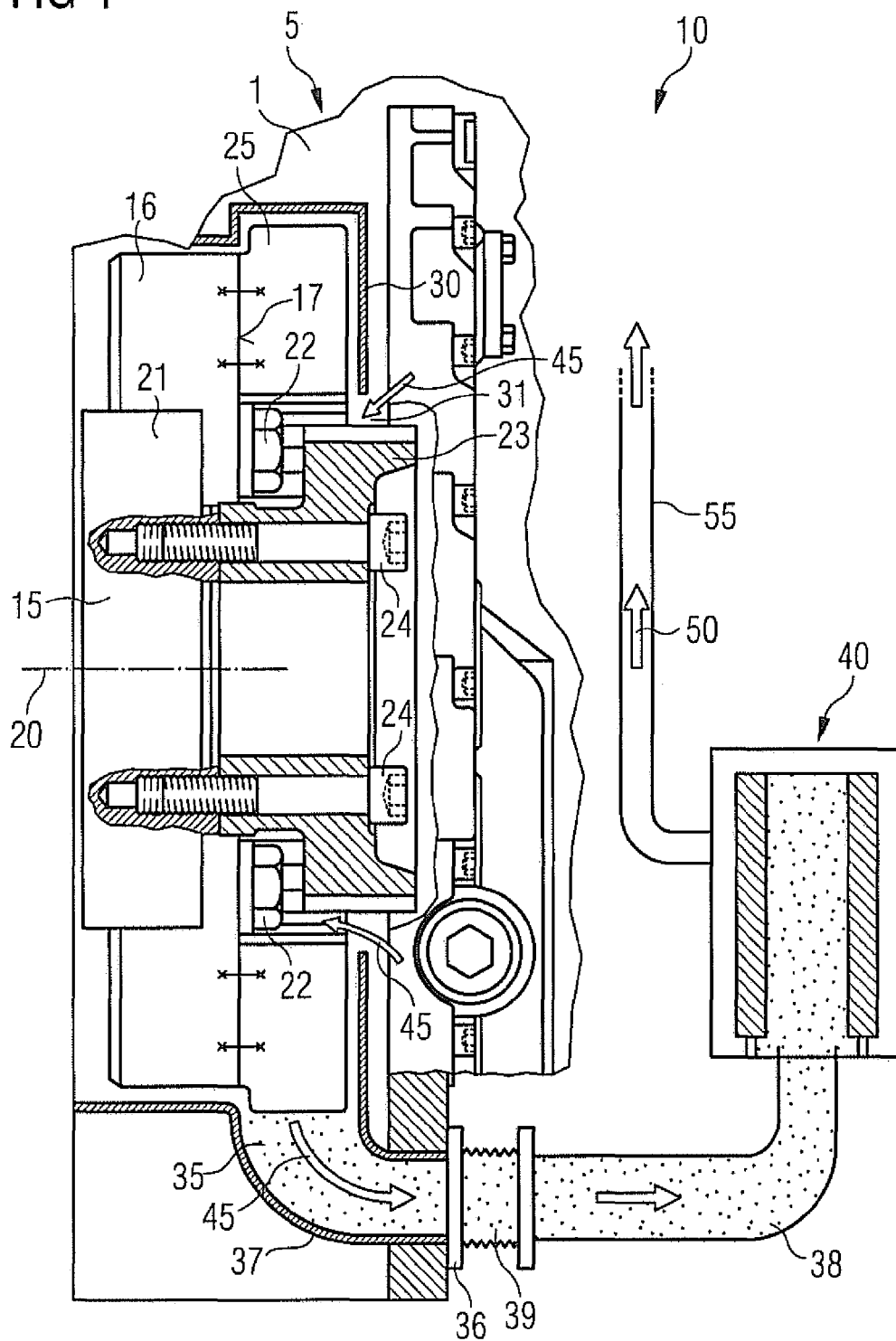
comprising:

