

(19)



(11)

EP 2 941 546 B1

(12)

EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention
of the grant of the patent:
21.12.2016 Bulletin 2016/51

(51) Int Cl.:
F01L 9/02 ^(2006.01) **F01L 13/00** ^(2006.01)
F01L 13/08 ^(2006.01)

(21) Application number: **14700516.9**

(86) International application number:
PCT/FI2014/050002

(22) Date of filing: **03.01.2014**

(87) International publication number:
WO 2014/106688 (10.07.2014 Gazette 2014/28)

(54) **CONTROL ARRANGEMENT AND METHOD FOR CONTROLLING AN EXHAUST VALVE**
STEUERANORDNUNG UND VERFAHREN ZUR STEUERUNG EINES AUSLASSVENTILS
AGENCEMENT DE COMMANDE ET PROCÉDÉ DE COMMANDE D'UNE SOUPAPE
D'ÉCHAPPEMENT

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

(30) Priority: **07.01.2013 FI 20135017**

(43) Date of publication of application:
11.11.2015 Bulletin 2015/46

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EP 2 941 546 B1

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Description

Technical field of the invention

[0001] The present invention relates to a control arrangement for an exhaust valve of an internal combustion engine in accordance with the preamble of claim 1. The control arrangement allows an additional opening of an exhaust valve for exhaust gas recirculation. The invention also concerns a method for controlling a cam-driven exhaust valve of an internal combustion engine, as defined in the preamble of the other independent claim. The method comprises a reopening mode, in which mode an additional opening of the exhaust valve for exhaust gas recirculation is in use.

Background of the invention

[0002] Nitrogen oxide (NOx) emissions of internal combustion engines are subject to continuously tightening regulations. In general, NOx emissions can be reduced by reducing the temperature in the combustion chamber. An effective way to reduce NOx emissions of an internal combustion engine is to use exhaust gas recirculation (EGR), where part of the exhaust gases are directed back to the cylinders of the engine. Since the heat capacity of the recirculated exhaust gas is higher than the heat capacity of air, the same amount of energy released by combustion leads to lower temperature increase in engines with EGR. Also the lower oxygen mass inside the cylinders and reduction of combustion speed help to achieve lower temperature increase. An EGR system can be either external or internal. In an external EGR system exhaust gases are recirculated from the exhaust gas duct into the air intake duct. In an internal EGR system part of the exhaust gas is trapped within the cylinder or back-flow from the exhaust duct into the combustion chamber is utilised. Typically, the exhaust valves of a cylinder are opened for a short period of time after closing of the intake valves. Exhaust pressure needs to be higher than the pressure in the cylinder in order to get exhaust gases to flow into the cylinder.

[0003] There are different ways for implementing the exhaust valve opening in internal EGR systems. Japanese patent application JP 2001065320 discloses a cam that comprises a second lobe that opens the exhaust valve for EGR. The second lobe is asymmetrical enabling adjustment of the valve lift by moving the cam in the camshaft direction.

[0004] Patent application GB 2442813 A discloses a camshaft assembly comprising a fixed cam and a moveable cam lobe. The movable cam lobe can be used for an extra exhaust valve opening event for internal EGR. The movable cam lobe can be moved by hydraulic pressure.

Summary of the invention

[0005] An object of the present invention is to provide an improved control arrangement for an exhaust valve of an internal combustion engine. The characterizing features of the control arrangement according to the present invention are given in the characterizing part of claim 1. Another object of the invention is to provide an improved method for controlling a cam-driven exhaust valve of an internal combustion engine. The characterizing features of the method according to the invention are given in the characterizing part of the other independent claim.

[0006] The control arrangement according to the invention allows an additional opening of an exhaust valve for exhaust gas recirculation and comprises a cam having a cam profile comprising a base circle and a lobe extending radially outwards from the base circle, a reciprocating cam follower unit comprising a body and a cam follower wheel that is attached to the body and engaged with the cam, force transmission means for transmitting movement of the cam follower unit to the exhaust valve, a hydraulic fluid chamber that is arranged between the cam and the force transmission means and delimited by a piston that is engaged with the force transmission means at least during the opening and closing movement of the exhaust valve, means for introducing hydraulic fluid into the hydraulic fluid chamber, and means for discharging hydraulic fluid from the hydraulic fluid chamber. The cam profile further comprises a portion below the base circle of the cam, and engagement of the cam follower wheel with the portion below the base circle is arranged to prevent outflow from the hydraulic fluid chamber.

[0007] In the method according to the invention, an exhaust valve is opened by transforming the rotational movement of a cam, which cam has a cam profile comprising a base circle and a lobe extending radially outwards from the base circle, into a reciprocating movement of a cam follower unit. The cam follower unit comprises a body and a cam follower wheel, and the movement of the cam follower unit is transmitted to the exhaust valve via force transmission means. The method comprises a reopening mode, in which mode an additional opening of the exhaust valve for exhaust gas recirculation is implemented by introducing hydraulic fluid into a hydraulic fluid chamber, which hydraulic fluid chamber is arranged between the cam and the force transmission means and delimited by a piston that is engaged with the force transmission means at least during the opening and closing movement of the exhaust valve. In the reopening mode, a portion of the cam that is arranged below the base circle of the cam is used for moving the cam follower unit into a position in which outflow from the hydraulic fluid chamber is prevented.

[0008] The portion below the base circle of the cam allows the movement of the piston in relation to the cam follower unit and hydraulic fluid can be introduced between the end of the chamber and the piston. When the outflow from the hydraulic fluid chamber is prevented and

the cam follower unit starts moving towards the base circle of the cam, the exhaust valve is reopened for allowing internal EGR. The arrangement and the method are reliable and simple to implement, and do not require high hydraulic pressure.

[0009] According to an embodiment of the invention, engagement of the cam follower wheel with the portion below the base circle is arranged to enable flow of hydraulic fluid into the hydraulic fluid chamber. The hydraulic fluid chamber can be arranged inside the cam follower unit. It is not necessary that the portion below the base circle triggers the fluid supply into the hydraulic fluid chamber. Alternatively, there can be constant flow into the chamber, and the piston starts moving when the outflow is prevented. However, when the portion below the base circle is used for controlling the flow into the hydraulic fluid chamber, there is no need for continuous flow through the hydraulic flow chamber.

[0010] According to an embodiment of the invention, the cam follower unit is provided with a first duct for discharging hydraulic fluid from the hydraulic fluid chamber, and the arrangement comprises a first stationary flow channel, which is arranged to be in flow communication with the first duct of the cam follower unit when the cam follower wheel is on the base circle of the cam.

