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(54) COMPRESSED AIR STARTING SYSTEM WITH A LIQUID DETECTION DEVICE FOR AN INTERNAL COMBUSTION ENGINE, AND METHODS THEREOF

DRUCKLUFT ANLASSSYSTEM MIT FLÜSSIGKEIT ERFASSUNGSVORRICHTUNG FÜR EINEN BRENNKRAFTMASCHINE UND VERFAHREN DAFÜR

SYSTEME DE DÉMARRAGE À AIR COMPRIMÉ AVEC UN DISPOSITIF DE DETECTION DE LIQUIDE POUR UN MOTEUR A COMBUSTION INTERNE ET PROCÉDÉS ASSOCIÉS

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Description

Technical field

[0001] The present invention relates to a liquid detection system for an internal combustion engine in accordance with the preamble of claim 1, a method of operating the liquid detection system for an internal combustion engine in accordance with the preamble of the first independent method claim, and a method of upgrading an internal combustion engine with a liquid detection system in accordance with a second independent method claim.

Background art

[0002] An internal combustion engine faces a risk of having liquid in one or more of its cylinders while starting the engine. The liquid such as water may originate not only from leakage of the cylinder head gasket, but also from leaking exhaust valve seat or leaking precombustion chamber gasket in gas engines. In case of oil leakage, the source might be a leaking diesel fuel injector or lube oil coming from injector cooling circuit or from piston cooling. The liquid present in the cylinder, i.e. in the combustion chamber increases, in the compression stage, the cylinder pressure due to its non-compressibility and, in the worst case, fills or even exceeds the volume of the combustion chamber in the top dead centre position of the piston causing a powerful pressure stroke in the cylinder, when the engine is rotated, for instance, for starting purpose. Such a pressure stroke subjects all related cylinder and engine components to failure, like for instance the cylinder head gasket, the piston, the piston rings, the piston pin, the connecting rod, its bearings, and the crank shaft and its bearings and bearing blocks.

[0003] Thus, an object of the present invention is to provide an internal combustion engine with means for preventing engine failures due to liquid in the cylinder.

[0004] Another object of the present invention is to provide an internal combustion engine with means for detecting the presence of liquid in a cylinder.

[0005] A further object of the present invention is to upgrade an internal combustion engine with means for detecting the presence of liquid in at least one of its cylinders.

[0006] A still further object of the present invention is to provide an internal combustion engine with means for reacting the presence of liquid in a cylinder, for instance by creating an alarm

[0007] US3572306A shows a compressed air starting device, which uses several purge valves to evacuate water from the cylinders. JP200356421 A shows a compressed air starting device with a purge valve and liquid detector.

Disclosure of the Invention

[0008] The above and other objects of the invention are met by a liquid detection system for an internal combustion engine, the engine being provided with an arrangement for starting the engine with compressed air, the starting arrangement comprising a source of compressed air, a master starting valve, a number of individual starting valves for at least a part of the cylinders of the engine, actuators for operating the individual starting valves, and a timing means, the at least a part of the engine cylinders being in communication with the compressed air source by means of at least the master starting valve and the individual starting valves via a pipe system having a main pipe and branch pipes, and the actuators being in communication with the timing means, the liquid detection system having additional means for rotating the engine, means for affecting the actuators for simultaneous opening of the individual starting valves, at least one drain valve arranged in one of the main pipe and at least one branch pipe, a drain pipe connected to the at least one drain valve for leading liquid from the at least a part of the cylinders out of the engine, and a liquid detector in the drain pipe.

[0009] The above and other objects of the invention are met by a method of operating the liquid detection system for an internal combustion engine, the engine being provided with an arrangement for starting the engine with compressed air, the starting arrangement comprising a pipe system having a main pipe and branch pipes, the main pipe being connected to a source of compressed air, to a master starting valve, and by means if branch pipes to a number of individual starting valves for at least a part of the cylinders of the engine; actuators for operating the individual starting valves; and a timing means for sequentially opening and closing the individual starting valves by means of the actuators in order to rotate the engine, the liquid detection system comprising additional means for rotating the engine, means for by-passing the timing means, at least one drain valve, at least one drain pipe, and at least one liquid detector, the method comprising the steps of by-passing the timing means for opening the individual starting valves simultaneously, opening a flow communication from at least a part of the engine cylinders via the individual starting valves to the at least one drain pipe by means of the at least one drain valve, and rotating the engine slowly for discharging liquid medium from at least a part of the engine cylinders through starting valves into the at least one drain pipe.

[0010] The above and other objects of the invention are also met by a method of upgrading an internal combustion engine with a liquid detection system, the engine being provided with an arrangement for starting the engine with compressed air, the starting arrangement comprising a pipe system having a main pipe and branch pipes, the main pipe connected to a source of compressed air, to a master starting valve, and by means of branch pipes to a number of individual starting valves for at least a part of the cylinders of the engine; actuators for operating the individual starting valves; and a timing means for sequentially opening and closing the starting

valves by means of the actuators in order to rotate the engine, the method comprising the steps of providing the engine with additional means for rotating the engine, providing the starting arrangement with means for by-passing the timing means, providing at least one drain valve in the pipe system, providing the at least one drain valve with a drain pipe, and providing the drain pipe with a liquid detector.

[0011] Other characteristic features of the present liquid detection system and the method of operating thereof will become apparent from the appended dependent claims.

[0012] The present invention, when solving the above-mentioned problem, removes the risk of engine failure due to liquid in one or more of the engine cylinders.

