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(54) Decompression device

(57) A camshaft (2) comprising a decompression device (1) for reducing pressure in a cylinder when an engine starts, the camshaft (2) having a flange (18) and at least one lobe (14, 15), for actuating a cylinder valve (62). The weight member (4) is pivotably connected to the camshaft (2) for actuating a drive pin (8). The drive pin (8) connects the weight member (4) and a shaft (10) such that the weight member (4) rotates the shaft (10). The shaft (10) is rotatable relative to the camshaft (2) to extend or retract a lifter (12, 13) radially. The lifter can extend outwardly or retract inwardly in the radial direction from the lobe face. The weight member (4) and the drive pin (8) are located on the camshaft (2) between the flange (18) and the lobe (14, 15).

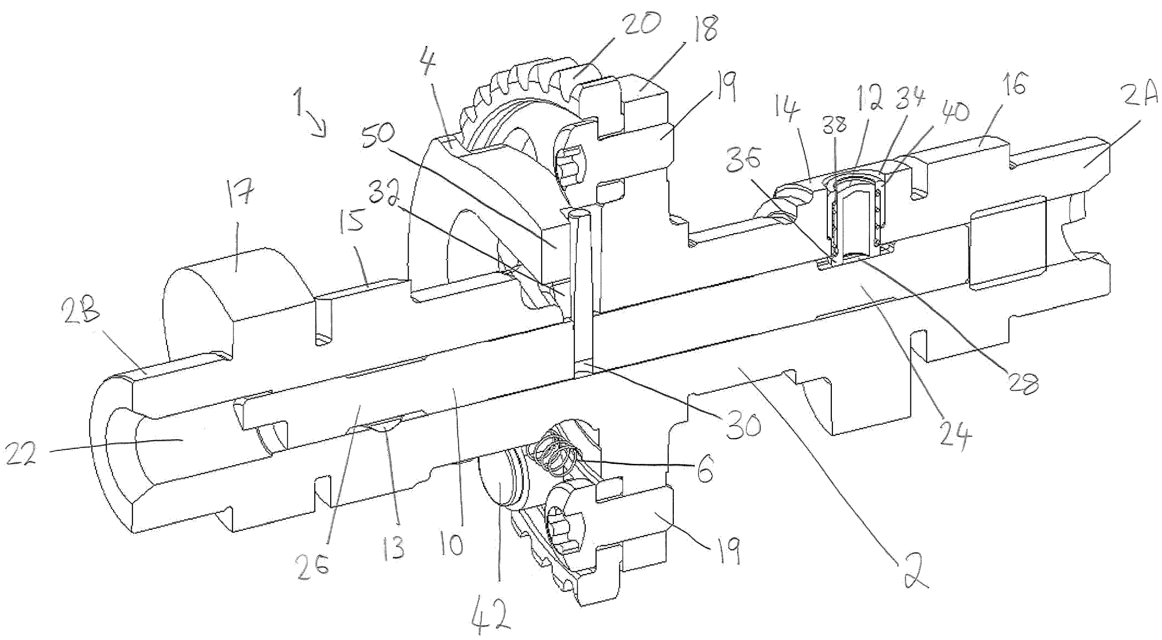

Fig 1A

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Description

Field of the Invention

[0001] This invention relates to a compression release system. Particularly, the invention relates to a decompressor system on an internal combustion engine.

Background to the Invention

[0002] Decompression devices are used on internal combustion engines to release in-cylinder pressure at low engine rpm such that starting the engine is made easier. This is usually achieved by a small opening of the exhaust valve when the engine is turning-over below its idle speed. This opening of the valve opens the cylinder to the atmosphere which reduces the pressure in the cylinder and thus reduces the starting torque of the engine. The compression release mechanism works to ease the starting of the engine by allowing it to accelerate to starting speed whilst reducing the work required to overcome the pumping action of the pistons in the cylinder. Once ignition occurs, the engine speed increases above a predetermined value and the decompressor no longer opens the exhaust valve.

[0003] The opening of the valve can be achieved by a local increase in the base circle height of the exhaust valve camshaft lobe, via a pin or similar lifter piece. The pin is provided in a bore in the camshaft lobe and when the speed of the engine is below a predetermined number of revolutions per minute the pin extends above the face of the camshaft lobe. The pin is commonly actuated by a bob-weight mounted to one end of the camshaft. The weight is pivoted such that it will open or close the lifter pin according to a predetermined engine speed. When the speed of the engine is above the predetermined engine speed, the centripetal force throws the bob-weight outwards such that the pin retracts below the face of the camshaft lobe.

[0004] The decompression device comprises a variety of parts and consequently increases the size of the cylinder head portion of the engine and also restricts the positions where components of the engine can be located.

[0005] The present invention has therefore been devised with the foregoing in mind. The invention seeks to overcome or ameliorate at least one of the disadvantages of the prior art, or provide a useful alternative.

Summary of the Invention

[0006] According to a first aspect of the present invention there is provided a camshaft comprising a decompression device for reducing pressure in a cylinder when an engine starts, the camshaft having a flange and at least one lobe for actuating a cylinder valve, the decompression device comprising a bias member for biasing a portion of a weight member toward the axis of the camshaft, the weight member pivotably connected to the camshaft for actuating a drive pin, the drive pin connecting the weight member and a shaft such that the weight member rotates the shaft, wherein said shaft is located axially within the camshaft, and rotatable relative to the camshaft to extend or retract a lifter radially, the lifter is provided inwardly of the lobe face on the camshaft in a radial direction of the camshaft such that the lifter can extend outwardly or retract inwardly in the radial direction from the lobe face, wherein the weight member and the drive pin are located on the camshaft between the flange and the lobe. Preferably the camshaft is supported for rotation at or near each end of the camshaft, the at least one lobe and the camshaft flange being disposed along the camshaft between the ends. The advantage of this is that when the speed of the engine is below a predetermined rpm the lifters are radially extended, the valves are opened slightly and the cylinder pressure is relieved. This means it is easier for the pistons to be moved in the cylinders to reach the rpm of the engine where the engine has sufficient momentum to start through ignition. When the speed of the engine is above a predetermined rpm the lifters are radially retracted and the valves do not have the additional slight opening to relive the cylinder pressure as it is not required.

[0007] There may be a second lifter provided inwardly of a second lobe in a radial direction of the camshaft. This gives the advantage of allowing pressure in another cylinder to be relived. Also, the activation of the lifters in both lobes rather than a more common method of only operating a single valve from a single lobe gives greater decompression in the cylinders of the engine and improved starting capability. This also means a smaller battery for starting the engine can be packaged saving further mass and cost.

[0008] The weight member and drive pin may be located between the first and second lobes. This has the advantage of simultaneously actuating both lifters in operation. This central mounting with subsequent dual activation gives a reduction in number of parts, mass of the engine and cost.

[0009] The flange may be located between the first and second lobes. This has the advantage of giving a reduction in engine width when compared to end mounted decompression devices and gives improved spark plug packaging/orientation.

[0010] There may be a camshaft sprocket, through which a rotational drive is provided to the camshaft, located between the flange and at least one lobe. This has the advantage of allowing adjustment of the cam timing without affecting the decompression function.

[0011] The weight member may be located between the camshaft sprocket and at least one lobe.

[0012] The sprocket may be located between the first and second lobes.

[0013] The weight member may be mounted at a pivot point to the flange. This has the advantage of allowing rotation of the weight member.

[0014] The camshaft sprocket may be mounted to the flange. This has the advantage of rotating the camshaft and the weight member with the sprocket.

[0015] The bias member may comprise a coil spring placed between the weight member and a connection pin mounted to the flange.

[0016] The pivot point of the weight member and an actuation end of the weight member may be on opposite sides of the camshaft axis.

[0017] The shaft may have a partial circumferential face at a shaft section corresponding to the location of the lobe for actuation of the lifter.

[0018] The shaft section may have a flat face portion and a circumferential face portion. This has the advantage of retracting and extending the lifter inside and outside of the cam face.

[0019] The shaft section may have a radiused portion between the flat face portion and the circumferential face portion. This has the advantage of providing a smoother transition from a flat face portion to a circumferential face portion. The radiused portion reduces the torque and loading on the shaft as it rotates.

[0020] The diameter of the shaft section corresponding to the location of the lobe may be less than the maximum diameter of the shaft. This has the advantage of providing space to form the flat and circumferential face portions.

[0021] The lifter may be biased to be in contact with the face of the shaft by a second biasing member. This has the advantage of holding the lifter against the shaft so it can be actuated by the flat or circumferential face portions.

[0022] The lifter may be held in the lobe by a retainer. This has the advantage of holding the lifter within the cam face and not allowing the lifter to extend too far outside of the cam face.

[0023] According to a second aspect of the present invention there is provided a method of decompression for reducing pressure in a cylinder when an engine starts comprising: biasing a portion of a weight member toward the centre axis of a camshaft, rotating the weight member located between a flange and a lobe on the camshaft by centripetal force, rotating a drive pin located between a flange and a lobe on the camshaft in contact with the weight member, actuating a shaft located axially within the camshaft, and rotatable relative to the camshaft, with the drive pin; and rotating the shaft to actuate a lifter provided inwardly of a lobe face on the camshaft in a radial direction of the camshaft to extend and retract in the radial direction from the lobe face.