[0011] According to an embodiment of the invention, the first stationary flow channel is provided with a valve for selectively allowing or preventing flow in the channel. With the valve, closing of the exhaust valve after the reopening can be delayed.

[0012] According to another embodiment of the invention, the first stationary flow channel is provided with an adjustable throttle for restricting flow in the channel. If the flow in the first stationary flow channel is restricted, the exhaust valve is closed more slowly.

[0013] According to another embodiment of the invention, the cam follower unit is provided with a second duct for introducing hydraulic fluid into the hydraulic fluid chamber.

[0014] According to another embodiment of the invention, the arrangement comprises a second stationary flow channel, which is connected to a pressure medium source and arranged to be in flow communication with the first or the second duct of the cam follower unit when the cam follower wheel is on the portion below the base circle of the cam for introducing hydraulic fluid into the hydraulic fluid chamber. The second stationary flow channel can be provided with an adjustable throttle for restricting flow in the channel, and/or with a valve for selectively allowing or preventing flow in the channel. If the flow into the hydraulic fluid chamber is prevented, the second opening of the exhaust valve is prevented, and the internal EGR is thus switched off. By restricting flow in the second stationary flow channel, the valve lift during the second opening can be adjusted.

[0015] According to another embodiment of the invention, the second duct or the second stationary flow channel is provided with a check valve for preventing outflow

from the hydraulic fluid chamber. If the second stationary flow channel or the second duct is provided with a check valve, the second flow channel can be constantly in flow communication with the cam follower unit. This leaves more time for filling the hydraulic fluid chamber.

Brief description of the drawings

[0016]

Fig. 1 shows a control arrangement according to an embodiment of the invention.

Fig. 2 shows a control arrangement according to another embodiment of the invention.

Fig. 3 shows a control arrangement according to a third embodiment of the invention.

Fig. 4 shows the control arrangement of figure 1 at different crank angles.

Detailed description of the invention

[0017] Embodiments of the invention are now described in more detail with reference to the accompanying drawings.

[0018] In figure 1 is shown a control arrangement according to an embodiment of the invention. The control arrangement is used for opening an exhaust valve 17 of a large internal combustion engine. The engine can be, for instance, a main or an auxiliary engine of a ship or an engine that is used for producing electricity at a power plant. The engine is provided with at least one camshaft for operating gas exchange valves of the engine. A V-engine can be provided with one camshaft for each bank of the engine. The camshaft is provided with one cam 2 for the exhaust valves 17 of each cylinder. Each cylinder can be provided with more than one exhaust valves 17, and the cam 2 can be used for opening all the exhaust valves 17 of the respective cylinder.

[0019] The cam 2 comprises, as any conventional exhaust cam, a cam profile having a base circle 2a and a lobe 2b that extends radially outwards from the base circle 2a. The control arrangement is provided with a reciprocating cam follower unit 4 that comprises a body 1 and a cam follower wheel 3. The cam follower wheel 3 is attached to the body 1 of the cam follower unit 4 with a bearing. The control arrangement is provided with a spring (not shown) that pushes the cam follower unit 4 towards the cam 2. The cam follower wheel 3 is thus engaged with the cam 2, and the cam follower unit 4 is moved away from the rotation axis of the cam 2 when the cam follower wheel 3 becomes engaged with the lobe 2c of the cam 2. The control arrangement is provided with force transmission means 12, 18 for transmitting the upward movement of the cam follower unit 4, i.e. the movement away from the rotation axis of the cam 2, to the exhaust valve 17. The force transmission means 12, 18 comprise a pushrod 12 and a rocker arm 18. Instead of the push rod 12 and the rocker arm 18, some other

kind of force transmission means could be used. The push rod 12 pushes one end of the rocker arm 18 upwards and turns thus the rocker arm 18 around the shaft 19 of the rocker arm 18. The other end of the rocker arm 18 is arranged to open the exhaust valve 17. The control arrangement comprises a stopper surface 20, against which the push rod 12 can rest when the cam follower wheel 3 is on the base circle 2a of the cam 2.

[0020] To allow an additional opening of the exhaust valve 17 for internal EGR, the cam 2 is provided with a portion 2c below the base circle 2a. The portion 2c below the base circle 2a has smaller radius than the base circle 2a of the cam 2. The portion 2c below the base circle 2a is arranged after the lobe 2b in the direction of rotation of the cam 2. In the embodiment of the figures, the cam 2 rotates clockwise. The radius of the portion 2c below the base circle 2a is not constant, but decreases and increases gradually for allowing smooth operation of the cam lifting arrangement. The cam follower unit 4 is provided with a hydraulic fluid chamber 11 that is arranged between the cam 2 and the force transmission means 12, 18. A piston 5 is arranged in the hydraulic fluid chamber 11. The piston 5 is engaged with the push rod 12 at least during the opening and closing movement of the exhaust valve 17. The control arrangement comprises means for introducing hydraulic fluid into the hydraulic fluid chamber 11 and means for discharging hydraulic fluid from the chamber 11. In the embodiment of figure 1, a first duct 6 is arranged in the body 2 of the cam follower unit 4. Via the first duct 6, the hydraulic fluid chamber 11 is in flow communication with a fluid port 21 that is arranged on the outer surface of the body 2 of the cam follower unit 4. Through the fluid port 21, hydraulic fluid can be introduced into the hydraulic fluid chamber 11 between the piston 5 and the camshaft end of the hydraulic fluid chamber 11. The hydraulic fluid chamber 11 can also be emptied through the same fluid port 21.

[0021] The cam follower unit 4 slides against a support surface 9, which can be arranged, for instance, in the cylinder head or the engine block. The control arrangement is provided with a first flow channel 7 and a second flow channel 8. The first and second flow channels 7, 8 are stationary and each of the flow channels 7, 8 has an open end on the slide surface 9. The open end of the second flow channel 8 on the support surface 9 is arranged closer to the camshaft than the open end of the first flow channel 7. The second flow channel 8 is in flow communication with a hydraulic fluid source 10. The hydraulic fluid source 10 can be, for instance, a tank from which hydraulic fluid is supplied to the second flow channel 8 with a pump. Alternatively, the hydraulic fluid source 10 could be a pressure accumulator. Also the first flow channel 7 can be in flow communication with the hydraulic fluid source 10 for returning the fluid to the hydraulic fluid source 10. The first flow channel 7 is located so that when the cam follower wheel 3 is on the base circle 2a of the cam 2, the fluid port 21 of the cam follower unit 4 is in flow communication with the first flow channel 7.

