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(54) APPARATUS AND METHOD FOR DIAGNOSING FAILURE OF PISTON COOLING JET OF ENGINE

(57) An apparatus for diagnosing failure of a piston cooling jet of an engine includes an oil line for a piston cooling jet arranged in a cylinder block in a longitudinal direction, a piston cooling jet mounted at the oil line for the piston cooling jet to inject oil to a piston, a solenoid valve mounted at an inlet of the oil line for the piston cooling jet to selectively allow an injection operation of the piston cooling jet, an oil pressure detecting means mounted at the oil line for the piston cooling jet after the solenoid valve to detect oil pressure, and a control unit configured to receive a detection signal of the oil pressure detecting means and determine whether the solenoid valve is in a failure state.

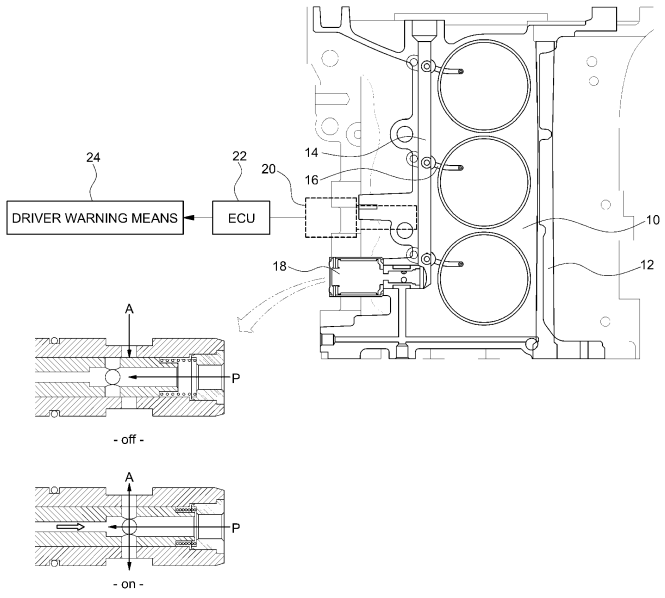

FIG.4

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Description

TECHNICAL FIELD

[0001] The present disclosure relates to an apparatus and a method for diagnosing a failure of a piston cooling jet of an engine, and more particularly, to an apparatus and a method for diagnosing a failure of a piston cooling jet of an engine, which are capable of determining a failure of a solenoid valve to selectively operate a piston cooling jet.

BACKGROUND

[0002] A main oil gallery formed in a cylinder block of an engine for a vehicle serves as a path for lubricating oil from the cylinder block to a crank shaft and various perturbation units.

[0003] In addition to the main oil gallery, to prevent the piston ring from being burned increasing thermal fatigue stresses of a piston, and preventing cylinder block damage, a piston cooling jet (PCJ) can be installed in the cylinder block.

[0004] Referring to FIGS. 1 and 2, a main oil gallery 12 is longitudinally arranged at one side of the cylinder block 10, an oil line 14 for a PCJ is longitudinally arranged at the opposite side, and a PCJ 16 for injecting oil into a piston is mounted at the oil line 14 for the PCJ.

[0005] A solenoid valve 18 is mounted at an inlet of the oil line 14 for the PCJ. When the solenoid valve 18 is turned on, oil flows to the oil line 14 for the PCJ, so that an oil injection operation of the PCJ 16 is performed. When the solenoid valve 18 is turned off, an oil flow to the oil line 14 for the PCJ is blocked.

[0006] To conform to particle material regulations under Emission regulations, considering that it is necessary to efficiently manage thermal efficiency of the engine, oil is not continuously circulated to the PCJ. Rather, the oil injection operation of the PCJ is controlled to be on or off in accordance with a running condition of the engine.

[0007] As can be seen in FIG. 3, the oil injection operation of the PCJ is divided into an oil jet injection region, in which oil is injected into the piston, and an oil jet stopped region, in which an oil injection is stopped, according to an engine load and an engine speed to be controlled.

[0008] In this case, the injection operation of the PCJ is run on/off by turning on/off, correspondingly, the solenoid valve.

