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[54] **ARRANGEMENT FOR AUTOMATICALLY POSITIONING A PISTON IN AN INTERNAL COMBUSTION ENGINE**

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[52] **U.S. Cl.** ..... **123/179 A**, 74/36, 123/185 A

[51] **Int. Cl.** **F02n 17/00**

[58] **Field of Search** ..... 123/179 S, 179 T, 123/185 A, 185 B, 185 BA, 185 BB; 188/166; 74/36, 44

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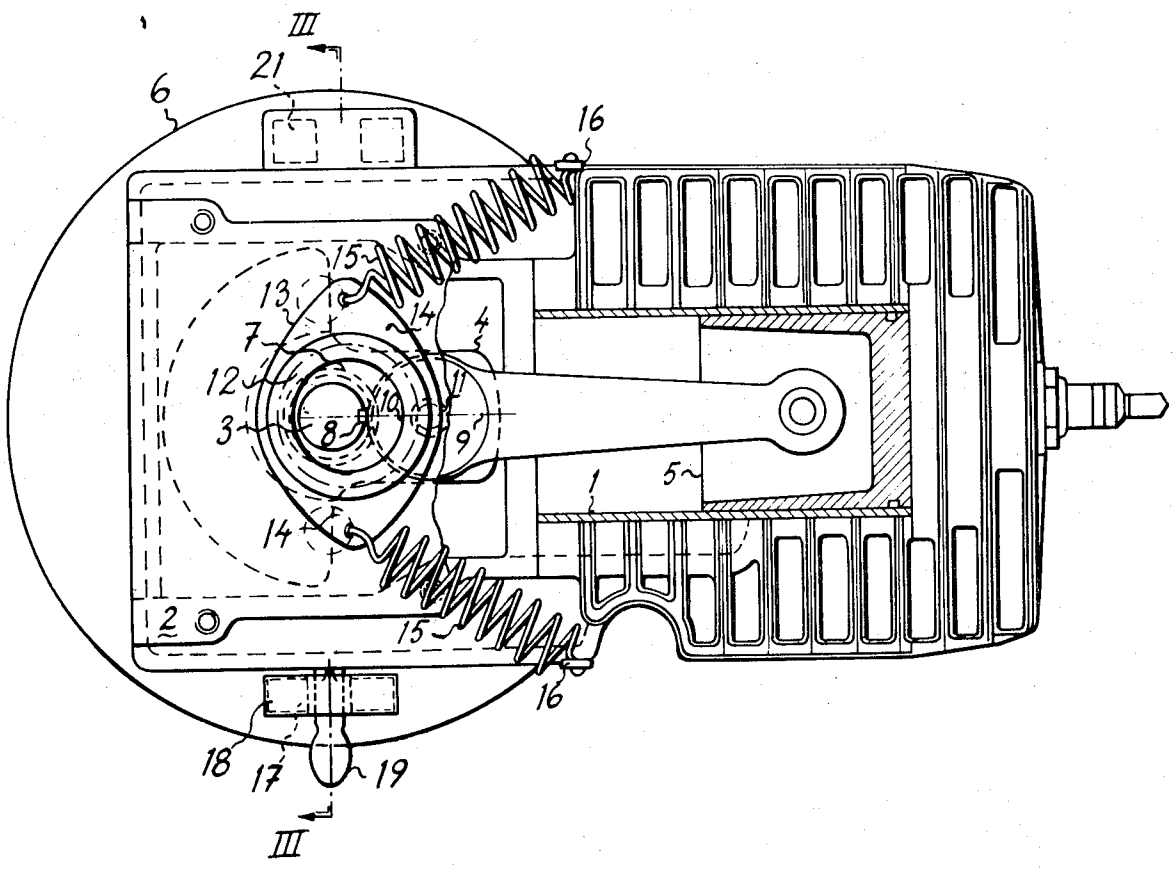
[57] **ABSTRACT**

A piston in an internal combustion engine is positioned, i.e., moved from any position in a complete working cycle including all strokes of the engine, to a distinct position by tensioning means and at least one elastic member which, as a result of the reciprocating movements of the piston mutually actuate each other so that the elastic member is tensioned during the passage of the piston from the distinct position in the working cycle and is relaxed during the moving of the piston towards the distinct position.

