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(54) Title: METHOD AND DEVICE FOR DETERMINING THE POSITION OF A CRANK- AND/OR CAMSHAFT OF AN INTERNAL COMBUSTION ENGINE

(57) Abstract: A method for determination of a crankshaft's (12) and/or camshaft's (13) position in a combustion engine (1) with at least one cylinder (61-66), comprising the steps of, at a movement of a piston (14) in said cylinder (61-66), detecting propagating movements in a cylinder head (8) of the cylinder (61-66) or in parts adjacent thereto in the engine (1), and determining said position based on said detected movements.

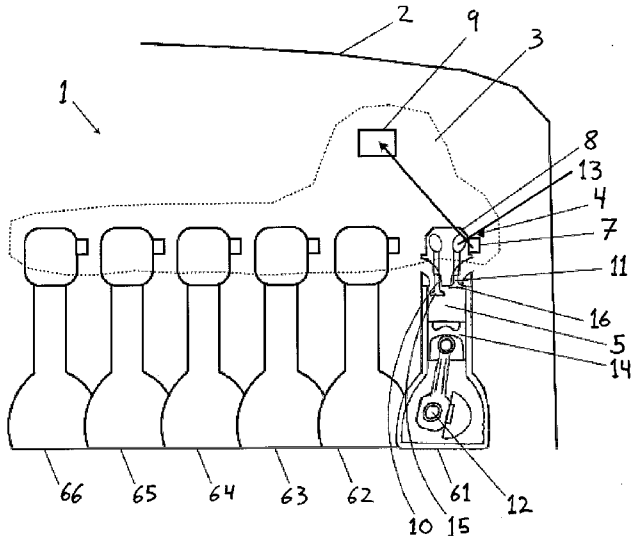


Fig. 1

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METHOD AND DEVICE FOR DETERMINING THE POSITION OF A CRANK- AND/OR CAMSHAFT OF AN INTERNAL COMBUSTION ENGINE

FIELD OF THE INVENTION

The present invention relates to a method and a device for determination of a crankshaft's and/or a camshaft's position in a combustion engine with at least one cylinder.

BACKGROUND

There is a constant aspiration to achieve control of a combustion engine, in such a manner that fuel used therein is burned in the engine's cylinders, while generating a maximum amount of energy/fuel mass output from the engine and a minimum amount of emissions of environmentally hazardous pollutants. It is of decisive importance in such aspiration to have constant knowledge of the combustion engine's operating conditions, such as the operating condition of the crankshafts and camshafts.

Good knowledge about the operating state of a crankshaft, such as its position and speed, may e.g. be used to determine when fuel must be supplied to the cylinder chambers and knowledge about the relationship between the respective so-called top dead centre or zero point of the crankshaft, the camshaft crank wheel and the piston may be used to reduce the precision requirements for manufacturing tolerances, which leads to cost savings in the production of these components.

Conventionally, two sensors are used, one arranged on a flywheel housing and the other on a camshaft housing. These may,

with the help of holes or protrusions arranged on a flywheel, on a crankshaft and/or on a camshaft, detect the rotational speed of the crankshaft and the position of the crankshaft, respectively. This information combined is accordingly used to determine the operating state of the camshaft, and the therewith connected crankshaft. The determination of the operating state of the crankshaft and camshafts, respectively, is expensive from a technical and production point of view, since stringent requirements relating to tolerances are required for a reliable determination to be achieved.

SUMMARY OF THE INVENTION

The objective of the present invention is to provide a method and a device, which at least partly solve the above problems, and which are improved in at least some respect in relation to prior art methods and devices.

This objective is achieved with the method and the device according to the enclosed claims. It has been shown that said position may be determined in a reliable manner in connection with movement of a piston in said cylinder, by detection of movements propagating in a cylinder head of the cylinder or in parts adjacent thereto in the engine, based on said detected movements. Examples of such adjacent parts in connection with the cylinder, but outside the cylinder, may for example be parts adjacent to the outlet from the cylinder or adjacent to the suction channel to the cylinder. Thus, e.g. the speed of the crankshaft and/or camshaft may be derived.

Therefore, this is possible without having to arrange holes or protrusions, interacting with sensors, on a flywheel of a camshaft, and in addition to a cost saving thus achieved, incorrect values as a consequence of failure of manufacturing tolerances or wear are also avoided, thanks to the invention.

The movements that may be detected and used at determination of the position and speed of said shafts may for example be vibrations, noise, i.e. gas movements, and various types of shape changes, such as protrusions, in said cylinder head or in parts adjacent thereto in the engine.

According to one embodiment of the invention, movements caused by at least one of the following events in said cylinder are detected in said detection step: turns of said piston, positional change in at least one valve, and pressure change in a cylinder chamber. It has been shown that said movements caused by any of said events in a method of this type are suitable to be detected and used in order to determine, reliably and in a relatively unproblematic manner, the position of a crankshaft and/or camshaft.

According to another embodiment of the invention, movements caused by more than one of said events in said cylinder are detected in said detection step. Through detection of movements caused by more than one of said events and thus use of such information in order to determine a crankshaft's and/or camshaft's position, this may be determined faster and with higher precision and reliability.

According to another embodiment of the invention, in said detection step movements caused by the turning of said piston and by pressure changes in a cylinder chamber in said cylinder are detected. It has been shown that it is possible to reliably determine a crankshaft's and/or camshaft's position, based on information about movements caused by said events.

