(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 685 632 A1**

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **94107140.9**

(51) Int. Cl.^{6}: **F01L 13/00**

(22) Date of filing: **06.05.94**

(43) Date of publication of application: **06.12.95 Bulletin 95/49**

(84) Designated Contracting States: **DE ES FR GB IT**

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(54) A mechanism for suspending operations of valves and other components of internal combustion engines or like machines.

(57) The improved internal combustion engine in one embodiment operates more efficiently under partial load conditions by alternating between the active and passive operating modes, the latter characterized by cylinder decompression by exhaust valves opening and charge elimination by suction valves closing throughout all strokes. Smooth change in operating modes is possible at very high speeds; by synchronous shifting of a mode camshaft (4) rotating at one eighth of the camshaft (2) speed, to and from a transient axial position where it sequentially toggles auxiliary cams (3) about valve rocker pivots (24) to change rocker geometry while rocker operated devices are inoperative in the cycle. Other embodiments of the invention provide for dynamic engine braking, simpler fuel injection, and selective operations with other engines or motors. Use of this invention with an earlier invention, described in European Patent Application 89104536.1, which provides a mechanism for elimination of piston movements, better achieves the common objects of both the inventions.

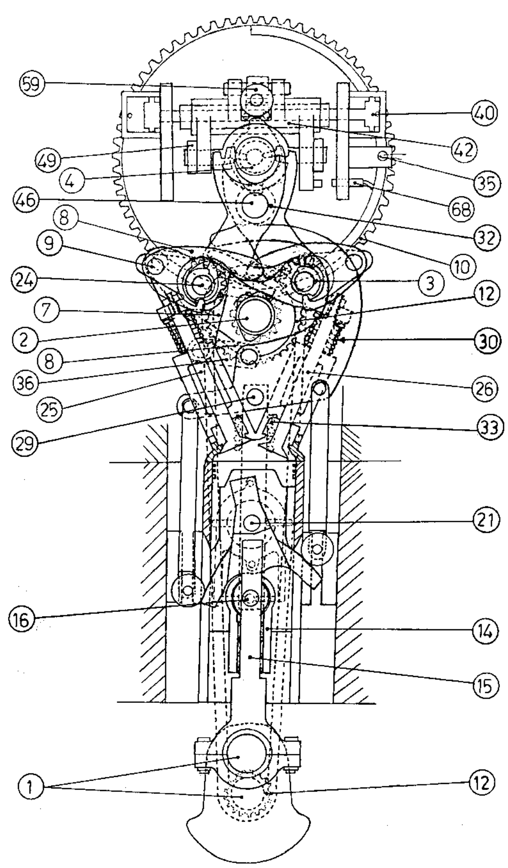

FIG. 1.

EP 0 685 632 A1

This invention relates to any engine or machine with cyclically intermittent or reciprocating device operations, and enables selective suspension of these operations over some cycles. It particularly relates to improving the inefficient operations of highly rated vehicle engines under normal partially loaded conditions. Engines modified by this invention produce lesser effluents, have minimized wear, and permit simpler fuel injecting arrangements. Other embodiments of the invention enable dynamic engine braking, multi-fuel operations, and selective operations from any of synchronously coupled prime movers, including another engine or electric motor.

Most of the energy produced by an idling or lightly loaded engine is internally dissipated by friction, gas compression and thermal losses. The present invention, in its most important embodiment, reduces these losses, by eliminating charging and combustion within some cylinders over some cycles while meeting partial power requirements from normal operations in other cylinder cycles. An earlier invention with similar objects, described in European Patent Application 89104536.1, has provided a mechanism for elimination of piston movements in a machine. Although the present invention is beneficial even without eliminating piston movements; simultaneous application of both inventions better achieves their common objectives.

The preferred embodiment of the invention is now described and illustrated for a four cylinder, four stroke engine, with a passive operating mode characterized by suspension of all valve and piston movements. Referring to the figures, the designations of various components are as follows: crankshaft 1, camshaft 2, auxiliary cam 3, mode camshaft 4, suction valve rocker 5, exhaust valve rocker 6, locking bracket rocker 7, lever 8, lever pivot 9, gears 10, locking bracket 11, chain sprockets 12, piston lifters 13, connecting arm 14, bearing block 15, locking pins 16, piston 17, fork 18, piston lever 19, piston lever pivot 20, fork pivot 21, bearings 22, gudgeon pin 23, rocker pivots 24, suction valve 25, exhaust valve 26, guides 27, mode cam 28, locking bracket pivot 29, valve spring 30, bearings 31, cam roller 32, piston lifter spring 33, push rod 34, mode cycle switch 35, locking bracket link 36, locking cams 37, rod bearing 38, shifter cam 39, shifter actuator 40, shifter lever pivot 41, shifter 42, shifter pipe 43, shifter lever 44, cylinders 45, cam follower pivot 46, cam follower 47, thrust bearing 48, link 49, potentiometer 50, tachogenerator 51, comparator 52, shift register 53, logical invertor 54, AND gate 55, driving sleeve 56, roller bearings 57, bush bearing 58, shifter roller 59, shifter spindle 60, bracket 61, pin 62, brake switch 63, NOR gate 64, valve cams 65, solenoid valve 66, bearing sleeve 67, shifter switch 68, cylinder block 69, pins 70.

Figure 1 shows the components relating to one cylinder of the preferred embodiment in the passive operating mode.

Figure 2 shows the re-arrangement of the same components in the active operating mode.

Figure 3 shows a schematic view of modified engine components showing piston, valve gear, related components, and arrangements for rotation and axial movement of the mode camshaft.

Figure 4 shows timings for mode changes. The curves represent: 1) shift register input, 2) outputs from mode cycle switch (solid lines) and shifter switch (dotted lines), 3) solenoid A excitation, 4) solenoid B excitation, 5) shifter lever tilt, 6) mode camshaft axial position, 7) combined auxiliary cam position, 8) position of separate auxiliary cam for exhaust valve, 9) locking bracket lift, 10) locking bracket tilt, 11) suction valve position, 12) exhaust valve position, 13) piston position, 14) camshaft cycle, 15) mode camshaft cycle. For curves 7 to 13, the solid and dotted lines represent timings for the first and fourth cylinders, respectively.

Figure 5 shows the logic for excitation of valve solenoids.

Figure 6a, 6b and 6c shows typical cross sections of mode cams, shifter cams, and shifter actuator; respectively.

Figure 7 shows the assembly of shifter components, and an alternate arrangement for changing modes.

Figure 3 shows links 49 connecting the shifter 42 to the sleeve 67 holding thrust bearing 48 mounted on the mode camshaft. Mode camshaft 4 supporting a pin mounted with roller bearings 57 engaging within and driven from slots in the driving sleeve 56 in all axial dispositions, rotates with the driving sleeve at one eighth of the camshaft speed through gears 10. The camshaft rotates at half the crankshaft speed through sprockets 12. Bush bearings 58 facilitate simultaneous rotary and axial movements of the mode camshaft.

