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(71) Applicant: **Caterpillar Energy Solutions GmbH**
68167 Mannheim (DE)

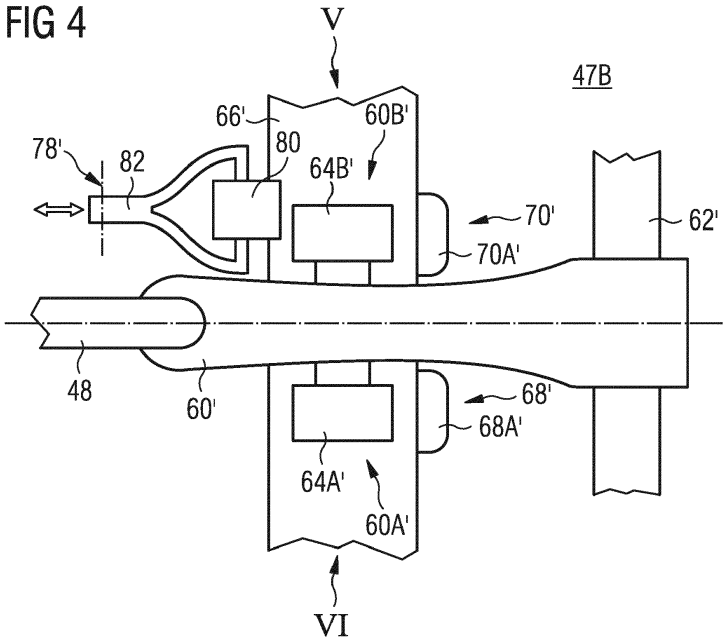
(72) Inventor: **Guisasola, Íñigo**
76829 Landau (DE)

(74) Representative: **Kramer Barske Schmidtchen**
Patentanwälte PartG mbB
European Patent Attorneys
Landsberger Strasse 300
80687 München (DE)

(54) **CAMSHAFT BASED VARIABLE VALVE TIMING**

(57) A camshaft system (47, 47A, 47B) for variably timing the operation of an engine valve (30) of an internal combustion engine (10) comprises a lever axis (62) and a lever (60) rotatably mounted to the lever axis (62) and comprising a push rod interaction section (60C), a first cam interaction section (60A), and a second cam interaction section (60B). The camshaft system (47, 47A, 47B) further comprises a camshaft (66) with a first cam (68) comprising a first cam lobe (68A) defining a first cam-profile for displacing the lever (60), a second cam (70) comprising a second cam lobe (70A) defining a second cam-profile, and an actuator unit (78, 78') for selectively bringing the second cam (70) into interaction with the second cam interaction section (60B) for modifying the displacing of the lever (60) in accordance with the second cam-profile. The disclosed configurations allow two types of camshaft driven operations, which may be specifically adapted to respective operation modes, e.g. part load and full load operation modes.

FIG 4



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Description

Technical Field

[0001] The present disclosure generally relates to valve operation systems for an internal combustion engine and, more particularly, to adapting valve timings.

Background

[0002] In internal combustion engines, camshaft driven rocker arm configurations are used to operate intake and exhaust valves. In particular several valves are provided, for example, within a cylinder head, each being operated by a respective rocker arm configuration. For example, an intake and an exhaust camshaft driven rocker arm configuration may control the opening and closing of two intake valves and two exhaust valves, respectively.

[0003] A common camshaft driving the rocker arm configurations may, for example, ensure respective timings. In some embodiments, intake and exhaust valves are driven by specifically shaped cams, thereby enforcing a specific valve timing that provides, for example, a Miller timing with a respective valve overlap.

[0004] There is a variety of valve timing adjustment mechanism known that allow, for example, an operation mode specific adjustment of valve timings.

[0005] The present disclosure is directed, at least in part, to improving or overcoming one or more aspects of prior systems.

Summary of the Disclosure

[0006] In an aspect of the present disclosure, a camshaft system for variably timing the operation of an engine valve of an internal combustion engine comprises a lever axis and a lever rotatably mounted to the lever axis and comprising a push rod interaction section, a first cam interaction section, and a second cam interaction section. The camshaft system further comprises a camshaft with a first cam comprising a first cam lobe defining a first cam-profile for displacing the lever, a second cam comprising a second cam lobe defining a second cam-profile, and an actuator unit for selectively bringing the second cam into interaction with the second cam interaction section for modifying the displacing of the lever in accordance with the second cam-profile. Other features and aspects of this disclosure will be apparent from the following description and the accompanying drawings.

[0007] In another aspect, an internal combustion engine comprises a plurality of cylinder units, each cylinder unit having at least one engine valve, and a plurality of camshaft systems as disclosed above. Each camshaft system is operatively connected to at least one engine valve of a respective cylinder unit of the plurality of cylinder units. Actuator units of the plurality of camshaft systems may be individually and/or commonly controllable to modify the displacing of the lever.

[0008] In some embodiments, the second cam may be mounted to the camshaft and the second cam interaction section may be formed by the first cam interaction section or provided separately next to the first cam interaction section. The actuator unit may comprise an actuator, and a transmission roller mounted to the actuator, wherein the actuator is configured to selectively bring the transmission roller into engagement with the second cam and the second cam interaction section, thereby modifying the displacing of the lever, or into disengagement from the second cam and/or the second cam interaction section, thereby displacing the lever in accordance with the first cam-profile.