According to another embodiment of the invention, in said detection step movements caused by a positional change of a valve and by pressure changes in a cylinder chamber of said cylinder are detected. It has been shown that it is possible to reliably determine a crankshaft's and/or camshaft's position, based on information about movements caused by said events.

According to another embodiment of the invention, said movements caused by turns of said piston or by positional changes of a valve, and said pressure change within an interval of a maximum of 40 crank angle degrees, a maximum of 25 crank angle degrees or a maximum of 15 crank angle degrees are detected. Since said movements are detected within such an interval, this ensures that sufficient information to determine a crankshaft's and/or camshaft's position is obtained quickly, which entails that said position may be determined with high precision.

According to another embodiment of the invention, said detection step comprises at least a detection of said movements caused by turns of said piston or by positional changes of a valve, at least at one first crank angle, and comprises at least one detection of said pressure change at a second crank angle, wherein the distance between said first and second crank angles is at least 5

crank angle degrees, 5-20 crank angle degrees or 5-15 crank angle degrees. By detecting said movements at least at two separate crank angles, which are separate from each other to such an extent, information entailing high reliability of the result at the determination of the position of a crankshaft and/or camshaft is obtained.

According to another embodiment of the invention, said movements caused by said pressure changes are detected before and after the detection of said movements caused by turns of said piston or by positional change in a valve within said interval. It has been shown that by determining a crankshaft's and/or camshaft's position with the help of information from such detection of said pressure change, reliable results are obtained in a simple manner.

According to another embodiment of the invention, said movements caused by said pressure change are detected before and after detection of said movements caused by turns of said piston or by positional change in a valve, at a distance of at least 5 crank angle degrees, 5-25 crank angle degrees or 5-15 crank angle degrees from the detection of said movements, caused by turns of said piston or by positional change of a valve on the respective sides thereof. Thus information is obtained, which may be used to determine a crankshaft's and/or camshaft's position in an advantageous manner and with very reliable results.

According to another embodiment of the invention, in said detection step movements caused by turns of said piston and by positional change of a valve are detected. It has been shown that it is

possible, when movements caused by said events are detected, to obtain information, which is advantageous for use when determining the position of a crankshaft and/or camshaft, such as for determining very quickly the position of such shaft or shafts.

According to another embodiment of the invention, movements caused by turns of said piston and/or by positional changes in a valve with at least one first frequency are detected, and movements caused by said pressure change with at least one second frequency are detected, so that the ratio between said first and second frequency is in the range of 300:1 to 10:1, 200:1 to 20:1, or 150:1 to 50:1. It has been shown that it is possible by detecting said movements with said frequency ratio, to obtain information which is suitable for use at the determination of a crankshaft's and/or camshaft's position.

According to another embodiment of the invention, the method also comprises the steps, in connection with movement of a piston in an additional cylinder, to detect movements propagating in a cylinder head of the additional cylinder or in parts adjacent thereto in the engine, to compare movements detected in the respective cylinder with each other, and at the determination of said position, to have regard to the result of such comparison. Thus, the determination of a crankshaft's and/or camshaft's position may be determined quickly and with very high reliability.

The invention also relates to a device for determination of a crankshaft's and/or camshaft's position in a combustion engine with at least one cylinder, arranged to function according to the above. The invention also relates to a computer program, a com-

puter program product, an electronic control device, and a motor vehicle.

The invention is not limited to any specific type of combustion engine, but encompasses Otto engines as well as compression ignited engines, nor to any specific fuel, non-exhaustive examples of which may comprise fuel in the form of petrol, ethanol, diesel and gas.

Likewise, the invention comprises combustion engines intended for all types of use, such as in industrial applications, in crushing machines and various types of motor vehicles, wheeled motor vehicles as well as trucks and buses, and boats and crawlers or similar vehicles.

Other advantageous features and advantages with the invention are set out in the description below.

BRIEF DESCRIPTION OF THE DRAWINGS

Below are descriptions of example embodiments of the invention, with reference to the enclosed drawings, in which:

Fig. 1 is a schematic view illustrating a part of a combustion engine according to one embodiment of the invention,

Fig. 2 is a diagram showing on the one hand the pressure over time in the cylinder chamber of a cylinder in a combustion engine according to the invention, and on the other hand several signals generated over time by sensor elements according to Fig. 1 of the combustion

engine, as a result of detection of movements in the cylinder head,

Fig. 3 is a flow chart showing a method according to an embodiment of the invention,

Fig. 4 is a fundamental diagram of an electronic control device for implementation of one or several methods according to the invention,

Fig. 5 shows a possible placement of a sensor element.

DETAILED DESCRIPTION OF EMBODIMENTS ACCORDING TO THE INVENTION

Fig. 1 illustrates very schematically a combustion engine 1 according to one embodiment of the invention, which engine is here arranged in an implied motor vehicle 2, for example a truck. The engine is equipped with a device 3, indicated with a dashed line, adapted to detect operating conditions in the engine, and such device has a schematically drawn device 4, which is adapted to detect pressure changes in the cylinder chambers 5 of the combustion engine's cylinders 61-66, of which there are six in this case, but of which there may be any number.

The device 4 has, in order to be able to detect said pressure changes in the cylinder chambers, one sensor element 7 per cylinder 61-66, and this is arranged separately from associated cylinder chamber 5 on the respective cylinders' cylinder heads 8. The sensor elements in this case consist of piezo resistive or

piezo electrical sensors, adapted to detect pressure changes in the relevant cylinder chambers, for example in the form of vibrations, generated by movements propagated in the cylinder head, caused by turns of a piston 14 in the respective cylinders 61-66 or positional changes in the valves 10, 11, arranged in the respective cylinder heads 8.