[0009] That is, when the ECU operates the solenoid valve 18 to be turned on according to the running condition of the engine, the solenoid valve 18 is opened and the oil flows to the oil line 14 for the PCJ, so that the oil injection operation of the PCJ 16 is performed. When the ECU operates the solenoid valve 18 to be turned off, the solenoid valve 18 is turned off, so that an oil flow to the oil line 14 for the PCJ is blocked.

[0010] However, when the solenoid valve has a failure, problems occur as described below.

[0011] First, when the solenoid valve is stuck in an open state due to failure, oil continuously flows to the PCJ, so that oil flow occurs and causes an increase in emissions according to a deterioration of engine thermal efficiency.

[0012] Second, when the solenoid valve is stuck in a closed state due to failure, oil cannot flow to the PCJ any longer, and the cylinder block may be damaged due to an increase in a temperature of the engine.

[0013] The above information disclosed in this Background section is only for enhancement of understanding of the background of the disclosure and therefore it may contain information that does not form the prior art that is already known in this country to a person of ordinary skill in the art.

SUMMARY OF THE DISCLOSURE

[0014] The present disclosure has been made in an effort to solve the above-described problems associated with prior art.

[0015] The present disclosure provides an apparatus and a method for diagnosing failure of a piston cooling jet of an engine, which are capable of diagnosing failure of a solenoid valve for selectively operating an injection operation of a piston cooling jet by using an oil pressure switch, thereby preventing an excess of an emission regulation value and a cylinder block from being damaged due to failure of the solenoid valve.

[0016] In one aspect, the present disclosure provides an apparatus for diagnosing a failure of a piston cooling jet of an engine, including: an oil line for a piston cooling jet arranged in a cylinder block in a longitudinal direction; a piston cooling jet mounted at the oil line for the piston cooling jet to inject oil to a piston; a solenoid valve mounted at an inlet of the oil line for the piston cooling jet to selectively allow an injection operation of the piston cooling jet; an oil pressure detecting means mounted at the oil line for the piston cooling jet after the solenoid valve to detect oil pressure; and a control unit configured to receive a detection signal of the oil pressure detecting means and determine whether the solenoid valve is in a failure state.

[0017] In a preferred embodiment, the apparatus may further include a driver warning means operated by the control unit when it is determined that the solenoid valve is in a failure state.

[0018] In another preferred embodiment, the oil pressure detecting means may be an oil pressure switch which is switched at a time of detecting oil pressure to generate a pressure detection signal.

[0019] In another aspect, the present disclosure provides a method of diagnosing failure of a piston cooling jet of an engine, including: opening or closing a solenoid valve in order to supply oil to an oil line for a piston cooling jet or block oil according to a running condition of an engine; injecting, by the piston oil jet, oil flowing into the

oil line for the piston cooling jet when the solenoid valve is opened; blocking oil from flowing to the oil line for the piston cooling jet when the solenoid valve is closed and stopping an injection operation of the piston oil jet; and detecting oil pressure within the oil line for the piston cooling jet, and determining that the solenoid valve is in a failure state when the oil pressure is not detected when the solenoid valve is opened or the oil pressure is detected when the solenoid valve is closed.

[0020] In a preferred embodiment, when the oil pressure is not detected when the solenoid valve is opened, it may be determined that the solenoid valve has a failure in a closed state.

[0021] In another preferred embodiment, when the oil pressure is detected when the solenoid valve is closed, it may be determined that the solenoid valve has a failure in the opened state.

[0022] In still another preferred embodiment, the method may further include operating, by a control unit, a driver warning means when it is determined that the solenoid valve has a failure.

[0023] Through the aforementioned technical solutions, the present disclosure provides the effects below.

[0024] First, it is possible to easily diagnose failure of the solenoid valve for running on/off an injection operation of the piston oil jet by detecting oil pressure of the oil line for the piston cooling jet by using the oil pressure switch, thereby preventing an excess of an emission regulation value and a cylinder block from being damaged due to failure of the solenoid valve.

[0025] Second, it is possible to reduce costs by using a cheap oil pressure switch, instead of an expensive oil pressure sensor.

[0026] Other aspects and preferred embodiments of the disclosure are discussed infra.