[0024] According to a third aspect of the present invention there is provided a camshaft of an internal combustion engine, the camshaft comprising at least one lobe for operating respective cylinder valves, the lobe being disposed along the camshaft, a flange, a recess formed in a surface of the camshaft and adapted for receiving at least a part of a mechanism for actuation of a decompression device, wherein the recess is located at a position along the camshaft between the flange and one of said lobes.

[0025] The camshaft may further comprise a sprocket through which a rotational drive is provided to the camshaft, wherein the recess is located at a position along the camshaft between the sprocket and one of said lobes.

[0026] The camshaft may further comprise a plurality of lobes for operating respective cylinder valves, the lobes being disposed along the camshaft, wherein the flange and the recess are located between two of the lobes.

[0027] The sprocket and the recess may be located between two of the lobes.

Brief Description of the invention

[0028] An embodiment of the invention will now be described, by way of example only, with reference to the accompanying drawings in which:

Figure 1A shows a cross sectional view of a camshaft having a decompression device with a weight member in its outward position in accordance with an embodiment of the present invention;

Figure 1B shows a cross sectional view of a camshaft having a decompression device with a weight member in its inward position of the embodiment of Figure 1A;

Figure 2 shows a radial cross section view of a shaft and a lifter extending outside a cam of the embodiment of Figure 1A;

Figure 3 shows a radial cross section view of a shaft and a lifter retracted within a cam of the embodiment of Figure 1A;

Figure 4A shows a perspective side view of the embodiment of Figure 1A with a weight member in its outward position;

Figure 4B shows a perspective side view of the embodiment of Figure 1A with a weight member in its inward position;

Figure 5 shows an axial cross section view of a pivot pin in a camshaft of the embodiment of Figure 1A;

Figure 6 shows a perspective side view of a camshaft of the embodiment of Figure 1A;

Figure 7 shows a radial cross section view of a weight member, in its outward position, of the embodiment of Figure 1A.

Figure 8 shows a radial cross section view of a weight member, in its inward position, of the embodiment of Figure 1A.

Figure 9 shows a perspective side view of the decompression device according to the embodiment of Figure 1A with rocker arm assemblies and exhaust valves;

Description of the embodiments of the invention

[0029] With reference to Figure 1A, there is provided a decompression device 1 incorporated in a camshaft 2 of an overhead cam type engine. The decompression device 1 comprises a weight member 4, a bias member 6 (i.e. a spring), a drive pin 8, a shaft 10 and lifters 12, 13.

[0030] The camshaft 2 extends axially between two camshaft ends 2A, 2B, and is supported for rotation about the camshaft axis. Two camshaft exhaust valve lobes (exhaust cams) 14, 15, two camshaft intake valve lobes (intake cams) 16, 17 and a camshaft flange 18 are located along the camshaft between the two ends 2A, 2B. A camshaft sprocket 20 abuts and affixes via bolts 19 to the camshaft flange. The sprocket 20 is a toothed wheel which is driven by a crankshaft (not shown) to rotate the camshaft 2. The flange 18 and the sprocket 20 are located substantially axially centrally in the camshaft 2 between the exhaust cams 14, 15. The shaft 10 is located concentrically with the camshaft 2 in a central bore 22 in the camshaft 2 and extends axially from approximately the axial centre of one intake cam 16 to approximately the axial outside of the other intake cam 17. The shaft 10 is substantially a cylindrical shaft with two shaft sections 24, 26, corresponding to the location of the exhaust cams 14, 15, where the diameter of the shaft 10 is less than the maximum diameter of the shaft 10. As seen in Figure 2 and Figure 3, the shaft section 24 is only partially circumferential and has a radiused portion 27 providing a smoother transition from a flat face portion 28 to a circumferential face portion 29. The flat face portion 28 and the circumferential face portion 29 enable operation of the lifters 12, 13 (described in more detail later). The radiused portion 27 is included to reduce the torque and loading on the shaft 10 as it rotates. Shaft section 26 is similar to shaft section 24. In another embodiment, the shaft sections 24, 26 may have a curved portion instead of a flat face portion 28, with a smaller diameter than the circumferential face portion 29, or an eccentric portion of smaller diameter than the shaft 10 that allows the lifters 12, 13 to be retracted.

[0031] Referring once more to Figure 1A, the shaft 10 has a hole 30 in an axially central portion that extends transversely through the shaft 10. The hole 30 is suitably sized for insertion of the drive pin 8 which is a cylindrical member longitudinally orientated perpendicularly to the axis of the shaft 10. The drive pin 8 is inserted into the shaft 10 and a first end of the drive pin extends radially outside the diameter of the shaft 10 in one direction through a recess 32 in the camshaft 2 to a distance greater than the diameter of the camshaft 2 main body. A second end of the drive pin 8 extends inside the shaft 10 to beyond the radial centre of the shaft 10 but does not extend through the shaft 10 fully. The drive pin 8 is a press fit into the shaft 10 at a controlled depth.

[0032] With reference to Figure 2 and Figure 3, the lifter 12 is a hollow cylinder orientated perpendicularly to the axis of the camshaft 2, with an open face at an inner end, with respect to the radial centre of the camshaft 2, and a closed partially spherical face at an outer end. Figure 2 shows the lifter extended as in Figure 1B and Figure 4B. Figure 3 shows the lifter retracted as in Figure 1A and Figure 4A. The lifter 12 is positioned in the exhaust cam 14 in a radial bore 34 which extends from the face of the exhaust cam 14 to the central bore 22 in the camshaft 2. The inner end of the lifter 12 has a shoulder 36 around its circumference for abutment of an inner end of a spring 38. The spring 38 is a helical spring which encloses the lifter 12, and is held in place in the exhaust cam 14 by a retainer 40. The retainer 40 is a hollow cylinder which is open at both its inner and outer ends and sits flush with the exhaust cam 14 face. The retainer 40 surrounds the circumference of the lifter 12 and extends partially along the length of the lifter 12. The lifter 12 can extend through the outer face of the retainer 40 and the retainer has an inner abutment section 41, at its outer end, to abut the outer end of the spring 38. The inner end face of the lifter 12 contacts with the partial circumferential face of the shaft 10 in the shaft section 24, which may be, as shown in Figure 3, the flat face portion 28 or, as shown in Figure 2, the circumferential face portion 29 of the shaft section 24. Similarly, there is an identical lifter 13 with corresponding components (not shown in Figure 1A) in the exhaust cam 15. Although this embodiment shows the lifters 12, 13 are positioned in the exhaust cams 14, 15, in another embodiment a lifter 12 may be, instead, positioned in one or both of the intake cams 16, 17. In other embodiments, the camshaft 2 may have a single lobe, e.g. a single cylinder engine with a single valve.

[0033] The weight member 4 will now be described with reference to Figures 1A and 4A. The weight member 4, or flyweight arm, is mounted adjacent, but not directly, to the sprocket 20 and has a pivot pin 42 that is mounted to the flange 18 and extends through a slot 43 in the sprocket 20. The slot 43 allows the camshaft 2 timing to be adjusted without affecting the position or timing of the decompression device 1. The weight member 4 is mounted in an axially central location on the camshaft 2, between the flange 18 and the exhaust cam 15. The sprocket 20 is located between the flange 18 and the weight member such that the weight member 4 is also located between the sprocket 20 and the exhaust cam 15. In another embodiment, the sprocket 20 may be on the opposite side of the flange 18. In another embodiment, gear teeth may be cut into the flange 18 and there would not be a separate sprocket 20. However, a separate sprocket 20 is preferred as it allows for angular adjustment of the sprocket 20 for adjustment of the camshaft 2 timing. With reference to Figure 5, the pivot pin 42 extends through a hole 44 in the flange 18 and is retained by an e-clip 45.

The weight member 4 is partially enclosed in a sprocket recess 46 and has a radially extending portion 47 which contacts the inside lip 48 of the sprocket 20.

[0034] Referring to Figures 1A and 4A once more, the weight member 4 has a cut out section 49 where the bias member 6 connects to weight member for clearance to the spring during operation and assembly. The weight member 4 has an outer periphery having a curvature radius which is less than a curvature radius of an outer periphery of the sprocket 20 and extends to a radius less than the outer periphery to an actuator end 50, i.e. the other end of the weight member 4 from the pivot pin 42 end, where it comes into contact with the drive pin 8. The actuator end 50, and also the first end of the drive pin 8, are located on the opposite side to the pivot pin 42 with respect to the camshaft 2 axis. The weight member 4 may be sized or orientated differently in other embodiments of the invention.

