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Maier

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[54] **PISTON FOR INTERNAL COMBUSTION ENGINES**

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[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.** ..... **92/31,** 123/45 R

[51] **Int. Cl.** **F01b 3/00**

[58] **Field of Search** 92/31, 32; 123/45

[56] **References Cited**

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[57] **ABSTRACT**

A stepping mechanism for causing progressive rotation of a piston, comprising an internally-toothed stepping ring, a curved leaf-spring and a control part by which the spring is deflected in a direction corresponding to an elongation, in accordance with the operating cycle of a combustion engine.

6 Claims, 6 Drawing Figures

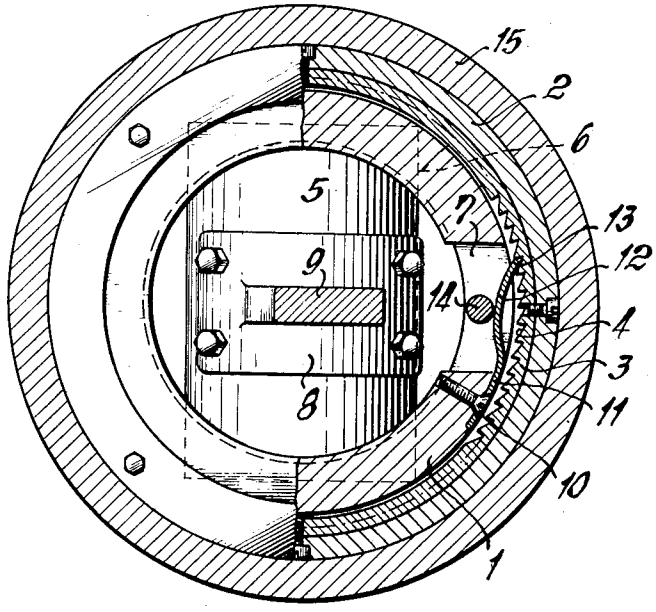


FIG. 1

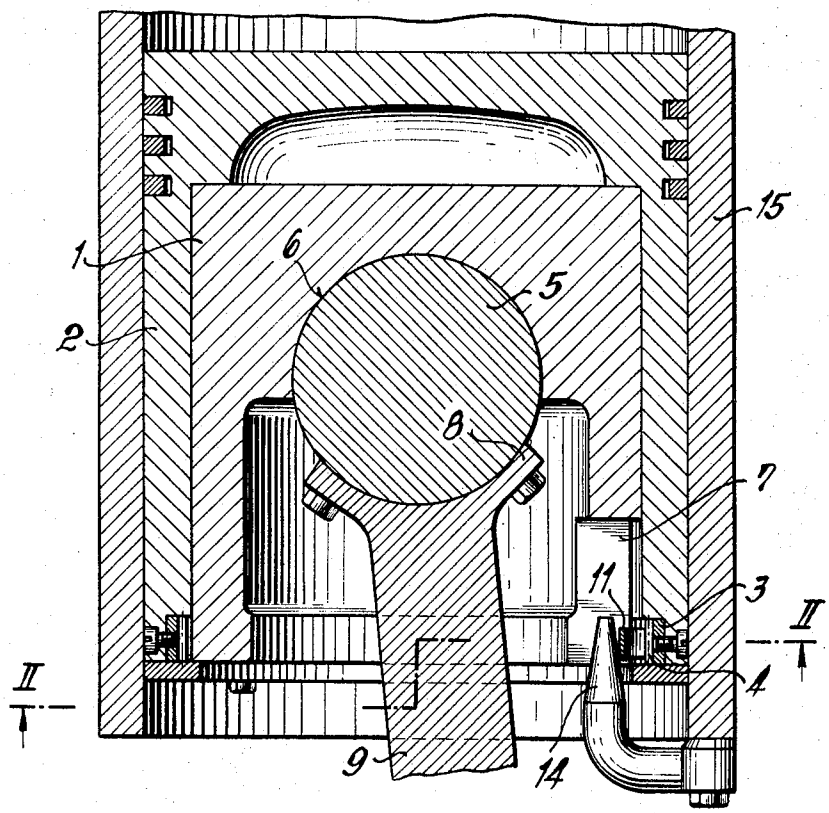


FIG. 2

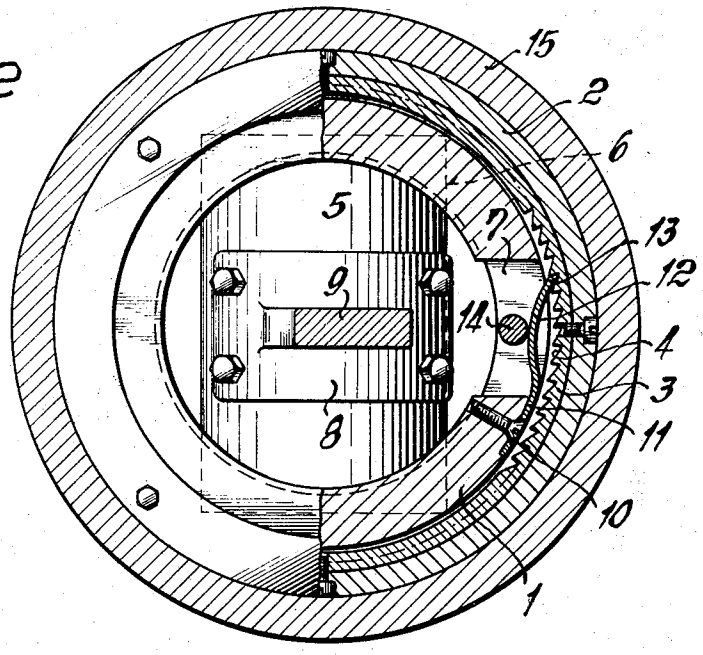


FIG. 4

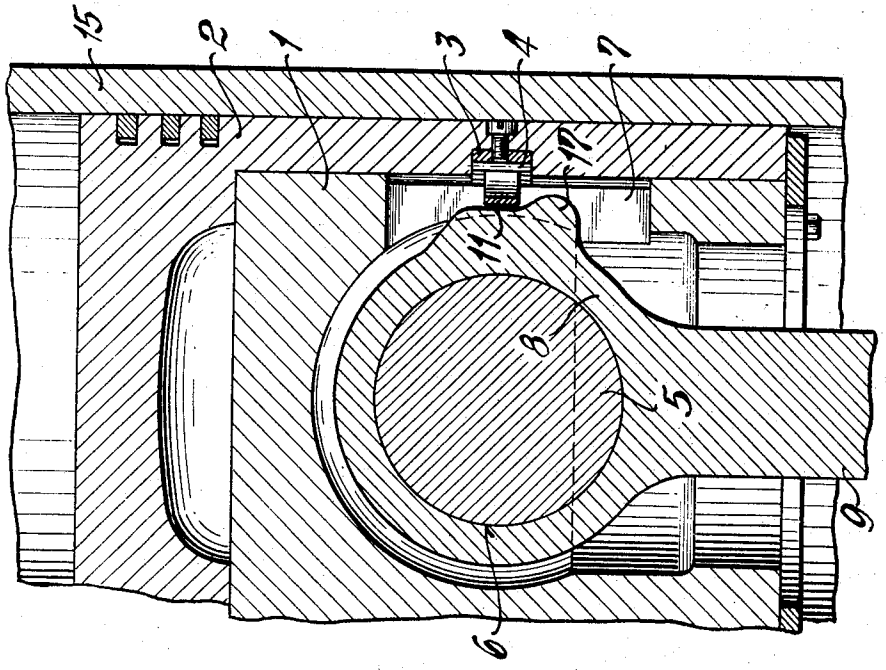