- an engine component (15; 16) configured to be driven and to rotate about a longitudinal axis (20) during the operation of the internal combustion engine (10);
 a fan wheel (25) fixed to the engine component (15; 16) such that the fan wheel (25) rotates together with the engine component (15; 16);
 a housing (30) covering at least partially the fan wheel (25), the housing (30) being provided with an outlet (35) configured to be connected to an oil separating device (40);
 wherein the fan wheel (25) and the housing (30) are configured in a manner that blow-by gas (45) is being sucked off the crankcase (1) and discharged through the outlet (35).
2. The blow-by gas removing device (5) of claim 1, the fan wheel (25) being integrally formed on the engine component (15; 16).
 3. The blow-by gas removing device (5) of claim 1 or 2, wherein the engine component comprises a rotatable shaft as, for example, a crank shaft (15).
 4. The blow-by gas removing device (5) of claim 1 or 2, wherein the engine component comprises a torsional vibration damper (16).
 5. The blow-by gas removing device (5) of claim 4, wherein the torsional vibration damper (16) is fixed to a crank shaft (15).
 6. The blow-by gas removing device (5) of any one of the preceding claims, the housing (30) enclosing the fan wheel (25) and the engine component (15; 16) at least partially.
 7. The blow-by gas removing device (5) of claim 6, the housing (30) enclosing in addition the oil separating device (40) at least partially.
 8. The blow-by gas removing device (5) of any one of the preceding claims, further comprising the oil separating device (40) and an inlet pipe (55) of the internal combustion engine, the oil separating device (40) being connected to the inlet pipe (55).
 9. The blow-by gas removing device (5) of any one of the preceding claims, further comprising the crankcase (1), the crankcase (1) enclosing at least one of the group comprising the engine component (15; 16), the fan wheel (25) and the housing (30).
 10. The blow-by gas removing device (5) of any one of the preceding claims, further comprising a hatch cover of the internal combustion engine, the oil separat-

ing device (40) being mounted on the hatch cover.

11. A method for removing blow-by gas including oil of an internal combustion engine having a crankcase (1), the method comprising the steps of:
 - rotating an engine component (15; 16) and a fan wheel (25) fixed to the engine component (15; 16) together about a longitudinal axis (20);
 - sucking blow-by gas (45) including oil off the crankcase (1) by the aid of the fan wheel (25);
 - compressing the blow-by gas (45) including oil by the aid of the fan wheel (25);
 - discharging the compressed blow-by gas (45) including oil to an oil separating device (40).
12. The method of claim 11, further comprising the step of integrally forming a fan wheel (25) on the engine component (15; 16).
13. The method of claim 11, further comprising the step of non-rotatably mounting a fan wheel (25) on the engine component (15; 16).
14. The method of any one of claims 11-13, the step of sucking off blow-by gas (45) including oil is performed at the radial inner side of the fan wheel (25).
15. The method of claim claims 11-14, the step of discharging the blow-by gas (45) including oil is performed at the radial outer side of the fan wheel (25).

FIG 1





EUROPEAN SEARCH REPORT

Application Number
EP 13 17 6549

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	JP 2009 121341 A (TOYOTA BOSHOKU CORP) 4 June 2009 (2009-06-04) * abstract; figures *	1-3,6-9, 11,13	INV. F01M13/04
X	DE 101 40 301 A1 (DAIMLER CHRYSLER AG [DE]) 27 February 2003 (2003-02-27) * paragraph [0017] - paragraph [0023]; figures *	1-3,6-9, 11-14	
X	US 5 954 035 A (HOEFER CHRISTIAN [DE] ET AL) 21 September 1999 (1999-09-21) * column 3, line 7 - column 4, line 36; figures *	1-3,6-9, 11-13	
A	US 2004/144071 A1 (HILPERT TORSTEN [DE] ET AL) 29 July 2004 (2004-07-29) * abstract; figure *	1,11	
X	DE 203 02 824 U1 (HENGST GMBH & CO KG [DE]) 8 July 2004 (2004-07-08) * abstract; figures *	1,11	
			TECHNICAL FIELDS SEARCHED (IPC)
			F01M
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 24 September 2013	Examiner Mouton, Jean
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	

1
EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 13 17 6549

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

24-09-2013

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 2009121341 A	04-06-2009	NONE	
DE 10140301 A1	27-02-2003	NONE	
US 5954035 A	21-09-1999	DE 19803872 A1 EP 0933507 A1 US 5954035 A	05-08-1999 04-08-1999 21-09-1999
US 2004144071 A1	29-07-2004	AT 373772 T DE 10251940 A1 EP 1422389 A2 US 2004144071 A1	15-10-2007 19-05-2004 26-05-2004 29-07-2004
DE 20302824 U1	08-07-2004	DE 20302824 U1 EP 1464797 A2	08-07-2004 06-10-2004