[0027] It is understood that the term "vehicle" or "vehicular" or other similar term as used herein is inclusive of motor vehicles in general such as passenger automobiles including sports utility vehicles (SUV), buses, trucks, various commercial vehicles, watercraft including a variety of boats and ships, aircraft, and the like, and includes hybrid vehicles, electric vehicles, plug-in hybrid electric vehicles, hydrogen-powered vehicles and other alternative fuel vehicles (e.g. fuels derived from resources other than petroleum). As referred to herein, a hybrid vehicle is a vehicle that has two or more sources of power, for example both gasoline-powered and electric-powered vehicles.

[0028] The above and other features of the disclosure are discussed infra.

BRIEF DESCRIPTION OF THE DRAWINGS

[0029] The above and other features of the present disclosure will now be described in detail with reference to certain exemplary embodiments thereof illustrated in the accompanying drawings which are given hereinbelow by way of illustration only, and thus are not limitative of the present disclosure, and wherein:

FIGS. 1 and 2 are schematic diagrams illustrating an example in which an oil line for a piston cooling jet including a main oil gallery and a piston cooling jet is arranged in a cylinder block;

FIG. 3 is a graph illustrating an injection operation region of the piston cooling jet according to a running condition of an engine;

FIG. 4 is a schematic diagram illustrating a piston cooling jet failure diagnosing apparatus of an engine according to the present disclosure; and

FIG. 5 is a flow chart illustrating a piston cooling jet failure diagnosing method of an engine according to the present disclosure.

[0030] Reference numerals set forth in the Drawings includes reference to the following elements as further discussed below.

[0031] It should be understood that the appended drawings are not necessarily to scale, presenting a somewhat simplified representation of various preferred features illustrative of the basic principles of the disclosure. The specific design features of the present disclosure as disclosed herein, including, for example, specific dimensions, orientations, locations, and shapes will be determined in part by the particular intended application and use environment.

DETAILED DESCRIPTION

[0032] Hereinafter reference will now be made in detail to various embodiments of the present disclosure, examples of which are illustrated in the accompanying drawings and described below. While the disclosure will be described in conjunction with exemplary embodiments, it will be understood that the present description is not intended to limit the disclosure to those exemplary embodiments. On the contrary, the disclosure is intended to cover not only the exemplary embodiments, but also various alternatives, modifications, equivalents and other embodiments, which may be included within the spirit and scope of the disclosure as defined by the appended claims.

[0033] Hereinafter, an exemplary embodiment of the present disclosure will be described in detail with reference to the accompanying drawings.

[0034] FIG. 4 is a schematic diagram illustrating a piston cooling jet failure diagnosing apparatus of an engine according to the present disclosure.

[0035] As can be seen in FIG. 4, a main oil gallery 12 is longitudinally arranged at one side of a cylinder block 10, an oil line 14 for a piston cooling jet is longitudinally arranged at the opposite side, and a piston cooling jet 16 for injecting oil into a piston is mounted at the oil line 14 for the piston cooling jet.

[0036] A solenoid valve 18 is mounted at an inlet of the oil line 14 for the piston cooling jet, and when the solenoid

valve 18 is turned on and opened, oil flows to the oil line 14 for the piston cooling jet, so that an oil injection operation of the piston cooling jet 16 is performed. In contrast, when the solenoid valve 18 is turned off and closed, an oil flow to the oil line 14 for the piston cooling jet is blocked.

[0037] When an electronic control unit (ECU) operates the solenoid valve 18 to be turned on according to a running condition of the engine, the solenoid valve 18 is opened and the oil flows to the oil line 14 for the piston cooling jet, so that the oil injection operation of the piston cooling jet 16 is performed. By contrast, when the ECU operates the solenoid valve 18 to be turned off, the solenoid valve 18 is closed, so that an oil flow to the oil line 14 for the piston cooling jet is blocked.

[0038] As described above, the running on/off of the injection operation of the piston cooling jet 16, that is, whether to perform the injection operation of the piston cooling jet 16, is performed by controlling the solenoid valve 18 to be turned on/off.