FIG. 3

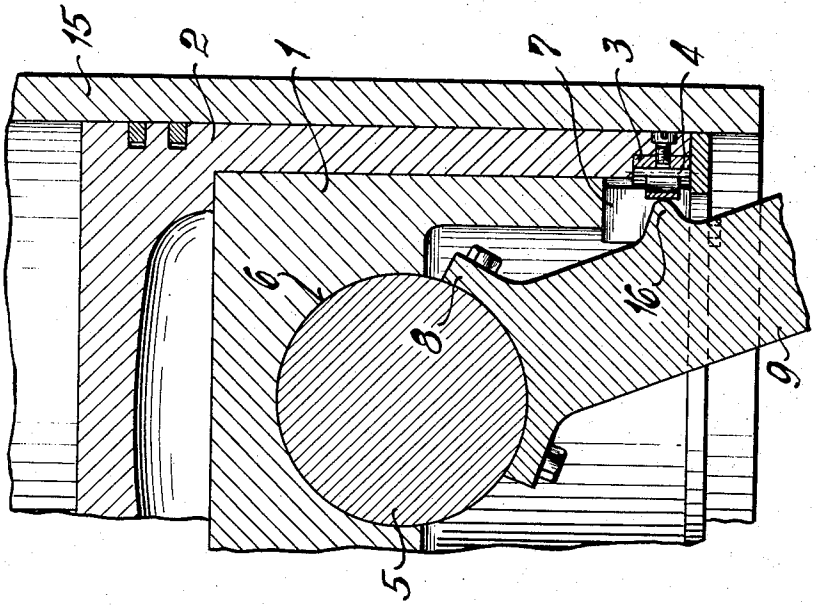


FIG. 5

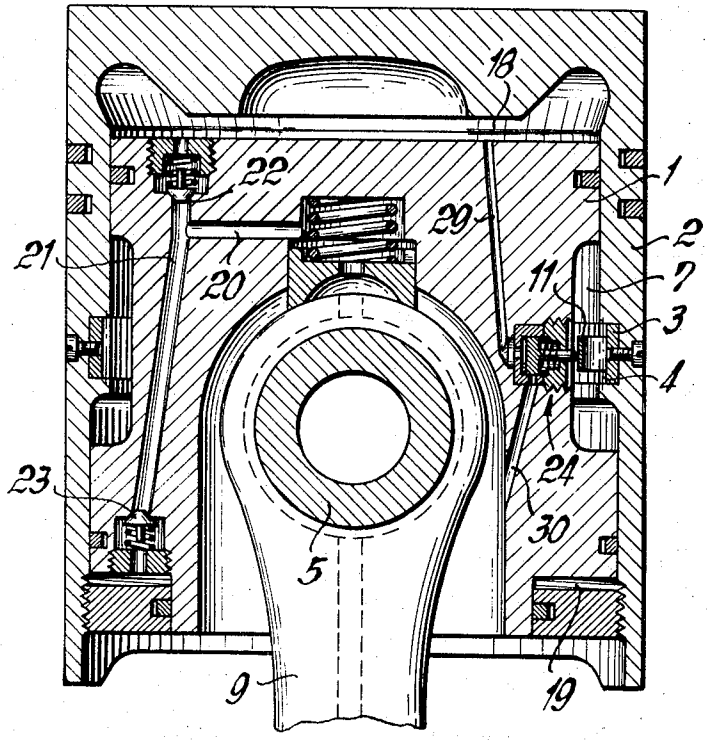
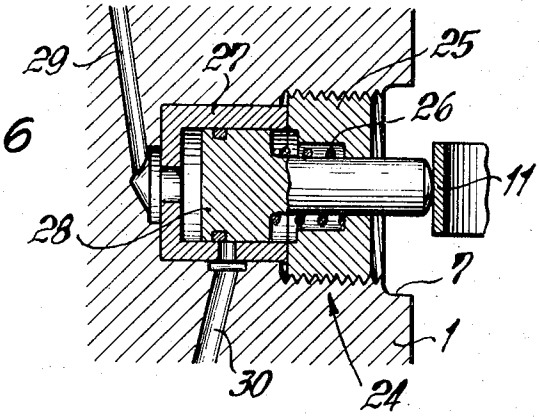


FIG. 6



PISTON FOR INTERNAL COMBUSTION ENGINES

BACKGROUND OF THE INVENITON

1. Field of the Invention.

This invention relates to a piston for internal combustion engines including a seat serving for the support of the piston, pin, a piston skirt and a device for causing the latter to perform a progressive rotation about its longitudinal axis.