Brief Description of Drawing

[0013] In the following, the liquid detection system for an internal combustion engine, the method of operating the liquid detection system for an internal combustion engine and the method of upgrading an internal combustion engine with a liquid detection system are explained in more detail in reference to the accompanying Figures, of which

Figure 1 illustrates schematically a prior art starting arrangement for an internal combustion engine,

Figure 2 illustrates schematically a liquid detection system of the present invention arranged in connection with a prior art starting arrangement of Figure 1, and

Figure 3 illustrates schematically a liquid detection system of the present invention arranged in connection with another prior art starting arrangement for an internal combustion engine.

Detailed Description of Drawings

[0014] Figure 1 illustrates schematically the basic structures and operating principles of a prior art starting arrangement 1 of an internal combustion engine that have, for instance, been discussed in more detail in WO-A1-2007003693 the disclosure of which is incorporated as a reference herein. For starting large internal combustion engines it is customary practice to use compressed air for rotating the engine. The source 2 of compressed air may, for instance, be a compressed air network or a compressor. Compressed air is led to the engine via a pipe system comprising a main pipe 4 and branch pipes 4' through a master starting valve 5 and a flame arrester 6. The compressed air is further supplied to the cylinders 3 of the internal combustion engine by means of starting valves 7, normally one starting valve 7 for each cylinder 3. However, sometimes there is no need to arrange as many starting valves as there are cylinders. For instance in V-engines there may be starting valves only on one bank of the engine. The starting valves 7 are normally arranged in connection with the cylinder head/s of the internal combustion engine so that compressed air for rotating the engine may be introduced into the combustion chamber irrespective of the position of the piston in the cylinder 3. The operation of the starting valves 7 is controlled by timing means 10, which sequentially switches on and off the connection of compressed control air from pipe 13 via pipes 12 to the actuators 8 of the starting valves 7 for sequentially opening and closing the starting valves 7.

[0015] The master starting valve 5 of the starting arrangement 1 opens communication from the compressed air source 2 via main pipe 4 and the branch pipes 4' to the starting valves 7 and is pneumatically controlled by so-called control air. The control air may be received from compressed air source 2 or from any other appropriate source via an electrically controlled solenoid valve 9. When the flow communication from the compressed air storage is opened by the electrically operated solenoid valve 9, the compressed control air affects the stem of the master starting valve 5, and moves the stem in such a position that a flow communication from the compressed air source 2 to the starting valves 7 is opened through the flame arrester 6, pipe 4 and the branch pipes 4'. At the same time compressed control air from source 2 is led along pipe 13 to the timing means 10. The timing means 10 is normally arranged in connection with the camshaft of the engine such that the operation of the timing means is synchronized with the working cycle of the engine. In a broader sense, the timing means 10 is advantageously coupled mechanically with a rotating part of the engine, whereby it enables a timely supply of compressed air to each cylinder.

[0016] A control air pipe 12 leads from the timing means 10 to each actuator 8 of the starting valves 7. The timing means 10 functions such that when switching on the flow communication from line 13 to an actuator 8 of a certain starting valve 7, the actuator 8 opens the starting valve 7, whereby compressed air from source 2 is able to enter a cylinder 3 of the engine. The opening of the starting valve 7 of an engine cylinder 3 is timed such that the cylinder is at its working cycle and the piston has just passed its top dead center position, whereby the compressed air pushes the piston down and rotates the crank shaft in proper direction.

[0017] The control air pipe 13 leading compressed air from compressed air source 8 to the timing means 10 is provided with a blocking valve 11. The purpose of the blocking valve 11 is to ensure that the engine cannot be started if, for instance, the engine turning gear is on. In other words, when the turning gear is on the valve stem has been pushed against the spring to the left to block the flow communication from the compressed air source 2 to the timing means 10.

[0018] Figure 2 illustrates a liquid detection system of the present invention arranged in connection with a prior

art starting arrangement for an internal combustion engine shown in Figure 1. Thus the same reference numerals refer to the same components. The starting arrangement illustrated in Figures 1 and 2 is normally used in smaller engines where the engine is considered to manage with one flame arrester.

[0019] The liquid detection system of the present invention comprises a valve block 20 arranged between the timing means 10 and the starting valves 7, or actually their actuators 8 in pipes 12. By means of the valve block 20 it is possible to by-pass the timing means 10, i.e. to introduce compressed control air directly from the compressed air source via pipe 22 and pipes 12 to the actuators 8 of the starting valves 7 to open the valves 7 and keep them open simultaneously. Pipe 22 may be connected to any applicable compressed air source, like for instance the one shown by reference numeral 2 in Figure 1.

[0020] The liquid detection system further comprises a drain valve 24, which is arranged in the pipe 4 normally leading compressed air from compressed air source via branch pipes 4' and starting valves 7 to the cylinders 3. A drain pipe 28 is connected to the drain valve 24 to discharge medium collected from the cylinders 3. The drain pipe 28 is provided with a liquid detector 26, which may be arranged to give an audible or visible alarm if liquid is detected in the medium. A further option is to arrange the liquid detector to make a note in the engine log, e.g. so that afterwards it is possible to see in case of a broken engine if the engine was started after the alarm. A still further option is to arrange the liquid detector to give a signal to engine automation, if liquid is detected, for blocking the starting of the engine. The liquid detector 26 may also initiate or perform other tasks, if such is desired. In addition to the above listed components the liquid detection system of the present invention requires means for rotating the engine. The means (not shown) for rotating the engine is preferably, but not necessarily, arranged in communication with the flywheel of the engine. The means may for instance be an electric or hydraulic motor or turning gear that is capable of slowly rotating the engine. In fact, the rotating means may correspond to a starter motor ordinarily used for starting a smaller-sized engine though its task is, preferably, to rotate the engine very slowly. Also other rotating means may be applied.