Figure 4 shows effects of mode changes. In the first phase of camshaft cycles A to H, individual cylinders change to their passive mode operations from their suction stroke between E3 and F2; and in the second phase of camshaft cycles E to D, individual cylinders change to their active mode operations from their suction stroke between A3 and B2.

In both phases, mode cams change operating modes of individual cylinder devices, in staggered timings, when the devices are inoperative preceding their active timings within the first cycle in the changed operating mode. For different engine constructions and mode controlled devices, these timings stagger within a range of 240 to 900 camshaft degrees; within 800 camshaft degrees for the preferred embodiment, corresponding to 100 mode camshaft degrees. Within this range, each device changes its operating mode in about 30 mode camshaft degrees, during its idle time in the cycle.

Shifter lever 44 pivots upon shifter lever pivot 41 on shifter 42, which pivots on shifter pipe 43. Axially movable shifter actuator 40 has two taper keyways on opposite sides, with increasing depths in opposite directions and a parallel keyway to provide anti-rotation within the shifter pipe. Parts of shifter lever enter through holes in the shifter and shifter pipe, to touch the taper keyway bottoms as shown in figure 6c. Mode changes are initiated by solenoid actuation of 5-port direction control valve 66, causing one of pneumatic cylinders 45 to axially move the shifter actuator and thereby rotate the shifter lever upon the shifter lever pivot till such movement is blocked by one of shifter rollers 59 touching one of shifter cams 39 on driving sleeve 56 in the regions around B3 or F3, when changing to the passive or the active mode, respectively (see curve 5, figure 4; and figure 6b). At this time, the shifter actuator is in its central position and its further movement is possible only by moving the shifter and the mode camshaft, for which its motive pneumatic force is inadequate. Instead, the rising cam profile of the shifter cam lifts the shifter lever with the shifter, upon the shifter pipe to move the mode camshaft axially, through links 49 and thrust bearing 48, in the regions C2 to D3, or G2 to H3 while changing to the passive or the active mode, respectively. This movement ends when the mode camshaft reaches its central position and both the shifter rollers 59 simultaneously contact the shifter cams at their maximum radius in the following D4 to E1, or H4 to A1. Within periods from D4 to G1, or H4 to C1, while changing to the passive or the active mode, respectively, covering about 100 mode camshaft degrees, all mode cams 28 move their cam followers 47 to change operating modes of all devices. Within E2 to G1, or A2 to C1, of these periods, the fall in the shifter cam profile allows further turning of the shifter lever upon the shifter lever pivot by the continuous pressure of the shifter actuator which finally completes its stroke. In the following period G2 to H3, or C2 to D3, respectively, the rising shifter cam profile lifts the shifter lever with the shifter upon the shifter pipe, to cause further and conclusive movement of the mode camshaft to its one end position, as seen in figure 7.

Two identical mode cams 28 identically oriented on the mode camshaft on either side of a cylindrical groove and between identical cylindrical cross-sections, move the same cam follower in opposite directions. Figure 6A shows the cross section of one mode cam, and the outlines of other mode cams in relative positions on the mode camshaft. Opposite sectors 1 and 3, of each cam profile have constant radii equal to one of the groove radius and the mode camshaft radius, and are joined by helical sectors 2 and 4. The mode camshaft is shifted between its central and other axial dispositions, within shiftable mode cam positions with every cam follower simultaneously incident upon the sector 1 or 3 of the mode cams of which radius equals the radius of the cylindrical section on its driven side when shifting between the central position and the driven side, and non-driven side when shifting between the central position and the non-driven side. Such shifting of the mode camshaft, therefore has no effect on the cam followers.

Figure 5 describes the mode changing logic. Signals from potentiometer 50 proportional to accelerator position, and tachogenerator 51 proportional to engine speed, give High output from comparator 52 when engine speed is less than required. Brake switch 63 gives High output on brake application. Shift register 53 gets High input in the absence of acceleration or braking requirements. Mode cycle switch 35 senses a half circular collar on gear 10 giving High output from A1 to E1 of every mode camshaft cycle, as shown by the solid lines in curve 2 of figure 4. Shifter switch 68 senses shifter proximity to give High output in its central position, as shown by the dotted lines in the same curve. In the absence of High disabling output from the shifter switch, data is clocked by the shift registers at the rising edges of pulses from mode cycle switch when Out1 is High, and at the falling edges of the pulses otherwise. Outputs Out1 and Out2 of shift register are its input at the time of the ultimate and penultimate enabled clock pulses, respectively. Difference in outputs Out1 and Out2 initiates change in operating modes by energizing solenoid valve through invertor 54 and AND gate 55.

Suction valve 25 and exhaust valve 26 are operable by valve cams 65 and locking bracket is operable by locking cams 37 through rockers 5,6, and 7 and levers 8. On the suction rocker pivot, the auxiliary cams for the suction valve and the looking bracket are combined with one auxiliary cam for the exhaust valve, the latter provided with another auxiliary cam to its valve rocker pivot. Levers are turned upon rockers by the auxiliary cams 3 turning around their respective rocker pivots 24, by rotation of cam followers 47. In the active mode, the auxiliary cams move down the levers on valve rockers 5 and 6 to their active positions of operation by valve cams 65; and in the passive mode, they lift up the levers to their passive positions upon rockers, distant from valve cams.

The forked lever on locking bracket rocker 7 has three positions against the locking cams on the camshaft; including a central position where it is inoperable by either locking cam, and one passive and one active end positions arrived by lever movement from the central position caused by movement of the auxiliary cam while changing to the passive or active mode, respectively. In the passive end position, the lever is operable by one locking cam between E2 and E3; and in the active end position, it is operable by the other locking cam between A2 and A3. Either way, the locking cams move the lever back to its central position while the locking bracket toggles from its active to passive position, or passive to active position, respectively.

The distance between the lowest piston ring and the top of the gudgeon pin exceeds the piston stroke. Slots rising up from the bottom to just below the lowest level reached by the lowest piston ring in the cylinder bore, connect the cylinder bore and parallel smaller bores on four sides. Two of these bores along the crankshaft axis accommodate piston lifters, and the other two bores accommodate push rods. Machined guides 27 within slots guide the bottom ends of piston lifters and push rods. The conventional connecting rod is substituted by connecting arm 14 and bearing block 15. Bearing block connects to the crankshaft 1 over bearings like the conventional connecting rod, while the connecting arm swivels upon rigidly held gudgeon pin 23 whose ends project through vertical slots into the piston lifter bores. The gudgeon pin has an hour-glass shaped vertical central hole and another axial bore holding both grooved locking pins 16. The bearing block is slideable within bearings in the connecting arm and freely movable within the vertical hole. Fork 18 pivoting on fork pivot 21 in the centre of piston 17 has arms extending through the vertical slots into the push rod bores. Cavities on piston accommodate piston levers 19 pivoting on piston lever pivots 20 on both sides of the fork pivot. Above and below their pivots, one piston lever connects to right-hand and left-hand helical cam faces on one side of the fork, respectively, and the other piston lever connects to left-hand and right-hand helical cam faces on the other side of the fork, respectively. The bottom ends of piston levers enter through longitudinal slots in the gudgeon pin into grooves of locking pins 16.