[0009] In some embodiments, the camshaft system may further comprise a second camshaft pivotably mounted via a rod to the lever axis, wherein the second cam is mounted to the second camshaft. The actuator unit may comprise an actuator for selectively pivoting the second camshaft to engage the second cam and the second interaction section, thereby modifying the displacing of the lever, or to disengage the second cam and the second cam interaction section, thereby displacing the lever in accordance with the first cam-profile

Brief Description of the Drawings

[0010] The accompanying drawings, which are incorporated herein and constitute a part of the specification, illustrate exemplary embodiments of the disclosure and, together with the description, serve to explain the principles of the disclosure. In the drawings:

Fig. 1 shows a schematic cross-sectional view of an internal combustion engine with a camshaft driven rocker arm based valve drive;
Fig. 2 shows a schematic illustration of exemplary valve lift curves;
Fig. 3 shows a schematic illustration of an exemplary camshaft system of a valve actuation system using two cams on separate camshafts;
Fig. 4 shows a schematic illustration of an exemplary camshaft system of a valve actuation system using two cams on a common camshaft; and
Figs. 5 and 6 show respective schematic illustration of the two sides indicated in Fig. 4 for illustrating the interaction of the two cams.

Detailed Description

[0011] The following is a detailed description of exemplary embodiments of the present disclosure. The exemplary embodiment described herein and illustrated in the drawings are intended to teach the principles of the present disclosure, enabling those of ordinary skill in the art to implement and use the present disclosure in many different environments and for many different applications. Therefore, the exemplary embodiments are not intended to be, and should not be considered as, a limiting

description of the scope of patent protection. Rather, the scope of patent protection shall be defined by the appended claims.

[0012] The present disclosure may be based in part on the realization that selectively using two cams for lifting a rocker shaft may allow influencing the valve closing and opening times. It was further realized that this may be advantageously used to differentiate engine operation at varying loads such as at part load, start-up, or full load operation.

[0013] Referring to the drawings, exemplary embodiments are disclosed that illustrate the herein disclosed adjustable valve timing concepts that can be employed, for example, in the internal combustion engine of Fig. 1.

[0014] Specifically, in Fig. 1 an exemplary embodiment of an internal combustion engine 10 is illustrated that uses a camshaft driven rocker arm system for valve actuation exemplarily for a pre-combustion chamber ignited gaseous fuel operation. Engine 10 may include features not shown, such as a fuel system, an air system, a cooling system, drivetrain components, etc. For the purpose of the present disclosure, engine 10 is exemplarily considered to be a four-stroke gaseous fuel internal combustion engine. One skilled in the art will recognize, however, that engine 10 may be any type of engine (two-stroke, turbine, gas, diesel, natural gas, propane, etc.). Furthermore, engine 10 may be of any size, with any number of cylinders, and in any configuration ("V", in-line, radial, etc.). Engine 10 may be used to power any machine or other device, including locomotive applications, on-highway trucks or vehicles, off-highway trucks or machines, earth moving equipment, generators, aerospace applications, marine applications, pumps, stationary equipment, or other engine powered applications.

[0015] Engine 10 includes an engine block 12 having a plurality of cylinder units 14 (one of which is illustrated in Fig. 1). A piston 16 is slidably disposed within cylinder unit 14 (e.g. within a cylinder liner 15) to reciprocate between a top-dead-center position (TDC) and a bottom-dead-center position (BDC). A connecting rod 18 connects piston 16 to an eccentric crankpin 20 of a crankshaft 22 such that reciprocating motion of piston 16 results in rotation of crankshaft 22.

[0016] Engine 10 includes further a cylinder head 24 (enlarged in Fig. 1) that is mounted to engine block 12 and covers cylinder unit 14, thereby delimiting a main combustion chamber 26. Cylinder head 24 provides intake and exhaust openings 28 to charge main combustion chamber 26, for example, with a charge air-gaseous fuel mixture and to release exhaust gases out of main combustion chamber 26 into an exhaust gas system (not shown). Engine valves 30 are configured to selectively open and close respective openings 28, e.g. by a valve stem with a valve head. Each cylinder unit 14 may include multiple intake and exhaust openings 28 and respectively multiple intake and exhaust valves 30.

[0017] Engine 10 further may include an assembly configured to initiate a combustion event. As exemplarily shown in Fig. 1, engine 10 may include a pre-combustion chamber assembly 32 (also referred to as pre-combustion chamber ignition device), which is positioned within cylinder head 24, for example between valves 30. Pre-combustion chamber assembly 32 may be configured in a variety of ways. In general, it is an assembly configured to initiate a combustion event within a pre-combustion chamber, and to direct the combustion into main combustion chamber 26.

[0018] The internal combustion engine 10 may include a series of valve actuation assemblies 40 (one of which is exemplarily illustrated in Fig. 1). Multiple valve actuation assemblies 40 may be provided per cylinder unit 14, e.g. for different valve types (e.g. intake or exhaust valve). For example, valve actuation assembly 40 is used to open and close the intake valve(s) and another, for example similar, valve actuation assembly 40 may be provided to open and close the exhaust valve(s).

[0019] Valve actuation assembly 40 includes a rocker arm 46, a push rod, and a camshaft system 47.