[0021] The liquid detection system of the present invention is operated before the engine is started, whereby the master starting valve 5 blocks the entrance of compressed air to pipe 4. Firstly, the valve block 20, for instance a series of pneumatically operating valves is arranged to by-pass the timing means 10 and to open, by means of allowing compressed control air from pipe 22 enter the actuators 8, all starting valves 7, i.e. open the communication from the cylinders 3 via branch pipes 4' to the pipe 4. Secondly, drain valve 24 is opened to arrange flow communication from pipe 4 to drain pipe 28. Thirdly, the engine is rotated slowly by the rotating means, whereby any liquid or other liquid present in the cylinders is, at least partially, pumped out to line 4. The liquid detector 26 detects the presence of liquid in the drain pipe 28 quickly and the control system may, if programmed in such a manner, stop the turning of the engine immediately and give an alarm, whereafter the cause for the presence of the water or liquid in one or more of the cylinders is found out, and, in the easiest case, the liquid, or at least a part of the liquid, is removed from the cylinder/s. Another alternative is to discharge the liquid manually. The root cause of the liquid leakage must, anyway, be found out, which normally requires the removal of the cylinder head. If it is a question of water leakage, and the leakage is bigger or has been there for a longer period of time, some part of the water may have gone via the gap between the piston and liner to the crankcase, whereby the water must be separated from lube oil. Thus a lot of manual work is required, but by means of the present invention the leakage is detected in time and larger damages are prevented.

[0022] Figure 3 illustrates another starting arrangement for an internal combustion engine including the liquid detection system of the present invention. The starting arrangement is in principle similar to the prior art arrangement discussed in connection with Figure 1. Thus the same reference numerals refer to the same components. In Figure 3, however, the starting arrangement of a larger engine has been shown, whereby a difference, compared to the starting arrangements of Figures 1 and 2, may be seen just upstream of the starting valves 7 where, in this case, an individual flame arrester 6 has been provided for each cylinder 3 in branch pipes 4'. Another difference can be seen in the position of the pipe 13 leading to the timing means 10. Now the pipe 13 is just an extension of pipe 4 taking compressed air from the master starting valve 5 to the starting valves 7, whereas in Figures 1 and 2 it was a separate pipe provided with a blocking valve. Naturally, the pipe arrangement of Figures 1 and 2, i.e. the one including the blocking valve could be used here, too.

[0023] The liquid detection system of Figure 3 functions and is operated in a similar manner as the one discussed above in connection with Figure 2.

[0024] The above description discusses the timing means 10, the valve block 20 and the actuator 8 of the starting valve 7 as pneumatic means. However, there are several options for those components. Thus, the starting point is that, since the engine has to be started with compressed air, the starting valves 7 are needed to deliver compressed air to the cylinders of the engine.

[0025] An option is that the timing means is electric, and the actuators of the starting valves 7 are electric, i.e. the valves 7 are solenoid valves. In such a case it is easy to provide the arrangement of the invention with an electric device for by-passing the timing means to open the starting valves simultaneously for operating the liquid detection system of the invention.

[0026] Another option is that the timing means is elec-

tric, and the valve block is formed of an array of solenoid valves for connecting the pneumatic actuators of the starting valves one after another, i.e. sequentially to the compressed air source for opening the valves in a timed fashion. In case all the valves are supposed to be opened simultaneously, as is needed when practicing the invention, it is easy to by-pass the timing means, to switch on all solenoid valves and, thereby, to connect all actuators simultaneously to the compressed air source.

[0027] Also, it should be understood that the pneumatic timing means 10 itself may be provided with means for opening a simultaneous communication from control pipe 13 to all control pipes 12. Thus, the use of this optional embodiment avoids the need for a separate valve block 20.

[0028] Further, it should be understood that a small group of engine cylinders (a bank of a V- engine, for instance) may be provided with a liquid detection means of their own. In a similar manner, at least a part of the engine cylinders 3 may be provided with an individual liquid detection means (the drain valve 24, the drain pipe 28 and the liquid detector 26) arranged for instance in connection with branch pipes 4', whereby the position of the leakage may be easily located. Thereby lesser measures are needed before initiating corrective actions.

[0029] It should be understood that the above is only an exemplary description of a novel and inventive liquid detection system for an internal combustion engine and a method of operating the liquid detection system. It should be understood that the above description discusses only a few preferred embodiments of the present invention without any purpose to limit the invention to only the discussed embodiments and their details. Thus the above specification should not be understood as limiting the invention by any means but the entire scope of the invention is defined by the appended claims only. From the above description it should be understood that separate features of the invention may be used in connection with other separate features even if such a combination has not been specifically shown in the description or in the drawings.

Claims

1. A liquid detection system for an internal combustion engine, the engine being provided with an arrangement for starting the engine with compressed air, the starting arrangement comprising a source (2) of compressed air, a master starting valve (5), a number of individual starting valves (7) for at least a part of the cylinders (3) of the engine, actuators (8) for operating the individual starting valves (7), and a timing means (10), the at least a part of the engine cylinders (3) being in communication with the compressed air source (2) by means of at least the master starting valve (5) and the individual starting valves (7) via a pipe system having a main pipe (4) and branch pipes (4'), and the actuators (8) being in communication with the timing means (10), **characterized in** additional means for rotating the engine, means (20) for affecting the actuators (8) for simultaneous opening of the individual starting valves (7), at least one drain valve (24) arranged in one of main pipe (4) and at least one branch pipe (4'), a drain pipe (28) connected to the at least one drain valve (24) for leading liquid from the at least a part of the cylinders (3) out of the engine, and a liquid detector (26) in the drain pipe (28).

