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(54) **COLD START MANAGEMENT SYSTEM FOR A DIESEL COMBUSTION ENGINE**

(57) Cold start management system for a diesel combustion engine (E), the combustion engine comprising a cylinder, a piston (P) mounted for reciprocating movement in the cylinder, a cylinder head (H) mounted to overlie the cylinder and with the primary cylinder and a face (F) of the piston defining a combustion chamber (CH) and a surface (CR) surrounding the combustion chamber; wherein said reciprocating movement defines a gap (G) between said surface (CR) and said cylinder head (H), the system comprising minimization means to minimize said gap on the basis of an engine temperature.

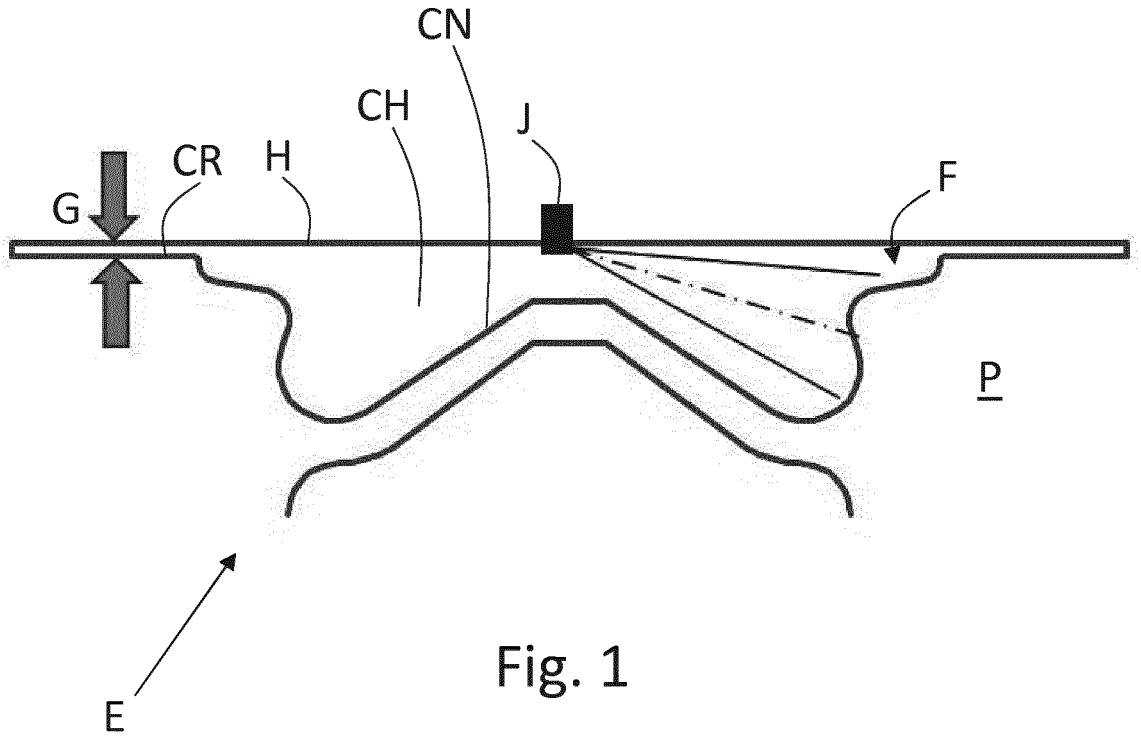

Fig. 1

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Description

Cross-reference to related applications

[0001] This patent application claims priority from Italian patent application no. 102018000009373 filed on 11/10/2018.

Field of the invention

[0002] The present invention relates to the combustion of a diesel engine and in particular to manage cold start.

Description of the prior art

[0003] One of the first internal combustion engine capable to vary the engine compression was Saab Variable Compression engine.

[0004] The US patent N. 5025757 discloses a solution where the block is mounted on the crankcase for pivotal movement about a pivot axis parallel to and spaced apart from the axis of the crank such that the size of the compression volume varies in accordance with the extent of the pivotal movement of the block about the pivot axis.