The operating mode of piston changes by one of locking cams 37 operating the forked lever 8, to ultimately operate the fork 16 through locking bracket rocker 7, locking bracket link 36, locking bracket 11, push rods 34, and rod bearings 38. While so turning, the locking bracket oscillates vertically as shown in curve 9 of figure 4, by its wavy top profile rolling over cam roller 32 by pressure of piston lifter springs 33 through piston lifter pivot 29. The opposite vertical push rod movements caused by rotation of the locking bracket, are thus modulated by the oscillatory movements which are equal to the vertical movements of the piston near its top dead centre position. This ensures constant contact of the fork with both rod bearings while it is rotated by their opposite movements. With the co-incidence of the respective axial hole of the gudgeon pin, locking hole in the bearing block, and holes of the piston lifters; and with the forces for retarding and accelerating the piston assembly near the top dead centre position, normally provided by the crankshaft, being provided by the piston lifters upon the gudgeon pin; the locking pins can freely move in and out of the bearing block and the piston lifters.

Activation of solenoid A initiates the move to the passive operating mode by shifting the mode camshaft to its central position (see figure 4). In the passive position of its lever, suction valve rocker remains inoperable by its cam keeping the suction valve 25 closed by its spring. By turning of the auxiliary cam for the exhaust valve on the suction rocker pivot, its lobe props up the extended projection of the exhaust valve rocker just below its maximum lifted position by the camshaft to keep the exhaust valve partially open throughout the passive mode. Subsequent lifting of the lever on the exhaust valve rocker by the auxiliary cam for the exhaust valve on its rocker pivot, eliminates all rocker operations by camshaft. The locking bracket rocker while moving to its passive position, turns fork 18 over fork pivot 21 causing locking pins 16 to pull out of bearing block 15 and enter holes of the piston lifters 13. Thereafter, piston lifter springs 33 lift the piston lifters along with the piston assembly to a level higher than the top dead centre position of the piston assembly in the active mode. With further movements of the crankshaft, the bearing block slides unobstructed within the swiveling connecting arm.

Solenoid B activation Initiates the active operating mode by causing reverse movements of the mode camshaft and auxiliary cams in the same order as when changing to the passive mode. Active operation of suction valves and the piston are followed by active operation of exhaust valves for each cylinder. Piston lifter springs 33 lift the piston lifters, locking bracket, push rods and rod bearings to their topmost positions making the rod bearings and piston lifters inaccessible to the fork and the gudgeon pin, respectively.

An alternate embodiment of the invention is shown in figure 7, having the rotary mode camshaft integrated with the driving sleeve. Links 49 connect the shifter to a shifter spindle 60 within tubular cam follower pivot 46. Cam followers 47 pivot upon pins 62 mounted on brackets 61, the latter pivoting on the cam follower pivot and engaging with auxiliary cams as the cam followers of the preferred embodiment. A central arm projecting from each cam follower enters into a groove on the shifter spindle through slots in the brackets and tubular can follower pivot. By axial shifting of the shifter spindle, in the shiftable angular position, the cam follower rotates around pin 62 on the bracket, to change relative disposition of the cam follower arms against the mode camshaft. In the operative angular positions, the cam followers with their brackets are moved around the tubular cam follower pivot, by the mode camshaft, as in the preferred embodiment, resulting in the movement of connected auxiliary cams.

The components for changing the mode of the exhaust valve can be omitted, including its mode cams, cam follower, the auxiliary cam on the exhaust rocker pivot and its lever, if the exhaust valve rocker is lifted higher by the lobe of the auxiliary cam for the exhaust valve on the suction rocker pivot, in the passive mode, than by the camshaft in the active mode. Alternately, by omitting the auxiliary cam on the suction rocker pivot, the exhaust valve can be held closed in the passive mode, like the suction valve.

In one embodiment, engines are provided with multiple mode camshafts or shifter spindles with independent shifting arrangements, each changing the operating mode of a group of cylinder devices at specific but distinct power levels. In other embodiments, shifter cams with N2 lobes are rotated at 2/N2 times the speed of the mode camshaft where N2 is other than 2.

As the invention allows control of power without throttling the cylinders or varying the amount of fuel injection, a fixed amount of fuel can be injected in cylinders or the suction path, in every cylinder cycle in the active mode in absence of braking.

In an embodiment of the invention, shifter actuators are moved by a double acting hydraulic cylinder. A single piston radial pump is operated by two cams on the driving sleeve to pump an amount of oil on one side of the cylinder, in each of the two periods A2-B3 and E2-F3, to move the shifter actuator by half its total stroke each time. A two solenoid 4 port, 3-position hydraulic valve is selectively energised prior to and including these periods, to direct oil to the desired side of the cylinder. When both solenoids are unenergized, the valve poppet returns to its central position where the pumped oil is unloaded to the tank without pressure, and the cylinder ports are closed to retain the position of the shifter actuator. In an alternate embodiment, with similar hydraulic pumping and direction control arrangements, the mode camshaft is shifted through thrust bearings, or the shifter spindle of figure 7 is directly shifted, in two installments by a hydraulic cylinder; in periods C2 to D3 and G2 to H3, in that order when changing to the passive mode, and in the reverse order while changing to the active mode.

Another embodiment of an engine controls the operating mode of cylinder valves to provide dynamic braking in a third operating mode. The mode camshaft is shiftable by the shifter cams between five axial positions, instead of the three in the preferred embodiment, after corresponding movement of the shifter actuator. A spring loaded one-armed cam follower follows the mode camshaft profile from one side. Three of the five axial dispositions of the mode camshaft are stable operating mode positions in which the arm connects to the mode camshaft upon cylindrical cross-sections of different diameters, resulting in corresponding stable operating mode positions of the auxiliary cam. In the intermediate transitional positions, the arm moves over four segment mode cams to move the auxiliary cam between these positions. In the passive operating mode, both shifter actuator and mode camshaft are in their central positions. To change to the active or braking modes, the shifter actuator is displaced in two steps in either direction, with each step followed by shifter cam movement of the mode camshaft. Each valve rocker has two levers movable between their active and passive dispositions. Each valve is operable by the valve cam in the four stroke cycle, by the active disposition of the first lever in the active mode position of the auxiliary cam, and by another braking cam on the camshaft by the active disposition of the second lever in the braking mode position of the auxiliary cam. Each valve is inoperable by either cams in the passive mode position of the auxiliary cam. In the braking mode the exhaust valves open in proximity of piston top dead centre position, and the suction valves open in every downward piston stroke, to dissipate energy by compressing air.

In another embodiment, the mode controlled device is an auxiliary piston entering into the cylinder cavity from the cylinder head in different measures in the active and passive modes, to change the residual volume and compression ratio of the cylinder.