2. The liquid detection system as recited in claim 1, **characterized in that** the timing means (10) and the actuators (8) are pneumatic, and that the means for affecting the actuators (8) is a valve block (20) for opening a communication from a compressed air source to the actuators (8) via a pipe (22) and control pipes (12).

3. The liquid detection system as recited in claim 1, **characterized in that** the timing means (10) and the actuators (8) are pneumatic, and that the timing means (10) is provided with means for opening a simultaneous connection from control pipe (13) to all control pipes (12).

4. The liquid detection system as recited in claim 1, **characterized in that** the timing means and the actuators are electric, whereby the means for affecting the actuators is an electric device by-passing the timing means for simultaneous operating of the actuators (8) for opening the starting valves (7).

5. The liquid detection system as recited in claim 1, **characterized in that** the timing means is electric, the actuators (8) are pneumatic, and the means for affecting the actuators (8) is a solenoid valve block (20) for opening a communication from a compressed air source to the actuators (8) via a pipe (22) and control pipes (12).

6. The liquid detection system as recited in any one of the preceding claims, **characterized in** means for rotating the engine slowly.

7. The liquid detection system as recited in claim 6, **characterized in that** the rotating means is an electric or hydraulic rotation gear.

8. The liquid detection system as recited in any one of the preceding claims, **characterized in that** the timing means (10) is arranged in connection with a rotating part of the engine, preferably with the camshaft.

9. A method of operating the liquid detection system for an internal combustion engine, the engine being

provided with an arrangement for starting the engine with compressed air, the starting arrangement comprising a pipe system having a main pipe (4) and branch pipes (4'), the main pipe (4) being connected to a source (2) of compressed air, to a master starting valve (5), and by means of branch pipes (4') to a number of individual starting valves (7) for at least a part of the cylinders (3) of the engine; actuators (8) for operating the individual starting valves (7); and a timing means (10) for sequentially opening and closing the individual starting valves (7) by means of the actuators (8) in order to rotate the engine, the liquid detection system comprising

- additional means for rotating the engine,
- means (20) for by-passing the timing means,
- at least one drain valve (24),
- at least one drain pipe (28), and
- at least one liquid detector (26),

characterized in the steps of,

- by-passing the timing means (10) for opening the individual starting valves (7) simultaneously,
- opening a flow communication from the at least a part of the engine cylinders (3) via the individual starting valves (7) to the at least one liquid detector (26) and drain pipe (28) by means of the at least one drain valve (24), and
- rotating the engine slowly for discharging liquid medium from at least a part of the engine cylinders (3) through starting valves (7) into the at least one drain pipe (28).

10. A method of upgrading an internal combustion engine with a liquid detection system, the engine being provided with an arrangement for starting the engine with compressed air, the starting arrangement comprising a pipe system having a main pipe (4) and branch pipes (4'), the main pipe (4) connected to a source (2) of compressed air, to a master starting valve (5), and by means of branch pipes (4') to a number of individual starting valves (7) for at least a part of the cylinders (3) of the engine; actuators (8) for operating the individual starting valves (7); and a timing means (10) for sequentially opening and closing the individual starting valves (7) by means of the actuators (8) in order to rotate the engine, **characterized in** the steps of

- Providing the engine with additional means for rotating the engine,
- Providing the starting arrangement with means (20) for by-passing the timing means (10),
- Providing at least one drain valve (24) in the pipe system,
- Providing the at least one drain valve (24) with a drain pipe (28), and
- Providing the drain pipe (28) with a liquid detector (26).

Patentansprüche

1. Flüssigkeitserfassungssystem für einen Verbrennungsmotor, wobei der Motor mit einer Anordnung zum Starten des Motors mit Druckluft ausgestattet ist, die Startanordnung eine Quelle (2) für Druckluft, ein Hauptstartventil (5), eine Anzahl von individuellen Startventilen (7) für mindesten einen Teil der Zylinder (3) des Motors, Aktuatoren (8) zur Betätigung der individuellen Startventile (7) und einen Zeitgeber (10) umfasst, wobei mindestens ein Teil der Motorzylinder (3) in Kommunikation mit der Druckluftquelle (2) mithilfe von mindestens dem Hauptstartventil (5) und den individuellen Startventilen (7) über ein Rohrsystem steht, das ein Hauptrohr (4) und Abzweigrohre (4') aufweist, und die Aktuatoren (8) in Kommunikation mit dem Zeitgeber (10) stehen, **gekennzeichnet durch** zusätzliches Mittel zum Rotieren des Motors, Mittel (20) zur Beeinflussung der Aktuatoren (8), um gleichzeitig die individuellen Startventile (7) zu öffnen, mindestens ein Ablassventil (24), das in einem von Hauptrohr (4) und mindestens einem Abzweigrohr (4') angeordnet ist, ein Ablassrohr (28), das an das mindestens eine Ablassventil (24) angeschlossen ist, um Flüssigkeit von mindestens einem Teil der Zylinder (3) aus dem Motor heraus zu leiten, und einen Flüssigkeitsdetektor (26) in dem Ablassrohr (28).

2. Flüssigkeitserfassungssystem nach Anspruch 1, **dadurch gekennzeichnet, dass** der Zeitgeber (10) und die Aktuatoren (8) pneumatisch sind und dass das Mittel zur Beeinflussung der Aktuatoren (8) ein Ventilblock (20) zum Öffnen einer Kommunikation von einer Druckluftquelle zu den Aktuatoren (8) über ein Rohr (22) und Steuerrohre (12) ist.