2. Description of the Prior Art.

Pistons of this kind, as is known, are very durable and comparatively insensitive to what is known as piston seizing, as the wear on the contact surface of the piston owing to the rotatory motion imparted to the latter, is very even. Despite these advantages, the constructions hitherto known have hardly found a footing in practice, as the devices by which the rotation is effected consist of very numerous and to some extent complicated parts liable to cause faults to develop in operation and expensive to manufacturing.

SUMMARY OF THE INVENTION

The purpose of the invention is therefore to provide an apparatus which will cause the piston shirt to perform a progressive rotation and which will act by simple means and without developing faults.

According to the present invention a piston for internal combustion engines including a seat, a piston pin mounted in the seat, a piston skirt and means for causing the skirt to perform a progressive rotation about its longitudinal axis, said means comprising a stepping ring with internal teeth affixed relative to the internal surface of the piston skirt, a curved leaf-type spring having one end affixed to the seat while the other end engages the teeth of the stepping ring, and control means by which the curved leaf-type spring is deflected in a direction corresponding to the straightening of the spring in accordance with the operating cycle of the engine to effect said rotation of the piston skirt.

The control part deflecting the leaf-type spring can take many different forms. A number of constructional embodiments of the invention will now be described by way of example with reference to the accompanying drawings, in which:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a longitudinal sectional view through a first embodiment of the invention;

FIG. 2 is a partial cross sectional view along the line II—II of FIG. 1;

FIG. 3 is a partial longitudinal sectional view through a second embodiment of the invention;

FIG. 4 is a partial longitudinal sectional view through a third embodiment of the invention;

FIG. 5 is a longitudinal sectional view through a fourth embodiment of the invention; and

FIG. 6 is a part sectional view of part of the embodiment of FIG. 5, on a larger scale.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In all four embodiments the piston consists of a seat 1 and of a piston skirt 2 which is mounted rotatably in respect of the said seat and to the inner surface of which is affixed a stepping ring 3 with internal teeth 4. A recess 6 in the seat 1 contains a piston pin 5 connected with the head 8 of a connecting rod 9. The seat

1 is also provided with a recess 7 to one edge of which is affixed one end 10 of a bent leaf-type spring 11 in such a way that its part 12, curved in the opposite direction to the stepping ring 3, extends into the recess 7, while its free end 13 engages the teeth 4 of the said stepping ring 3.

In the embodiment shown in FIGS. 1 and 2 the control part by which the leaf-type spring 11 is deflected in the direction of an elongation, in accordance with the operating cycle of the combustion engine, is formed by a pin member 14 affixed to the cylinder 15 and extending into the open end of the piston in such a way that it engages the leaf-type spring 11 when the piston, as shown in the drawing, has almost reached its bottom dead center.

The curvature and length of the leaf-type spring 11 and also the shape of the pin 14 are selected to ensure that the piston skirt 2, when the leaf-type spring has been deflected to the maximum extent, will be rotated anticlockwise through an angle corresponding to at least the pitch of the teeth.

In the embodiment shown in FIG. 3 the control part is formed by a projection 16 from the body of the connecting rod 9, the said projection engaging the leaf-type spring 11 shortly before the maximum deflection of the connecting rod has been reached. In this embodiment the sliding path between the projection 16 and the leaf-type spring 11 is very short, which is a particular advantage as regards the wear suffered by these parts.

In the embodiment shown in FIG. 4, the stepping ring 3, the recess 7 and the curved leaf-type spring 11 are situated on a level with the axis of the piston pin. The said piston pin 5 is in this case completely surrounded by the connecting rod head 8, from which a control cam 17 projects and engages with the leaf-type spring 11.

In the embodiment shown in FIGS. 5 and 6 the piston is of the type having a variable compression ratio, such as described, for example, in U.S. Pat. No. 3,405,697 by W.C. Marchand. In this case the piston skirt 2 is displaceable in respect of the seat 1 in the direction of the longitudinal axis of the piston. Between the said skirt and the said seat 1 two chambers 18 and 19 are formed, which can be fed with pressure oil in a known manner, via a boring in the connecting rod 9 and feed borings 20 and 21 in the seat, controlled by nonreturn valves 22 and 23. The chamber 19 has in addition a throttle aperture (not shown) to allow the pressure in the chamber to be released by discharge of oil into the engine crank chamber.