[0039] The present disclosure focuses on a point that it is possible to prevent an excess of an emissions and the cylinder block from being damaged due to failure of the solenoid valve by diagnosing a failure of the solenoid valve 18 being able to run on/off the injection operation of the piston cooling jet 16 as described above.

[0040] To this end, in order to detect a pressure of oil flowing within the oil line 14 for the piston cooling jet, an oil pressure detecting means 20 is mounted in the oil line 14 for the piston cooling jet after the solenoid valve 18.

[0041] The oil pressure detecting means 20 may be an oil pressure switch which is switched at the time of detecting an oil pressure to generate a pressure detection signal.

[0042] A control unit 22, that receives a detection signal of the oil pressure detecting means and determines a failure of the solenoid valve 18, is connected to the oil pressure detecting means 20.

[0043] A driver warning means 24 (for example, a warning lamp of a cluster) is connected to an output terminal of the control unit 22, so that when the control unit 22 determines that the solenoid valve 18 has failure, the driver warning means 24 is operated by a control signal of the control unit 22.

[0044] Here, a piston cooling jet failure diagnosing method of the present disclosure based on the aforementioned configuration will be described below with reference to FIGS. 4 and 5.

[0045] When the engine starts and enters a running state, and a coolant temperature of the engine is equal to or higher than a reference value, the cylinder block needs to be cooled by the oil injection operation of the piston cooling jet 16.

[0046] When the coolant temperature of the engine is equal to or higher than the reference value, the control unit turns on the solenoid valve 18 mounted at the inlet of the oil line 14 for the piston cooling jet, so that the solenoid valve 18 is opened and the piston cooling jet becomes a piston cooling jet active state. In such a state, oil passes through the solenoid valve 18 and flows to the oil line 14 for the piston cooling jet, and an oil injection operation of the piston cooling jet 16 is performed.

[0047] The cylinder block is cooled by the piston cooling jet active state in which the oil injection operation of the piston cooling jet 16 is performed.

[0048] In this case, the oil pressure switch adopted as the oil pressure detecting means 20 detects a pressure of oil flowing within the oil line 14 for the piston cooling jet in the piston cooling jet active state.

[0049] Accordingly, when the oil pressure switch detects the pressure of the oil flowing within the oil line 14 for the piston cooling jet and transmits a detection signal to the control unit 22, the control unit 22 determines that the solenoid valve 18 is normally opened, so that oil normally flows to the oil line 14 for the piston cooling jet.

[0050] By contrast, when the oil pressure switch does not transmit the pressure detection signal to the control unit 22 within a predetermined time, the control unit 22 determines that oil does not flow within the oil line 14 for the piston cooling jet because the solenoid valve 18 is maintained in a closed state due to the failure (for example, failure due to being stuck in the closed state) of the solenoid valve 18.

[0051] When the solenoid valve 18 is stuck in the closed state due to the failure, the solenoid valve 18 cannot send the oil to the piston cooling jet 16 any longer, and the cylinder block may be damaged due to an increase in a temperature of the engine. Accordingly, the control unit 22 may warn a driver of a failure state of the piston cooling jet and induce the driver to repair the piston cooling jet by operating the driver warning means 24 (for example, a warning lamp of the cluster).

[0052] When the coolant temperature of the engine is equal to or lower than a reference value, it is not necessary to cool the cylinder block by the oil injection operation of the piston cooling jet 16.

[0053] Accordingly, when the coolant temperature of the engine is equal to or lower than a reference value, the control unit turns off the solenoid valve 18 mounted at the inlet of the oil line 14 for the piston cooling jet, so that the solenoid valve 18 is closed. Thus the oil is blocked to flow to the oil line 14 for the piston cooling jet, and the piston cooling jet becomes a piston cooling jet inactive state, in which the oil injection operation of the piston cooling jet 16 is stopped.

[0054] In this case, the oil pressure switch adopted as the oil pressure detecting means 20 detects a pressure of oil flowing within the oil line 14 for the piston cooling jet in the piston cooling jet inactive state.

[0055] Accordingly, when the oil pressure switch does not transmit the pressure detection signal to the control unit 22 within a predetermined time, the control unit determines that the solenoid valve 18 is normally closed and the piston cooling jet is in a normal oil blocked state where oil does not flow to the oil line 14 for the piston cooling jet, by the closing operation of the solenoid valve 18.