3. Flüssigkeitserfassungssystem nach Anspruch 1, **dadurch gekennzeichnet, dass** der Zeitgeber (10) und die Aktuatoren (8) pneumatisch sind und dass der Zeitgeber (10) mit Mittel zum Öffnen einer gleichzeitigen Verbindung von Steuerrohr (13) zu allen Steuerrohren (12) ausgestattet ist.

4. Flüssigkeitserfassungssystem nach Anspruch 1, **dadurch gekennzeichnet, dass** der Zeitgeber und die Aktuatoren elektrisch sind, wodurch das Mittel zur Beeinflussung der Aktuatoren eine elektrische Vorrichtung ist, die den Zeitgeber zur gleichzeitigen Betätigung der Aktuatoren (8) für die Öffnung der Startventile (7) umgeht.

5. Flüssigkeitserfassungssystem nach Anspruch 1, **dadurch gekennzeichnet, dass** der Zeitgeber elek-

trisch ist, die Aktuatoren (8) pneumatisch sind und das Mittel zur Beeinflussung der Aktuatoren (8) ein Magnetventilblock (20) zum Öffnen einer Kommunikation von einer Druckluftquelle zu den Aktuatoren (8) über ein Rohr (22) und Steuerrohre (12) ist.

6. Flüssigkeitserfassungssystem nach einem der vorstehenden Ansprüche, **gekennzeichnet durch** Mittel zum langsamen Rotieren des Motors.

7. Flüssigkeitserfassungssystem nach Anspruch 6, **dadurch gekennzeichnet, dass** das Rotationsmittel ein elektrisches oder hydraulisches Rotationsgetriebe ist.

8. Flüssigkeitserfassungssystem nach einem der vorstehenden Ansprüche, **dadurch gekennzeichnet, dass** der Zeitgeber (10) in Verbindung mit einem rotierenden Teil des Motors, vorzugsweise der Nockenwelle, angeordnet ist.

9. Verfahren zum Betreiben des Flüssigkeitserfassungssystems für einen Verbrennungsmotor, wobei der Motor mit einer Anordnung zum Starten des Motors mit Druckluft ausgestattet ist, die Startanordnung ein Rohrsystem umfasst, das ein Hauptrohr (4) und Abzweigrohre (4') aufweist, wobei das Hauptrohr (4) an eine Quelle (2) für Druckluft, an ein Hauptstartventil (5) und mittels Abzweigrohre (4') an eine Anzahl von individuellen Startventilen (7) für mindestens einen Teil der Zylinder (3) des Motors angeschlossen ist; Aktuatoren (8) zum Betreiben der individuellen Startventile (7) und einen Zeitgeber (10), um nacheinander die individuellen Startventile (7) mithilfe der Aktuatoren (8) zu öffnen und zu schließen, um den Motor zu rotieren, wobei das Flüssigkeitserfassungssystem Folgendes umfasst:

- zusätzliches Mittel zum Rotieren des Motors,
- Mittel (20) zum Umgehen des Zeitgebers,
- mindestens ein Ablassventil (24),
- mindestens ein Ablassrohr (28) und
- mindestens einen Flüssigkeitsdetektor (26),

gekennzeichnet durch folgende Schritte:

- Umgehen des Zeitgebers (10) zum gleichzeitigen Öffnen der individuellen Startventile (7),
- Öffnen einer Strömungsverbindung von mindestens einem Teil der Motorzylinder (3) über die individuellen Startventile (7) zu dem mindestens einen Flüssigkeitsdetektor (26) und Ablassrohr (28) mittels des mindestens einen Ablassventils (24) und
- langsames Rotieren des Motors, um flüssiges Medium aus mindestens einem Teil der Motorzylinder (3) durch Startventile (7) in das mindestens eine Ablassrohr (28) ausfließen zu lassen.

10. Verfahren zum Aufrüsten eines Verbrennungsmotors mit einem Flüssigkeitserfassungssystem, wobei der Motor mit einer Anordnung zum Starten des Motors mit Druckluft ausgestattet wird, wobei die Startanordnung Folgendes umfasst: ein Rohrsystem, das ein Hauptrohr (4) und Abzweigrohre (4') aufweist, wobei das Hauptrohr (4) an eine Quelle (2) für Druckluft, an ein Hauptstartventil (5) und mittels Abzweigrohren (4') an eine Anzahl von individuellen Startventilen (7) für mindestens einen Teil der Zylinder (3) des Motors angeschlossen ist; Aktuatoren (8) zum Betätigen der individuellen Startventile (7) und einen Zeitgeber (10), um nacheinander die individuellen Startventile (7) mithilfe der Aktuatoren (8) zu öffnen und zu schließen, um den Motor zu rotieren, **gekennzeichnet durch** folgende Schritte:

- Ausstatten des Motors mit zusätzlichem Mittel zum Rotieren des Motors,
- Ausstatten der Startanordnung mit Mittel (20) zum Umgehen des Zeitgebers (10),
- Bereitstellen von mindestens einem Ablassventil (24) im Rohrsystem,
- Ausstatten des mindestens einen Ablassventils (24) mit einem Ablassrohr (28) und
- Ausstatten des Ablassrohrs (28) mit einem Flüssigkeitsdetektor (26).