Engagement of the cam follower wheel 3 with the base circle 2a of the cam 2 thus enables outflow from the hydraulic fluid chamber 11. When the cam follower wheel 3 is on the portion 2c below the base circle, flow from the hydraulic fluid chamber 11 into the first flow channel 7 is prevented. The second flow channel 8 is located so that the fluid port 21 is in flow communication with the second flow channel 8 when the cam follower wheel 3 is on the portion 2c below the base circle 2a of the cam 2. In practice, there has to be a certain minimum distance between the first and the second flow channels 7, 8. Therefore, the flow communication between the fluid port 21 and the second flow channel 8 is established and the flow communication between the fluid port 21 and the first flow channel 7 is terminated when the cam follower unit 4 has moved a certain predetermined distance from the position where it is when the cam follower wheel 3 is on the base circle 2a of the cam 2. Correspondingly, the flow communication between the fluid port 21 and the second flow channel 8 is terminated and the flow communication between the fluid port 21 and the first flow channel 7 is established a little bit before the cam follower wheel 3 leaves the portion 2c below the base circle 2a and enters the base circle 2a.

[0022] Functioning of the control arrangement is now described with reference to figures 1 and 4. In phase A, the piston of the engine is in the middle of the power stroke and the crank angle is approximately 90 degrees. The cam follower wheel 3 of the cam follower unit 4 is on the base circle 2a of the cam 2 and the exhaust valve 17 is closed. The piston 5 of the cam follower unit 4 is at the camshaft end of the hydraulic fluid chamber 11 and the push rod 12 is engaged with the piston 5. The fluid port 21 of the cam follower unit 4 is in flow communication with the first flow channel 7. In phase B, the piston of the engine has passed bottom dead center and is in the middle of the exhaust stroke. The crank angle is approximately 270 degrees. The cam follower wheel 3 has left the base circle 2a of the cam 2 and entered the lobe 2b of the cam 2. As a result, the cam follower unit 4 has been moved upwards, i.e. away from the rotation axis of the cam 2. The piston 5 of the cam follower unit 4 is still at the camshaft end of the hydraulic fluid chamber and the pushrod 12 is engaged with the piston 5. The pushrod 12 of the cam lifting arrangement has pushed one end of the rocker arm 18 upwards and turned thus the rocker arm 18 around the rocker arm shaft 19. The other end of the rocker arm 18 has opened the exhaust valve 17. This is the normal exhaust valve opening.

[0023] In phase C, the piston of the engine has passed top dead center and is close to the end of the intake stroke. The crank angle is approximately 470 degrees. The exhaust valve 17 has been closed again. The cam follower wheel 3 has entered the portion 2c below the base circle 2a, and the body 1 of the cam follower unit 4 has followed. The push rod 12 rests against the stopper surface 20, and it is therefore in the same position as in phase A, where the cam follower wheel 3 is on the base

circle 2a of the cam 2. The position of the rocker arm 18 or the exhaust valve 17 is thus not affected. The fluid port 21 of the cam follower unit 4 is now in flow communication with the second flow channel 8 and hydraulic fluid can flow from the hydraulic fluid source 10 via the duct 6 of the cam follower unit 4 into the hydraulic fluid chamber 11. There is no flow communication between the first hydraulic duct 6 and the first flow channel 7, and outflow from the hydraulic fluid chamber 11 through the first flow channel 7 is thus prevented. Because the push rod 12 is prevented from following the movement of the cam follower unit 4, a gap is formed between the piston 5 and the push rod 12. The hydraulic fluid that flows into the hydraulic fluid chamber 11 of the cam follower unit 4 can move the piston 5 and push it towards the push rod 12. Because of the gap between the piston 5 and the push rod 12, even a small pressure of the hydraulic fluid is enough for moving the piston 5. The flow communication between the fluid port 21 and the second flow channel 8 is terminated a little bit before the cam follower wheel 3 enters again the base circle 2a of the cam 2. When the flow communication between the fluid port 21 and the second flow channel 8 is terminated, the hydraulic fluid is prevented from escaping the hydraulic fluid chamber 11. When the cam follower unit 4 moves upwards, the piston 5 becomes eventually engaged with the push rod 12. Because of the hydraulic fluid in the hydraulic fluid chamber 11, this happens before the cam follower wheel 3 enters the base circle 2a of the cam 2. The exhaust valve 17 is thus opened for a second time allowing internal EGR. In phase D, the cam follower wheel 3 has left the portion 2c below the base circle 2a and entered again the base circle 2a. The fluid port 21 has become in flow communication with the first flow channel 7, and the hydraulic fluid can thus flow out of the hydraulic fluid chamber 11. The piston 5 is pushed towards the camshaft end of the hydraulic fluid chamber 11 by the push rod 12. The exhaust valve 17 remains open until the hydraulic fluid chamber 11 is emptied. The time needed for this depends on how fast the hydraulic fluid can flow out of the hydraulic fluid chamber 11.

[0024] The valve lift can be adjusted by adjusting the pressure of the hydraulic fluid. If the hydraulic fluid is supplied at a higher pressure, the hydraulic fluid chamber 11 can receive more hydraulic fluid during the period when the fluid port 21 is in flow communication with the second flow channel 8. The exhaust valve 17 opens thus more when the cam follower wheel 3 enters the base circle 2a of the cam 2.

[0025] In figure 2 is shown another embodiment of the invention. A difference between the embodiments of figure 1 and 2 is that in figure 2 the first flow channel 7 is provided with a valve 13. The valve 13 is a quick-opening valve that can be used for adjusting the duration of the second exhaust valve opening. When the valve 13 is closed, the exhaust valve 17 can be kept open even when the fluid port 21 is in flow communication with the first flow channel 7. The cam follower unit 4 comprises a sec-

ond duct 23. The second duct 23 works as an inlet channel, through which the hydraulic fluid chamber 11 is filled. The first duct 6 works as an outlet channel for emptying the hydraulic fluid chamber 11. The second duct 23 is in flow communication with a second fluid port 24 that is arranged on the outer surface of the body 1 of the cam follower unit 4. The control arrangement is also provided with a check valve 22 that is arranged in the cam follower unit 4. The check valve 22 in the second duct 23 is arranged to allow filling of the hydraulic fluid chamber 11 but prevent flow in the opposite direction. Due to the check valve 22, the second fluid port 24 can be constantly in flow communication with the second flow channel 8. Filling of the hydraulic fluid chamber 11 begins thus immediately after the cam follower wheel 3 has entered the portion 2c below the base circle 2a of the cam 2, and the check valve 22 prevents the hydraulic fluid chamber 11 from being emptied through the second flow channel 8. This gives more time for filling of the hydraulic fluid chamber 11. The check valve 22 could also be arranged in the second flow channel 8. Otherwise the embodiment of figure 2 works in the same way as the embodiment of figure 1.