[0056] By contrast, when the oil pressure switch detects the pressure of the oil flowing within the oil line 14 for the piston cooling jet and transmits the detection signal to the control unit 22, the control unit 22 determines that oil flows within the oil line 14 for the piston cooling jet because the solenoid valve 18 is maintained in an opened state due to the failure (for example, failure due to being stuck in the opened state) of the solenoid valve 18.

[0057] When the solenoid valve 18 is stuck in the opened state due to the failure, oil continuously flows to the piston cooing jet 16, so that an oil flow occurs, and the oil flow phenomenon causes an emissions increase according to a deterioration of the thermal efficiency of the engine. Accordingly, the control unit 22 may warn the driver of a failure state of the piston cooling jet and induce the driver to repair the piston cooling jet by operating the driver warning means 24 (for example, a warning lamp of the cluster).

[0058] The disclosure has been described in detail with reference to preferred embodiments thereof. However, it will be appreciated by those skilled in the art that changes may be made in these embodiments without departing from the principles and spirit of the disclosure, the scope of which is defined in the appended claims and their equivalents.

Claims

1. An apparatus for diagnosing a failure of a piston cooling jet of an engine, comprising:

   an oil line for a piston cooling jet arranged in a cylinder block in a longitudinal direction;
   a piston cooling jet mounted at the oil line for the piston cooling jet to inject oil to a piston;
   a solenoid valve mounted at an inlet of the oil line for the piston cooling jet to selectively allow an injection operation of the piston cooling jet;
   an oil pressure detecting means mounted at the oil line for the piston cooling jet after the solenoid valve to detect oil pressure; and
   a control unit configured to receive a detection signal of the oil pressure detecting means and determine whether the solenoid valve is in a failure state.

2. The apparatus of claim 1, further comprising:

   a driver warning means operated by the control unit when it is determined that the solenoid valve is in a failure state.

3. The apparatus of claim 1 or 2, wherein the oil pressure detecting means is an oil pressure switch which is switched at a time of detecting oil pressure to generate a pressure detection signal.

4. A method of diagnosing a failure of a piston cooling jet of an engine, comprising:

   Selectively opening and closing a solenoid valve in order to supply oil to an oil line for a piston cooling jet or block oil according to a running condition of an engine;
   injecting, by the piston oil jet, oil flowing into the oil line for the piston cooling jet when the solenoid valve is opened;
   blocking oil from flowing to the oil line for the piston cooling jet when the solenoid valve is closed and stopping an injection operation of the piston oil jet; and
   detecting oil pressure within the oil line for the piston cooling jet, and determining that the solenoid valve is in a failure state when the oil pressure is not detected when the solenoid valve is opened or the oil pressure is detected when the solenoid valve is closed.

5. The method of claim 4, wherein when the oil pressure is not detected when the solenoid valve is opened, it is determined that the solenoid valve has a failure in a closed state.

6. The method of claim 4, wherein when the oil pressure is detected when the solenoid valve is closed, it is determined that the solenoid valve has a failure in the opened state.

7. The method of any one of claims 4 to 6, further comprising:

   operating, by a control unit, a driver warning means when it is determined that the solenoid valve is in a failure state.