Revendications

1. Système de détection de liquide destiné à un moteur à combustion interne, le moteur étant muni d'un agencement destiné au démarrage du moteur avec de l'air comprimé, l'agencement de démarrage comprenant une source (2) d'air comprimé, une vanne de démarrage principale (5), un certain nombre de vannes de démarrage individuelles (7) pour au moins une partie des cylindres (3) du moteur, des actionneurs (8) destinés au fonctionnement des vannes de démarrage individuelles (7), et un moyen de chronométrage (10), l'au moins une partie des cylindres de moteur (3) étant en communication avec la source d'air comprimé (2) au moyen d'au moins la vanne de démarrage principale (5) et des vannes de démarrage individuelles (7) par l'intermédiaire d'un système de tuyauterie ayant un tuyau principal (4) et des tuyaux ramifiés (4'), et les actionneurs (8) étant en communication avec le moyen de chronométrage (10), **caractérisé en ce que** des moyens supplémentaires de rotation du moteur, des moyens (20) permettant d'influer sur les actionneurs (8) destinés à l'ouverture simultanée des valves de démarrage individuelles (7), au moins une vanne de vidange (24) disposée dans l'un des tuyaux principaux (4) et au moins dans un tuyau ramifié (4'), un tuyau de vidange (28) relié à l'au moins une vanne de vidange (24) pour diriger un liquide provenant de l'au moins

une partie des cylindres (3) hors du moteur, et un détecteur de liquide (26) dans le tuyau de vidange (28).

2. Système de détection de liquide selon la revendication 1, **caractérisé en ce que** le moyen de chronométrage (10) et les actionneurs (8) sont pneumatiques, et **en ce que** le moyen permettant d'influer sur les actionneurs (8) est un bloc de vanne (20) destiné à l'ouverture d'une communication provenant d'une source d'air comprimé aux actionneurs (8) par l'intermédiaire d'un tuyau (22) et de tuyaux de commande (12).

3. Système de détection de liquide selon la revendication 1, **caractérisé en ce que** le moyen de chronométrage (10) et les actionneurs (8) sont pneumatiques, et **en ce que** le moyen de chronométrage (10) est équipé d'un moyen destiné à l'ouverture d'une connexion simultanée d'un tuyau de commande (13) à tous les tuyaux de commande (12) .

4. Système de détection de liquide selon la revendication 1, **caractérisé en ce que** le moyen de chronométrage et les actionneurs sont électriques, moyennant quoi le moyen permettant d'influer sur les actionneurs est un dispositif électrique contournant le moyen de chronométrage destiné au fonctionnement simultané des actionneurs (8) pour l'ouverture des vannes de démarrage (7).

5. Système de détection de liquide selon la revendication 1, **caractérisé en ce que** le moyen de chronométrage est électrique, les actionneurs (8) sont pneumatiques, et le moyen permettant d'influer sur les actionneurs (8) est un bloc de vanne de solénoïde (20) destiné à l'ouverture d'une communication provenant d'une source d'air comprimé aux actionneurs (8) par l'intermédiaire d'un tuyau (22) et de tuyaux de commande (12).

6. Système de détection de liquide selon l'une quelconque des revendications précédentes, **caractérisé par** des moyens destinés à la rotation lente du moteur.

7. Système de détection de liquide selon la revendication 6, **caractérisé en ce que** le moyen de rotation est un engrenage de rotation électrique ou hydraulique.

8. Système de détection de liquide selon l'une quelconque des revendications précédentes, **caractérisé en ce que** le moyen de chronométrage (10) est disposé en connexion avec une partie de rotation du moteur, de préférence avec l'arbre à cames.

9. Procédé de fonctionnement du système de détection liquide pour un moteur à combustion interne, le moteur étant équipé d'un agencement destiné au démarrage du moteur avec de l'air comprimé, l'agencement de démarrage comprenant un système de tuyauterie ayant un tuyau principal (4) et des tuyaux ramifiés (4'), le tuyau principal (4) étant relié à une source (2) d'air comprimé, à une vanne de démarrage principale (5), et au moyen de tuyaux ramifiés (4') à un certain nombre de vannes de démarrage individuelles (7) pour au moins une partie des cylindres (3) du moteur ; des actionneurs (8) destinés au fonctionnement des vannes de démarrage individuelles (7) ; et un moyen de chronométrage (10) destiné à l'ouverture et à la fermeture séquentielle des vannes de démarrage individuelles (7) au moyen des actionneurs (8) de manière à faire tourner le moteur, le système de détection de liquide comprenant

- un moyen supplémentaire permettant de faire tourner le moteur,
- un moyen (20) permettant de contourner le moyen de chronométrage,
- au moins une vanne de vidange (24),
- au moins un tuyau de vidange (28), et
- au moins un détecteur de liquide (26), **caractérisé par** les étapes consistant à,
- contourner le moyen de chronométrage (10) destiné à l'ouverture des vannes de démarrage individuelles (7) de manière simultanée,
- ouvrir une communication de flux provenant de l'au moins une partie des cylindres de moteur (3) par l'intermédiaire des vannes de démarrage individuelles (7) à l'au moins un détecteur de liquide (26) et d'un tuyau de vidange (28) au moyen de l'au moins une vanne de vidange (24), et
- faire tourner lentement le moteur pour la décharge de milieu liquide provenant d'au moins une partie des cylindres de moteur (3) par l'intermédiaire de vannes de démarrage (7) dans l'au moins un tuyau de vidange (28).

