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Rust et al.

[11] **3,915,129**

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[54] **INTERNAL COMBUSTION ENGINE**

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[51] **Int. Cl.²** **F01L 1/34**

[58] **Field of Search** 123/90.18, 90.2, 90.16, 123/90.17, 90.15, 90.6, 90.28; 74/569

[56] **References Cited**

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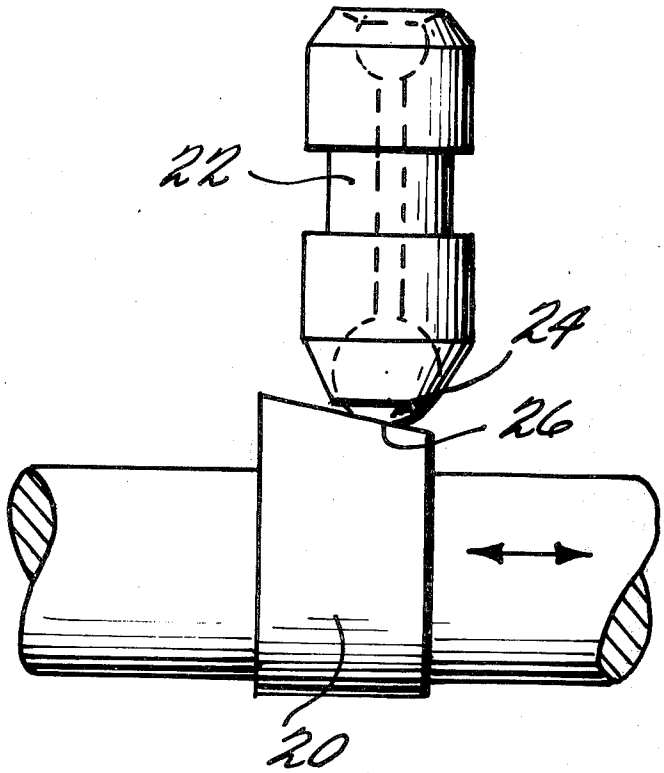
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Assistant Examiner—Daniel J. O'Connor
Attorney, Agent, or Firm—Cushman, Darby & Cushman

[57] **ABSTRACT**

In an internal combustion engine of the type having a timing cam with a distance from center to cam surface with varies along its axis of rotation and at least one cam follower which rides on the cam surface to operate a valve so that the valve operating characteristics vary as a function of the position of the cam follower along the axis of rotation of the cam, the improvement wherein the cam follower includes a ball having a flat surface engaging the cam surface so that a line of contact always exists between the ball and the cam surface and means for mounting said ball in the follower, producing a mechanism which is durable, cheap to manufacture and adaptable to present day engines.

1 Claim, 2 Drawing Figures



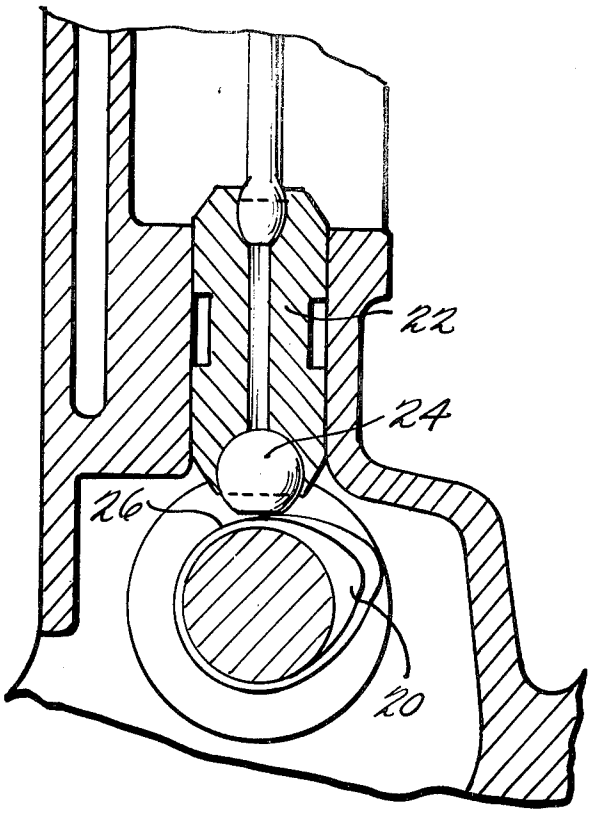


Fig. 1

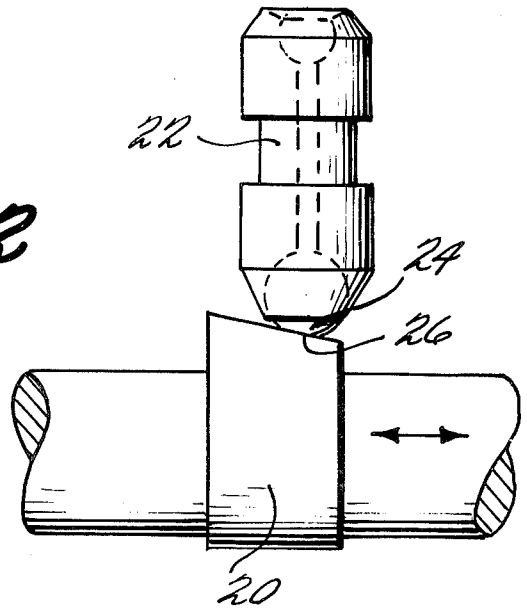


Fig. 2

INTERNAL COMBUSTION ENGINE

BRIEF DESCRIPTION OF THE PRIOR ART AND SUMMARY OF THE INVENTION

The invention relates to an improved internal combustion engine of the type having a timing cam and a cam follower which rides on the cam surface to operate a valve.