9 Claims, 6 Drawing Figures



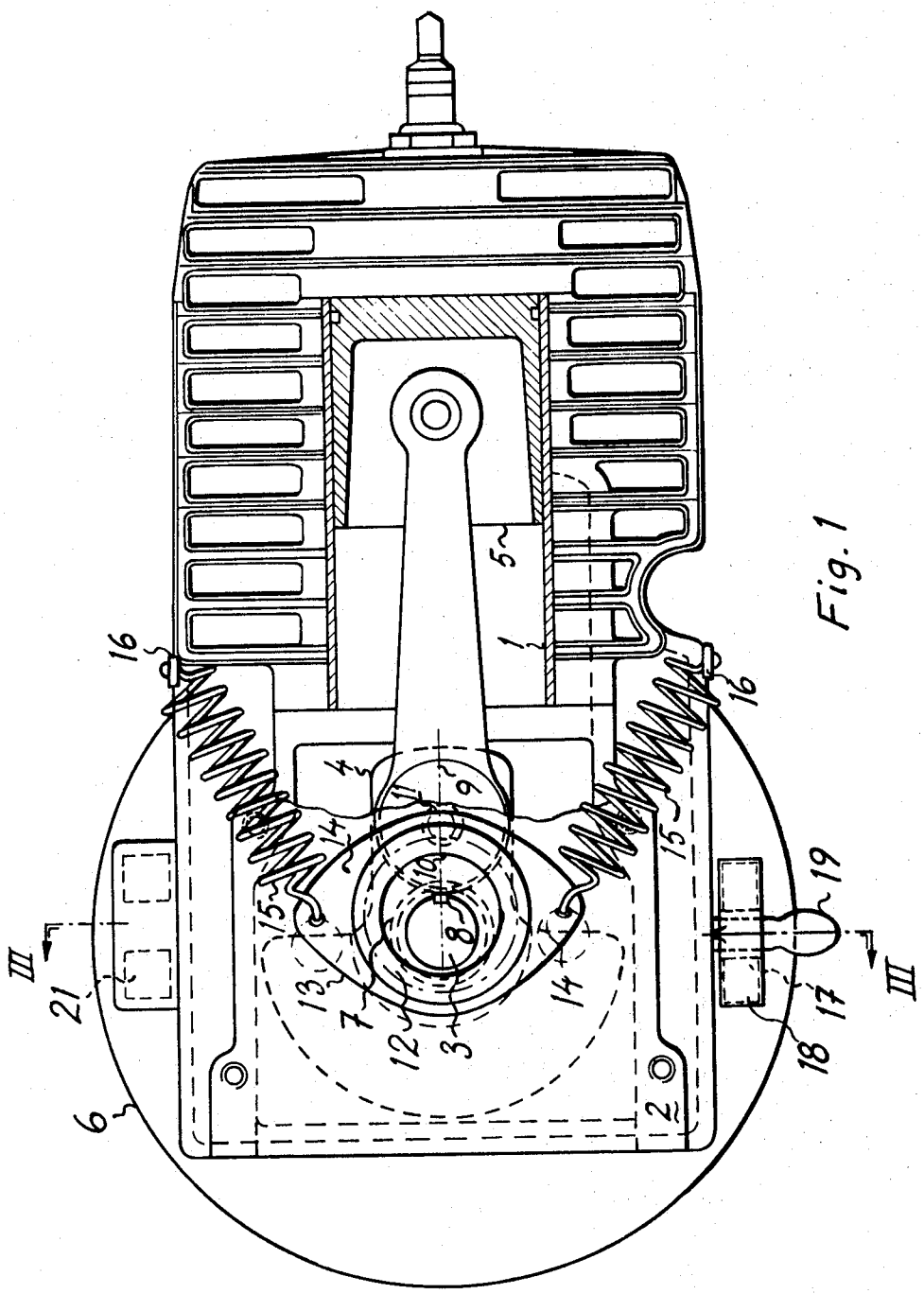


Fig. 1

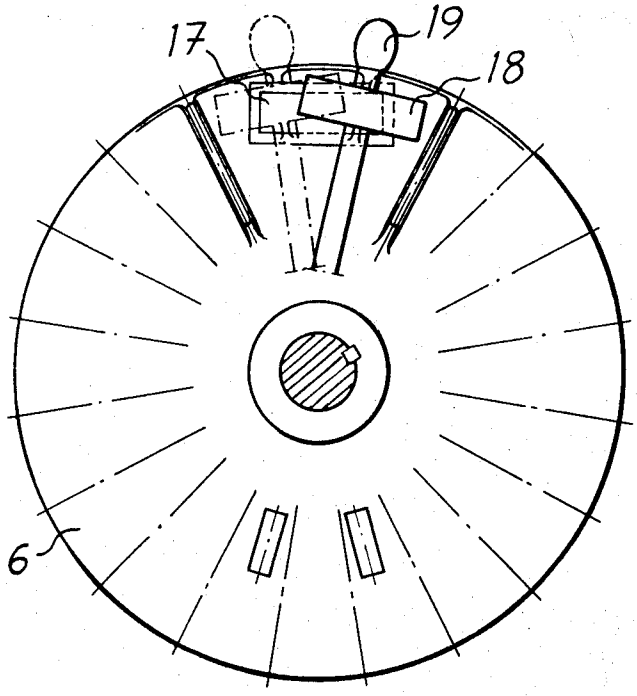


Fig. 2

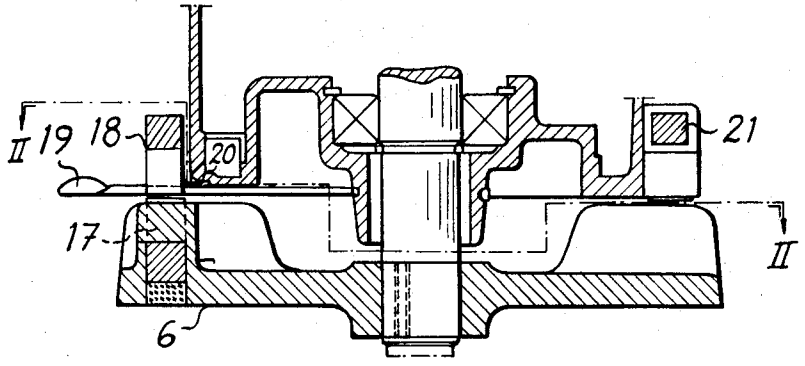


Fig. 3

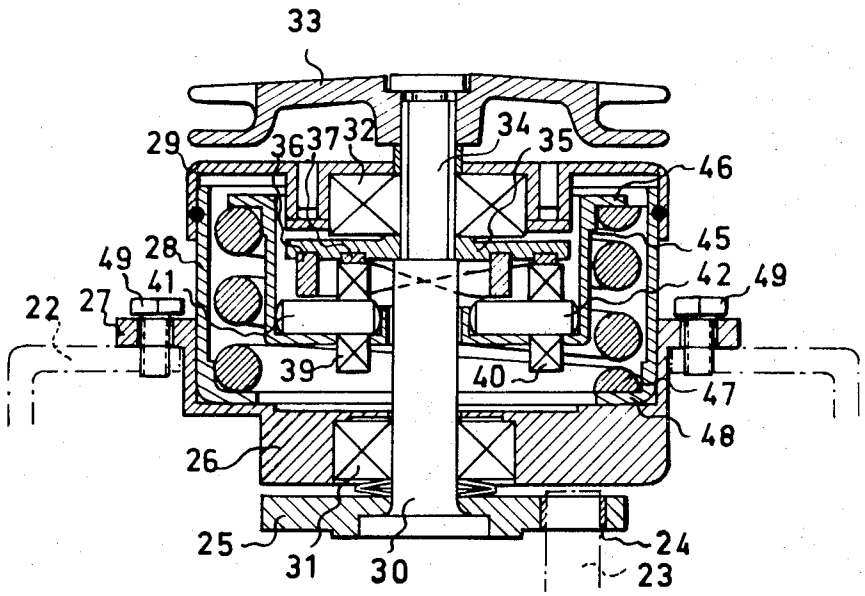


Fig. 4

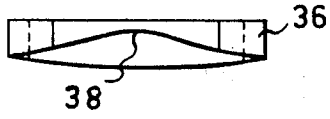


Fig. 5

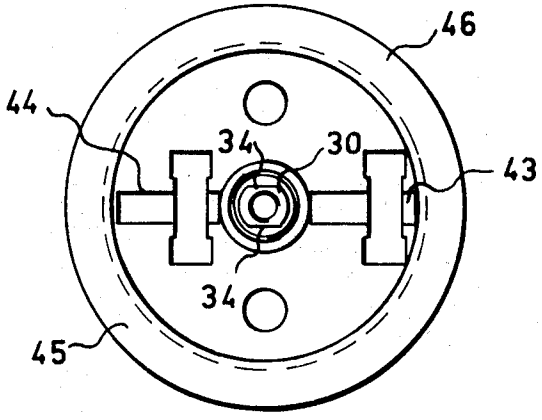


Fig. 6

ARRANGEMENT FOR AUTOMATICALLY POSITIONING A PISTON IN AN INTERNAL COMBUSTION ENGINE

BACKGROUND OF THE INVENTION

The present invention relates to arrangements for positioning a piston in an internal combustion engine in connection with starting the engine. Auxiliary engine starting means, for example an engine starting means with which gas under pressure is passed to the cylinder, but more usually pull-cord starting means, are more or less dependent on a favorable position of the piston when starting the engine.

Positioning of pistons in internal combustion engines is an old problem which has previously been resolved by a number of different auxiliary means. The most common of these is thought to be a crank mounted on the crank shaft of the engine. The majority of auxiliary means known hitherto, however, require manual action on the part of the person starting the engine. Manual activation of the auxiliary starting means may be troublesome and strenuous if energy has to be expended for a number of repeated starting attempts. Positioning of a piston in the engine when effecting a start