[0026] Figure 3 shows still another embodiment of the invention. This embodiment differs from the embodiment of figure 1 in that the first flow channel 7 is provided with a valve 13 and an adjustable throttle 14. Also the second flow channel 8 is provided with a valve 15 and an adjustable throttle 16. The valve 15 of the second flow channel 8 can be used for switching the EGR on and off. If the valve 15 is closed, hydraulic fluid flow into the hydraulic fluid chamber 11 is not allowed and the EGR is not in use. By opening the valve 15, fluid flow into the hydraulic fluid chamber 11 is allowed and the EGR is in use. The throttle 16 in the second flow channel 8 allows adjustment of the valve lift. If the flow into the hydraulic fluid chamber 11 is restricted by the throttle 16, less fluid flows into the chamber 11 during the time the fluid port 21 is in flow communication with the second flow channel 8, and the valve lift is smaller. The valve 13 in the first flow channel 7 allows adjustment of the duration of the exhaust valve opening. When the valve 13 is closed, the exhaust valve 17 can be kept open even when the cam follower wheel 3 is engaged with the base circle 2a of the cam 2 and the fluid port 21 is in flow communication with the first flow channel 7. The throttle 14 in the first flow channel 7 allows adjustment of the closing speed of the exhaust valve 17. If the flow in the first flow channel 7 is restricted, the hydraulic fluid chamber 11 is emptied more slowly and closing of the exhaust valve 17 takes more time.

[0027] It will be appreciated by a person skilled in the art that the invention is not limited to the embodiments described above, but may vary within the scope of the appended claims. For instance, the piston could be attached to the push rod. Also, different arrangements can be used for introducing hydraulic fluid into the hydraulic fluid chamber.

Claims

1. A control arrangement for an exhaust valve (17) of an internal combustion engine, which control arrangement allows an additional opening of an exhaust valve (17) for exhaust gas recirculation and comprises
 - a cam (2) having a cam profile comprising a base circle (2a) and a lobe (2b) extending radially outwards from the base circle (2a),
 - a reciprocating cam follower unit (4) comprising a body (1) and a cam follower wheel (3) that is attached to the body (1) and engaged with the cam (2),
 - force transmission means (12, 18) for transmitting movement of the cam follower unit (4) to the exhaust valve (17),
 - a hydraulic fluid chamber (11) that is arranged between the cam (2) and the force transmission means (12, 18) and delimited by a piston (5) that is engaged with the force transmission means (12, 18) at least during the opening and closing movement of the exhaust valve (17),
 - means (6, 8, 23) for introducing hydraulic fluid into the hydraulic fluid chamber (11), and
 - means (6, 7) for discharging hydraulic fluid from the hydraulic fluid chamber (11),

characterized in that the cam profile further comprises a portion (2c) below the base circle (2a) of the cam (2), and engagement of the cam follower wheel (3) with the portion (2c) below the base circle (2a) is arranged to prevent outflow from the hydraulic fluid chamber (11).
2. A control arrangement according to claim 1, **characterized in that** the hydraulic fluid chamber (11) is arranged inside the cam follower unit (4).
3. A control arrangement according to claim 1 or 2, **characterized in that** the cam follower unit (4) is provided with a first duct (6) for discharging hydraulic fluid from the hydraulic fluid chamber (11), and the arrangement comprises a first stationary flow channel (7), which is arranged to be in flow communication with the first duct (6) of the cam follower unit (4) when the cam follower wheel (3) is on the base circle (2a) of the cam (2).
4. A control arrangement according to claim 3, **characterized in that** the first stationary flow channel (7) is provided with a valve (13) for selectively allowing or preventing flow in the channel (7).
5. A control arrangement according to claim 3 or 4, **characterized in that** the first stationary flow channel (7) is provided with an adjustable throttle (14) for restricting flow in the channel (7).
6. A control arrangement according to any of claims 3-5, **characterized in that** the cam follower unit (4) is provided with a second duct (23) for introducing hydraulic fluid into the hydraulic fluid chamber (11).
7. A control arrangement according to any of claims 3-6, **characterized in that** the arrangement comprises a second stationary flow channel (8), which is connected to a pressure medium source (10) and arranged to be in flow communication with the first or the second duct (6, 23) of the cam follower unit (4) when the cam follower wheel (3) is on the portion (2c) below the base circle (2a) of the cam (2) for introducing hydraulic fluid into the hydraulic fluid chamber (11).
8. A control arrangement according to claim 7, **characterized in that** the second stationary flow channel (8) is provided with an adjustable throttle (16) for restricting flow in the channel (8).
9. A control arrangement according to claim 7 or 8, **characterized in that** the second stationary flow channel (8) is provided with a valve (15) for selectively allowing or preventing flow in the channel (8).
10. A control arrangement according to any of claims 7-9, **characterized in that** the second duct (23) or the second stationary flow channel (8) is provided with a check valve (22) for preventing outflow from the hydraulic fluid chamber (11).
11. A method for controlling a cam-driven exhaust valve (17) of an internal combustion engine, in which method an exhaust valve (17) is opened by transforming the rotational movement of a cam (2), which cam (2) has a cam profile comprising a base circle (2a) and a lobe (2b) extending radially outwards from the base circle (2a), into a reciprocating movement of a cam follower unit (4), which cam follower unit (4) comprises a body (1) and a cam follower wheel (3), and transmitting the movement of the cam follower unit (4) to the exhaust valve (17) via force transmission means (12, 18), the method comprising a reopening mode, in which mode an additional opening of the exhaust valve (17) for exhaust gas recirculation is implemented by introducing hydraulic fluid into a hydraulic fluid chamber (11), which hydraulic fluid chamber (11) is arranged between the cam (2) and the force transmission means (12, 18) and delimited by a piston (5) that is engaged with the force transmission means (12, 18) at least during the opening and closing movement of the exhaust valve (17), **characterized in that** in the reopening mode a portion (2c) of the cam (2) that is arranged below the base circle (2a) of the cam (2) is used for moving the cam follower

unit (4) into a position in which outflow from the hydraulic fluid chamber (11) is prevented and that engagement of the cam follower wheel (3) with the portion (2c) below the base circle (2a) is arranged to enable flow of hydraulic fluid into the hydraulic fluid chamber (11).