Heretofore, one of the major compromises affecting the performance of an automobile engine has been valve timing, duration and lift (generally referred to as TDL). Valve TDL determines to a large extend the smoothness and power characteristics of an engine at various RPMs. With conventional engines, due to valve TDL, an engine with a smooth idle is unfortunately limited in its power production at high RPM. Conversely, an engine that produces optimum power at high RPM lacks smoothness and tractability at lower speeds. The reason for this problem is that the breathing characteristics of the engine, i.e., the ability of the engine to draw in a full charge of air-gas mixture into the cylinder and, after combustion, to reject the spent exhaust gasses, changes with engine RPM. In conventional engines, however, the valve TDL is fixed while the "breathing" characteristics of the engine change with RPM. Accordingly, the valve TDL is conventionally a compromise to produce relatively smooth idle with adequate power at high RPMs. This compromise produces neither optimum smoothness at idle nor optimum power at high RPM.

One possible technique to deal with this problem which has been suggested in the past is to construct the cam to have a distance from center to cam surface which varies along its axis of rotation. The cam follower can then be shifted along its axis of rotation as a function of engine speed by centrifugal or other mechanisms so that the cam follower rides on a portion of the cam surface which is optimum for the speed at which the engine is rotating. The U.S. Pat. No. 2,980,089, to Sampietro, is typical of this general type of improved engine.

The primary drawback to improvements of this type in the part is that they provide essentially a single point of contact between the cam follower and the cam surface. The most common mechanism in this type of structure employs a roller having a rounded contour which enables it to follow the varying contours of the cam surface.

However, this single point of contact is insufficient for the surfaces of the cam follower and the cam surface to endure the tremendous pressures which result from the inertia in the valve train mechanism. In contrast with those variable cam arrangements having a point of contact, a conventional lifter has a line of contact of about three-eighths inch with the conventional surface which permits it to stand up under long-range operating conditions.

The present invention relates to an improved internal combustion engine in which a cam follower is employed which includes a ball having a flat surface engaging the cam surface. This engagement results in a line of contact which always exists between the ball and the cam surface. The result is a mechanism which is simple, durable, cheap to manufacture and easily adaptable to present day internal combustion engines.

At least two patents in the prior art describes arrangements of this general type which do not have a single point of contact. The U.S. Pat. No. 3,618,573, to Allen, describes an arrangement in which a universally mounted rocker is used. Such a rocker, however, may not be entirely practical due to the necessity of the rocker mechanism being subjected to tremendous lateral acceleration because the entire rocker must follow the contours of the cam lobe. The U.S. Pat. No. 3,730,150, to Codner, describes a mechanism in which a roller is used and a line of contact is attempted to be maintained at a fixed angle. This fixed angle is not compatible with varying angles of the cam lobe.

Many other objects and purposes of the invention will be clear from the following detailed description of the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a cut-away view of a portion of an improved internal combustion engine of this invention;

FIG. 2 shows a schematic view of the cam follower and can which comprise the improvement of this invention.

DETAILED DESCRIPTION OF THE DRAWINGS

Reference is now made to FIGS. 1 and 2 which illustrate the improvement of this invention. As in conventional internal combustion engines, cam **20** is mounted for rotation with the engine and the speed of rotation of the timing cam is a function of the speed of rotation of the engine. Further, cam **20** is mounted in any conventional way so as to be movable along its axis as a function of the engine RPM. Any conventional mechanism, such as the arrangement which is described in the Allen U.S. Pat. No. 3,618,573, can be employed. Centrifugal, hydraulic, electrical or any other mechanisms for moving the cam shaft can be employed and the way in which that shaft is moved along its axis is not part of the invention of this application.

Also, in the same fashion as in conventional engines, a mechanical cam follower or lifter **22** is mounted for longitudinal movement as it follows the surface of cam **20.** It will, of course, be understood that while the embodiment of this application illustrates a mechanical lifter, hydraulic and other conventional lifters can also be employed in the same fashion.

However, in contrast with conventional arrangements, the cam follower **22** in the embodiment of this invention comprises a ball **24** having a flat surface **26** which engages the surface of cam **20.** As can be seen in FIG. **2,** cam **20** has a distance between its axis of rotation and its surface which varies along the length of that axis so that, as cam **20** is moved in the direction of the arrows of FIG. **2,** the flat surface **26** engages different portions thereof to change the TDL characteristics of the valve which is mechanically or otherwise connected to the lifter **22.** By using a ball having a flat surface, a continuous line of contact always exists between the ball and the cam surface and this results in a mechanism which is practical, durable, cheap to manufacture and adaptable to present day engines.

Many changes and modifications in the above described embodiment of the invention can, of course, be carried out without departing from the scope thereof. Accordingly, that scope is intended to be limited only by the scope of the appended claims.

What is claimed is:

1. In an internal combustion engine of the type having a timing cam with a distance from center to cam

surface which varies along its axis of rotation and at least one cam follower which rides on said cam surface to operate a valve so that the valve operating characteristics vary as a function of the position of the cam follower along the axis of rotation of the cam, the improvement wherein the cam follower includes a ball having a flat surface engaging the cam surface so that a line of contact always exists between the ball and the cam surface and means for mounting said ball in said follower.

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