[0035] Referring to Figure 4A, the bias member 6 is connected at one end to the weight member 4 relatively close to the pivot pin 42, i.e. in the cut out section 49, and extends to connect at its other end to a connection pin 51. The connection pin 51 is located at a substantially similar diameter around the camshaft 2 axis as the pivot pin 42 and at a different circumferential location. The connection pin 51 is mounted to the flange 18 through another hole in the sprocket 20 and extends from the flange 18 with a parallel axis to the camshaft 2. The connection pin 51 is retained by an e-clip (not shown), in a similar manner to the pivot pin 42 which is shown in Figure 5. The bias member 6 may be located in and connected to different locations in other embodiments of the invention.

[0036] Referring now to Figure 6, the camshaft 2 is shown without the sprocket 20 or the other components of the decompression device 1. The recess 32 is shown formed into the body of the camshaft 2 to provide space for the drive pin 8 to both insert through the body of the camshaft 2 into the shaft 10 and to partially rotate around the central axis of the camshaft 2 (the actuation of the drive pin 8 will be described later). The recess 32 is a cast-in pocket and is formed when the camshaft 2 is formed - e.g. by casting. The camshaft 2 and recess 32 may also be formed by other methods, such as forging or machining.

[0037] When the engine is off or during starting the engine, the speed of the engine is below a predetermined number of revolutions per minute (rpm), the weight member 4 is biased by the bias member 6 so that the weight member 4 is relatively close to the camshaft 2 and in its most radially inward position - see Figure 1B and Figure 4B. When the engine is running, the camshaft 2 is rotated due to the sprocket 20 being driven by its connection to the crankshaft which is in turn rotated by the movement of the pistons in the cylinders of the engine (not shown). As the camshaft 2 rotates, it, and the other components that rotate with the camshaft, become subject to centripetal forces and as the weight member 4 is pivotably attached to the camshaft 2 it is free to move within its restrictions. When the speed of the engine exceeds the predetermined number of rpm, the centripetal force of the weight member 4 will overcome the bias force of the bias member 6 holding the weight member 4 in its inward position and the weight member 4 will swing around the pivot point (i.e. the pivot pin 42) to its most radially outward position - see Figure 1A and Figure 4A.

[0038] Figure 7 shows the weight member 4 in its most outward position with the radially extending portion 47 in contact with the sprocket lip 48 restricting further outward movement. Figure 8 shows the weight member 4 in its most inward position with an inner portion of the weight member 4 resting on the camshaft surface 2 restricting further inward movement. With reference to both Figures 7 and 8, the drive pin 8 is in contact with the weight member 4 but not actively fixed to it. The weight member 4 has a recess 52 facing the sprocket 20 and suitably sized to allow the drive pin 8 to freely rotate. When the weight member 4 moves outwards from its most inward position, one radially extending wall 54 of the recess 52 impacts a first side of the drive pin 8 and rotates the drive pin 8 in an anti-clockwise direction (as viewed in Figures 7 and 8). When the weight member 4 moves inwards from its most outward position, a second radially extending wall 56 of the recess 52 impacts a second side of the drive pin 8, and rotates the drive pin 8 in a clockwise direction (as viewed in Figures 7 and 8).

[0039] As described above, the weight member 4 is in contact with the drive pin 8 and the drive pin 8 can rotate partially around the axis of the camshaft 2 due to the space created by the recess 32 and because the shaft 10 is freely rotatable inside the camshaft 2. When the drive pin 8 rotates, so too does the shaft 10 due to the drive pin 8 being inserted into the hole 30 in the shaft 10. Thus, when the weight member 4 swings due to the speed of the engine reaching the predetermined rpm, the shaft 10 will be rotated in the same direction along with the drive pin 8. When the speed of the engine returns below the predetermined rpm, the bias force of the bias member will overcome the centripetal force of the weight member 4 and the weight member 4 will return to its inward position. Although in this embodiment a drive pin 8 is used, any member that is suitable to connect the weight member 4 to the shaft 10 and actuate the shaft 10 may be used.

[0040] As described above in Figures 2 and 3, the inner end face of the lifter 12 contacts with the face of the shaft 10 in the shaft section 24. The spring 38 is held by the retainer 40 and the spring force holds the lifter 12 against the face of the shaft 10. When the weight member 4 is in its inward position, the shaft 10 presents the circumferential face portion 29 to the inner end face of the lifter 12. The distance from the circumferential face portion 29 to the outer face of the exhaust cam 14 is such that the lifter 12 radially extends outside the body of the exhaust cam 14 when the lifter 12 is in contact with the circumferential face portion 29. When the engine speed is above the predetermined rpm and the weight member 4 is therefore in its outward position the shaft 10 is rotated such that the flat face portion 28 of the shaft section 24 is presented to the inner end face of the lifter 12. In this case, the distance from the flat face portion 28 to the outer face of the exhaust cam 14 is such that the lifter 12 is fully retracted within the body of the exhaust cam 14. The spring force of the spring 38 holds the inner end of the lifter 12 against the face of the shaft section 24 and the spring force restricts the radial distance the lifter 12 is able to move.

[0041] With reference to Figure 9, the faces of the exhaust cams 14, 15 are in contact with cam followers 58 of exhaust valve rocker arm assemblies 60 and the irregular shape of the exhaust cams 14, 15 activates the rocker arms 60 to open exhaust valves 62 in the cylinder (not shown). While this embodiment shows the rocker arms 60 actuating two exhaust valves 62 each, the rocker arms 60 may actuate only one exhaust valve 62 or more than two exhaust valves 62. Also in different embodiments, the rocker arms 60 may actuate intake valves. When the lifters 12, 13 are radially extended the rocker arms 60 are also activated at this point in the rotation of the camshaft 2 to allow the exhaust valves 62 to be opened slightly and therefore the cylinder pressure is relieved. When the lifters 12, 13 are retracted the rocker arms 60 are not activated at this point in the rotation of the camshaft 2 and thus the cylinder pressure is not reduced. Due to nature of the decompression device 1, as described above, the lifters 12, 13 only extend when the speed of the engine is below the predetermined rpm. The opening of the exhaust valves 62 to the atmosphere at low rpm of the engine reduces the pressure in the cylinders and makes it easier for the pistons (not shown) to be moved in the cylinders to reach the rpm of the engine where the engine has sufficient momentum to start through ignition, i.e. the starting torque of the engine is reduced. At this point the lifters 12, 13 are retracted, the ignition is engaged and the normal engine cycle begins without the additional pressure release of the lifters 12, 13.

[0042] As mentioned above, and shown in Figures 1 and 4, the flange 18, the sprocket 20 and the weight member mounted to the flange are located axially centrally in the camshaft 2 between the exhaust cams 14, 15. The weight member 4 is located between the flange 18 and the exhaust cam 15. Also, the weight member 4 is located between the sprocket 20 and the exhaust cam 15. In another embodiment, the weight member 4 may be located between the flange 18 and the exhaust cam 14. In another embodiment, the weight member 4 may be located between the sprocket 20 and the exhaust cam 14. The weight member 4 of the present invention simultaneously actuates both lifters 12, 13 in operation. This central mounting with subsequent dual activation gives a reduction in number of parts, mass of the engine and cost. The activation of the lifters in both exhaust cams 14, 15, rather than a more common method of only operating a single exhaust cam and exhaust valve, e.g. from an end mounted decompression device, gives greater decompression in the cylinders of the engine and improved starting capability. This means a smaller battery (not shown) for starting the engine can be packaged saving further mass and cost. The weight member 4 is mounted to the camshaft 2, through the sprocket 20 directly into the flange 18 which allows for adjustment of the cam timing without affecting the decompression function. The present invention gives a reduction in engine width when compared to end mounted decompression devices and gives improved spark plug (not shown) packaging/orientation, i.e. the spark plugs can have a more vertical orientation which gives an improvement in combustion speed and efficiency. This also results in better emissions and fuel economy.

[0043] It will be appreciated by persons skilled in the art that various modifications may be made to the above embodiment without departing from the scope of the present invention as defined by the claims. For example, whilst the above discussion has been concerned with a two cylinder engine, the invention is equally applicable to engines with one cylinder or more than two cylinders.

Claims

1. A camshaft comprising a decompression device for reducing pressure in a cylinder when an engine starts, the camshaft having a flange and at least one lobe for actuating a cylinder valve, the decompression device comprising:

a bias member for biasing a portion of a weight member toward the axis of the camshaft;
the weight member pivotably connected to the camshaft for actuating a drive pin;
the drive pin connecting the weight member and a shaft such that the weight member rotates the shaft;
wherein said shaft is located axially within the camshaft, and rotatable relative to the camshaft to extend or retract a lifter radially;
the lifter is provided inwardly of the lobe face on the camshaft in a radial direction of the camshaft such that the lifter can extend outwardly or retract inwardly in the radial direction from the lobe face;
wherein the weight member and the drive pin are located on the camshaft between the flange and the lobe.

2. The camshaft according to claim 1, wherein a second lifter is provided inwardly of a second lobe in a radial direction of the camshaft.

3. The camshaft according to claim 2, wherein the weight member and drive pin are located between the first and second lobes.