The fact that said at least one sensor element is arranged separately from the cylinder chamber, i.e. the cylinder's combustion chamber, means that it does not come into direct contact with the inside volume of the cylinder chamber, but is completely separate therefrom. However, some form of external recess could be adapted in the wall of the cylinder chamber, in which a sensor element could be arranged.

The device 3 also comprises a unit 9, which may consist of the vehicle's 2 electronic control device, adapted to receive information about the detected movements from the sensor elements 7, and to compare such information, or information calculated based on such sensor information with stored values, and to deliver measuring values for the state of the engine 1 and/or processes in the engine, such as positions and/or speeds in a crankshaft 12 and/or camshaft 13 based on such comparison. Thus, information about the engine's operating conditions or divergences from these, which suitably provide the bases for control of various components in the combustion engine, such as for example fuel injection, may be obtained based on the sensor elements' 7 detection.

It has been shown that, by arranging such sensor elements in the manner described, so that they have the ability to detect movements propagating in the cylinder head 8 or in parts adjacent thereto in the engine 1, derived from pressure changes in the cylinder chamber 5, turns of said piston 14 and/or positional changes in said valves 10, 11, high quality signals may be obtained, which signals do not require filtering or further processing, or alternatively, which require a simple filtering or processing, to be used at the determination of a crankshaft's and/or camshaft's position.

Fig. 2 illustrates in a diagram the development of the pressure P over the time t during a working cycle in a cylinder chamber 5, without combustion in the engine 1 that uses diesel as fuel during operation and works in four strokes, which are referred to hereafter as the suction stroke, the compression stroke, the combustion stroke and the exhaust stroke and jointly constitute one said working cycle.

The markings BDC1, TDC1, BDC2, TDC2 on the time axis show at what points the piston 14 of a cylinder 61 turns, i.e. is located at a top and bottom dead centre, respectively, where BDC1 refers to the piston's turn at a first bottom dead centre at the end of the suction stroke, DC1 refers to the piston's turn at a first top dead centre at the end of the compression stroke and the beginning of the combustion stroke, BDC2 refers to the piston's turn at a second bottom dead centre at the beginning of the exhaust stroke, and TDC2 refers to the piston's turn at a second top dead centre at the end of the exhaust stroke and the beginning of the suction stroke.

The curve in the diagram shows clearly how the pressure in the cylinder chamber 5 increases between BDC1 and TDC1, reduces between TDC1 and BDC2 and remains substantially constant between BDC2 and TDC2, and between TDC2 and BDC1. At different points along the curve, there may also be noise in the form of noise IVC illustrating detected vibrations caused by the closing of the inlet valve 10, noise AVO illustrating detected vibrations caused by the opening of the exhaust valve 11, and noise a-d illustrating detected vibrations caused by a turn of said piston 14.

The pressure as well as the respective noise in the diagram are examples of movements propagating in a cylinder head 8 of the cylinder 61 or in parts adjacent thereto in the engine 1, detected by the sensor element 7. Experiments have shown that such a sensor element may be used both to detect the pressure and thus to generate signals which correspond, with great reliability, with signals generated by a conventional pressure sensor, and to detect other said movements, such as vibrations which are illustrated by way of said noise a-d, IVC, AVO.

The movements and noise IVC, AVO thus shown, deriving from positional changes in said valves 10, 11, are caused by the valve lids 15, 16 of these hitting against or repelling parts in the cylinder head 8 at closing and opening, respectively, of said valves, through which vibrations spreading in the cylinder head are created.

The movements, which are shown in the diagram as noise a-d and are derived from turns of said piston 14, are caused because

parts of the piston, at turns, come into contact with parts of the cylinder 61 connecting the piston and the crankshaft 12, so that vibrations spreading in the cylinder are created.

The measuring values displayed in the above described diagram may in various ways be used by the device 3 at the determination of e.g. the crankshaft's 12 or a camshaft's 13 position and speed.

If only pressure is detected by the sensor element 7, the device 3 may, by tracking the point on the curve where the pressure is at its highest, determine when the piston 14 turns in the first top dead centre TDC1 and accordingly, in which positions the crankshaft 12 and a camshaft 13 connected therewith are located.

Another procedure for the device 3 that may be used to determine said positions is, at the detection of a noise a-d, to measure the pressure at the same point in time, to try to find the noise b that derives from the piston's 14 turn in the first top dead centre TDC1.

Additional such approaches include, for example, at the detection of a noise a-d, to measure the pressure before and/or after said noise, in order to determine which noise is detected and thus where the crankshaft 12 and the cam shaft 13 are located. If the pressure in such an approach is measured, for example 10 and 5 crank angle degrees before the noise a-d, the noise b and c may be determined, when the pressure increases and drops, respectively, before the piston reaches the noise's corresponding dead centres TDC1 and BDC2, respectively.

If the pressure is measured instead, for example 10 and 5 crank angle degrees after the noise a-d, the noise a and b may be determined, when the pressure increases and drops, respectively, after the piston reaches the noise's corresponding dead centres BDC1 and TDC1, respectively.