[0020] Rocker arm 46 is pivotally mounted on cylinder head 24 by a rocker shaft unit 49 via a rocker shaft 50 and interacts with engine valves 30 at a valve actuation section 46A and with push rod 48 at a push rod section 46B.

[0021] Push rod section 46B engages with one end of push rod 48, the other end of push rod 48 engages camshaft system 47. As exemplarily shown in Fig. 1, push rod 48 engages with a cam lobe 58 disposed on a camshaft 56 to drive (lift) push rod 48 when camshaft 56 is rotated. Camshaft 56 may be driven by crankshaft 22. Camshaft 56 may be connected with crankshaft 22 in any manner readily apparent to one skilled in the art where rotation of crankshaft 22 may result in a rotation of camshaft 56. For example, camshaft 56 may be connected to crankshaft 22 through a gear train (not shown).

[0022] The displacement of push rod 48 corresponds to an actuation movement of push rod 48 of a conventional activation of valve 30. Specifically, the actuation movement includes a lifting movement L and a return movement R. Lifting movement L is caused by the shape, specifically a lifting side of cam lobe 58 and results in a lifting force Fl onto rocker arm 46 redirected via the pivot mounting onto the valve stem. Thus, due to engagement with valve actuation section 46A, the valve stem of valve 30 moves from a closed position to an open position during lifting movement L.

[0023] Assuming non-fixed connections between rocker arm 46 and push rod 48 as well as rocker arm 46 and the valve stem, return movement R will not automatically result in a closing of the valve (e.g. return of the valve stem into the closed position of valve 30). Therefore, valve actuation assembly 40 may include - as a biasing force providing unit - for example, a valve spring 52 that provides a biasing force Fb onto the valve stem of valve 30 towards the closed position and, thus, generally counteracts against lifting force Fl.

[0024] Once the maximum extension of cam lobe 58

is reached, biasing force Fb enforces that push rod 48 follows the trailing side of cam lobe 58, thereby return movement R allows closing of opening 28 via the respective valve head.

[0025] One skilled in the art may recognize that camshaft 56 may include additional cam lobes to engage with additional push rods in order to actuate additional engine valves.

[0026] Fig. 2 shows a plot of exemplary valve lift curves. In particular, Fig. 2 shows an exhaust valve curve 92 extending from about 140° to 370° crankshaft angle during an exhaust stroke, and an intake valve curve 94 extending from about 350° to 490° crankshaft angle during an intake stroke. The schematically indicated valve lift curves 92 and 94 illustrate as an example an extreme Miller valve timing that reaches a high efficiency and may be applied, for example, at full load. In Fig. 2, the operation at full load is indicated by reference F. However, those valve lift curves 92 and 94 may not be optimal to start engine 10 or to operate the same at part load as then a relative small load acceleration may be present.

[0027] As an example for part load operation, a filling optimized lift curve 96 for an intake valve is schematically included in Fig. 2. Filling optimized lift curve 96 extends, for example, from 350° to 570° crankshaft angle and allows increasing the filling of main combustion chamber with charge air. In Fig. 2, the operation at part load when starting the engine is indicated by reference S. Filling optimized operation may reduce the risk of knocking at part load such that a larger power output and improved load acceleration may be achieved. In particular when operated as a separate power supply, this aspect may affect the combustion tuning.

[0028] Exemplary configurations for implementing part load operation as well as full load operation by a specifically designed camshaft system are illustrated in the following. Those configurations may allow adaptation of valve timings, for example, for the full load operation of engine 10 in Miller-like manner with one cam and for part load with another cam.

[0029] With reference to Fig. 3, a schematic illustration of a camshaft system 47A for variably timing the operation of an engine valve of an internal combustion engine (as, for example, shown in Fig. 1) is illustrated.

[0030] Camshaft system 47A is configured to actuate via push rod 48 and a rocker arm (not shown in Fig. 3) one or more engine valves. Camshaft system 47A comprises a lever 60 rotatably mounted to a lever axis 62. Lever 60 comprises a first cam interaction section 60A, a second cam interaction section 60B, and a push rod interaction section 60C. Push rod interaction section 60C may be configured - as known in the art - to guide push rod 48 during lifting movement L and return movement R in a reliable manner.

[0031] First cam interaction section 60A and second cam interaction section 60B may comprise lever rollers 64A, 64B rotatably mounted to lever 60. Lever rollers 64A, 64B are configured to interact with cams, specifically with cam lobes to displace lever 60 and, thus, push rod 48.

[0032] Camshaft system 47A comprises further a camshaft 66 with a first cam comprising a first cam lobe 68A. First cam lobe 68A defines a first cam-profile for displacing lever 60, resulting, for example, in a valve actuation as indicated in Fig. 2 by curve 94.

[0033] In the embodiment of Fig. 3, camshaft system 47A comprises further a second cam 70 with a second cam lobe 70A defining a second cam-profile. In the position shown in Fig. 3, first cam 68 is interacting with lever roller 64A, while second cam 70 is not interacting with lever roller 64B.

[0034] Second cam 70 is mounted to a separate second camshaft 72, which is connected to lever axis 62 by a rod 74. The mounting of second camshaft allows second camshaft 72 to pivot around lever axis 62.