10. Procédé de mise à niveau d'un moteur à combustion interne avec un système de détection de liquide, le moteur étant équipé d'un agencement destiné au démarrage du moteur avec de l'air comprimé, l'agencement de démarrage comprenant un système de tuyauterie ayant un tuyau principal (4) et des tuyaux ramifiés (4'), le tuyau principal (4) étant relié à une source (2) d'air comprimé, à une vanne de démarrage principale (5), et au moyen de tuyaux ramifiés (4') à un certain nombre de vannes de démarrage individuelles (7) pour au moins une partie des cylindres (3) du moteur ; des actionneurs (8) destinés au fonctionnement des vannes de démarrage individuelles (7) ; et un moyen de chronométrage (10) destiné à l'ouverture et à la fermeture séquentielle des vannes de démarrage individuelles (7) au moyen

des actionneurs (8) de manière à faire tourner le moteur, **caractérisé par** les étapes consistant à

- fournir au moteur un moyen supplémentaire pour faire tourner le moteur,
- fournir à l'agencement de démarrage un moyen (20) permettant de contourner le moyen de chronométrage (10),
- fournir au moins une vanne de vidange (24) dans le système de tuyauterie,
- fournir à l'au moins une vanne de vidange (24) un tuyau de vidange (28), et
- fournir au tuyau de vidange (28) un détecteur de liquide (26).