In order to quickly and with high reliability determine, with this approach, the positions of said shafts 12, 13, the device 3 may measure the pressure before and after a noise a-d, for example 10 crank angle degrees on the respective sides thereof. Noise a is thus determined by way of detection of a higher pressure after the noise than before, noise b is determined by way of detection of a high pressure before and after the noise, noise c is determined by way of detection of a higher pressure before the noise than after and noise b is determined by way of detecting a substantially constant, relatively low, pressure before and after the noise.

The unit 9 in the device 3 may, through the frequency of a noise, determine whether this derives from a turn of said piston 14, which event results in noise a-d with a first frequency, or from a positional change of a valve 10, 11, which event results in noise IVC, AVO with a second, higher frequency.

At the detection of a noise IVC, AVO with said second higher frequency, by measuring the pressure, for example 10 crank angle degrees before and after said noise, the device 3 may determine the noise detected and thus where said shafts 12, 13 are located. When the pressure before such a noise is lower than the pressure after, an IVC noise has been detected, and when the pres-

sure before is higher than the pressure after, an AVO noise has been detected.

IVC, AVO noise with the higher frequency may also be used at the determination of the positions of said shafts 12, 13 without having regard to pressure measurements. When such a noise is detected, the device 3 may instead seek to find a noise a-d with a lower frequency within an interval of e.g. 15 crank angle degrees, with said noise with a higher frequency as a middle point. When such a noise a with a lower frequency has been detected before the one with the higher frequency, the latter noise is referred to as IVC and when noise c with a lower frequency is detected after the one with the higher frequency, the latter noise is accordingly referred to as AVO.

At the determination of, for example, the speed of a crankshaft 13, the device 9 may determine at what points in time it is located in a certain or certain positions, and based on such information calculate the time it takes for the crankshaft to rotate from one position to another. For example, the device 9 may measure the time it takes for the piston 14 to return from TDC1 in one working cycle to TDC1 in the next working cycle, or the time which is required before AVO is detected after IVC has been detected.

With the help of detection of said movements, the measuring results of which in several cylinders 61-66 of the engine 1 are illustrated in Fig. 1, the positions and speeds of said shafts 12, 13 may be determined at the same time, by way of additional advantageous approaches. For example, the detection of said move-

ments generating noise IVC in the first cylinder 61 in the engine 1 with six cylinders 61-66, entails that the exhaust valve opens in the sixth cylinder 66 at the same time, which generates noise AVO. Such information from several interacting cylinders in the engine 1, detected with the help of a sensor element for the respective cylinder, may be used by the unit 9 in order to determine the operating conditions in the engine, such as the crankshaft's 12 position, in a more complex and significantly faster manner, providing a higher level of precision.

Fig. 3 shows a flow chart illustrating an embodiment of a method according to the present invention to determine a crankshaft's and/or camshaft's position in a combustion engine with at least one cylinder, when a piston in said cylinder moves. In a first step S_1 movements propagating in a cylinder head of the cylinder or in parts adjacent thereto in the engine are detected, and in a second step S_2 said position is determined based on said detected movements.

A computer program code for the implementation of a method according to the invention is suitably included in a computer program, loadable into the internal memory of a computer, such as the internal memory of an electronic control device of a combustion engine. Such a computer program is suitably provided via a computer program product, comprising a data storage medium readable by an electronic control device, which data storage medium has the computer program stored thereon. Said data storage medium is e.g. an optical data storage medium in the form of a CD-ROM, a DVD, etc., a magnetic data storage medium in the

form of a hard disk drive, a diskette, a cassette, etc., or a Flash memory or a ROM, PROM, EPROM or EEPROM type memory.

Fig. 4 very schematically illustrates an electronic control device 9 comprising execution means 17, such as a central processor unit (CPU), for the execution of computer software. The execution means 17 communicates with a memory 18, e.g. a RAM memory, via a data bus 19. The control device 9 also comprises a data storage medium 20, e.g. in the form of a Flash memory or a ROM, PROM, EPROM or EEPROM type memory. The execution means 17 communicates with the data storage means 20 via the data bus 19. A computer program comprising computer program code for the implementation of a method according to the invention is stored on the data storage medium 20.

Fig. 5 shows a possible sensor placement. The sensor element 7 is here placed on a section adjacent to the cylinder head. In this example, the sensor element is placed on the engine, specifically on the engine block. The sensor elements/sensors 7 may be of a suitable type, e.g. piezo resistive or piezo electrical elements or optical sensors. The sensor element may here be placed on the engine, in an area adjacent to the outlet of the exhaust channel from a cylinder. For example, it may be placed on a surface on the engine block next to the outlet, on the engine, of the exhaust channel from a cylinder. The surface where the sensor 7 is placed may be substantially vertical. The sensor may be arranged to detect movements, which are perpendicular to the movements of the piston. The sensor may also be arranged to detect movements, which are perpendicular both in relation to the piston's direction of movement and in relation to the engine's

longitudinal direction. In one embodiment, the sensor is located on the engine's long side. The sensor may be arranged to detect movements in a direction, which is perpendicular in relation to the surface on which it is placed.

In another embodiment (not displayed), the sensor element 7 may be placed in a corresponding manner as when placed on the engine at the outlet of the exhaust channel from a cylinder, but instead placed in a corresponding location on the engine, at the suction channel's inlet to a cylinder.