[0005] The aim of such solution is to minimize the clearance volume within the cylinder according to the engine load. The compression ratio is calculated as swept volume + clearance volume divided for clearance volume.

[0006] The swept volume is determined by the piston displacement between the top dead center and the bottom dead center, while the clearance volume is defined substantially by the combustion chamber and the gap between the piston crown and the engine head.

[0007] The minimum gap between the pistons and the engine head is usually about 1.2 mm and selected as the result of a statistic tolerance chain, assuring that there is no collision with the engine head or valves in any operating condition, especially at high speed.

Summary of the invention

[0008] The main object of the present invention to improve engine performances.

[0009] The basic idea of the present invention is to implement a system for compression ratio variation suitable to adjust the gap between the piston and the relating engine head, arranged and/or configured to maintain said gap, as much as possible close to zero in a diesel engine, in any fired operating condition.

[0010] The application of a gap control strategy to a diesel engine implies that such control departs from the load applied to the engine, being the load managed by adjusting the fuel injection.

[0011] According to a first embodiment of the invention, said gap control is realized on the basis of the engine temperature, thanks to minimization and/or control means.

[0012] While in US5025757 the gap is selected to achieve optimal working temperature and pressure, here the aim is to assure the minimum gap possible in any engine operating condition. Several are the mechanical components coupling the piston and the engine head on which the control of the present invention can apply, so that the invention is not limited by the specific kind of mechanical components used to adjust/minimize/eliminate the gap.

[0013] For example, US5025757 is suitable to adjust the distance between the crankshaft and the engine head due to a pivoting coupling between the engine block with its own crankcase.

[0014] According to other solutions, still by way of example, the engine head position can translate with respect to the engine block. According to another known solution the crankshaft is supported by an eccentric bushing. According to a further known solution, the piston rod has an adjustable length as in US2018179949.

[0015] Nevertheless, also in this case the distance between the engine head and the engine crankshaft is virtually varied.

[0016] According to a second embodiment of the invention that can be combined with the previous one, the gap control is realized also on the basis of the engine speed, thanks to said minimization and/or control means. More in particular the distance, at least virtual, between the engine head and the engine crankshaft is increased according to the engine speed increase, in order to avoid collisions between piston and engine head.

[0017] Therefore, a look up table can be implemented to control the gap as a function of the engine temperature and speed. According to a further preferred embodiment of the invention, a further parameter is implemented to control said gap. This parameter is the signal generated by a noise sensor associated with the engine head. Indeed, the aim is to detect initial slight impacts between said piston and said engine head, wherein the gap is adjusted on the basis of the signal generated by the noise sensor, thereby increasing the above gap when such initial slight impact is detected.

[0018] According to a preferred embodiment of the invention, the noise sensor is arranged in a sort of learning process which upgrades the above look up table. Indeed, the wear of the engine sliding components could lead to the increase of tolerances over the time. Thus, said parameter not only is exploited to directly adjust the gap, but also to correct the above look up table.

[0019] Even a small sectional impact can be foreseen when the piston crown is not completely parallel to the cylinder head flame deck.

[0020] Thanks to the present invention, improved fuel consumption is achieved due to a higher combustion efficiency and/or lower air pumping requirement for same combustion air fuel ratio.

[0021] According to a preferred embodiment of the invention, the above gap control is applied to a diesel combustion engine. The aim of the present invention is achieved through gap minimization/elimination of a die-

sel engine according to claim 1.

[0022] According to the present invention, the gap is considered to be zero when it is between 0.01 and 0.2 mm according to the machining tolerances of the head and the piston crown. Even considering 0.2 mm, the clearance volume is relevantly reduced.

[0023] These and further objects are achieved by means of the attached claims, which describe preferred embodiments of the invention, forming an integral part of the present description.

Brief description of the drawings

[0024] The invention will become fully clear from the following detailed description, given by way of a mere exemplifying and non limiting example, to be read with reference to the attached drawing figures, wherein:

- Fig. 1 shows a longitudinal section of a piston coupled with the head of a cylinder, wherein the piston is at TDC where a gap is defined between the piston crown and the head.

[0025] The same reference numerals and letters in the figures designate the same or functionally equivalent parts.