4. The camshaft according to claim 2 or 3, wherein the flange is located between the first and second lobes.

5. The camshaft according to any preceding claim, wherein a camshaft sprocket, through which a rotational drive is provided to the camshaft, is located between the flange and at least one lobe.

6. The camshaft according to claim 5, wherein the weight member is located between the camshaft sprocket and at least one lobe.

7. The camshaft according to claim 5 or 6, wherein the sprocket is located between the first and second lobes.

8. The camshaft according to any preceding claim, wherein the weight member is mounted at a pivot point to the flange.

9. The camshaft according to any one of claims 5 to 8, wherein the camshaft sprocket is mounted to the flange.

10. The camshaft according to any preceding claim, wherein the bias member comprises a coil spring placed between the weight member and a connection pin mounted to the flange.

11. The camshaft according to any one of claims 8 to 10, wherein the pivot point of the weight member and an actuation end of the weight member are on opposite sides of the camshaft axis.

12. The camshaft according to any preceding claim, wherein the shaft has a partial circumferential face at a shaft section corresponding to the location of the lobe for actuation of the lifter, and the shaft section has a flat face portion and a circumferential face portion.

13. The camshaft according to claim 12, wherein the shaft section has a radiused portion between the flat face portion and the circumferential face portion.

14. The camshaft according to any preceding claim, wherein the lifter is biased to be in contact with the face of the shaft by a second biasing member, and the lifter is held in the lobe by a retainer.

15. A method of decompression for reducing pressure in a cylinder when an engine starts comprising:

biasing a portion of a weight member toward the centre axis of a camshaft;
rotating the weight member located between a flange and a lobe on the camshaft by centripetal force;
rotating a drive pin located between a flange and a lobe on the camshaft in contact with the weight member;
actuating a shaft located axially within the camshaft, and rotatable relative to the camshaft, with the drive pin; and
rotating the shaft to actuate a lifter provided inwardly of a lobe face on the camshaft in a radial direction of the camshaft to extend and retract in the radial direction from the lobe face.

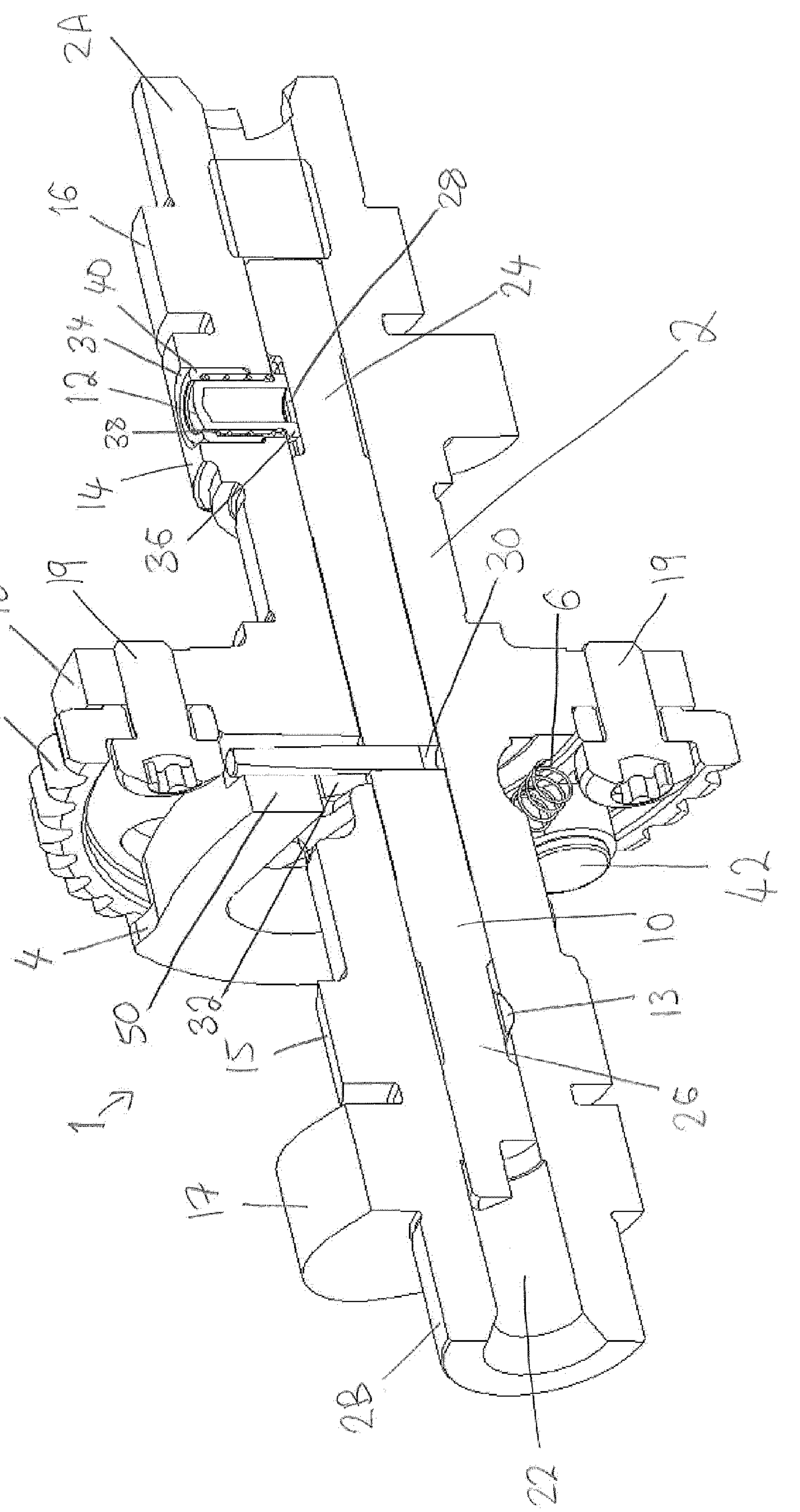
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Fig 1A

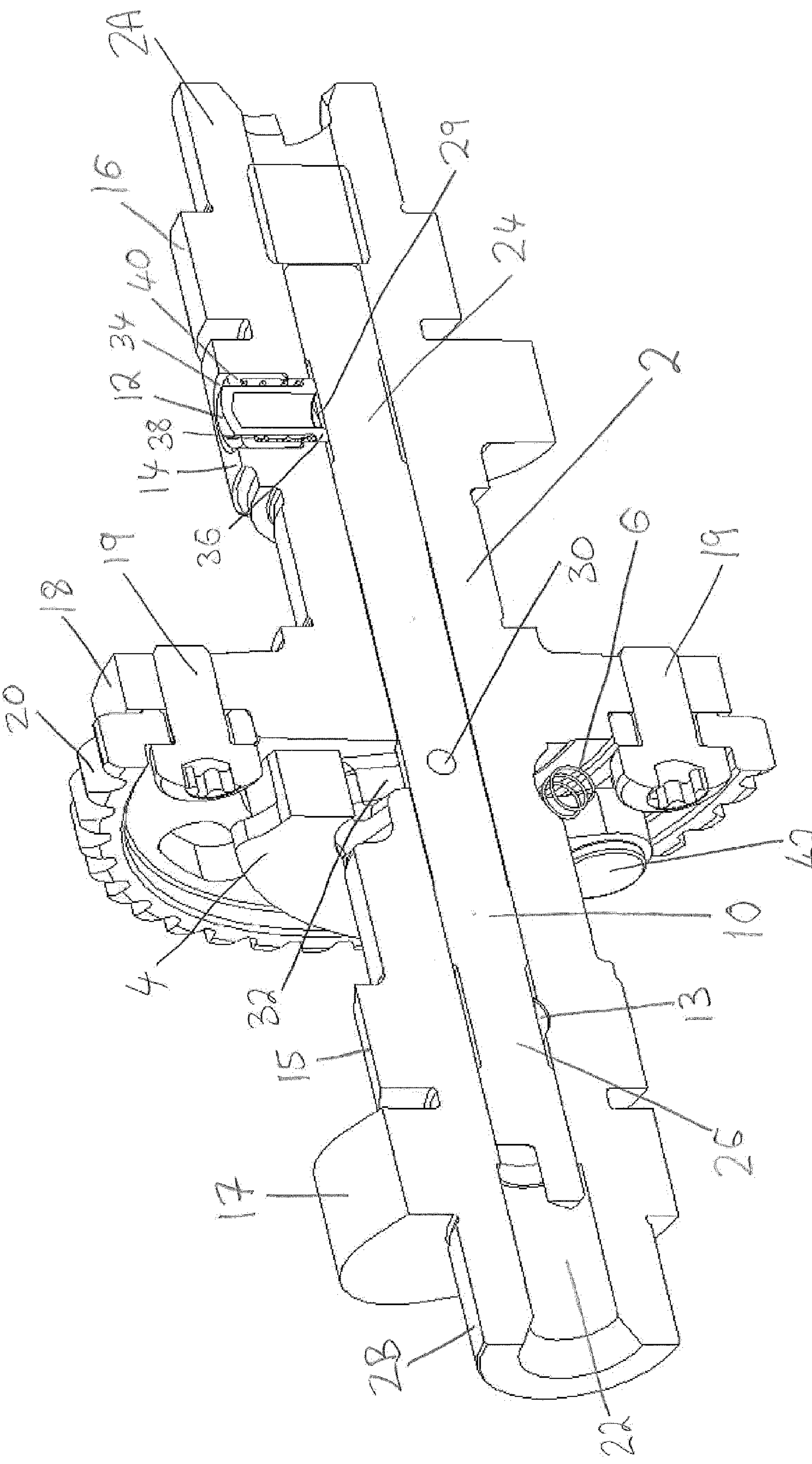
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Fig 1B