The signal detected by the sensor element 7 may be treated in various ways. For example, the following signal treatment steps may be carried out. First the sensor's electrical signal is entered into a control device/signal treatment device. The signal is filtered with a bandpass filter in order to remove superfluous information, which does not belong to the frequency range around which information is required. The signal is evened out by way of filtering, averaging or by being replaced with one or several continuous function(s) with good likeness. Subsequently, the signal is scaled, e.g. with the help of the correlation between pressure and volume at compression. Subsequently, (a) suitable part(s) of the signal is/are transformed to the pressure domain. Supplemental modelling closes gaps in the signal's reliability, in order to form a pressure curve. The thus formed pressure curve is used to calculate different values at engine control. In some embodiments one or several of the steps above may be omitted.

The invention is obviously not limited in any way to the embodiments described above, but numerous possible modifications

thereof should be obvious to a person skilled in the area, without such person departing from the spirit of the invention as defined by the appended claims.

For example, the combustion engine could have another number of cylinders than displayed. A sensor element to detect movements derived from the cylinder chambers in all cylinders is also unnecessary, and it is even plausible that the device may have only one sensor element, intended to detect movements derived from pressure changes in only one of the engine's cylinders.

The sensor elements may be adapted to detect said movements also when there is no combustion in the engine's cylinders, but when there are still changes in the pressure inside the cylinder chambers, for example when starting the combustion engine with a starting engine, or when combustion occurs in the engine's cylinder chamber.

The diagram displayed in Fig. 2 is prepared for illustrative purposes, and thus the information that may be derived therefrom is not necessarily realistic with respect to scales etc. Corresponding diagrams for different types of engines may also differ in terms of appearance, as a consequence of, for example, different timing of opening and/or closing of a valve in these.

A piston which, at a turn, gives rise to movements, such as vibrations, relates to a piston which, when the engine is in operation, carries out a forward and backward movement in the cylinder and therefore operates a crankshaft connected with the piston.

The number of valves per cylinder may vary from only one inlet valve and one outlet valve, respectively, up to three or four of such respective valve types, or even more.

Detection of movements caused by a pressure change also relates to comprising detection of the absence of such movements, in a sensor element adapted to detect such movements when pressure changes arise. This detected absence then indicates that the pressure is substantially unchanged during a certain time, which indicates that we are currently in, for example, the suction stroke or the exhaust stroke.

The described manners in which the innovative device may use movements detected by the sensor element to determine the position of a crankshaft's and/or camshaft are examples thereof, and thus not intended to limit the area of use of the invention.

Claims

1. Method for determination of a crankshaft's (12) and/or camshaft's (13) position in a combustion engine (1) with at least one cylinder (61-66), **characterised** in that it comprises the steps, in connection with movement of a piston (14) in said cylinder (61-66)

   - to detect propagating movements in a cylinder head (8) of the cylinder (61-66) or in parts adjacent thereto in the engine (1), and

   - to determine said position based on said detected movements.

2. Method according to claim 1, **characterised** in that the detection is carried out in or on said cylinder head (8).

3. Method according to claim 1, **characterised in that** the detection is carried out in an area on the engine, adjacent to the outlet of the exhaust channel from a cylinder.

4. Method according to claim 1, **characterised** in that the detection is carried out in an area on the engine, adjacent to the suction channel's inlet to a cylinder.

5. Method according to any of claims 1 - 4, **characterised** in that, at said detection step movements caused by at least one of the following events in said cylinder (61-66) are de-

tected: turns of said piston (14), positional change in a valve (10, 11) and pressure change in a cylinder chamber (5).

6. Method according to claim 5, **characterised** in that in said detection step, movements caused by more than one of said events in said cylinder (61-66) are detected.

7. Method according to one of the previous claims, **characterised** in that in said detection step movements caused by turns of said piston (14) and pressure changes in a cylinder chamber (5) of said cylinder (61-66) are detected.

8. Method according to one of the previous claims, **characterised** in that in said detection step movements caused by a positional change of a valve (10, 11) and a pressure change in a cylinder chamber (5) in said cylinder (61-66) are detected.

9. Method according to claim 7 or 8, **characterised** in that said movements, caused by turns of said piston (14) or a positional change in a valve (10, 11) and said pressure change, are detected within an interval of a maximum of 40 crank angle degrees, a maximum of 25 crank angle degrees or a maximum of 15 crank angle degrees.

10. Method according to claim 7 or 8, **characterised** in that said detection step comprises at least one detection of said movements, caused by a turn of said piston (14) or a positional change of a valve (10, 11) at least at one first crank angle, and at least one detection of said pressure change at a second crank angle, wherein the distance between said first and second crank

angles is at least 5 crank angle degrees, 5-20 crank angle degrees or 5-15 crank angle degrees.

11. Method according to claims 9 and 10, **characterised** in that said movements caused by said pressure change are detected before and after the detection of said movements caused by a turn of said piston (14) or by a positional change of a valve (10, 11) within said interval.

12. Method according to claim 11, **characterised** in that said movements caused by said pressure change is detected before and after the detection of said movements caused by a turn of said piston (14) or by a positional change in a valve (10, 11), at a distance of at least 5 crank angle degrees, 5-25 crank angle degrees or 5-15 crank angle degrees from the detection of said movements caused by a turn of said piston (14) or by a positional change in a valve (10, 11) on the respective sides thereof.

13. Method according to any of the previous claims, **characterised** in that in said detection step the movements caused by a turn of said piston (14) and by a positional change in a valve (10, 11) are detected.