[0026] According to the present invention, the term "second element" does not imply the presence of a "first element", first, second, etc.. are used only for improving the clarity of the description and they should not be interpreted in a limiting way.

Detailed description of the preferred embodiments

[0027] Figure 1 discloses a piston P at its TDC position.

[0028] A gap G is defined between the piston P and its relating cylinder head.

[0029] In particular, the piston has a crown CR, circa circumferentially flat, while in central portion of the crown the combustion engine CH is arranged.

[0030] It should be understood that the piston and its head could have different shapes with respect to the example in figure 1. For example, a portion of the combustion chamber is defined also in a cavity of the head. Nevertheless, the gap between the circumferential portion of the piston and the head does not participate to the combustion, therefore, the aim of the present invention is to reduce such gap as much as possible to improve combustion efficiency.

[0031] According to the invention, the gap control is executed on the basis of the engine temperature.

[0032] The engine temperature can be measured through a sensor associated to an engine cooling circuit and/or an engine lubricating circuit.

[0033] Usually water is implemented to cool the engine, while oil is implemented both to lubricate and cool the engine.

[0034] Therefore, the gap is adjusted during thermal transient.

[0035] According to a further embodiment of the invention, the gap control is executed also on the basis of the engine speed.

[0036] This control can be applied in order to achieve a further reduction of the gap, with respect to the sole temperature control.

[0037] According to a further embodiment of the invention, the gap is controlled as a response of a feedback of a noise sensor coupled with at least one on the cylinder head.

[0038] Preferably, a look up table can be used with said two entries, temperature/speed, to manage the gap control.

[0039] The noise sensor can be preferably implemented to modify the look up table so as to account for engine wear.

[0040] Any known solution to vary the engine compression ratio can be implemented to maintain said gap constantly close to zero.

[0041] It will be apparent to those skilled in the art that specific details need not be described, that example embodiments may be embodied in many different forms and that neither should be construed to limit the scope of the disclosure. In some example embodiments, well known processes, well-known device structures, and well known technologies are not described in detail.

[0042] This invention can be implemented advantageously in a computer program arranged and/or configured to manage system to control piston TDC and programmed to implement the present invention. The computer program comprising program code means for performing one or more steps of such method, when such program is run on a computer. For this reason, the patent shall also cover such computer program and the computer-readable medium that comprises a recorded message, such computer-readable medium comprising the program code means for performing one or more steps of such method, when such program is run on a computer.

[0043] The features disclosed in the prior art background are introduced only in order to better understand the invention and not as a declaration about the existence of known prior art. In addition, said features define the context of the present invention, thus such features shall be considered in common with the detailed description.

[0044] Further implementation details will not be described, as the man skilled in the art is able to carry out the invention starting from the teaching of the above description.

Claims

1. Cold start management system for a diesel combustion engine (E), the combustion engine comprising a cylinder, a piston (P) mounted for reciprocating movement in the cylinder, a cylinder head (H) mount-

ed to overlie the cylinder and with the cylinder and a face (F) of the piston defining a combustion chamber (CH) and a surface (CR) surrounding the combustion chamber; wherein said reciprocating movement defines, when the piston is in a closest position with respect to said cylinder head, a gap (G) between said surface (CR) and said cylinder head (H), the system comprising minimization means configured to minimize said gap on the basis of an engine temperature.

2. System according to claim 1, wherein the engine comprises a temperature sensor associated with an engine coolant circuit and/or an engine lubricating circuit.

3. System according to any one of previous claims 1 or 2, wherein the system further comprises speed sensor means arranged to measure an engine speed and wherein said minimization means are arranged to minimize said gap on the basis of an engine speed also.

4. System according to any one of the previous claims 1 - 3, further comprising a noise sensor associated with said engine head, wherein said gap is adjusted on the basis of a signal generated by said noise sensor, thereby increasing said gap when a slight collision is detected between said piston and said engine head.

5. System according to claim 4, wherein said minimizing means are arranged to implement a look up table having two inputs and a gap adjustment as output, wherein a first input of said two inputs is said measured temperature and a second input of said two inputs is said engine speed and wherein said minimizing means are arranged to modify said look up table when a slight collision is sensed by said noise sensor.