Combining the features of various embodiments of the invention, engines or machines can be operated with different fuels, variable number of valves, and more importantly, in combination with other prime-movers to include an internal combustion engine or electric motor. In the last case, a larger engine rotated, with decreased losses in the passive mode, by a secondary smaller engine or an electric motor; is capable of synchronously delivering large amount of power by its active operations, by changing to its active mode.

Any machine with cam or crank operated intermittently operating or reciprocating devices can be controlled in the manner described by the invention. Such machines include pumps, rotary internal combustion engines, and industrial machines.

Passive mode operations can be delayed, altered or reduced operations of the device, as compared to its active mode operations. The names of parts in this description are only suggestive of their functions and do not restrict their construction or shape.

Claims

1. An improved internal combustion engine or like machine with a cylinder block defined to include connected static components, rotary cams including at least one device cam on a camshaft, at least one spring, at least one device movable between at least two dispositions against said cylinder block by first of said device cams in camshaft positions called active positions, characterized by; at least one rotary cam called mode cam rotated about an axis at 1/N1 times the camshaft speed where N1 is a natural number greater than unity, at least one cam follower movable by said rotary cam, selective means for moving one of mode cam and cam follower along or parallel to mode cam axis to change between at least two axial dispositions of the former against the latter in at least one range of mode cam angular positions called shiftable angular positions, mode cam means in at least one range of angular positions called operative angular positions and the first of said axial dispositions for moving said cam follower between at least two positions including a passive position, means to restrain said cam follower from at least one of said positions in all operative angular positions and second of said axial dispositions, said device movable to first disposition by first of said device cams in one of said camshaft active positions when said cam follower is in one other than the passive position, and means by one of: said cam follower, another of said device cams, and said spring, to place said device in second disposition in last said camshaft active position when said cam follower is in the passive position.

2. An improved internal combustion engine or like machine as claimed in claim 1, with said selective means comprising means to one of assess and measure the load on the machine, means to cause an increased number of camshaft rotations during one of said axial dispositions with heavier loads, and means to cause an increased number of camshaft rotations during another of said axial dispositions with lighter loads, at the same machine speed.

3. An improved internal combustion engine or like machine as claimed in claim 1, which is an internal combustion engine with cylinders working in the four stroke cycle, said device being a cylinder valve in one of suction or exhaust strokes in said active position, said spring being a valve spring, said first disposition of the valve being an open position, said second disposition of the valve being the closed position, said means to place said device in said second disposition being said valve spring means.

4. An improved internal combustion engine or like machine as claimed in claim 1, which is an internal combustion engine with cylinders working in the four stroke cycle, said device being a cylinder exhaust valve working in the exhaust stroke in said active position, first disposition of valve being one of open positions, second disposition of valve being another of open positions, said means to place said device in said second disposition being said cam follower means.

5. An improved internal combustion engine or like machine as claimed in Claim 1 with said N1 being greater than 3 and a multiple of 2, and at least two of said shiftable angular positions 180 degrees apart on said mode cam.

6. An improved internal combustion engine or like machine as claimed in Claim 1 with said cylinder block having at least two cylinders, each with at least one of said devices, said N1 being greater than 5.

7. An improved internal combustion engine or like machine as claimed in Claim 1 with means to substantially exclude said operative angular positions from said shiftable angular positions.

8. An improved internal combustion engine or like machine as claimed in Claim 1 with mode cam positions synchronous with said active positions substantially excluding said operative angular positions.

9. An improved internal combustion engine or like machine as claimed in Claim 1, with at least three axial dispositions of mode cam against cam follower, at least two ranges of operative angular positions following one each of at least

two ranges of shiftable angular positions by mode cam rotation, said cam follower with one active position distinct from said passive position, said means to restrain said cam follower from at least one of said positions being means to retain said cam follower proximate to said passive position, means to retain said cam follower proximate to said active position in all of said operative angular positions in the third of said axial dispositions, said cam follower movable to the passive position in the first range of operative angular positions and the active position in the second range of operative angular positions in the first of said axial dispositions, said selective means to change between the first and second axial dispositions in the first range of shiftable angular positions and between the first and third axial dispositions in the second range of shiftable angular positions.

10. An improved internal combustion engine or like machine as claimed in Claim 1 with said selective means comprising of; at least one rotary cam called shifter cam (39) rotating at 2/(N1 x N2) times the camshaft speed, where N2 is a natural number, a shifter pivot (43) connecting to said cylinder block, a shifter (42) pivoting on shifter pivot connecting to movable one of mode cam and cam follower, a shifter lever pivoting (41) upon the shifter and shiftable by shifter cam in at least one shiftable disposition, a shifter actuator either within, around or in the close proximity of the shifter pivot, shifter actuator means for moving said shifter lever on shifter to one shiftable disposition in mode cam positions substantially different than said shiftable positions, said selective means comprising shifter cam means in shiftable disposition of said shifter lever to move said shifter around said shifter pivot.

11. An improved internal combustion engine or like machine as claimed in claim 1, with at least one rocker pivoting on a rocker pivot, at least one lever (8) movably disposed on said rocker in at least two dispositions, at least one auxiliary cam partly (3) inside, around or in the close proximity of said rocker pivot (24) movable by said cam follower, said lever moved by said auxiliary cam to the first disposition on said rocker in the said other than the passive position of said cam follower and to the second disposition on said rocker in the passive position of said cam follower, both lever and rocker connecting to one each of said device and first of said device cams in the first lever disposition on rocker, either of lever and rocker not connecting to either of said device and first of said devices cam in the second lever disposition on rocker, said device movable to first disposition by said device cam through said rocker means and said lever means.

12. An improved internal combustion engine or like machine as claimed in Claim 11 wherein said lever is rotably disposed on said rocker about a lever axis not co-axial with said rocker pivot axis, said two dispositions of said lever on said rocker being different rotary positions of said lever characterizing different radial positions from said rocker pivot axis of the part of said lever connecting most proximately to the auxiliary cam.

13. An improved internal combustion engine or like machine as claimed in Claim 1 which is an improved engine as claimed in European Patent Application 89104536.1, wherein said device is part of said means for changing between the operating modes when the piston is near its top or bottom dead centre positions.

14. An improved internal combustion engine or like machine as claimed in Claim 1 which is an improved engine as claimed in European Patent Application 89104536.1, wherein said device is part of said means for locating, holding or restricting the piston at or approximate to one of its dead centre positions in the second disposition of said lever on said rocker.

15. An improved internal combustion engine or like machine as claimed in Claim 9 wherein said mode cam is located between generally cylindrical cross-sections of a mode camshaft (4) driven from one end, each mode cam profile comprising of at least two arc segments each with different radii substantially equal to the radii of the cylindrical sections of said mode camshaft on the driven and non-driven sides of the mode cam, said mode cam in first of said axial dispositions having said cam follower incident upon first of said arc segments in all positions comprising the first range of shiftable angular positions and second of said arc segments in all positions comprising the second range of shiftable angular positions.