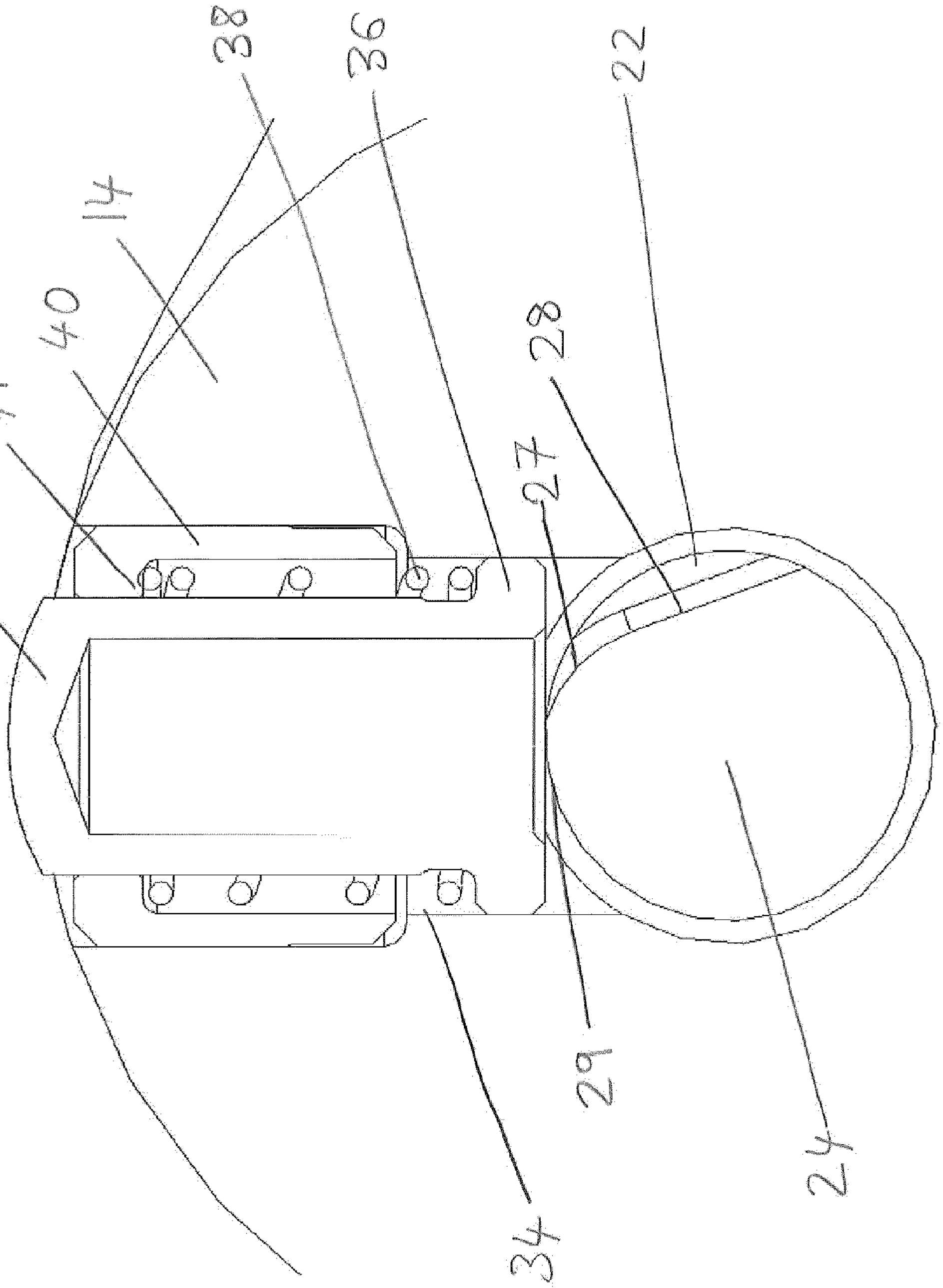

Fig 2

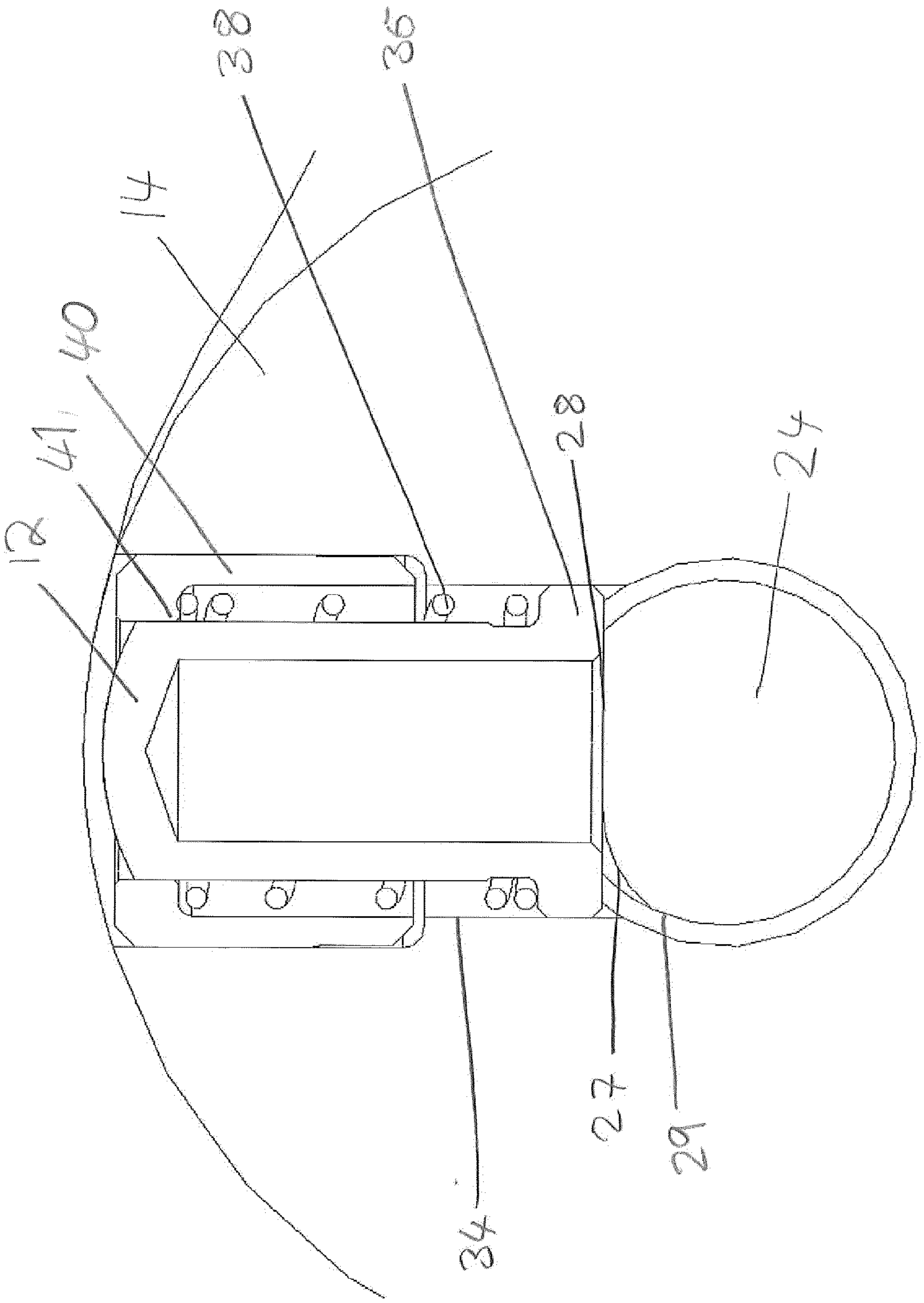

Fig 3

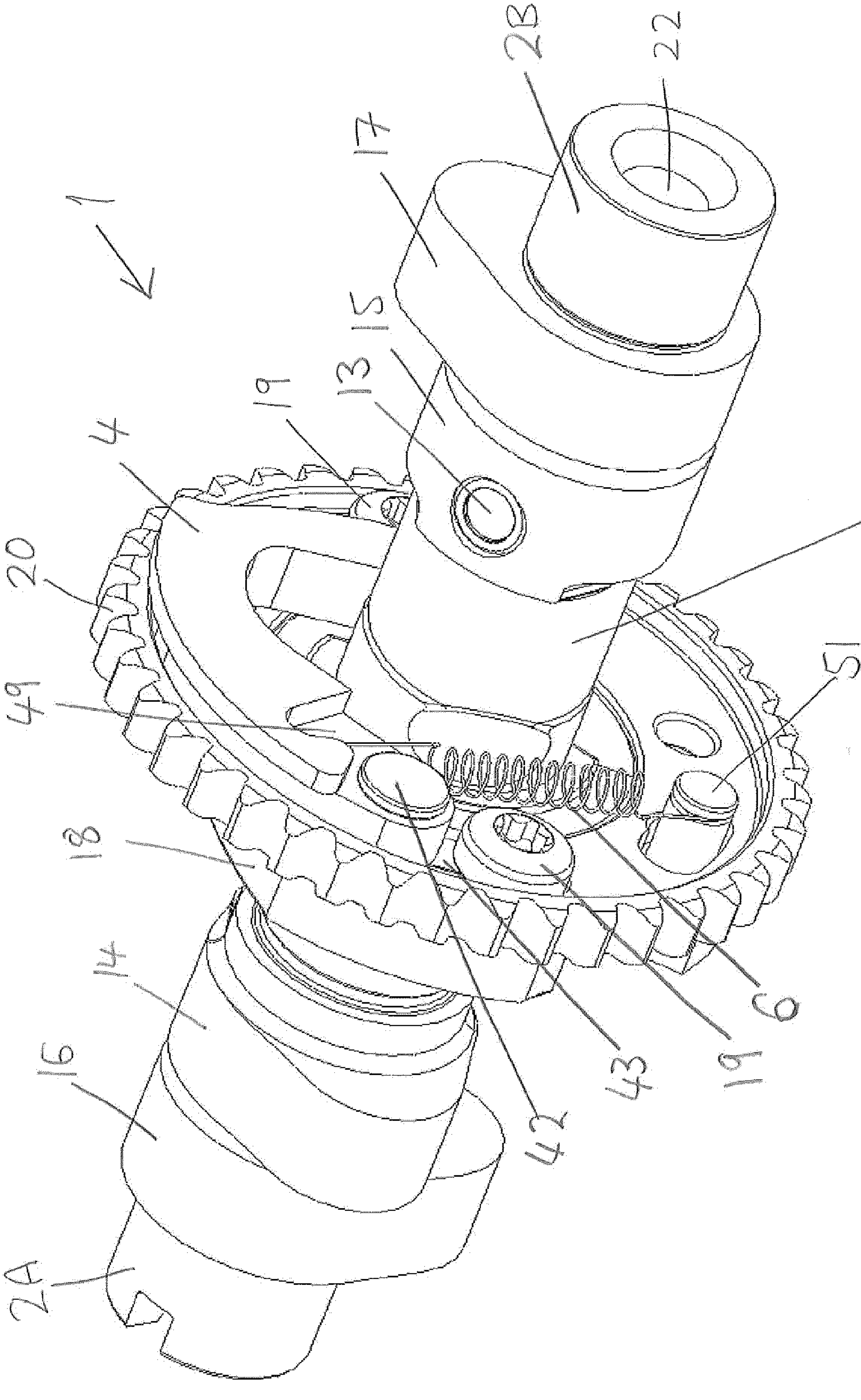

Fig 4A

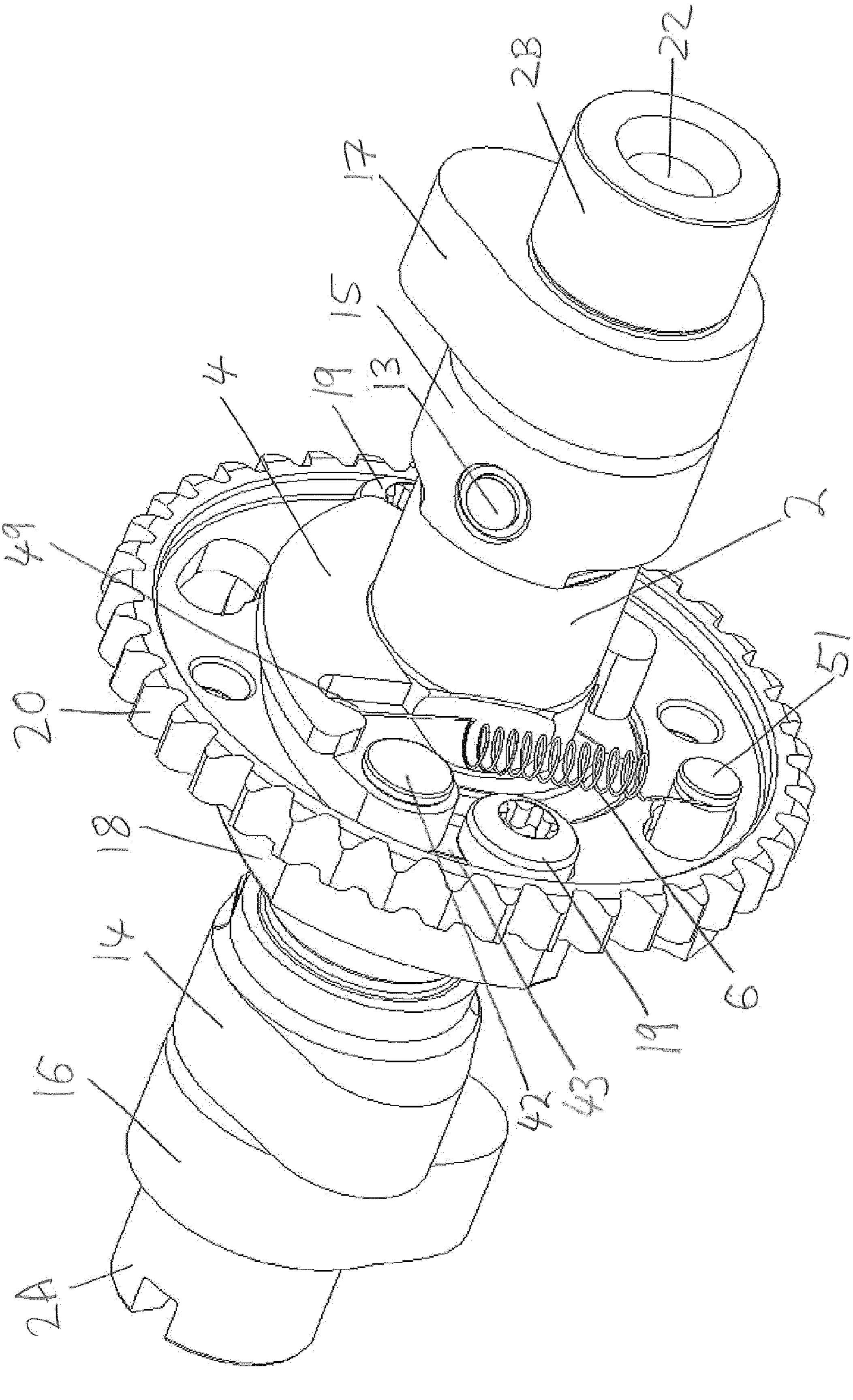

Fig 4B

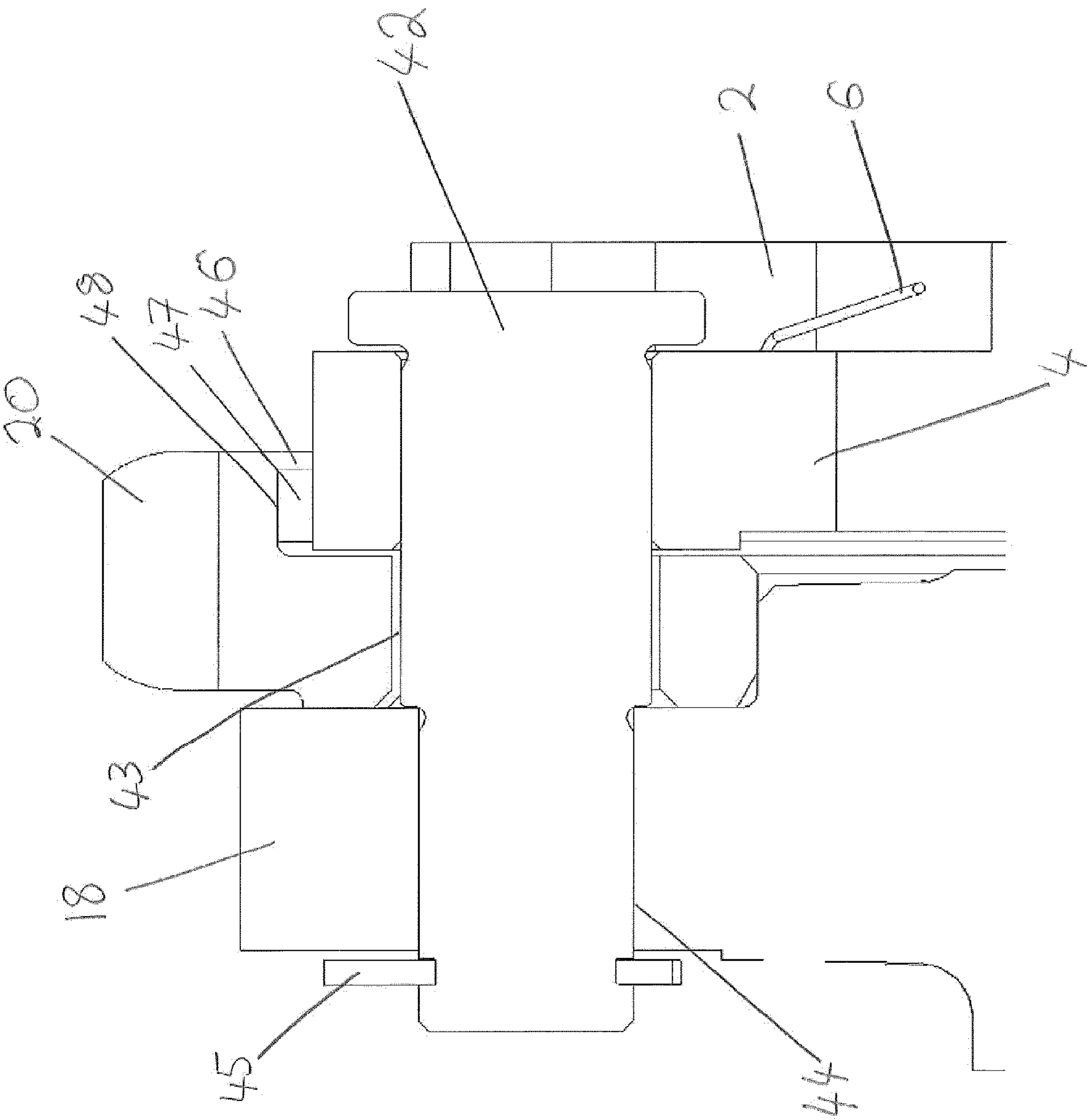