by means of a pull-cord considerably reduces the amount of energy required to start the engine. When starting an engine by means of a pull-cord, it is of substantial importance that the flywheel mass of the engine be strongly rotated before the compression stage of the engine. This is achieved by positioning the piston so that the starting movement begins at a point in the cycle at which the first compression stage is as far advanced in the cycle as possible. In the case of a two-stroke engine with one cylinder, the cylinder, when correctly positioned, should be slightly in front of the top-dead-center position. In the case of a four-stroke engine with one cylinder, the piston should be in a position at which the exhaust valve has just begun to open. The crank shaft must then rotate at least three quarters of a turn or one and one quarter of a turn on a two-stroke and a four-stroke engine respectively before the compression stage begins. In these instances, the piston can be positioned by means of the pull-cord, although an automatic starting means is more effective and operates suitably during the time taken in rewinding the cord on its pulley. In the case of engines employing other auxiliary starting means in which the starting movement is initiated directly on the piston, an automatic piston positioning means is a valuable supplement to the starting means.

SUMMARY OF THE INVENTION

The object of the present invention is to provide an arrangement which automatically drives the crank shaft until one of the pistons in the engine takes up a special determined position in the cylinder, and that driving of the crank shaft is repeated at each starting attempt without any form of external interference being necessary. In accordance with the invention, such a positioning means is characterized by a tensioning means and at least one elastic member which, as a result of the reciprocating movements of the piston, mutually actuate each other so that the elastic member is tensioned during the passage of the piston from the distinct position in the working cycle and relaxed during movement of the piston towards the distinct position.

Embodiments of the invention will now be described with reference to the accompanying drawings, in which

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates a positioning arrangement mounted on and adjacent the crank shaft of an engine,

FIG. 2 illustrates a means for finely setting the position of the piston, with the means being mounted on and adjacent the flywheel of the crank shaft,

FIG. 3 illustrates in side elevation and partly in section the fine setting means of FIG. 2,

FIG. 4 in a sectional view another positioning arrangement,

FIG. 5 a side view of a cam curve included in the arrangement in FIG. 4, and

FIG. 6 is a horizontal view of a roll holder included in the arrangement in FIG. 4.