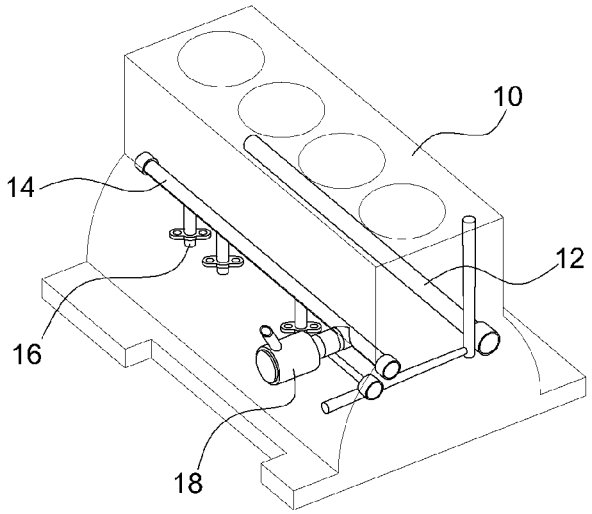


FIG.1

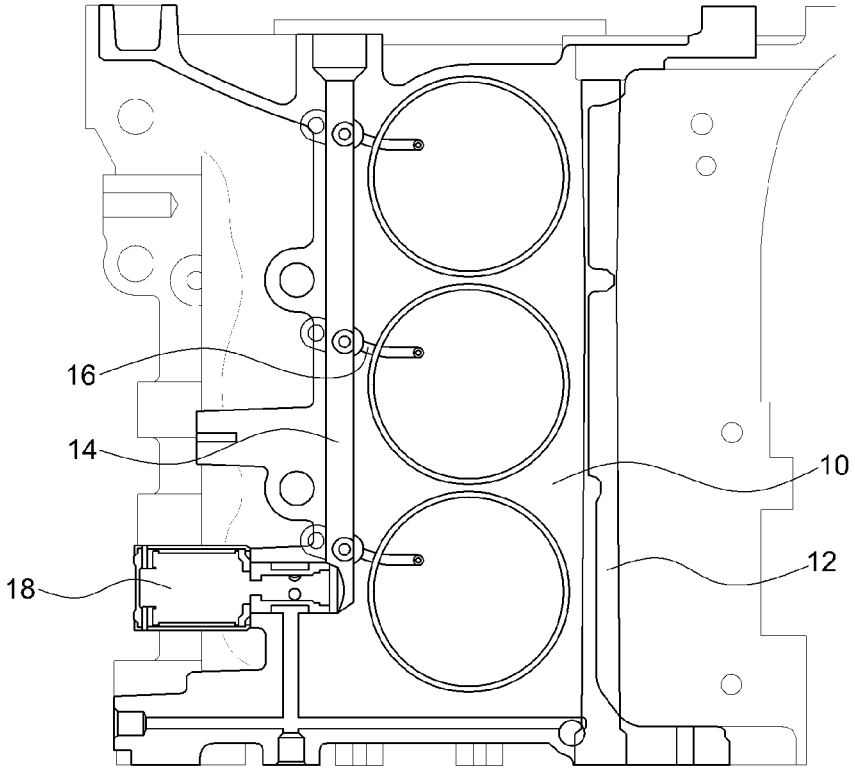
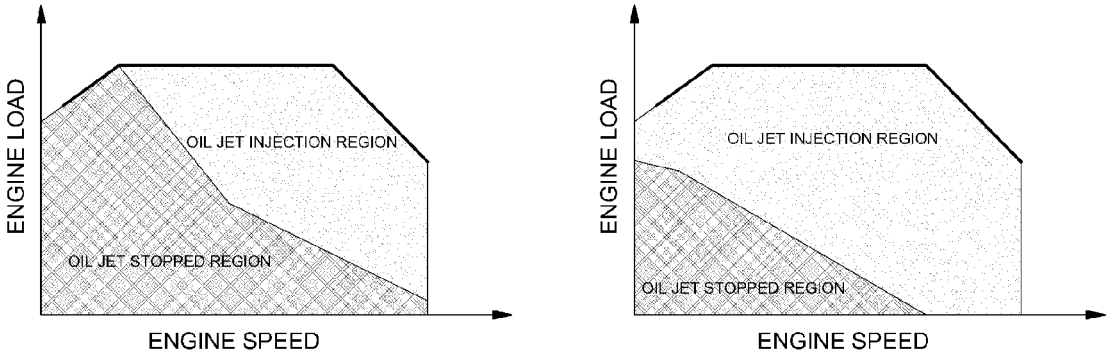


FIG.2


ENGINE LOAD
OIL JET INJECTION REGION
OIL JET STOPPED REGION
ENGINE SPEED
ENGINE LOAD
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OIL JET STOPPED REGION
ENGINE SPEED