[0035] An actuator unit 78 is provided to control the pivot angle as indicated by an arrow along the pivot circle line. Actuator unit 78 may interact, for example, with rod 74 or a mounting configuration (not shown) of second camshaft 72. In general, actuator 78 may positioned at various locations along the engine, if several cylinder units should be synchronized, or may be provided and positioned in a specific manner for each cylinder unit.

[0036] Moreover, Fig. 3 illustrates exemplarily two gears 76A, 76B. Gear 76A is mounted to lever axis 62 and gear 76B to second camshaft 72. Accordingly, second camshaft 72 may continuously rotate with the respective speed as driven by lever axis 62.

[0037] Moreover, when lever axis 62 is rotated (e.g. acting as a drive for the second camshaft), gears 76A, 76B result in rotation of second cam 70. Actuation unit 78 may bring second cam 70 into engagement with lever roller 64B.

[0038] In other words, gears 76A, 76B and actuator unit 78 are configured to selectively pivot second camshaft 72 to engage second cam 70 with second interaction section 60B, when needed.

[0039] In the embodiment of Fig. 3, camshaft system 47A allows providing two types of actuation movements for push rod 48. In case, actuator unit 78 disengaged second cam 70 and second cam interaction section 60B (specifically lever roller 64B), first cam lobe 68A defines the displacement of the lever. However, if actuator unit 78 engaged second cam 70 and second interaction section 60B (specifically lever roller 64B) the displacement of lever 60 may be modified in accordance with the cam-profile of second cam 70.

[0040] For example, a lifting side displacing by first cam lobe 68A may be replaced by a lifting side displacing by second cam lobe 70A, and/or a trailing side displacing by first cam lobe 68A may be replaced with a trailing side displacing by second cam lobe 70A.

[0041] In general, in camshaft systems as disclosed herein, whenever any cam-profile is interacting with a respective cam interaction section, a displacement of lever 60, and thus push rod 48, will take place. For example,

assuming second cam lobe 70A being wider at the trailing side than the first cam lobe 68A, valve operation curve 96 being longer at the valve closing side may be enforced by bringing second cam 70 into interaction with lever roller 64B.

[0042] Referring to Fig. 4, a schematic (top) view of another camshaft system 47B is illustrated. In particular, Fig. 4 shows push rod 48 interacting with a lever 60' at one end of lever 60'. At the other end of lever 60', lever 60' is mounted to a lever axis 62'.

[0043] Lever 60' further comprises at one side a first cam interaction section 60A' and on the other side a second cam interaction 60B'. As exemplarily shown, first and second cam interaction sections 60A' and 60B' comprise respective lever rollers 64A' and 64B'. Lever rollers 64A', 64B' are mounted rotatably to lever 60' along a direction identical or at least similar to the direction of lever axis 62'.

[0044] Camshaft system 47B further comprises a camshaft 66' having one section with a first cam lobe 68A' of a first cam 68' for interacting with first cam interaction section 60A' (specifically lever roller 64A'). Furthermore, camshaft 66' comprises a section with a second cam lobe 70A' of a second cam 70' for interacting with second cam interaction section 60B' (specifically lever roller 64B').

[0045] Camshaft system 47B comprises further an actuator unit 78' with a transmission roller 80, a rod 82, and an actuator 84 (see also Fig. 5). Actuator unit 78' is configured to selectively bring transmission roller 80 into engagement with second cam 70' and with second cam interaction section 60B', thereby modifying the displacing of lever 60' in accordance with second cam lobe 70A', or into disengagement from second cam lobe 70A' and/or second cam interaction section 60B' (specifically lever roller 64B'), thereby displacing the lever in accordance with the first cam-profile of first cam lobe 68A'.

[0046] Figs. 5 and 6 illustrate the engagement and the disengagement as the two types of operation modes of the camshaft system 47B.

[0047] Specifically, Fig. 5 shows a schematic side view of lever 60' to illustrate the engagement of transmission roller 80 with lever roller 6 4B and second cam 70'. For simplifying the drawing, lever roller 64A is, for example, not shown in Fig. 5.

[0048] Referring to actuator unit 78', transmission roller 80 is mounted via rod 82 to actuator 84. As rod 82 is moved by actuator 84, transmission roller 80 can be positioned between lever roller 64B' and second cam 70' or remote from the same. In Fig. 5, the position of transmission roller 80 is indicated in dashed lines when engaging lever roller 64B' as well as second cam 70'.

[0049] In addition, rod 82 is tiltably mounted to actuator 84 to allow transmission roller 80 to follow the second cam-profile of second cam lobe 70A' and to transfer that displacement to lever roller 64B', thereby lifting lever 60' in accordance with the second cam-profile, and accordingly to lift push rod 48, respectively.

[0050] In general, the position of transmission roller 80 with respect to second cam 70' defines the absolute timing of the displacement of lever 60' by second cam 70'.

[0051] Fig. 6 illustrates the engagement of first cam 68 with lever roller 64A', which may correspond to standard cam-lever-push rod interaction implementations. For simplifying the drawing, lever roller 64B' as well as actuator unit 78' are not shown in Fig. 6. Lever roller 64B' will directly follow the displacement of first cam lobe 68A', thereby lifting lever 60' in accordance with the first cam-profile.

[0052] Looking again at both operation modes, if second cam lobe 70A' extends over a larger angular range than first cam lobe 68A', in particular, the opening time of a valve with respect to an opening time provided by first cam lobe 68A' may be extended.