DETAILED DESCRIPTION OF THE INVENTION

The engine illustrated in FIG. 1 is a single-cylinder two-stroke engine with a horizontal cylinder 1 and having one crank housing end-wall 2 facing upwards. The engine has a through passing crank shaft, of which upper end 3 is visible in the figure. Parts of the housing end wall and the cylinder wall have been removed, so that a crank 4 and a piston 5 can be seen. A flywheel 6 is mounted underneath the motor, on the other end of the crank shaft, on which end means for transmitting power from the engine are also secured. The piston is shown in its top-dead-center position, to which position it is automatically moved by the positioning arrangement mounted in the close proximity of the crank shaft. A more detailed description of the positioning arrangement will be given hereinafter.

An eccentric plate 7 is securely mounted on the end 3 of the crank shaft and is retained in a specific angular position by means of a key 8. The angle between a symmetry line 9 diametrically across the plate and the crank 4 on the crank shaft is, in this case zero, i.e. outermost point 10 of the eccentric is always in the same angular position as crank pin 11 on the crank.

Mounted on the eccentric plate is a ball bearing 12 and outside of the bearing is positioned an outer ring 13 having two diametrically positioned projections 14. When the crank shaft rotates, each of the projections will move in circular paths to the side of the end 3 of the shaft in a known manner, as indicated by dotted circle lines in FIG. 1, due to the eccentricity of the outer ring in relation to the end 3. A coil spring 15 is secured to each projection and tensioned against an attachment 16 on the engine body. The angle formed by the longitudinal extensions of the two springs lies between zero and 180°. The springs 15, which are heavy springs, therefore attempt to move the ring towards the cylinder 1. When the crank shaft rotates, the ends of the springs secured to the projections follow the dotted circles, i.e. the springs are tensioned and relaxed once during each revolution of the crank shaft. The springs are tensioned during the working stroke of the engine and energy is stored therein. This energy is released during the compression stroke and hence the springs act as an extra flywheel on the crank shaft.

The main purpose of the springs, however, is to ensure that, when the engine stops, the piston always occupies its top-dead-center position or a position in the vicinity of top-dead-center. As aforementioned, energy is accumulated in the springs when these are tensioned,

and the energy is used to move the outer ring **13** from the position it occupies in its path of movement to the position in the path which corresponds to the top-dead-center position of the piston in the cylinder. In a similar manner, the piston can be set to other positions in the cylinder, either by changing the point of attachment of the spring or by adapting the plate **7** for rotation on the shaft and setting the plate at a certain angle from the illustrated position.

It is also possible to bring the piston to two or more alternative positions in the cylinder and an arrangement by means of which this can be effected is shown in FIGS. **2** and **3**. A permanent magnet **17** is mounted in a recess in the flywheel **6** at the periphery thereof; such magnets are found on engines using magnetic ignition and cooperate with an ignition coil or charging circuit (not shown) for providing the ignition spark to the engine. The same magnet can be used with such engines for positioning the piston in the cylnder. A second permanent magnet **18** is movably arranged on the motor body in the proximity of the path of movement of the flywheel magnet and the poles of the second magnet **18** are reversed in relation to the poles of the flywheel magnet **17** so that the two magnets are strongly attracted towards each other. The position at which the two magnets lie opposite each other is therefore very distinct and the magnets can thus serve as a fine setting means for the positioning arrangement. The movability of the magnets mounted on the engine body enable the piston to be set to different positions in the cylinder and FIG. **2** shows (in solid lines) the magnet in one of its two alternative positions (the other position being shown by dash lines) on either side of the top-dead-center position of the piston. Thus, by means of the movable magnet **18**, which is secured on an arm **19** journalled on the engine body and self locking in a groove **20** arranged thereon, the piston can be positioned in the cylinder with great accuracy to take one of two piston positions symmetrically situated on each side of the top-dead-center position. Which of these alternative positions is chosen may depend on outside circumstances, for example, starting of the engine in one or the other direction (two-stroke engines are naturally disposed to start both forwards and backwards). The arm **19** can then be moved from one position to the other with the subsequent change in position of the piston. Furthermore, the strength of the magnet is sufficient to draw the piston to its turning point on the side thereof at which it is not intended to position the piston. This property is particularly advantageous if the engine does not start at the first attempt, since the piston can be positioned for the next attempt without it being necessary to move the arm **19**.