6. Method for cold start management for a diesel combustion engine (E), the combustion engine comprising a cylinder, a piston (P) mounted for reciprocating movement in the cylinder, a cylinder head (H) mounted to overlie the cylinder and with the primary cylinder and a face (F) of the piston defining a combustion chamber (CH) and a surface (CR) surrounding the combustion chamber; wherein said reciprocating movement defines a gap (G) between said surface (CR) and said cylinder head (H), the method comprising a minimization step of minimizing said gap on the basis of an engine temperature.

7. Method according to claim 6, wherein minimization step is carried out also on the basis of an engine speed.

8. Engine control unit configured for carrying out all the steps of any one of previous clams 6 and 7 and configured to interact with the minimizing means according to any one of claims 1 - 5.

9. Diesel combustion engine provided with the cold start management system according to any one of claims 1 - 5.

10. Terrestrial vehicle comprising the diesel combustion engine of claim 9.

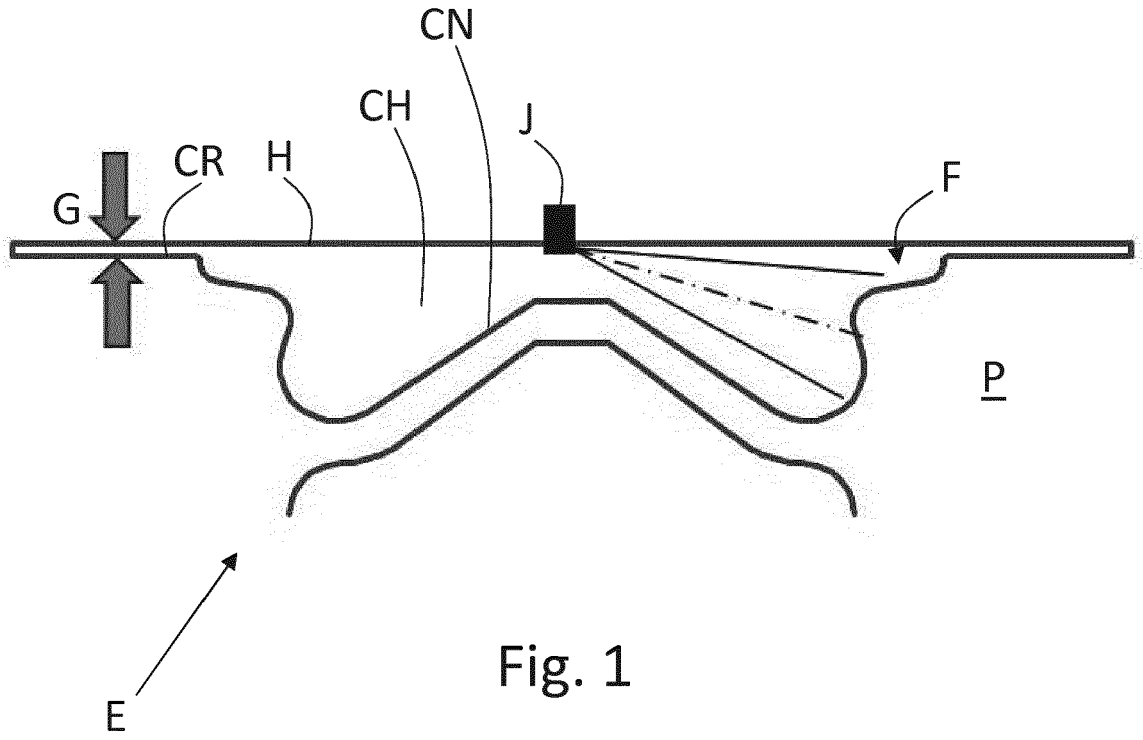

Fig. 1

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EUROPEAN SEARCH REPORT

Application Number
EP 19 20 2838

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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A	* paragraphs [0016], [0020] - [0022]; claims 3,4; figures 1,3 *	4,5	
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A	* claims 1-4; figures 1-8 *	4,5	
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
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X : particularly relevant if taken alone
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 19 20 2838

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
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