12. A method according to claim 11, **characterized in that** the outflow from the hydraulic fluid chamber (11) is additionally controlled by a valve (13).
13. A method according to claim 11 or 12, **characterized in that** the outflow from the hydraulic fluid chamber (11) is additionally controlled by throttling.
14. A method according to any of claims 11-13, **characterized in that** the flow into the hydraulic fluid chamber (11) is controlled by the portion (2c) below the base circle (2a) of the cam (2).
15. A method according to any of claims 11-14, **characterized in that** the flow into the hydraulic fluid chamber (11) is additionally controlled by a valve (15).
16. A method according to any of claims 11-15, **characterized in that** the flow into the hydraulic fluid chamber (11) is additionally controlled by throttling.

Patentansprüche

1. Steueranordnung für ein Auslassventil (17) einer Brennkraftmaschine, wobei die Steueranordnung eine zusätzliche Öffnung eines Auslassventils (17) für eine Abgasrezirkulation ermöglicht und wobei die Steueranordnung Folgendes umfasst:

- eine Nocke (2), die ein Nockenprofil aufweist, das einen Basiskreis (2a) und eine Nockenerhebung (2b), die sich von dem Basiskreis (2a) radial nach außen erstreckt, umfasst,
- eine hin- und hergehende Nockenstößleinheit (4), die einen Körper (1) und ein Nockenstößelrad (3) umfasst, das an dem Körper (1) befestigt und mit der Nocke (2) in Eingriff ist,
- Kraftübertragungsmittel (12, 18), um eine Bewegung der Nockenstößleinheit (4) an das Auslassventil (17) zu übertragen,
- eine hydraulische Fluidkammer (11), die zwischen der Nocke (2) und den Kraftübertragungsmitteln (12, 18) angeordnet ist und durch einen Kolben (5) begrenzt ist, der mit den Kraftübertragungsmitteln (12, 18) mindestens während der Öffnungs- und Schließbewegung des Auslassventils (17) in Eingriff ist,
- Mittel (6, 8, 23), um ein hydraulisches Fluid in die hydraulische Fluidkammer (11) einzuführen, und

- Mittel (6, 7), um ein hydraulisches Fluid aus der hydraulischen Fluidkammer (11) abzuführen,

dadurch gekennzeichnet, dass das Nockenprofil ferner einen Abschnitt (2c) unterhalb des Basiskreises (2a) der Nocke (2) umfasst, und dass ein Eingriff des Nockenstößelrads (3) in den Abschnitt (2c) unterhalb des Basiskreises (2a) bewerkstelligt wird, um eine Ausströmung aus der hydraulischen Fluidkammer (11) zu verhindern.

2. Steueranordnung nach Anspruch 1, **dadurch gekennzeichnet, dass** die hydraulische Fluidkammer (11) innerhalb der Nockenstößleinheit (4) angeordnet ist.
3. Steueranordnung nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** die Nockenstößleinheit (4) mit einer ersten Leitung (6) versehen ist, um ein hydraulisches Fluid aus der hydraulischen Fluidkammer (11) abzuführen, und dass die Anordnung einen ersten stationären Strömungskanal (7) umfasst, der angeordnet ist, um in einer Strömungskommunikation mit der ersten Leitung (6) der Nockenstößleinheit (4) zu stehen, wenn sich das Nockenstößelrad (3) auf dem Basiskreis (2a) der Nocke (2) befindet.
4. Steueranordnung nach Anspruch 3, **dadurch gekennzeichnet, dass** der erste stationäre Strömungskanal (7) mit einem Ventil (13) versehen ist, um wahlweise eine Strömung in dem Kanal (7) zuzulassen oder zu verhindern.
5. Steueranordnung nach Anspruch 3 oder 4, **dadurch gekennzeichnet, dass** der erste stationäre Strömungskanal (7) mit einer anpassbaren Drossel (14) versehen ist, um die Strömung in dem Kanal (7) zu beschränken.
6. Steueranordnung nach einem der Ansprüche 3 - 5, **dadurch gekennzeichnet, dass** die Nockenstößleinheit (4) mit einer zweiten Leitung (23) versehen ist, um ein hydraulisches Fluid in die hydraulische Fluidkammer (11) einzuführen.
7. Steueranordnung nach einem der Ansprüche 3 - 6, **dadurch gekennzeichnet, dass** die Anordnung einen zweiten stationären Strömungskanal (8) umfasst, der mit einer Quelle (10) eines Druckmediums verbunden ist und angeordnet ist, um in einer Strömungskommunikation mit der ersten oder der zweiten Leitung (6, 23) der Nockenstößleinheit (4) zu stehen, wenn sich das Nockenstößelrad (3) auf dem Abschnitt (2c) unterhalb des Basiskreises (2a) der Nocke (2) befindet, um ein hydraulisches Fluid in die hydraulische Fluidkammer (11) einzuführen.