[0053] Referring again to Fig. 1, providing, for example, actuator unit 78' individually for each cylinder unit 14 (and/or for each engine valve 30 to be operated), the various resulting valve actuations can be individually set and aligned with respect to each other by displacing rod 82 as required for each operated engine valve. Alternatively, actuation unit 78' for different valves may be combined in one common actuation unit to synchronize all valve actuations.

Industrial Applicability

[0054] The herein disclosed concepts may be used, for example, in gas engines manufactured by Caterpillar Energy Solutions GmbH as well as in engines manufactured by Caterpillar Motoren GmbH & Co. KG.

[0055] Although the preferred embodiments of this invention have been described herein, improvements and modifications may be incorporated without departing from the scope of the following claims.

Claims

1. A camshaft system (47, 47A, 47B) for variably timing the operation of an engine valve (30) of an internal combustion engine (10), the camshaft system (47) comprising:

   a lever axis (62);
   a lever (60) rotatably mounted to the lever axis (62) and comprising a push rod interaction section (60C), a first cam interaction section (60A), and a second cam interaction section (60B);
   a camshaft (66) with a first cam (68) comprising a first cam lobe (68A) defining a first cam-profile for displacing the lever (60);
   a second cam (70) comprising a second cam lobe (70A) defining a second cam-profile; and
   an actuator unit (78, 78') for selectively bringing the second cam (70) into interaction with the second cam interaction section (60B) for modifying the displacing of the lever (60) in accordance with the second cam-profile.

2. The camshaft system (47B) of claim 1, wherein
the second cam (70') is mounted to the camshaft (66');
the second cam interaction section (60B') is formed by the first cam interaction section (60A') or provided separately next to the first cam interaction section (60A'); and
the actuator unit (78') comprises an actuator (84), and a transmission roller (80) mounted to the actuator (84),
wherein the actuator (84) is configured to selectively bring the transmission roller (80) into engagement with the second cam (70') and the second cam interaction section (60B'), thereby modifying the displacing of the lever (60'), or into disengagement from the second cam (70') and/or the second cam interaction section (60B'), thereby displacing the lever (60') in accordance with the first cam-profile.

3. The camshaft system (47B) of claim 2, wherein
the actuator (84) is configured to linearly move a joint connection to which the transmission roller (80) is pivotably mounted.

4. The camshaft system (47B) of claim 2 or claim 3, wherein
the position of the transmission roller (80) with respect to the second cam (70') and the second cam interaction section (60B') defines the absolute timing of the displacement of the lever (60') by the second cam (70').

5. The camshaft system (47A) of claim 1, further comprising:

a second camshaft (72) pivotably mounted via a rod (74) to the lever axis (62), and
wherein the second cam (70) is mounted to the second camshaft (72), and
the actuator unit (78) comprises an actuator for selectively pivoting the second camshaft (72) to engage the second cam (70) and the second interaction section (60B), thereby modifying the displacing of the lever (60), or to disengage the second cam (70) and the second cam interaction section (60B), thereby displacing the lever (60) in accordance with the first cam-profile.

6. The camshaft system (47A) of claim 5, wherein the actuator unit (78) comprises a gear system (76A, 76B) operatively connected to the lever (60) and the second camshaft (72) for rotating the second camshaft (72) in dependence of a rotation of the lever (60).

7. The camshaft system (47, 47A, 47B) of any one of the preceding claims, wherein modifying the displacement of the lever (60) comprises:

replacing a lifting side displacing by the first cam lobe (68A, 68A') with a lifting side displacing by the second cam lobe (70A, 70A'), and/or
replacing a trailing side displacing by the first cam lobe (68A, 68A') with a trailing side displacing by the second cam lobe (70A, 70A').

8. The camshaft system (47, 47A, 47B) of any one of the preceding claims, wherein the second cam lobe (70A, 70A') extends over a larger angular range than the first cam lobe (68A, 68A'), in particular to extend the opening time of the engine valve (30) with respect to an opening time provided by the first cam lobe (68A, 68A').

9. The camshaft system (47, 47A, 47B) of any one of the preceding claims, wherein the first cam interaction section (60A) comprises a first lever roller (64A) for interacting with the first cam (68) and/or the actuator unit (78, 78').

10. The camshaft system (47, 47A, 47B) of any one of the preceding claims, wherein the second cam interaction section (60B) comprises a second lever roller (64B) for interacting with the actuator unit (78, 78').

11. The camshaft system (47, 47A, 47B) of any one of the preceding claims, wherein the second cam interaction section (60B)
is formed by the first cam interaction section (60A) or is provided separately from the first cam interaction section (60A), and/or
is provided at the same side of the lever (60) with respect to the lever axis (62), or at the opposite side of the lever (60) with respect to the lever axis (62).

12. The camshaft system (47, 47A, 47B) of any one of the preceding claims, wherein the first cam (68) is rotated by a rotation of the lever (60) via a gear system.

13. An internal combustion engine (10) comprising:

a plurality of cylinder units (14), each cylinder unit (14) having at least one engine valve (30);
a plurality of camshaft systems (47, 47A, 47B) of any one claims 1 to claim 12, each camshaft system (47, 47A, 47B) operatively connected to at least one engine valve (30) of a respective cylinder unit (14) of the plurality of cylinder units (14),
wherein actuator units (78, 78') of the plurality of camshaft systems (47) are individually and/or commonly controllable to modify the displacing of the lever (60).