16. An improved internal combustion engine or like machine as claimed in claim 1, with one of said mode cam and cam follower movable by at least one of hydraulic, pneumatic or electrical actuators, controllable by at least one electrical solenoid or motor, said selective means comprising means for selective excitation of said solenoid or motor.

17. An improved internal combustion engine or like machine as claimed in claim 10, with said shifter actuator movable by at least one of hydraulic, pneumatic or electrical actuators, controllable by at least one electric solenoid or motor, said selective means comprising means for selective excitation of said solenoid or motor.

18. An improved internal combustion engine or like machine as claimed in claim 9, where said selective means leading to the first axial disposition in one range of shiftable angular positions lead to one of the second and third axial dispositions in the immediately succeeding range of shiftable angular positions of the mode cam.

19. An improved internal combustion engine or like machine as claimed in claim 11, where said selective means are means for moving said mode cam axially, said cam follower pivoting on said cylinder block about an axis parallel to said mode cam axis, said mode cam means for moving said cam follower being means to rotate said cam follower about its pivot axis.

20. An improved internal combustion engine or like machine as claimed in claim 11, with said cam follower movably disposed on a bracket, said bracket pivoting on said cylinder block about a pivot axis parallel to said mode cam axis, said selective means being means for moving part of said cam follower most proximately connecting to said mode cam, upon said bracket, along a direction generally parallel to said mode cam axis, said mode cam means for moving said cam follower being means to rotate said cam follower and said bracket about said pivot axis.

21. An improved internal combustion engine or like machine as claimed in claim 1 working in a four stroke internal combustion cycle in the said other than passive position of said cam follower, and in a two stoke air compressing cycle in the passive position of said cam follower, said device being a cylinder valve, at least two device cams for moving said valve, said second device disposition being one open position, said means to place said device in the second disposition being provided by said another of said device cams.

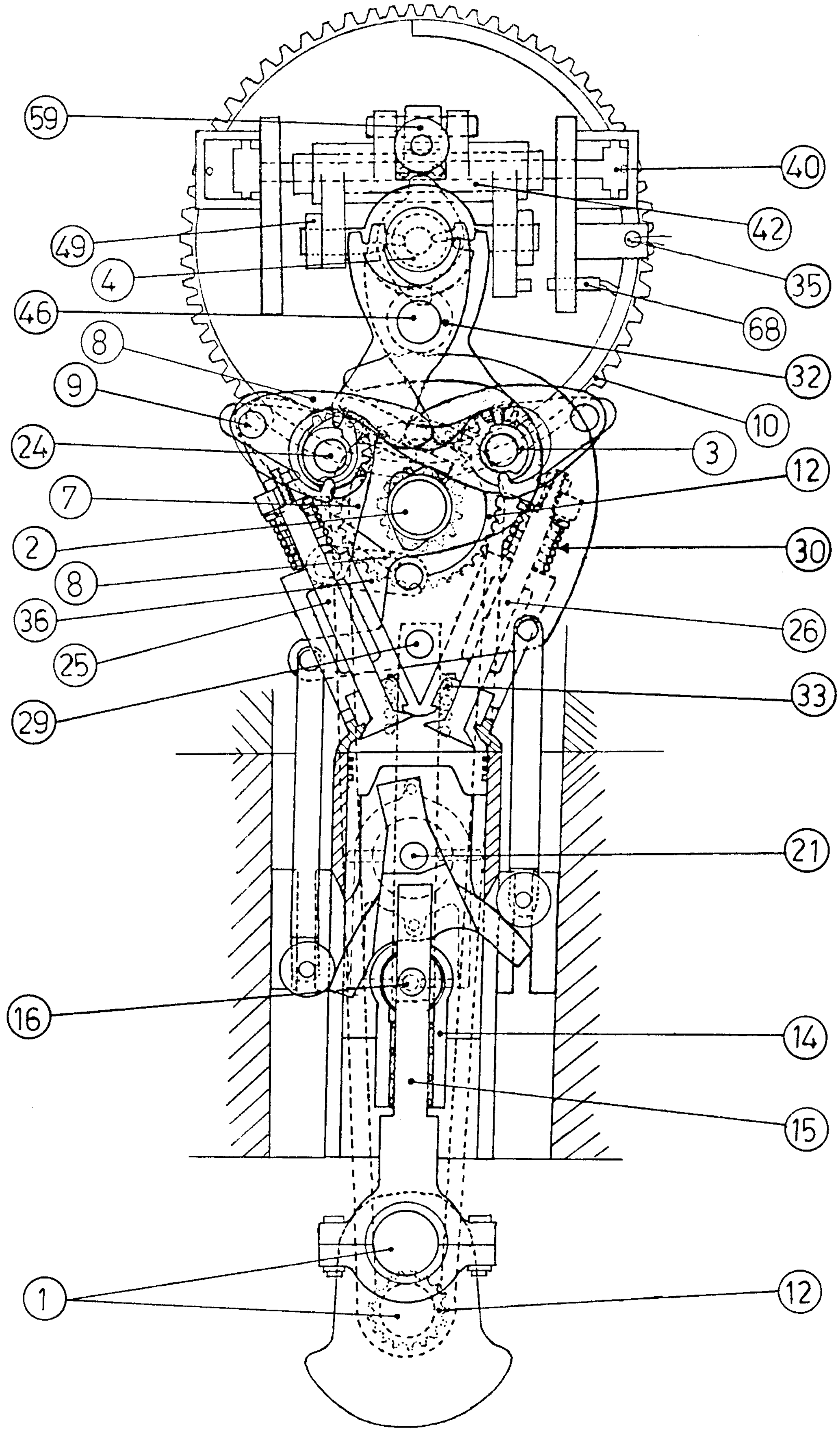
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FIG. 1.