8. Steueranordnung nach Anspruch 7, **dadurch gekennzeichnet, dass** der zweite stationäre Strömungskanal (8) mit einer anpassbaren Drossel (16) versehen ist, um die Strömung in dem Kanal (8) zu beschränken.
9. Steueranordnung nach Anspruch 7 oder 8, **dadurch gekennzeichnet, dass** der zweite stationäre Strömungskanal (8) mit einem Ventil (15) versehen ist, um wahlweise eine Strömung in dem Kanal (8) zuzulassen oder zu verhindern..
10. Steueranordnung nach einem der Ansprüche 7 - 9, **dadurch gekennzeichnet, dass** die zweite Leitung (23) oder der zweite stationäre Strömungskanal (8) mit einem Rückschlagventil (22) versehen ist, um eine Ausströmung aus der hydraulischen Fluidkammer (11) zu verhindern.
11. Verfahren zum Steuern eines nockengetriebenen Auslassventils (17) einer Brennkraftmaschine, wobei in dem Verfahren ein Auslassventil (17) geöffnet wird, indem die Drehbewegung einer Nocke (2) in eine hin- und hergehende Bewegung einer Nockenstößleinheit (4) übertragen wird, wobei die Nocke (2) ein Nockenprofil aufweist, das einen Basiskreis (2a) und eine Nockenerhebung (2b), die sich von dem Basiskreis (2a) radial nach außen erstreckt, umfasst, und wobei die Nockenstößleinheit (4) einen Körper (1) und ein Nockenstößelrad (3) umfasst, und indem die Bewegung der Nockenstößleinheit (4) über Kraftübertragungsmittel (12, 18) an das Auslassventil (17) übertragen wird, wobei das Verfahren einen erneuten Öffnungsmodus umfasst, in dem eine zusätzliche Öffnung des Auslassventils (17) für eine Abgasrezirkulation implementiert wird, indem ein hydraulisches Fluid in eine hydraulische Fluidkammer (11) eingeführt wird, wobei die hydraulische Fluidkammer (11) zwischen der Nocke (2) und den Kraftübertragungsmitteln (12, 18) angeordnet ist und durch einen Kolben (5) begrenzt ist, der mit den Kraftübertragungsmitteln (12, 18) mindestens während der Öffnungs- und Schließbewegung des Auslassventils (17) in Eingriff ist, **dadurch gekennzeichnet, dass** in dem erneuten Öffnungsmodus ein Abschnitt (2c) der Nocke (2), der unterhalb des Basiskreises (2a) der Nocke (2) angeordnet ist, dazu verwendet wird, um die Nockenstößleinheit (4) in eine Position zu bewegen, in der eine Ausströmung aus der hydraulischen Fluidkammer (11) verhindert wird, und dass ein Eingriff des Nockenstößelrads (3) in den Abschnitt (2c) unterhalb des Basiskreises (2a) angeordnet ist, um eine Strömung des hydraulischen Fluids in die hydraulische Fluidkammer (11) zu ermöglichen.
12. Verfahren nach Anspruch 11, **dadurch gekennzeichnet, dass** die Ausströmung aus der hydraulischen Fluidkammer (11) zusätzlich von einem Ventil (13) gesteuert wird.
13. Verfahren nach Anspruch 11 oder 12, **dadurch gekennzeichnet, dass** die Ausströmung aus der hydraulischen Fluidkammer (11) zusätzlich durch ein Drosseln gesteuert wird.
14. Verfahren nach einem der Ansprüche 11 - 13, **dadurch gekennzeichnet, dass** die Strömung in die hydraulische Fluidkammer (11) durch den Abschnitt (2c) unterhalb des Basiskreises (2a) der Nocke (2) gesteuert wird.
15. Verfahren nach einem der Ansprüche 11 - 14, **dadurch gekennzeichnet, dass** die Strömung in die hydraulische Fluidkammer (11) zusätzlich durch ein Ventil (15) gesteuert wird.
16. Verfahren nach einem der Ansprüche 11 - 15, **dadurch gekennzeichnet, dass** die Strömung in die hydraulische Fluidkammer (11) zusätzlich durch ein Drosseln gesteuert wird.

Revendications

1. Dispositif de commande pour vanne d'échappement (17) d'un moteur à combustion interne, lequel dispositif de commande permet une ouverture supplémentaire d'une vanne d'échappement (17) pour la recirculation de gaz d'échappement et comprend
- une came (2) ayant un profil de came comprenant un cercle de base (2a) et un lobe (2b) s'étendant radialement vers l'extérieur depuis le cercle de base (2a),
 - une unité suiveuse de came à mouvement alternatif (4) comprenant un corps (1) et une roue suiveuse de came (3) qui est fixée au corps (1) et engagée dans la came (2),
 - un moyen de transmission de force (12, 18) pour transmettre le mouvement de l'unité suiveuse de came (4) à la vanne d'échappement (17),
 - une chambre à fluide hydraulique (11) qui est disposée entre la came (2) et le moyen de transmission de force (12, 18) et délimitée par un piston (5) qui est engagé dans le moyen de transmission de force (12, 18) au moins pendant le mouvement d'ouverture et de fermeture de la vanne d'échappement (17),
 - un moyen (6, 8, 23) d'introduction de fluide hydraulique dans la chambre à fluide hydraulique (11) et
 - un moyen (6, 7) de déchargement de fluide hydraulique hors de la chambre à fluide hydraulique (11),

- caractérisé en ce que** le profil de came comprend en outre une section (2c) située en-dessous du cercle de base (2a) de la came (2), et que l'engagement de la roue suiveuse de came (3) dans la section (2c) située en-dessous du cercle de base (2a) est conçu pour empêcher l'écoulement depuis la chambre à fluide hydraulique (11).
2. Dispositif de commande selon la revendication 1, **caractérisé en ce que** la chambre à fluide hydraulique (11) est disposée à l'intérieur de l'unité suiveuse de came (4).
 3. Dispositif de commande selon la revendication 1 ou 2, **caractérisé en ce que** l'unité suiveuse de came (4) est pourvue d'une première conduite (6) pour décharger du fluide hydraulique depuis la chambre à fluide hydraulique (11), et que le dispositif comprend un premier canal stationnaire d'écoulement (7), qui est conçu pour être en communication de flux avec la première conduite (6) de l'unité suiveuse de came (4) lorsque la roue suiveuse de came (3) est sur le cercle de base (2a) de la came (2).
 4. Dispositif de commande selon la revendication 3, **caractérisé en ce que** le premier canal stationnaire d'écoulement (7) est pourvu d'une vanne (13) pour permettre ou empêcher sélectivement l'écoulement dans le canal (7).
 5. Dispositif de commande selon la revendication 3 ou 4, **caractérisé en ce que** le premier canal stationnaire d'écoulement (7) est pourvu d'un étrangleur réglable (14) pour restreindre l'écoulement dans le canal (7).
 6. Dispositif de commande selon l'une quelconque des revendications 3 - 5, **caractérisé en ce que** l'unité suiveuse de came (4) est pourvue d'une seconde conduite (23) pour introduire du fluide hydraulique dans la chambre à fluide hydraulique (11).
 7. Dispositif de commande selon l'une quelconque des revendications 3 - 6, **caractérisé en ce que** le dispositif comprend un second canal stationnaire d'écoulement (8), qui est connecté à une source de fluide de pression (10) et conçu pour être en communication de flux avec la première ou la seconde conduite (6, 23) de l'unité suiveuse de came (4) lorsque la roue suiveuse de came (3) est sur la section (2c) située en-dessous du cercle de base (2a) de la came (2) pour introduire du fluide hydraulique dans la chambre à fluide hydraulique (11).
 8. Dispositif de commande selon la revendication 7, **caractérisé en ce que** le second canal stationnaire d'écoulement (8) est pourvu d'un étrangleur réglable (16) pour restreindre l'écoulement dans le canal (8).
 9. Dispositif de commande selon la revendication 7 ou 8, **caractérisé en ce que** la seconde conduite stationnaire d'écoulement (8) est pourvue d'une vanne (15) pour permettre ou empêcher sélectivement l'écoulement dans le canal (8).
 10. Dispositif de commande selon l'une quelconque des revendications 7 - 9, **caractérisé en ce que** la seconde conduite (23) ou le second canal stationnaire d'écoulement (8) est pourvu d'une vanne de contrôle (22) pour empêcher l'écoulement depuis la chambre à fluide hydraulique (11).
 11. Procédé de commande d'une vanne d'échappement entraînée par came (17) d'un moteur à combustion interne, dans lequel procédé une vanne d'échappement (17) est ouverte en transformant le mouvement de rotation d'une came (2), laquelle came (2) a un profil de came comprenant un cercle de base (2a) et un lobe (2b) s'étendant radialement vers l'extérieur depuis le cercle de base (2a), en un mouvement alternatif d'une unité suiveuse de came (4), laquelle unité suiveuse de came (4) comprend un corps (1) et une roue suiveuse de came (3), et transmettre le mouvement de l'unité suiveuse de came (4) à la vanne d'échappement (17) via un moyen de transmission de force (12, 18), ce procédé comprenant un mode de réouverture, dans lequel mode une ouverture supplémentaire de la vanne d'échappement (17) servant à la recirculation du gaz d'échappement est mise en oeuvre en introduisant du fluide hydraulique dans une chambre à fluide hydraulique (11), laquelle chambre à fluide hydraulique (11) est disposée entre la came (2) et le moyen de transmission de force (12, 18) et délimitée par un piston (5) qui est engagé dans le moyen de transmission de force (12, 18) au moins pendant le mouvement d'ouverture et de fermeture de la vanne d'échappement (17), **caractérisé en ce que**, en mode de réouverture, une section (2c) de la came (2) qui est disposée en-dessous du cercle de base (2a) de la came (2) est utilisée pour déplacer l'unité suiveuse de came (4) dans une position dans laquelle l'écoulement depuis la chambre à fluide hydraulique (11) est empêché et l'engagement de la roue suiveuse de came (3) dans la section (2c) en-dessous du cercle de base (2a) est conçu pour permettre l'écoulement de fluide hydraulique dans la chambre à fluide hydraulique (11).
 12. Procédé selon la revendication 11, **caractérisé en ce que** l'écoulement depuis la chambre à fluide hydraulique (11) est en outre commandé par une vanne (13).
 13. Procédé selon la revendication 11 ou 12, **caractérisé en ce que** l'écoulement depuis la chambre à fluide hydraulique (11) est en outre commandé par étranglement.