The described arrangement is connected and active all the time the engine is running, which may appear unwarranted in view of the fact that the function of the arrangement to actuate the crank shaft when starting the engine takes but a short period of time to effect in relation to the length time the engine is kept running. This disadvantage, however, can be overcome by providing an extra power system for relaxing the spring once the engine has been started. The source for such a power system may, for example, be in the form of a vacuum or positive pressure in the gas passages of the engine or in the form of the oil pressure used for lubricating the engine. There is no disadvantage, however, to the operation of the engine if the whole spring force is active while the engine is running; the force, as previously mentioned, serves as an additional flywheel. An additional means which improves the positioning arrangement is the presence of an extra magnet **21** adjacent the flywheel, which cooperates with the magnet **17** on the fly wheel when the piston is in its bottom-dead-center position. The magnets **17,21**, however, are arranged to repel each other, so that the crank shaft, when the engines stops, is prevented from stopping in the center of its bottom-dead-center position; the springs **15** are not capable of moving the piston from this position to the top-dead-center position since the crank shaft is then theoretically in a labile position of equilibrium in relation to the springs, although in practice a small area around the lower turning position of the piston is in a stabile position of equilibrium as a result of friction.

In FIG. **4**, which is a general view of the other arrangement, all parts included therein are shown. It is mounted on one crankcase end wall **22** of the engine in connection with a crank pin **23**, which is extended and enters a bushing **24** in a driving plate **25** included in the arrangement. This is built on a bearing shell **26** provided with a flange **27** which abuts on the end wall of the crank case and is fastened by screws **49** thereon. The bearing shell is circular and sunk in a circular aperture in the center of the end wall of the crank case. In the bearing shell a cylindrical case **28** is sunk and provided with a lid **29** and constitutes a body of the arrangement. A shaft **30** extending along the center line of the case is journalled in two bearings **31, 32.** At its lower end, the shaft **30** carries the driving plate **25** and at its upper end a pull-cord wheel or pulley **33** on which a pull-cord may be wound. The upper portion of the shaft has a reduced diameter and a couple of flatly cut parallel side faces **34** which give a solid attachment for the wheel **33** and a cam flange **35** which have center holes of the same shape as the section of the upper portion of the shaft. The bearing **32** above the cam flange **35** is an axial bearing, which prevents the flange from being displaced on the shaft. The lower bearing **31** is a radial bearing with a certain guidance also in the axial direction. In the cam flange **35,** a couple of cam rings **36, 37** are fit in circular grooves and are provided with a profile as shown in FIG. **5.** A hollow **38** in the one ring is displaced 180° angularly from the hollow in the other ring at fastening the rings in the flange. The bottom surfaces of the rings are in contact with rollers, e.g. ball bearings **39, 40,** with each one being secured to a pin **41, 42,** which are fit in slots **43, 44** in the bottom of a bowl like holder **45** (FIG. **3**). The top of the holder has a flange **46.** A helical spring **47** is tensioned against the flange **46** and supported by the inner surface of the case **28.** The spring presses, via the holder **45** and the rollers, the cam flange against the bearing **32** and the action is taken up by the lid **29,** which is fastened to the shell by means of threads, a shrink fit or the like.

The working mode of the arrangement is as follows. In the illustrated position, the rollers **39,40** are pressed to the lowest portion **38** of the cam rings. If the shaft is rotated in any direction from the shown position, the distance between the cam flange **35** and the pins **41, 42** will increase as the rollers then are forced onto higher portions of the cam rings. The spring **47** becomes then more tensioned and receives, after half a revolution, a maximal tension. At further rotation the spring is untensioned and endeavors to rotate the shaft to the illus-

trated position which thus is an equilibrum. Once for every revolution, the spring is tensioned and untensioned. When the engine is working, the shaft is forced to rotate and the arrangement has no special function during such rotation, but when the engine is stopped, the shaft **30** (and the crank shaft) are positioned in accordance with the equilibrium between the rollers and the cam-rings. As shown in FIG. **1**, the engine is stopped in such a position that the crank pin **23** has come to its right hand end position; if the cylinder of the engine is located to the right in the figure, the piston has then come to its top dead end position. The piston takes this position after any rotation of the shaft, e.g. after a failure of a start by means of the pull-cord and the wheel **33**. In the same way, the piston can be set into other positions, either by resetting the hollows **38** of the cam rings relatively to the crank pin **23** or by turning the bearing shell **26** through a certain angle. The screws **49** enter holes in the flange **27** and which holes may be oblong so that the screws need not be unscrewed and moved when turning the shell. The shell may also be provided with a protruding handle by which the shell can be turned between two alternative positions, defined by the ends of the oblong holes. Such a handle may also be helpful when moving the piston from one alternative position to the other.