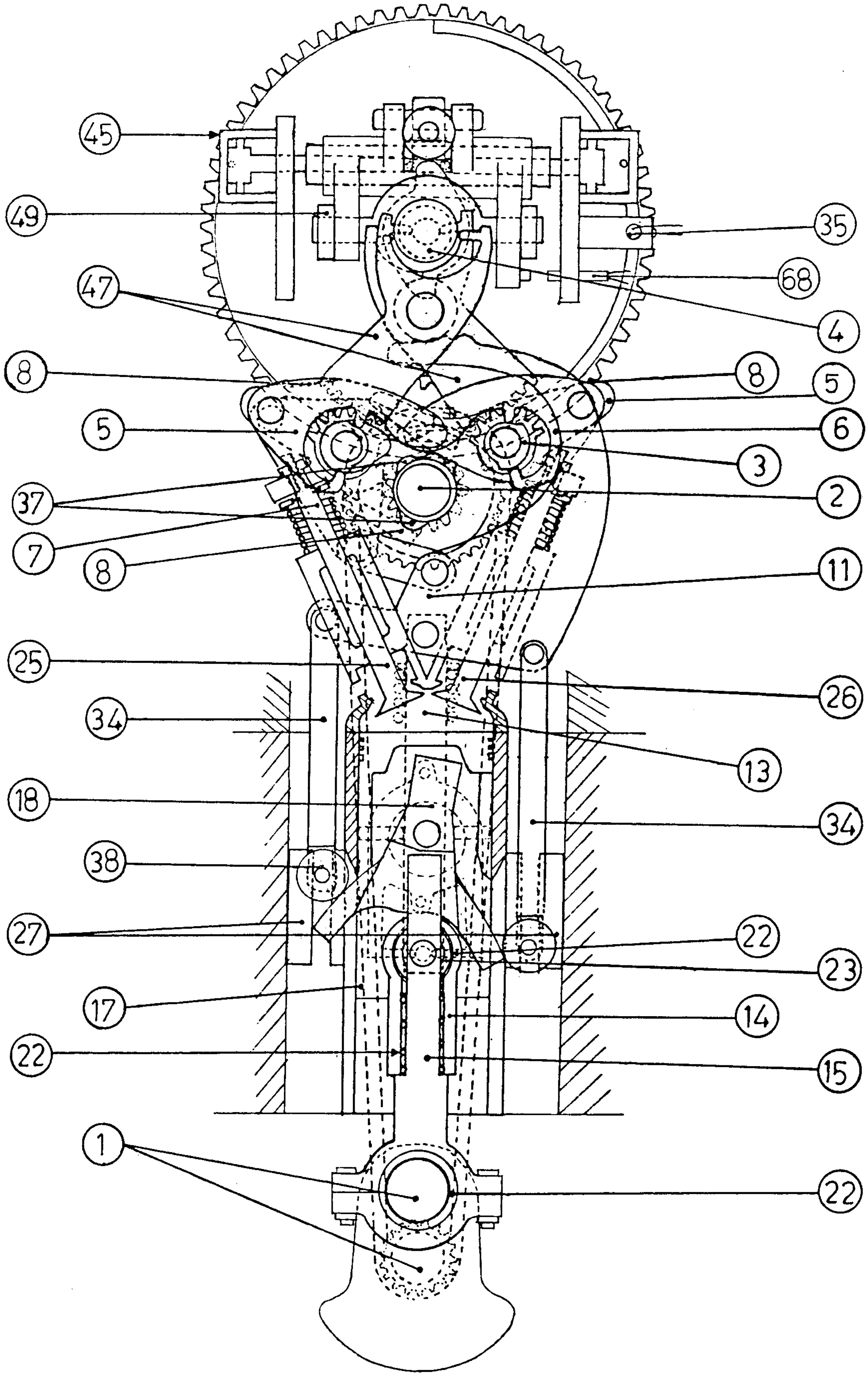
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FIG. 2.

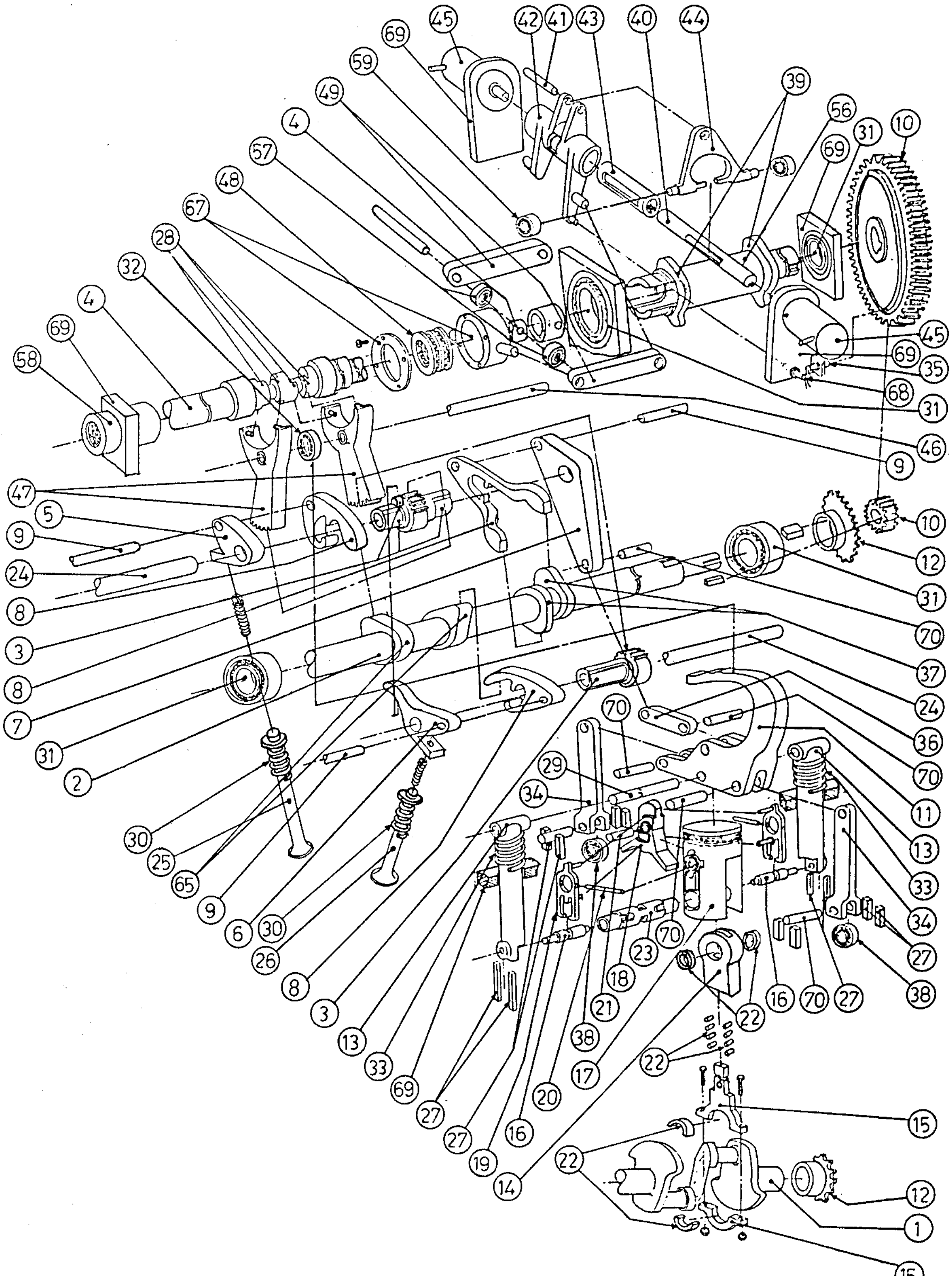
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FIG. 3.