14. Procédé selon l'une quelconque des revendications 11 - 13, **caractérisé en ce que** l'écoulement dans la chambre à fluide hydraulique (11) est commandé par la section (2c) située en-dessous du cercle de base (2a) de la came (2). 5
15. Procédé selon l'une quelconque des revendications 11 - 14, **caractérisé en ce que** l'écoulement dans la chambre à fluide hydraulique (11) est en outre commandé par une vanne (15). 10
16. Procédé selon l'une quelconque des revendications 11 - 15, **caractérisé en ce que** l'écoulement dans la chambre à fluide hydraulique (11) est en outre commandé par étranglement. 15

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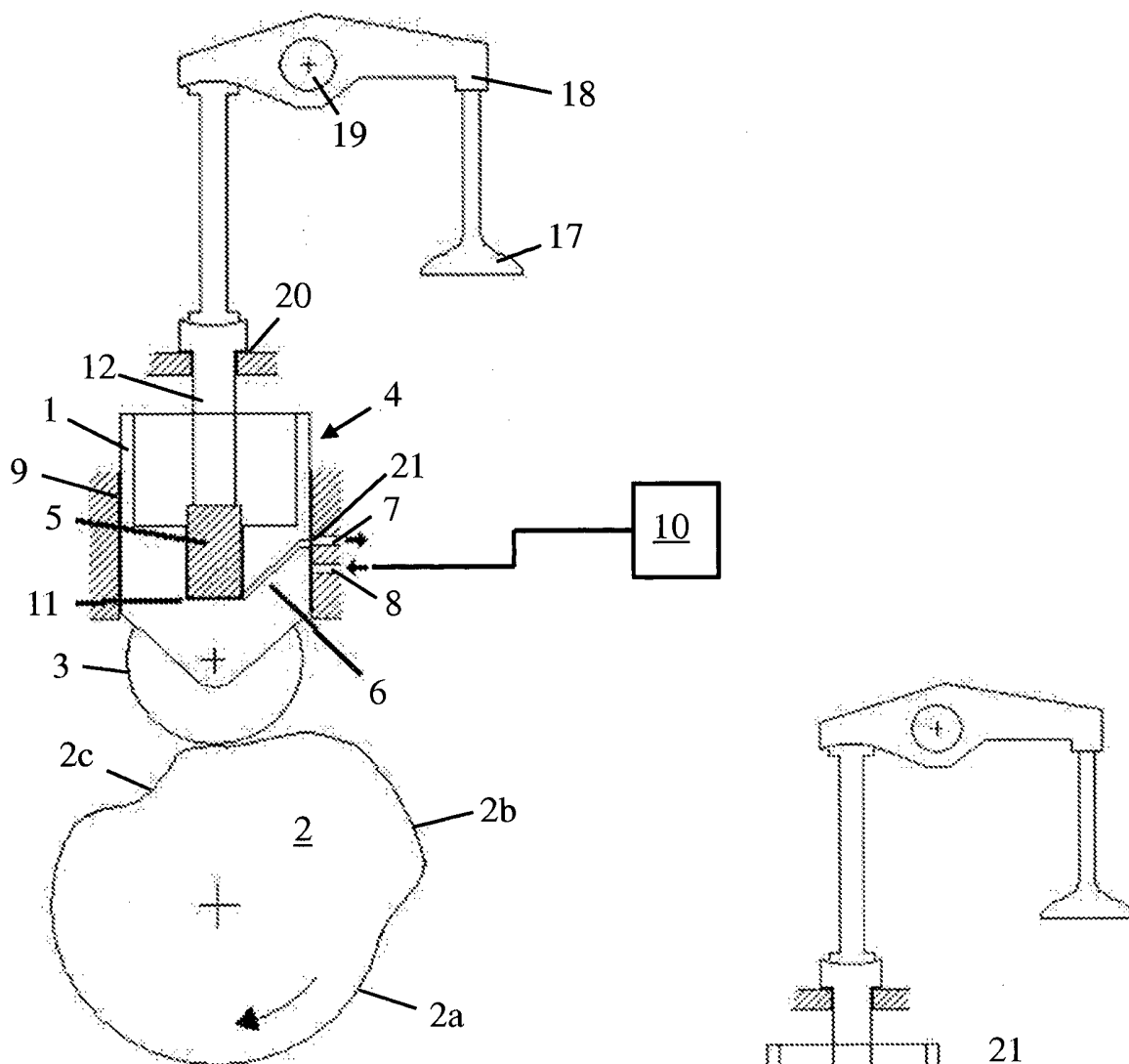