14. Method according to any of the previous claims, **characterised** in that movements caused by a turn of said piston (14) and/or by a positional change in a valve (10, 11) with at least a first frequency are detected, and movements caused by said pressure change with at least one second frequency are detected, wherein the ratio between said first and second frequency is in the range of 300:1 to 10:1, 200:1 to 20:1, or 150:1 to 50:1.

15. Method according to any of the previous claims, **characterised** in that it also comprises the steps of, at a movement of a piston (14) in an additional cylinder (61-66),

- detecting propagating movements in a cylinder head (8) of the cylinder (61-66) or in parts adjacent thereto in the engine (1),

- comparing the movements detected in the respective cylinder (61-66) with each other, and

- at the determination of said position, having regard to the result of such comparison.

16. Device (3) for determination of a crankshaft's (12) and/or camshaft's (13) position in a combustion engine (1) with at least one cylinder (61-66), **characterised** in that it comprises at least one sensor element (7), arranged separately from a cylinder chamber (5) in said cylinder (61-66) on a part of a cylinder head (8) or in parts adjacent thereto in the engine (1), and adapted to detect, at a movement of a piston (14) in said cylinder chamber (5), movements propagating in said cylinder head (8) or said parts.

17. Device according to claim 16, **characterised** in that said sensor element (7) is arranged in or on said cylinder head (8).

18. Device according to claim 16, **characterised** in that said sensor element (7) is placed on the engine, in an area adjacent to the outlet of the exhaust channel from a cylinder.

19. Device according to claim 16, **characterised** in that said sensor element (7) is placed on the engine, in an area adjacent to the inlet of the suction channel to a cylinder.

20. Combustion engine (1), **characterised in that** it comprises a device (3) according to any of claims 16 - 19.

21. Computer program which may be downloaded directly into the internal memory of a computer, which computer program comprises a computer program code in order to make the computer control the steps according to any of claims 1-15 when said computer program is executed in the computer.

22. Computer program product comprising a durable data storage medium (20), which is readable by a computer, the computer program code of a computer program according to claim 21 being stored on the data storage medium (20).

23. Electronic control device (9) for a combustion engine (1), comprising an execution means (17), a memory (18) connected to the execution means (17) and an execution means (17) connected to the data storage medium (20), the computer program code in a computer program according to claim 21 being stored on said data storage medium (20).

24. Motor vehicle, **characterised in that** it comprises a combustion engine (1) according to claim 20.

25. Motor vehicle according to claim 24, **characterised** in that it is a wheeled motor vehicle, such as a truck or a bus, or a boat or a crawler.