FIG 1

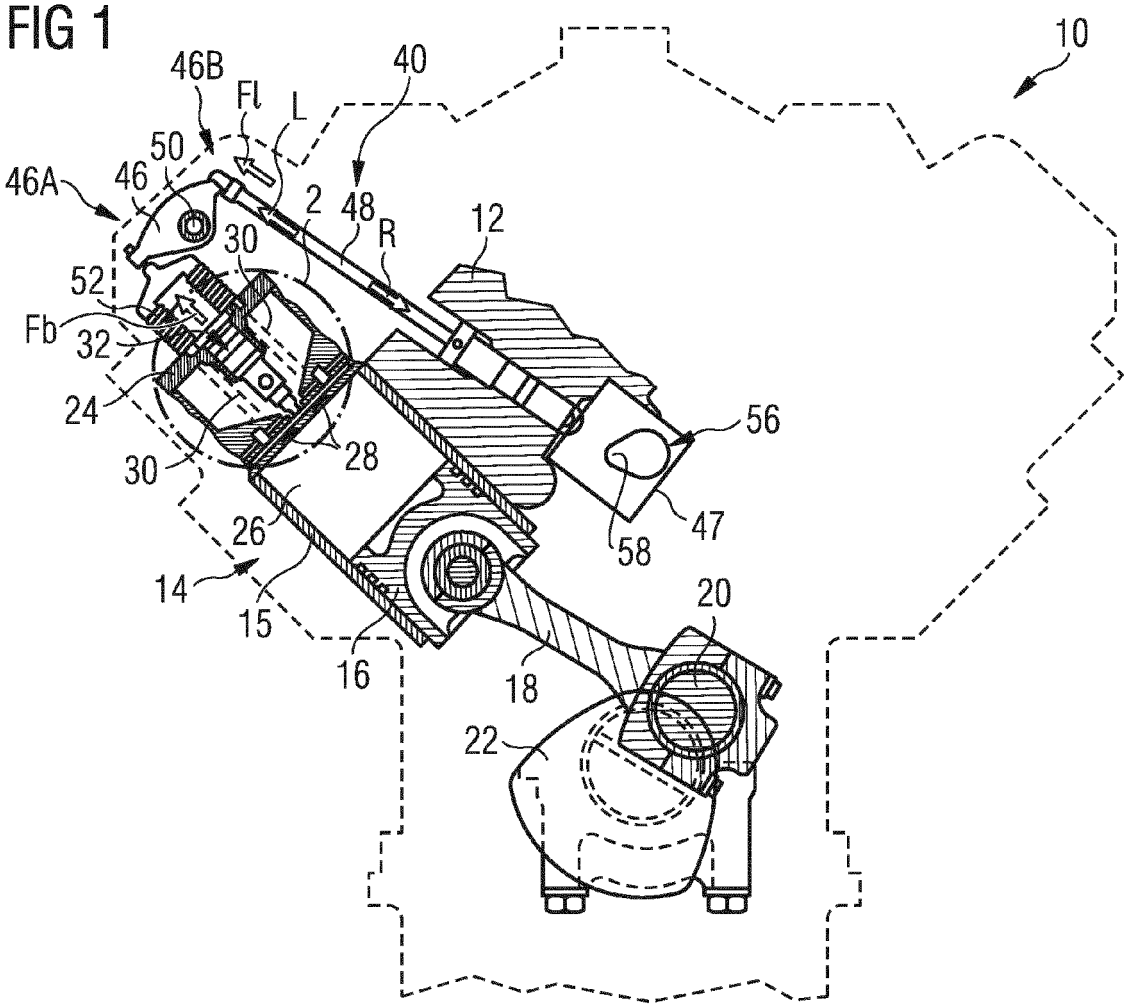

10
46B
Fl
L
40
50
46A
46
2
48
R
12
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52
Fb
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30
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15
16
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20
22