The aforedescribed embodiments of the invention can naturally be modified within the spirit of the invention. For example, the invention can also be applied to four-stroke engines, with the positioning arrangement in this instance being mounted on the cam shaft instead of the crank shaft. Positioning of the piston may also be useful for reasons other than for starting purposes, for example to position the engine so that all openings adjacent the cylinder are closed thereby, among other things, preventing corrosion. The springs in the illustrated embodiment in FIGS. **1–3** are shown as tension springs, although pressure springs, torsion springs or other types of springs may also be used, and the eccentric plate on the projecting shaft can be designed to be actuated, for example, by a pressure roller bearing against the periphery of the plate. A simpler solution than the one just described can be obtained if the eccentric is substituted with a crank; it is not often, however, that a crank shaft pin is free to take a crank and therefore the embodiment which includes an eccentric is preferred when describing the invention. In the embodiment shown in FIGS. **4–6**, it is possible to make a substitution of the holder and the cam flange so that another holder fastened to the shaft and a flange fastened to the body of the arrangement are used. Such structural variations of the shown and described embodiments are naturally included in the inventive idea, which is defined in its entirety of the following claims.

I claim:

1. An automatic positioning means for a piston reciprocable in a cylinder in an internal combustion engine, for moving the piston from any position in a complete working cycle, including all strokes of the engine to a top-dead-center position of the piston, comprising a shaft driven by the reciprocating movement of the piston, an eccentric mounted on the shaft, an outer ring journalled on the eccentric, and at least one elastic member tensioned between the outer ring and a point on the engine body whereby the eccentric and elastic member mutually actuate each other so that the elastic member is tensioned during the passage of the piston from its top-dead-center position in the working cycle and relaxed during movement of the piston towards the top-dead-center position.

2. The arrangement according to claim **1**, characterized in that, when said engine is a two-stroke engine, said shaft is constituted by the crank shaft of the engine.

3. The arrangement according to claim **1**, characterized in that, when the engine is a four-stroke engine, said shaft is constituted by the cam shaft of the engine.

4. The arrangment according to claim **1**, in which the engine is provided with a flywheel characterized by a permanent magnet being positioned on the engine body adjacent the flywheel, and a second magnet being positioned on the flywheel, with said magnets cooperating in a position of the flywheel which corresponds to the top-dead-center position of the piston.

5. The arrangement according to claim **4**, characterized in that the magnet positioned on the engine body is capable of movement between different positions around the periphery of the flywheel and means for locking said magnet in at least one position.

6. An automatic positioning means for a piston reciprocable in a cylinder in an internal combustion engine, for moving the piston from any position in a complete working cycle, including all strokes of the engine, to a distinct position, including a shaft driven by the reciprocating movement of the piston, at least one cam ring located concentrically around the shaft, a cam follower, and an elastic member, a bearing shell and a case constituting a body of the arrangement, fastening means for mounting the body on a crankcase of the engine, the cam ring being provided with a curved surface defining a hollow and the elastic member being tensioned against the body and pressing the cam follower and cam ring together with the cam follower and cam ring mutually actuating each other so that the elastic member is tensioned during the passage of the piston from the distinct position in the working cycle and relaxed during movement of the piston towards the distinct position.

7. The arrangement according to claim **6** in which said body is turnably mounted on the crankcase.

8. The arrangement according to claim **6** in which said engine is a two-stroke engine, and the shaft is connected to the crankshaft of the engine.

9. The arrangement according to claim **6** in which, when the engine is a four-stroke engine, the shaft is connected to the cam shaft of the engine.

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