FIG.3

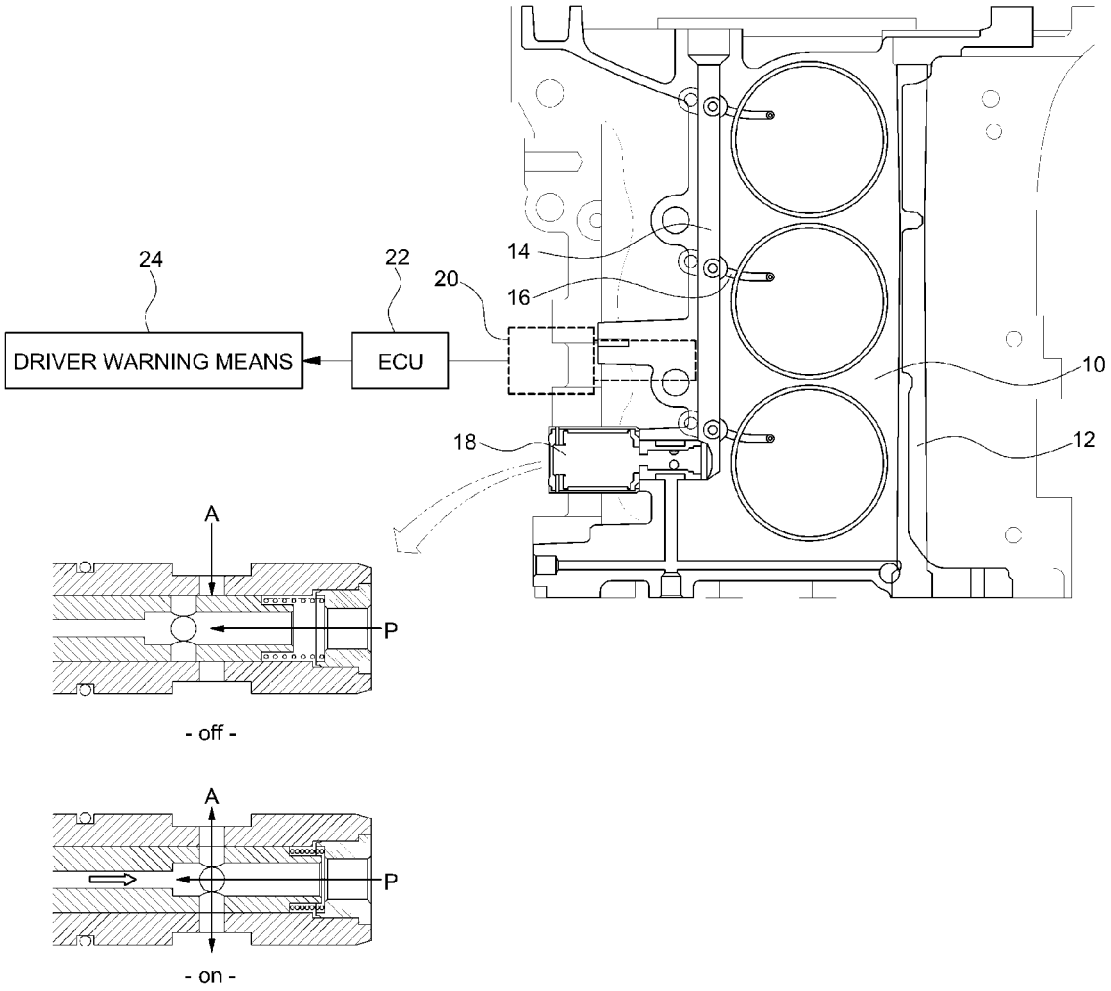
24
22
20
14
16
DRIVER WARNING MEANS
ECU
10
18
12
A
P
- off -
A
P
- on -