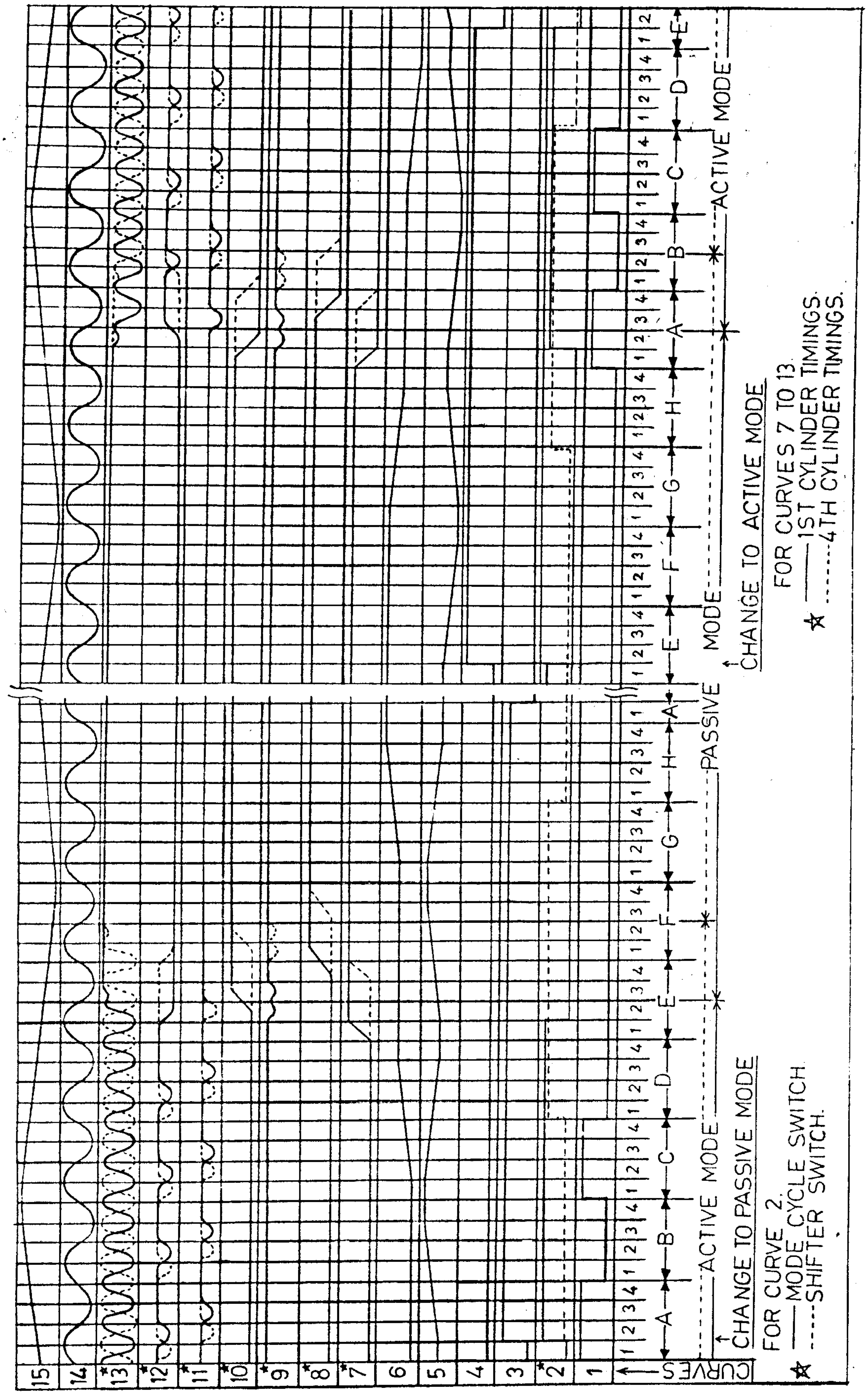
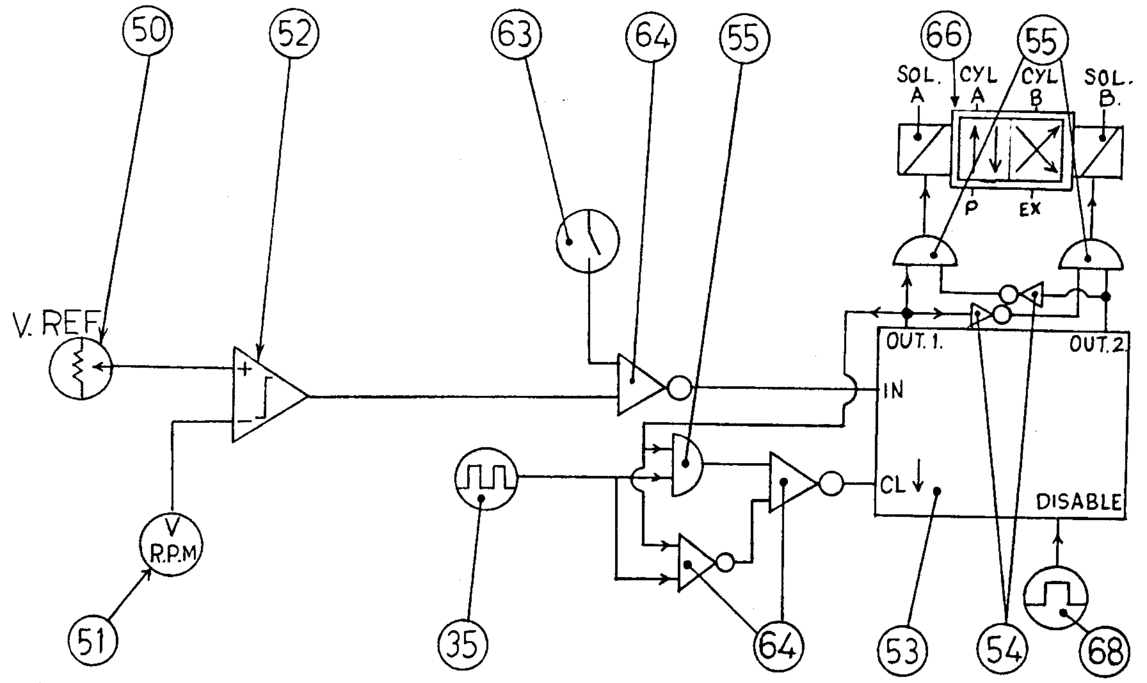

CURVES
ACTIVE MODE
CHANGE TO PASSIVE MODE
FOR CURVE 2.
—— MODE CYCLE SWITCH.
---- SHIFTER SWITCH.
PASSIVE MODE
CHANGE TO ACTIVE MODE
ACTIVE MODE
FOR CURVES 7 TO 13.
—— 1ST CYLINDER TIMINGS.
---- 4TH CYLINDER TIMINGS.

FIG. 4.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52
63
64
55
66
55
SOL. A
CYL A
CYL B
SOL. B.
P
EX
V. REF
OUT.1.
OUT.2.
IN
CL
DISABLE
V R.P.M
51
35
64
53
54
68

FIG. 5.