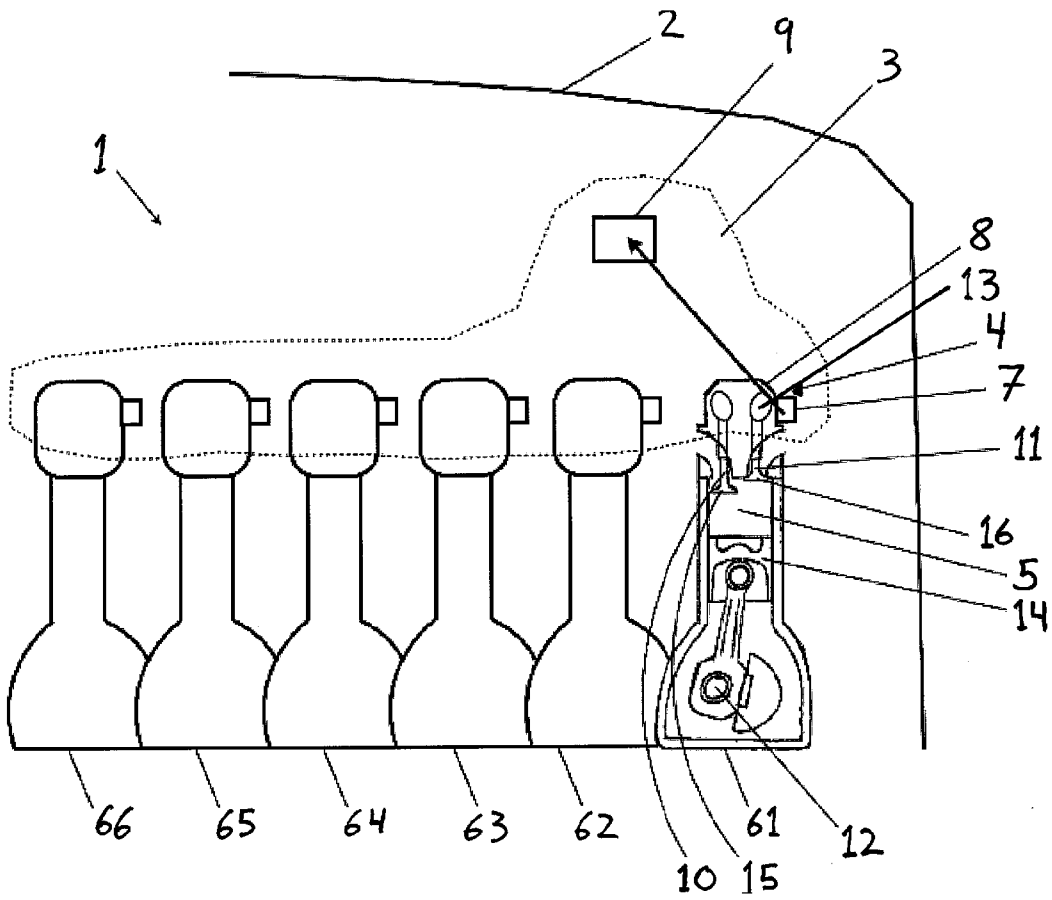


Fig. 1

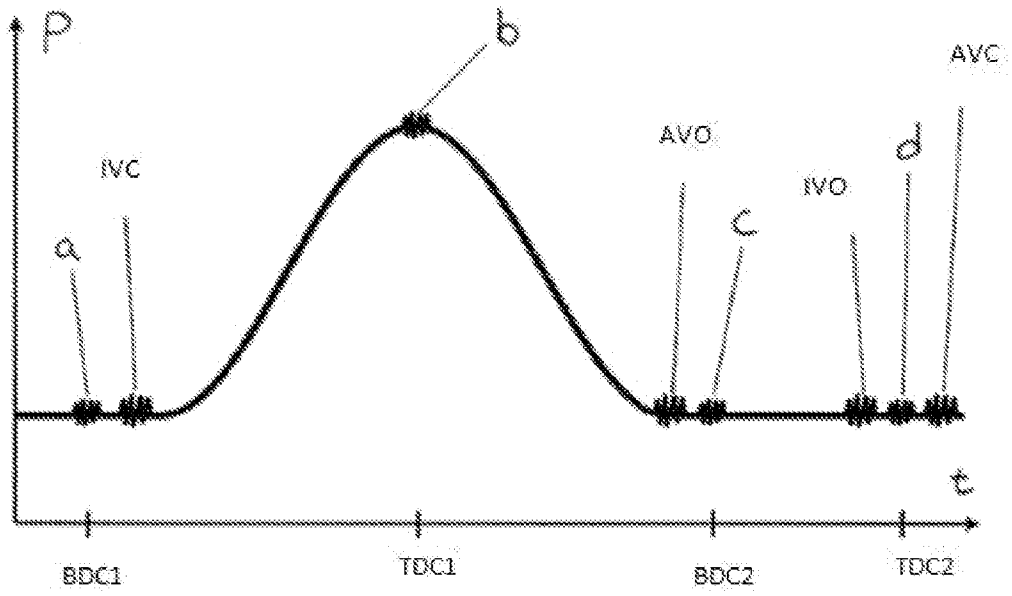

P
b
AVC
IVC
AVO
d
IVO
c
a
t
BDC1
TDC1
BDC2
TDC2

Fig. 2

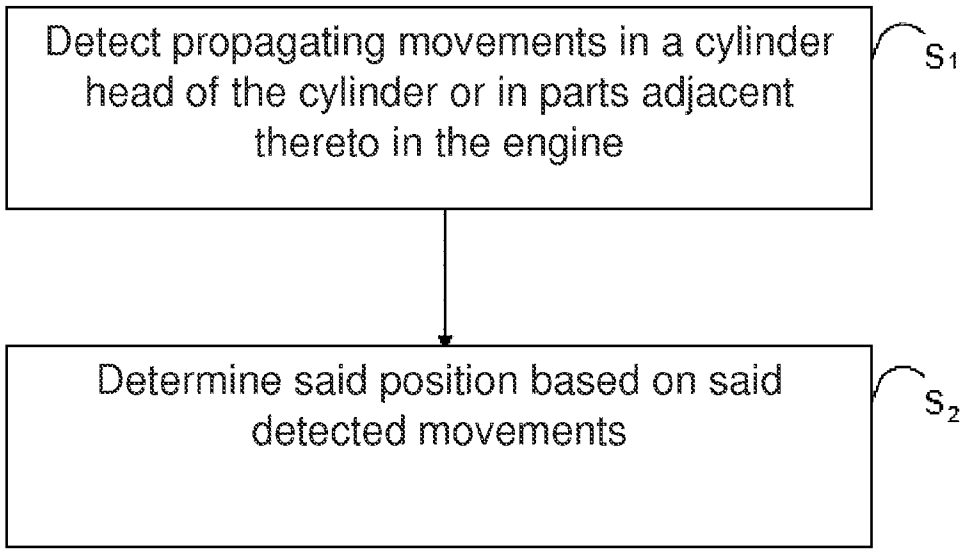

Detect propagating movements in a cylinder head of the cylinder or in parts adjacent thereto in the engine
S1
Determine said position based on said detected movements
S2