FIG 2

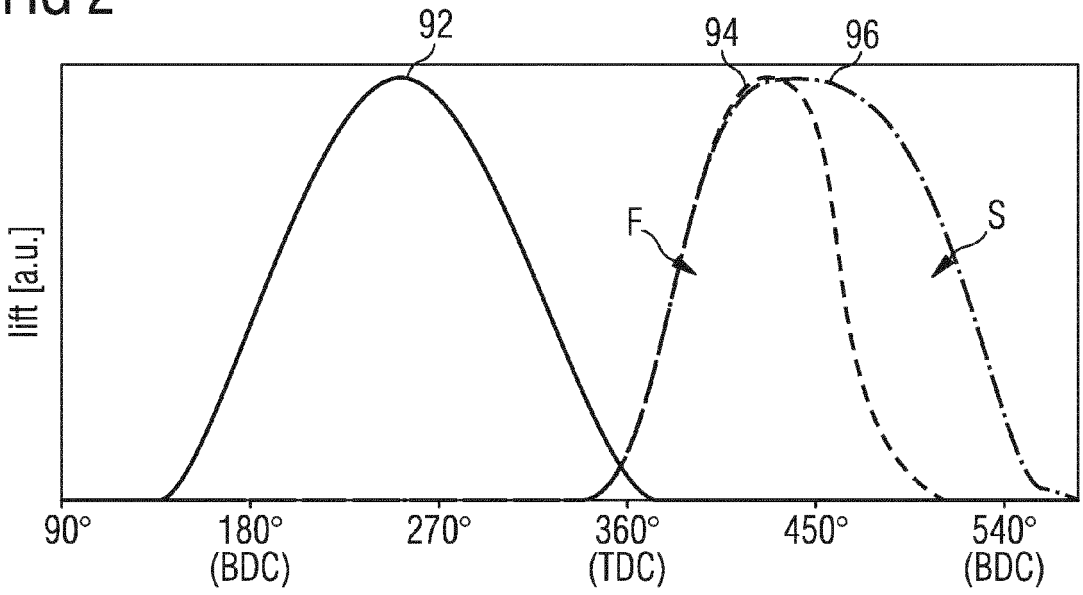

92
94
96
F
S
lift [a.u.]
90°
180°
(BDC)
270°
360°
(TDC)
450°
540°
(BDC)