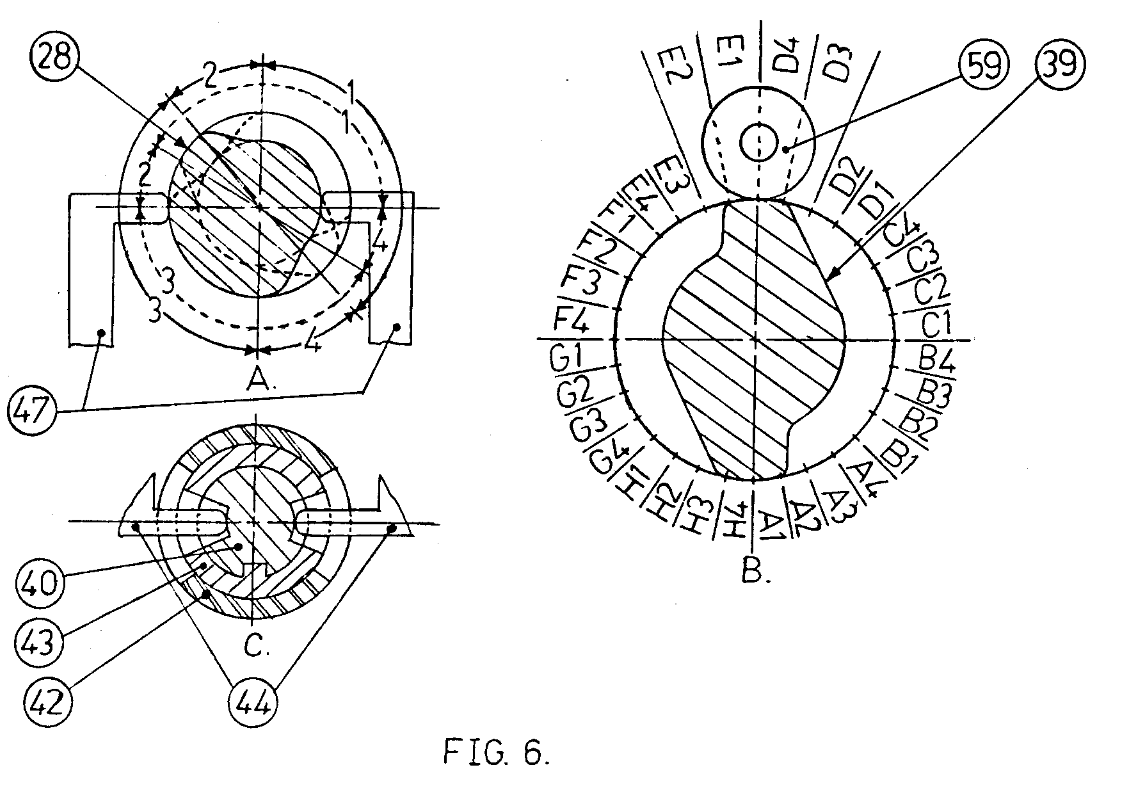
28
47
A.
40
43
42
44
C.
59
39
B.

FIG. 6.

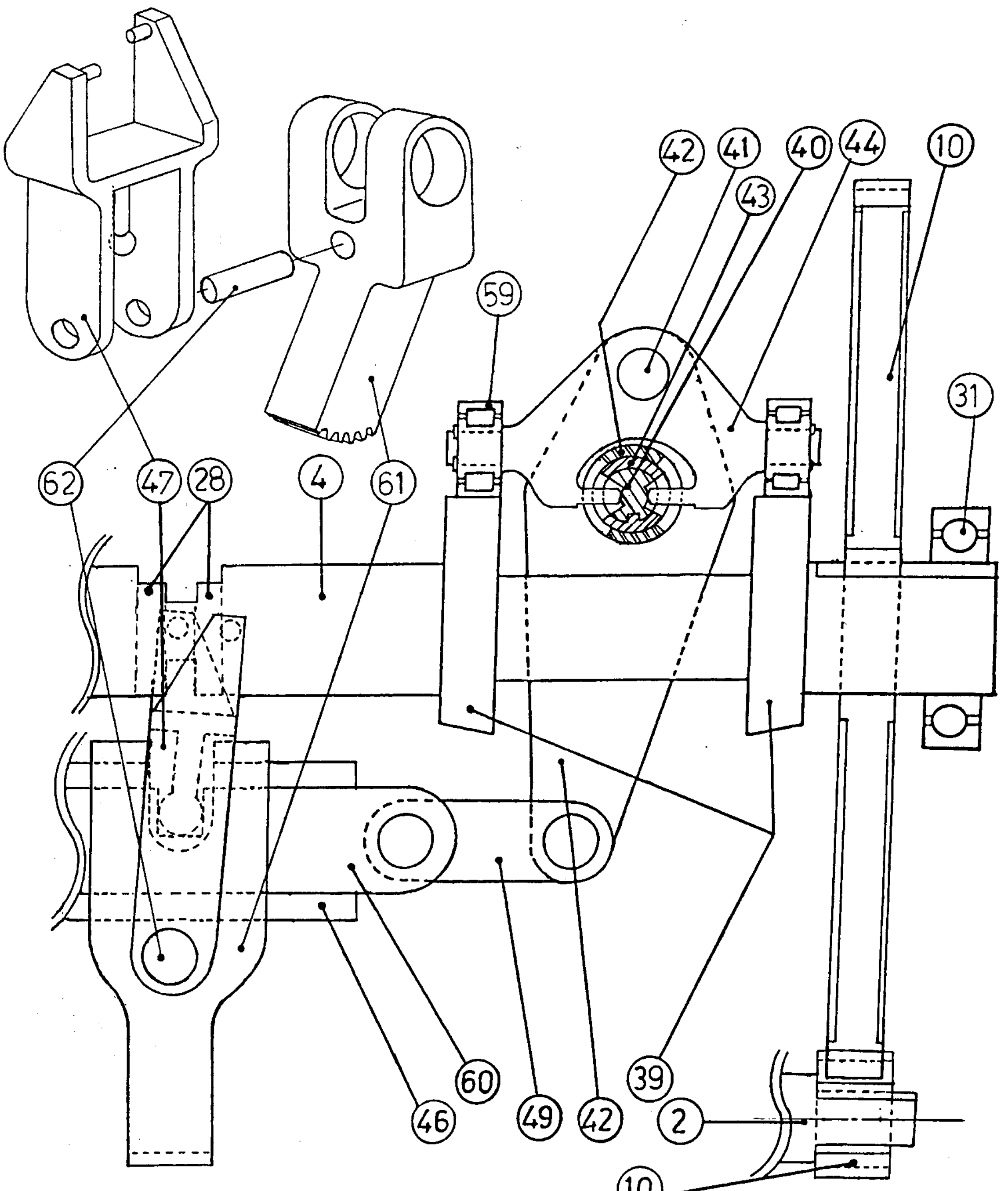

FIG. 7

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 94 10 7140

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	EP-A-0 216 647 (PEUGEOT) * column 2, line 19 - column 3, line 57 * * figures 1-4 *	1	F01L13/00
A	FR-A-493 221 (SCHNEIDER) * the whole document *	1	
A	EP-A-0 235 981 (GENERAL MOTORS) * page 8, line 40 - line 52 * * figures 8-12 *	1	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

F01L

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	4 October 1994	Lefebvre, L

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
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