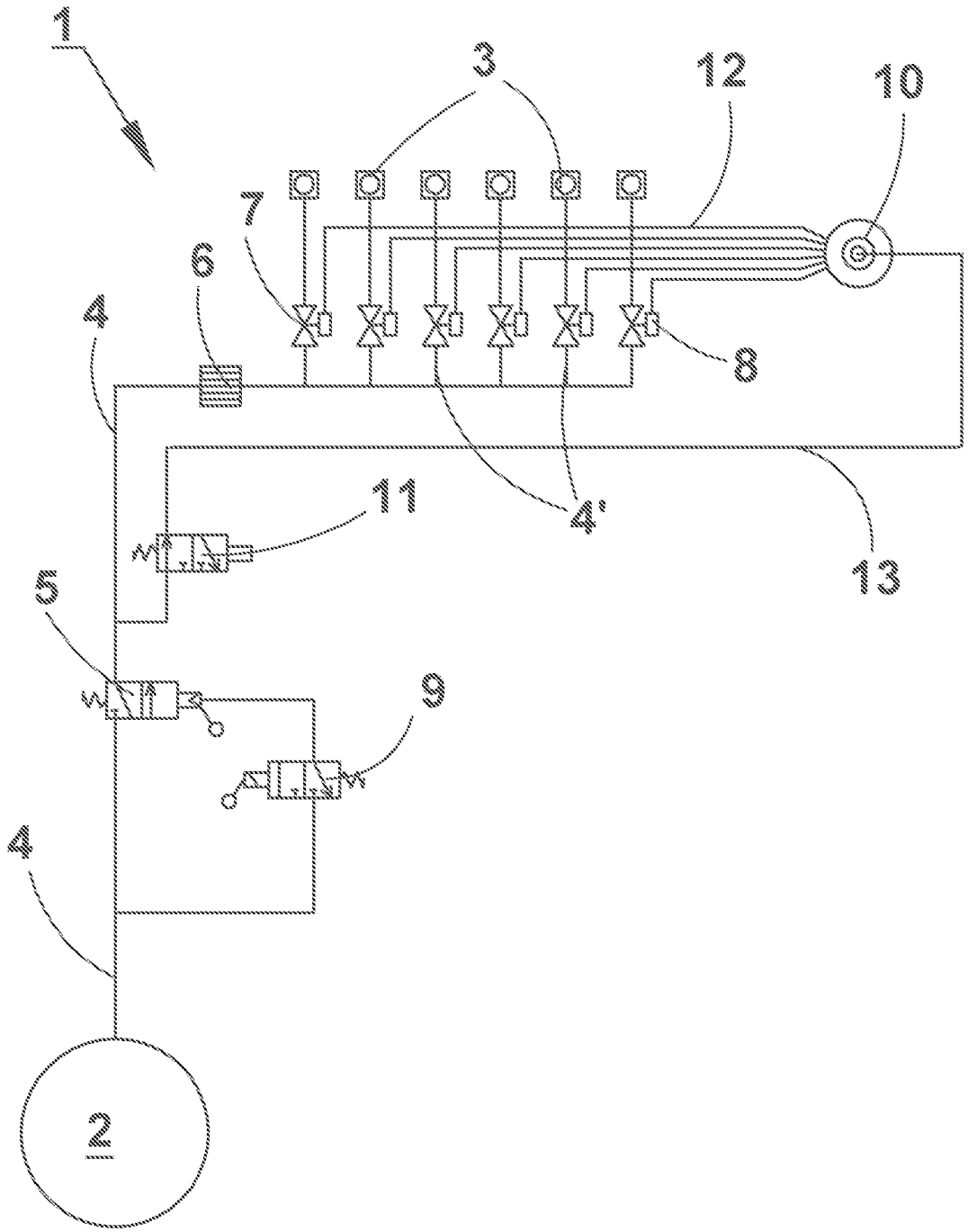

Fig. 1 Prior Art

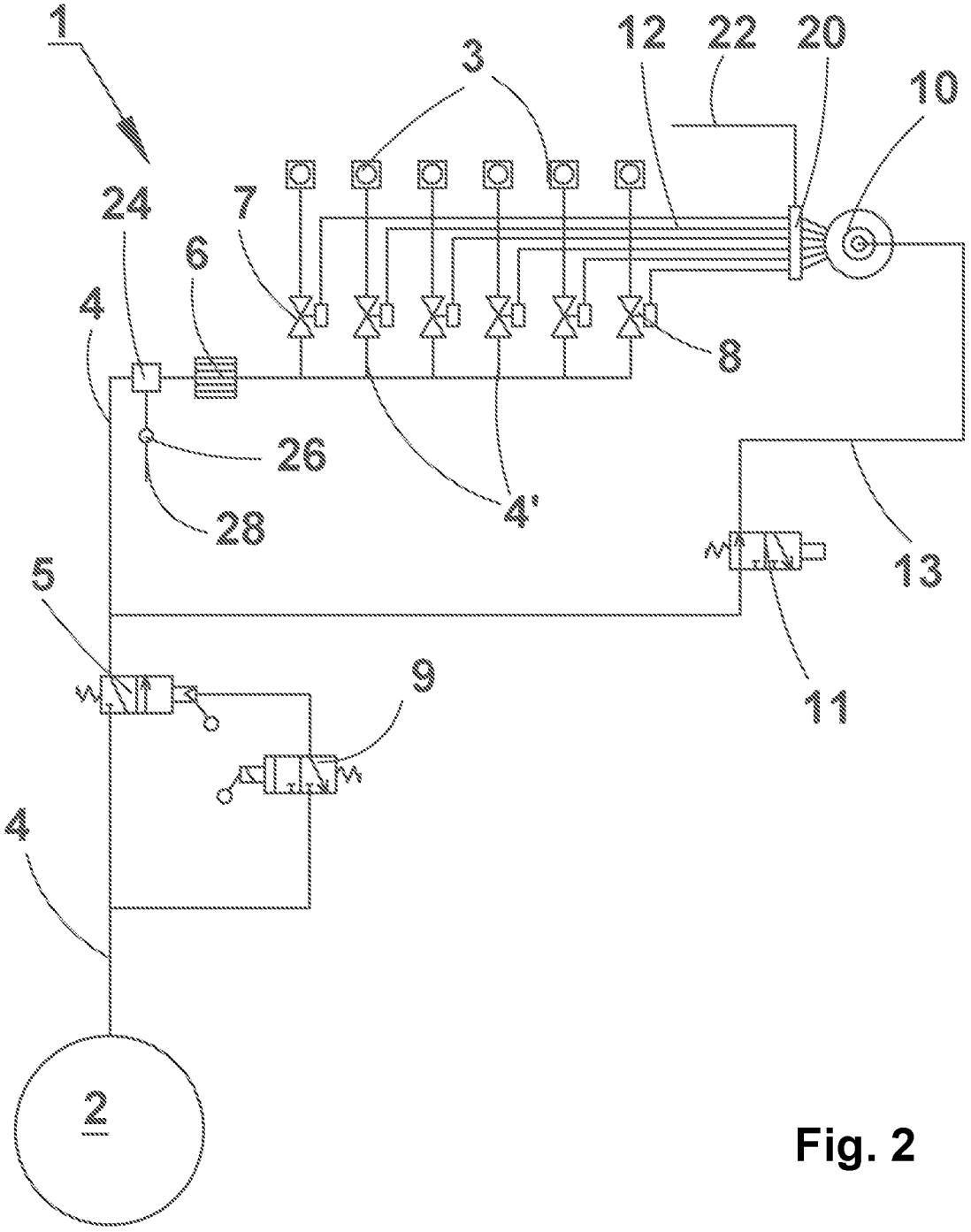

Fig. 2

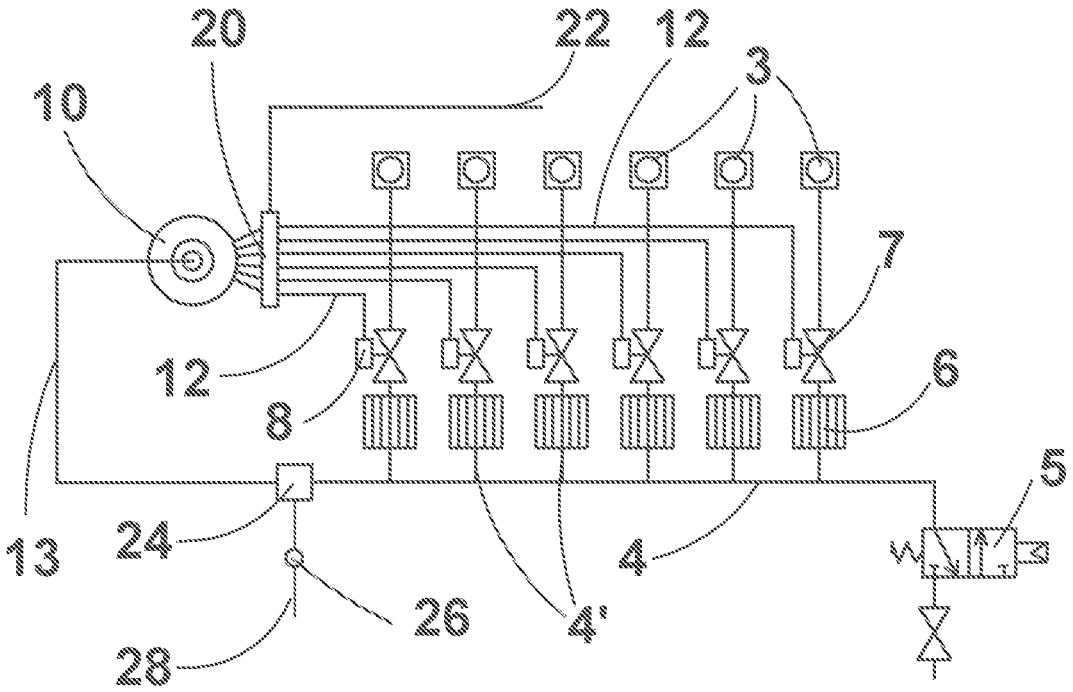

Fig. 3

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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- JP 200356421 A **[0007]**
- WO 2007003693 A1 **[0014]**