Fig 5

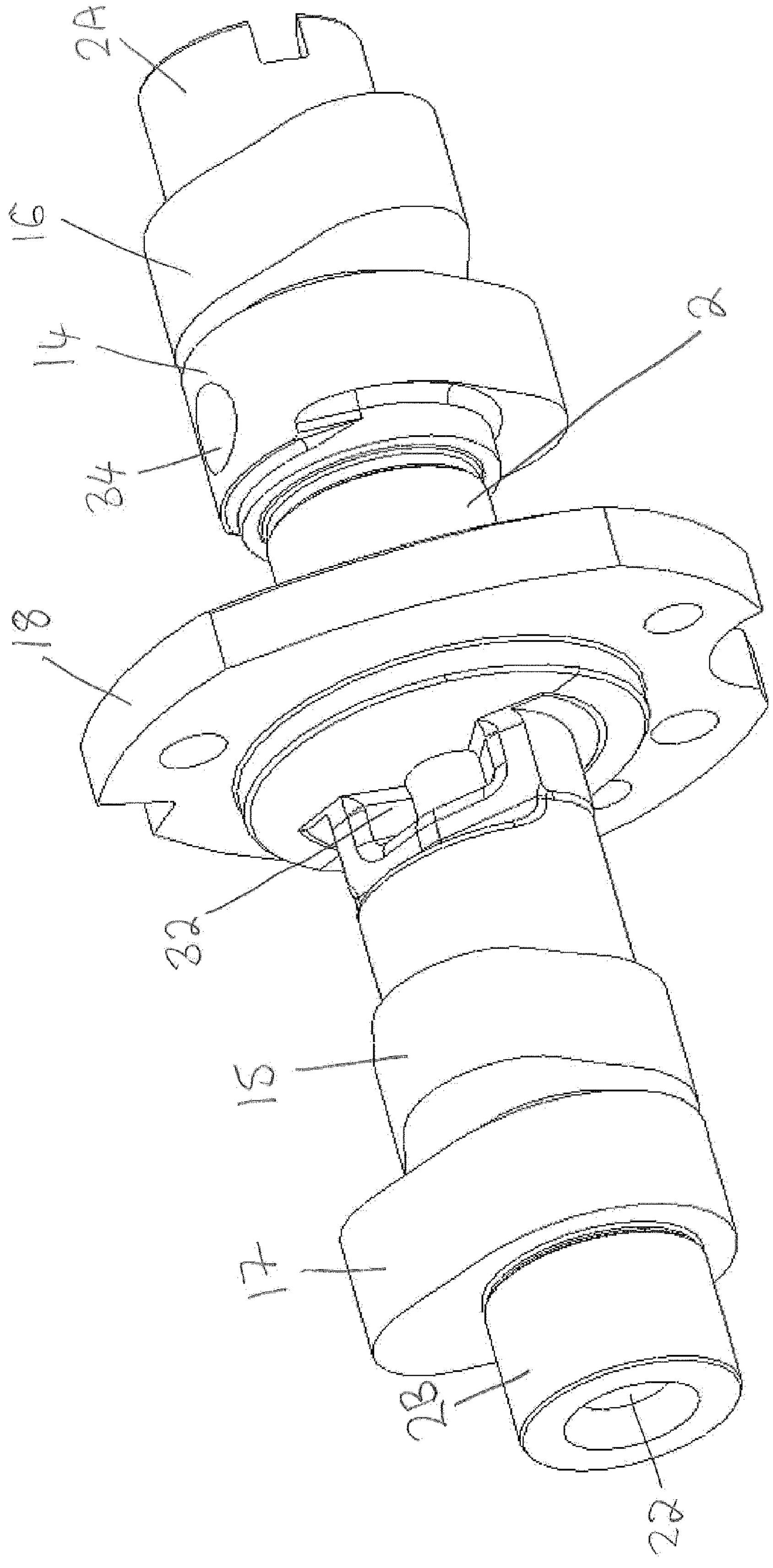

Fig 6

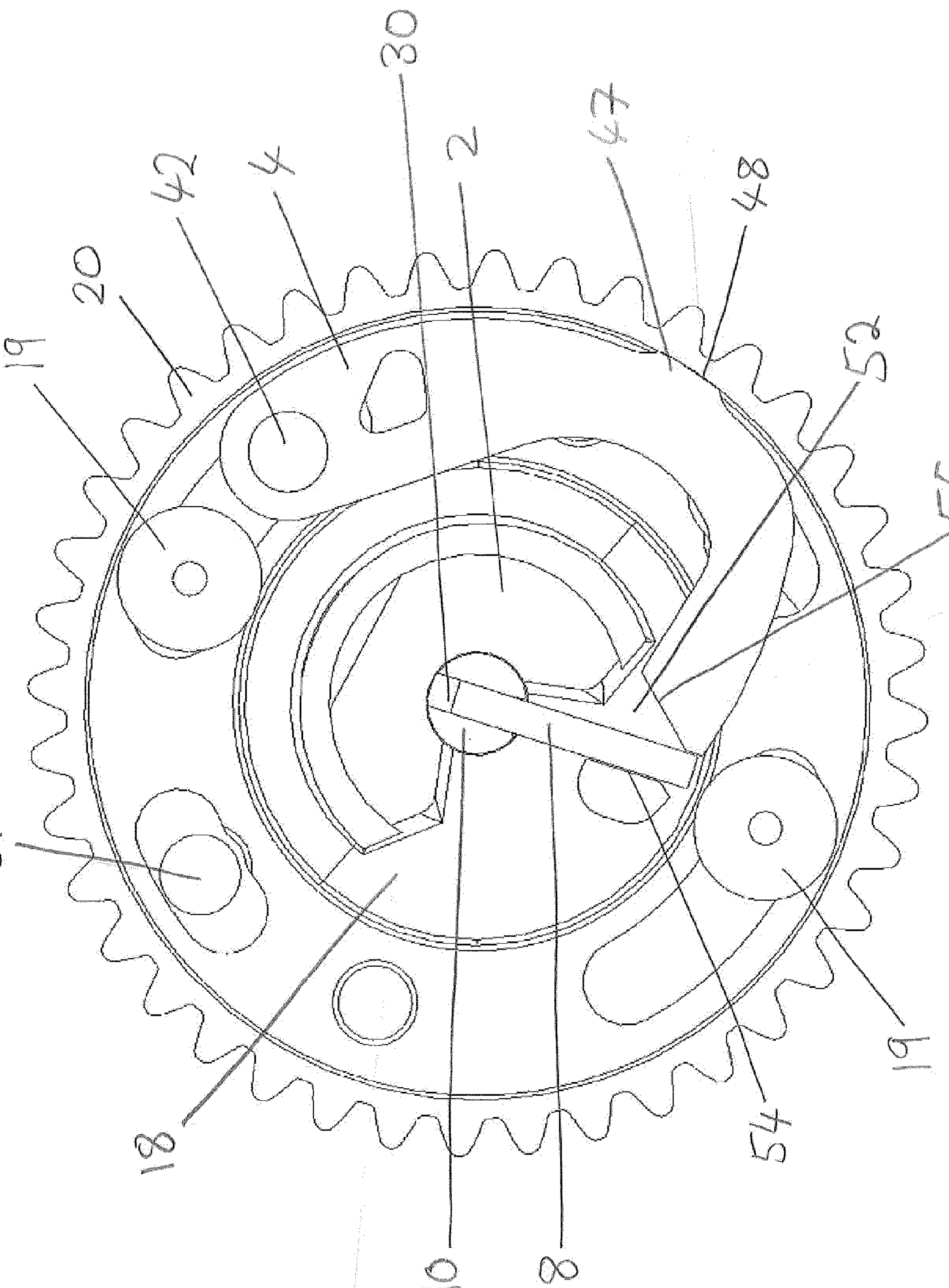

Fig 7

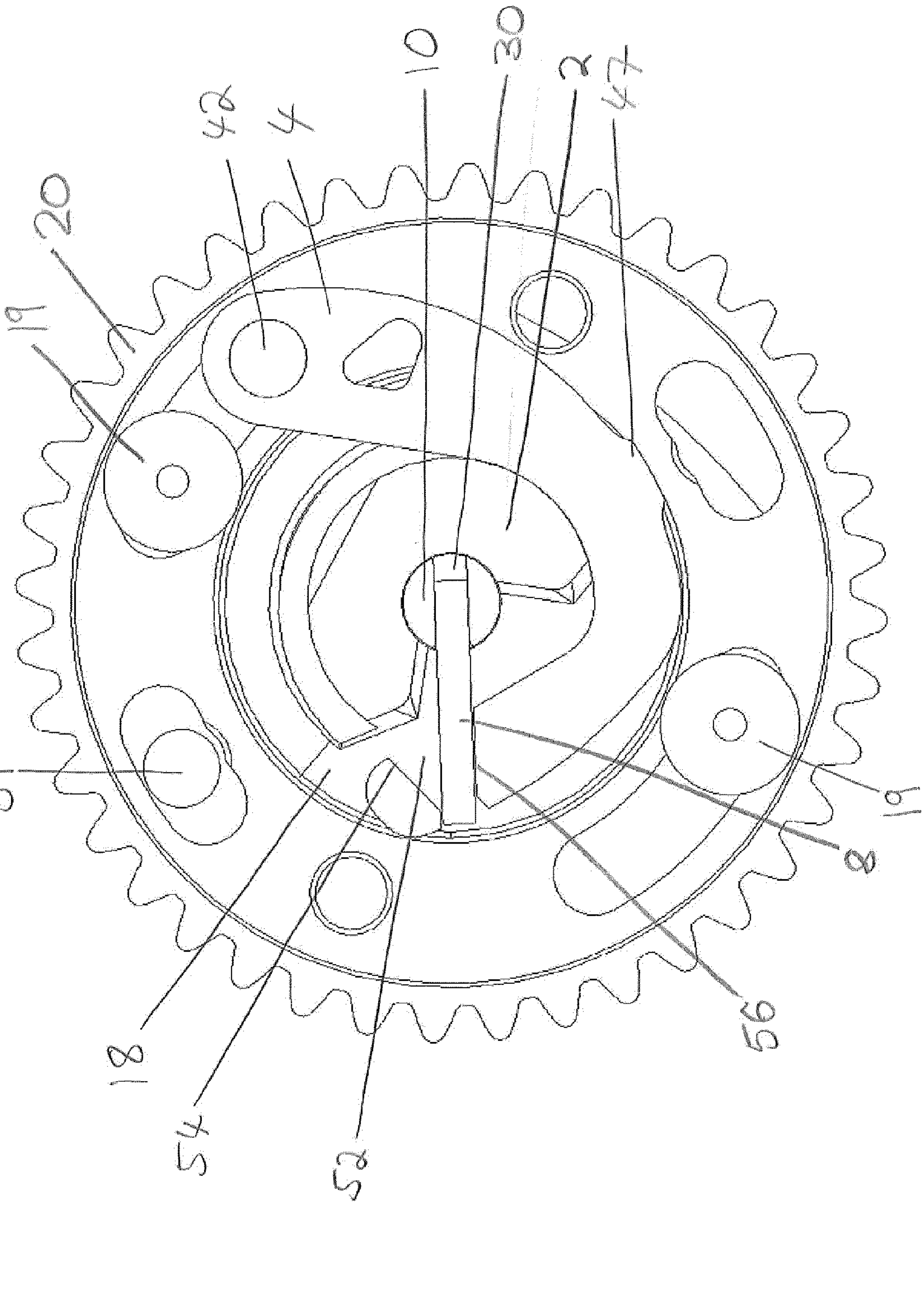

Fig 8

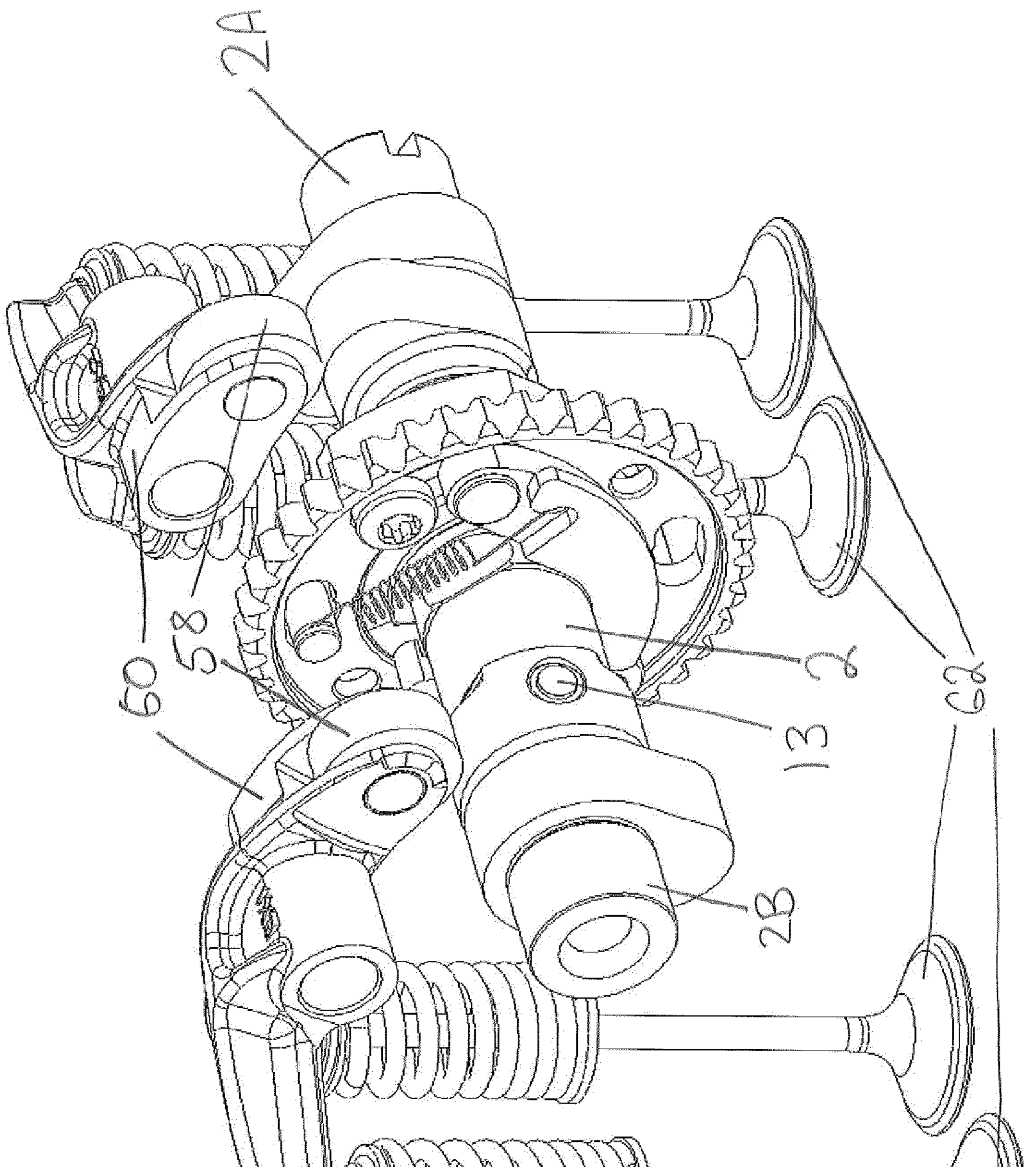

Fig 9

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EUROPEAN SEARCH REPORT

Application Number
EP 15 15 9032

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TECHNICAL FIELDS SEARCHED (IPC)

F01L

The present search report has been drawn up for all claims

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Place of search	Date of completion of the search	Examiner
The Hague	21 July 2015	Paquay, Jeannot

CATEGORY OF CITED DOCUMENTS

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