FIG 3

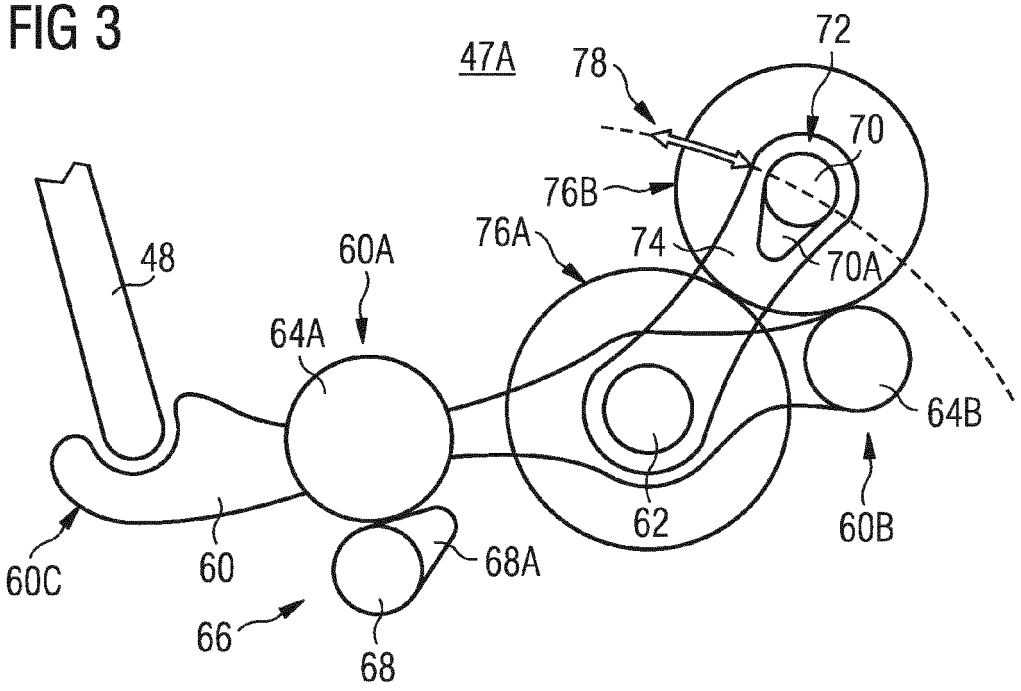

47A
78
72
70
76B
76A
74
70A
48
60A
64A
64B
62
60B
60C
60
68A
66
68

FIG 4

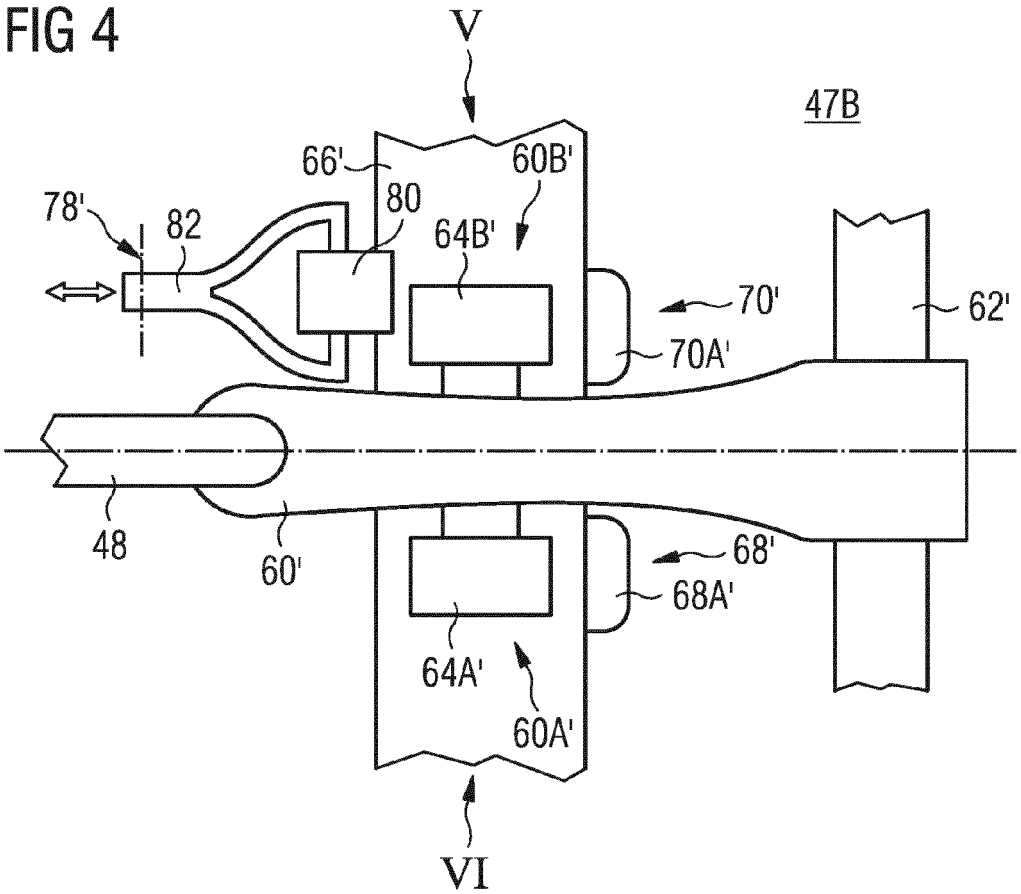

V
47B
66'
60B'
78'
82
80
64B'
70'
62'
70A'
48
60'
68'
68A'
64A'
60A'
VI

FIG 5

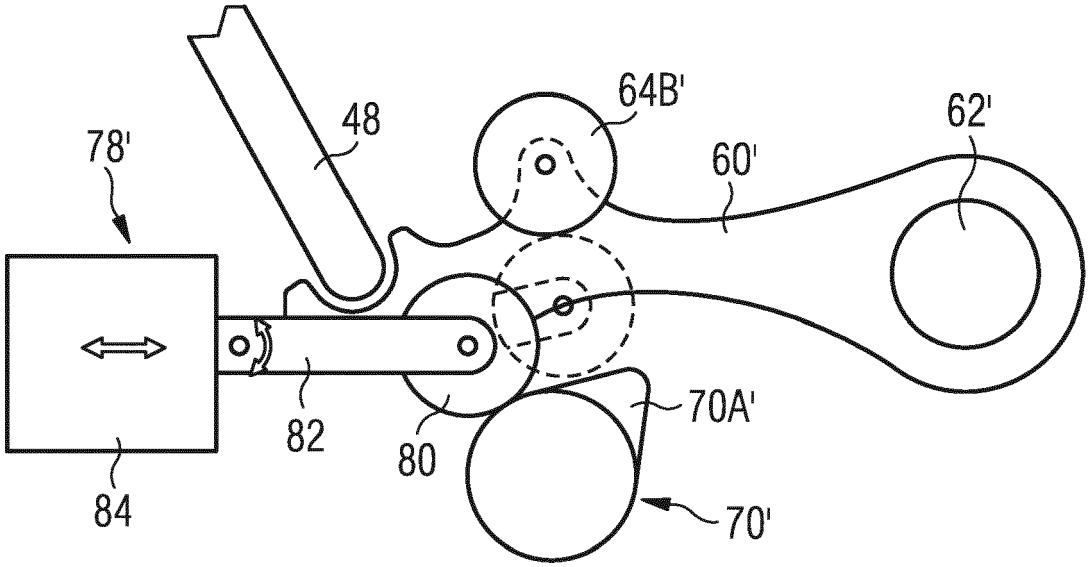
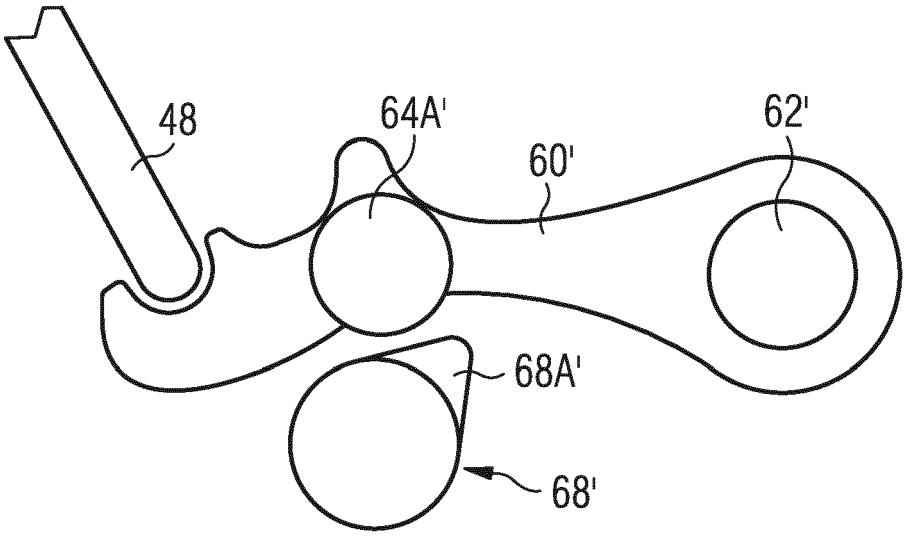


FIG 6



Europäisches Patentamt
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EUROPEAN SEARCH REPORT

Application Number
EP 15 16 0893

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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F01L

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	15 September 2015	Klinger, Thierry

CATEGORY OF CITED DOCUMENTS

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