FIG. 1

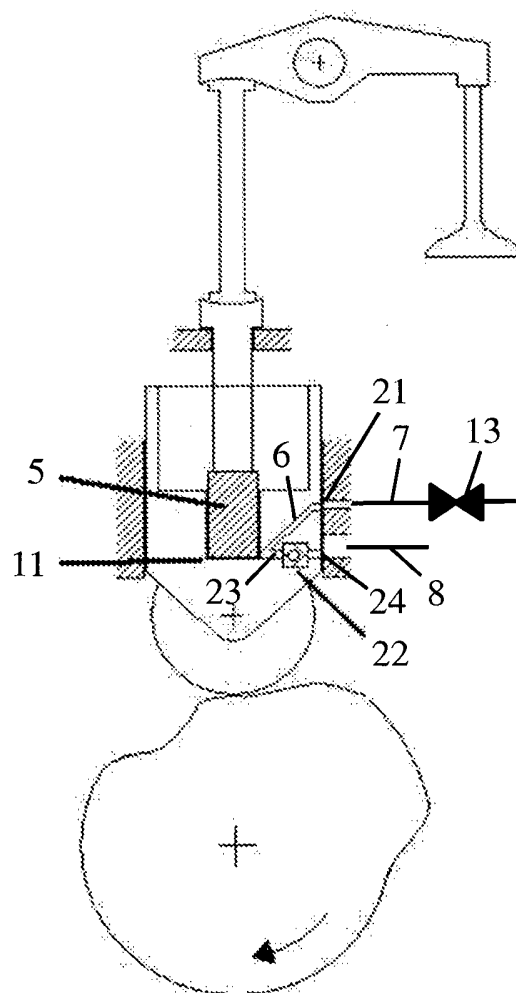


FIG. 2

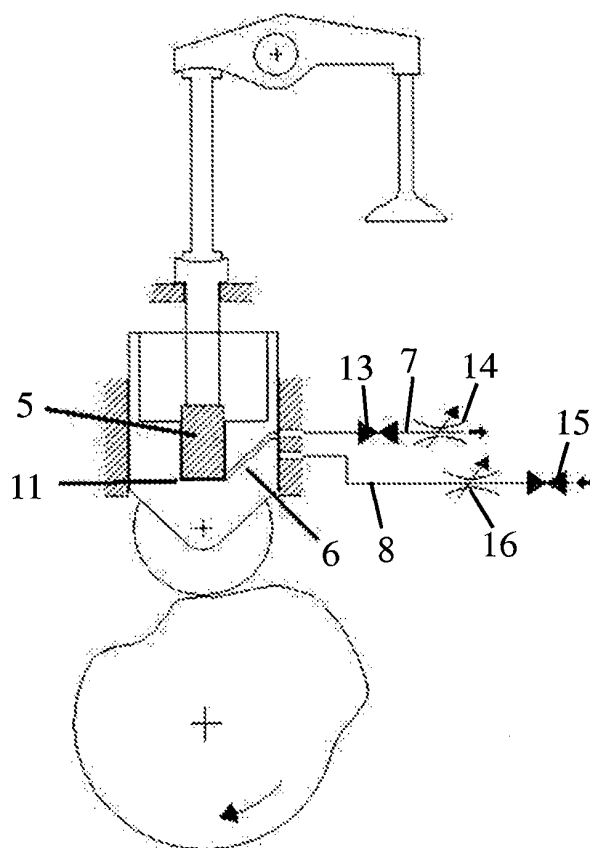


FIG. 3

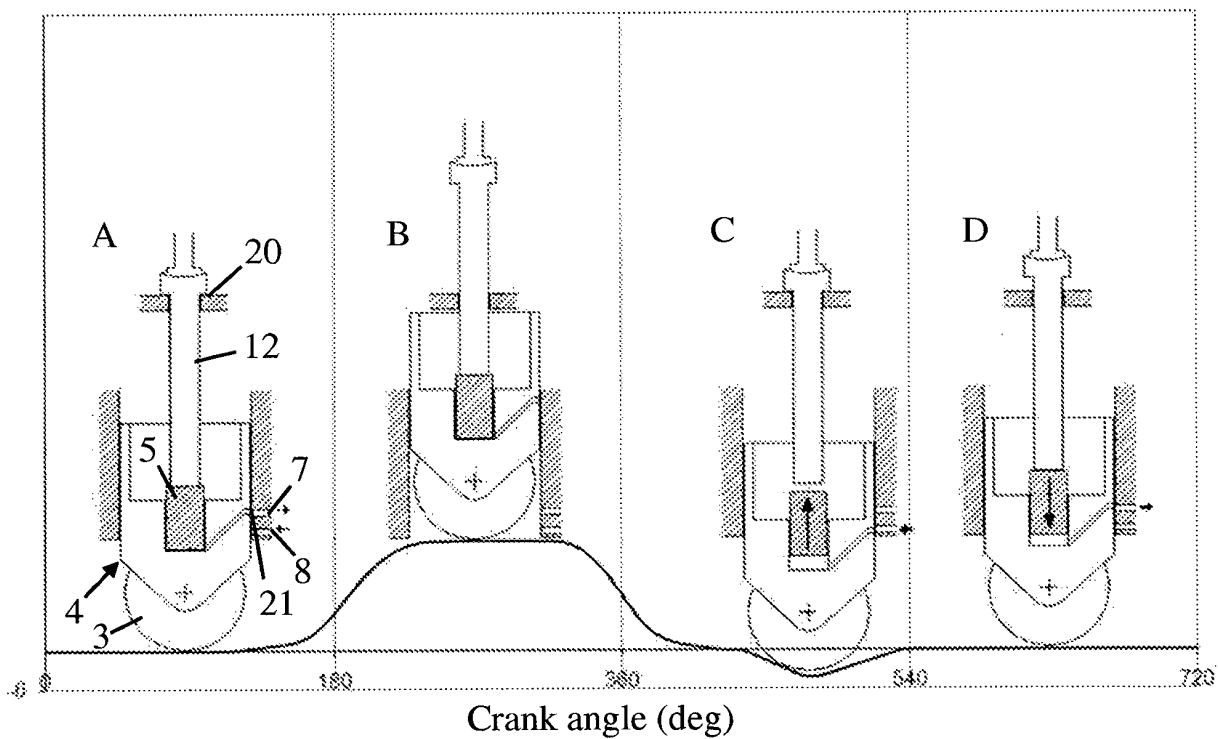


FIG. 4

REFERENCES CITED IN THE DESCRIPTION

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