Fig. 3

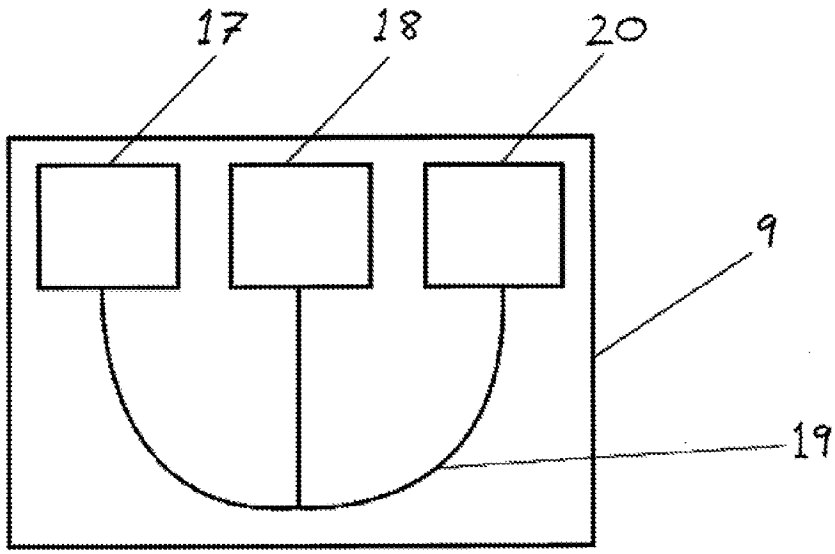


Fig. 4

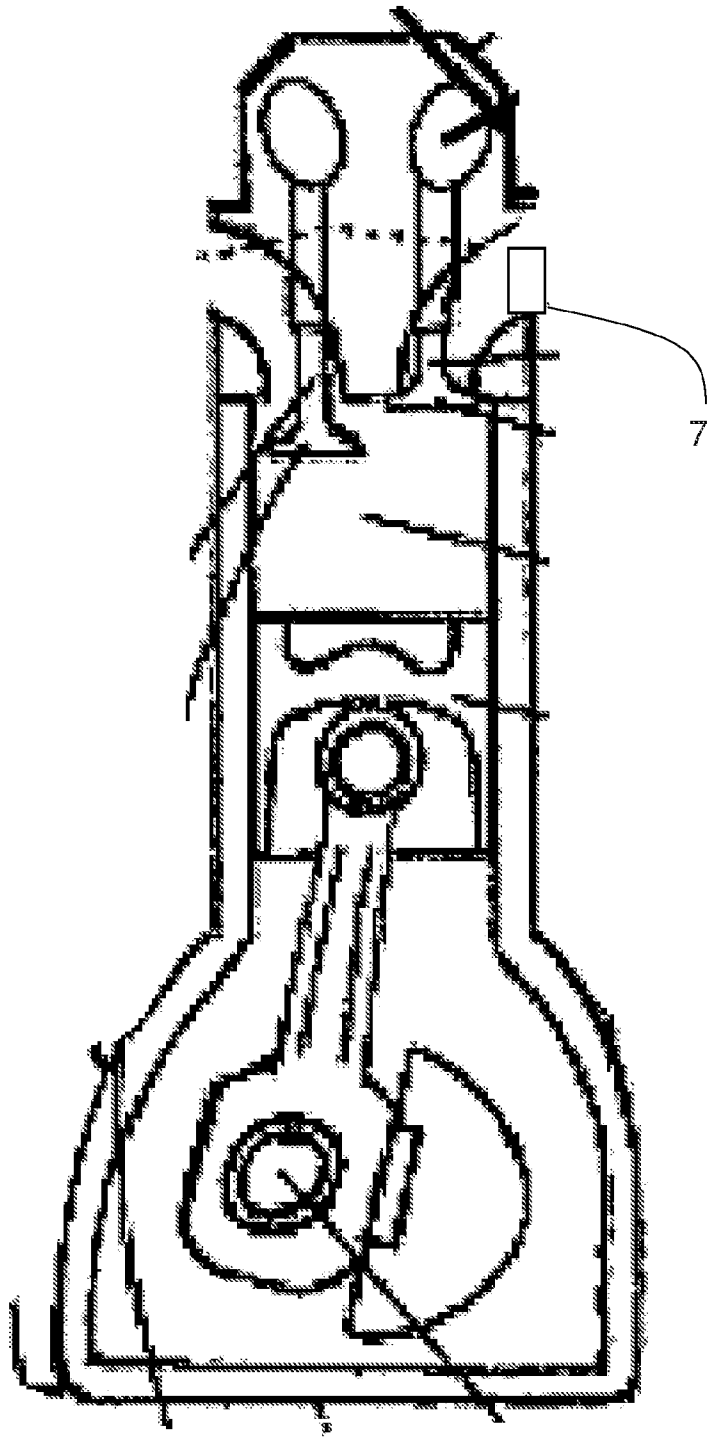


Fig. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2015/050694

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

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)

IPC: F02B, F02D, G01M

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, PAJ, WPI data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 06173751 A (NIPPON DENSO CO), 21 June 1994 (1994-06-21); abstract; paragraphs [0020], [0033]; figures 2,7 --	1-25
X	JP 2013024063 A (HITACHI AUTOMOTIVE SYSTEMS LTD), 4 February 2013 (2013-02-04); abstract; paragraph [0019]; figures 1,4 --	1-25
X	US 20130211694 A1 (TAGLIALATELA FERDINANDO ET AL), 15 August 2013 (2013-08-15); paragraphs [0017], [0046]; claim 1 --	1-25

☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
16-10-2015	16-10-2015
Name and mailing address of the ISA/SE Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. + 46 8 666 02 86	Authorized officer Marianne Dickman Telephone No. + 46 8 782 28 00

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2015/050694

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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A	US 4640250 A (HOSAKA AKIO ET AL), 3 February 1987 (1987-02-03); column 3, line 62 - column 4, line 13; figure 4	1-25
A	US 20110132327 A1 (ASO KOJI ET AL), 9 June 2011 (2011-06-09); abstract; paragraph [0168]	1-25
A	DE 102006061566 A1 (BOSCH GMBH ROBERT), 3 July 2008 (2008-07-03); abstract; paragraph [0002]; claims	1-25

International application No.
PCT/SE2015/050694

Continuation of: second sheet

International Patent Classification (IPC)

F02D 35/02 (2006.01)
F02B 77/08 (2006.01)
G01M 15/12 (2006.01)

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				EP	2066891	A1	10/06/2009
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