FIG.4

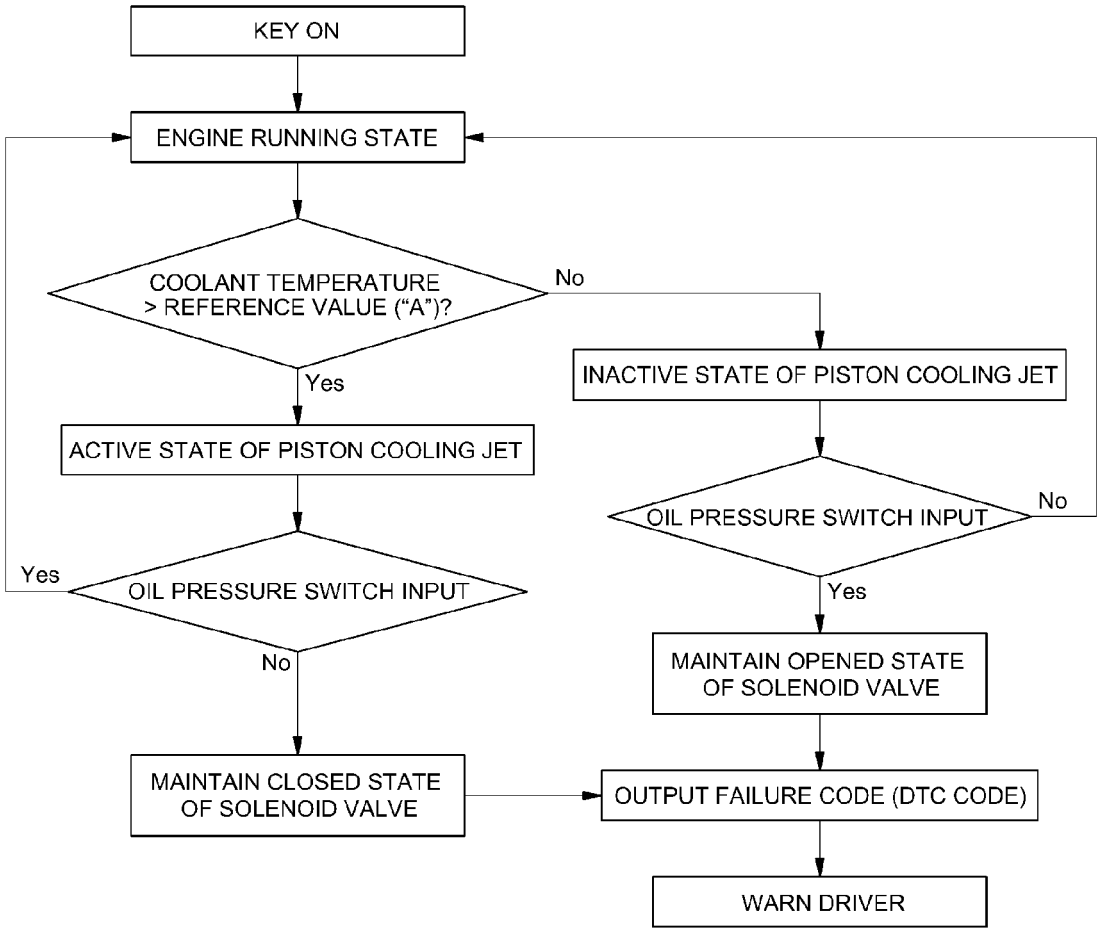
KEY ON
ENGINE RUNNING STATE
COOLANT TEMPERATURE > REFERENCE VALUE ("A")?
No
Yes
INACTIVE STATE OF PISTON COOLING JET
ACTIVE STATE OF PISTON COOLING JET
OIL PRESSURE SWITCH INPUT
No
Yes
Yes
OIL PRESSURE SWITCH INPUT
No
MAINTAIN OPENED STATE OF SOLENOID VALVE
MAINTAIN CLOSED STATE OF SOLENOID VALVE
OUTPUT FAILURE CODE (DTC CODE)
WARN DRIVER

FIG.5

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EUROPEAN SEARCH REPORT

Application Number
EP 15 19 1586

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	US 2012/296518 A1 (BRUNO MORENA [IT] ET AL) 22 November 2012 (2012-11-22) * paragraphs [0006], [0019] * * paragraphs [0045] - [0060] * * claim 1 * * figures 1-5 *	1-7	INV. F01P3/08 F01M1/08 F01M1/16 F01P11/18
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			TECHNICAL FIELDS SEARCHED (IPC) F01P F01M

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	5 October 2016	Schwaller, Vincent

CATEGORY OF CITED DOCUMENTS

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05-10-2016

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