The seat 1 also contains an excess pressure relief valve assembly 24 of which the valve 28 contained in a valve housing 27 and spring loaded by a spring 26 adjustable by means of a threaded ring 25, engages the curved leaf-type spring 11. The cavity formed by the valve 28 and the valve housing 27 communicates with the upper chamber 18 via a boring 29 and with the crank chamber via a boring 30. The boring 30 is so arranged that it is exposed by the valve 28 when the latter moves from its closed position into a position which deflects the leaf-type spring 11. This occurs, as hereinafter described, when the oil pressure prevailing in the chamber 18 becomes greater than the counter pressure acting through the springs 26 and 11 on the valve 28. The excess pressure relief valve assembly 24 thus forms the control part by which the leaf-type spring 11 is de-

flected in accordance with the operating cycle of the combustion engine.

More particularly the operation of the piston of FIGS. 5 and 6 is as follows:

Initially it is assumed that oil is fed under pressure through bore 21 and valve 23 into the chamber 19 and that oil is allowed to flow from the chamber 19 through the throttle aperture at a predetermined rate.

The variation, in particular an increased, of the compression ratio is accomplished by the inertia acting on the skirt at the upper end of the exhaust stroke and the early part of the downward intake stroke causing the skirt to separate from the seat 1 to the extent permitted by the release of oil from lower chamber 19 through the throttle aperture. As the members separate the upper chamber 18 expands and the valve 22 opens to permit oil to be directed to the expanding chamber 18 from the bore 21. The inlet valve 22 is closed at this time because of the pressure within chamber 19 so that oil will only be permitted to escape through the throttle aperture, in this way the separation of the skirt and seat is increased in small increments during each cycle of operation of the engine until a predetermined combustion chamber pressure has been achieved. When the pressure in chamber 18 overcomes the stress on the valve 28 caused by the springs 26 and 11, the valve 28 moves to the right in the drawings causing the spring 11 to straighten and cause relative rotational movement between seat 1 and skirt 2. The valve 28 continues to move until the bore 30 is exposed whereupon the chamber 18 is vented through bores 29 and 30 into the engine crank chamber and the valve 28 moves to the left to close the bore 30 so as to make ready for the next operation, when the pressure in chamber 18 is sufficiently reduced.

As the oil is being relieved from the chamber 18 the inlet valve 22 is closed by the pressure differential across the valve and similarly inlet valve 23 is opened by the pressure differential across that valve to permit the chamber 19 to fill with oil as it is expanding.

A piston of this construction, such as shown in FIGS. 5 and 6, combines the advantages of a piston having a variable compression ratio and of a piston of which the skirt is rotated in steps. It is naturally also possible for the pressure differences of the pressure oil supplied through the boring in the connecting rod 9 to be utilized solely for operating the device by which the progressive rotatory movement of the piston skirt is effected.

In addition to its great simplicity, leading to a reduction in manufacturing costs, the invention offers two further important advantages:

Owing to its elastic properties the leaf-type spring 11 can take up without danger the deformations to which it is subjected if the rotatory motion is impeded.

It also acts as a shock absorber, thus preventing the rotation from commencing in a sudden and violent manner. The durability of the stepping mechanism is thus improved.

I claim:

1. In an internal combustion engine a piston including a seat, a piston pin mounted in the seat, a piston skirt mounted on said seat and means interconnecting the piston seat and skirt for providing progressive rotation between said piston seat and skirt about the longitudinal axis of the piston, the provision of a stepping ring with internal teeth affixed relative to the internal surface of the piston skirt, a curved leaf-type spring having one end affixed to the seat while the other end engages the teeth of the stepping ring, and control means by which the curved leaf-type spring is deflected in a direction corresponding to the straightening of the spring in accordance with the operating cycle of the engine to effect said rotation of the piston skirt.

2. Piston in accordance with claim 1, in which the control means is formed by a pin member which is fixed to the engine cylinder and extends into the open shaft end of the piston and which engages with the leaf-type spring when the piston has almost reached its bottom dead center.

3. Piston in accordance with claim 1, in which the control means is formed by a projection on the connecting rod, the said projection engaging the leaf-type spring when the connecting rod has almost reached its maximum deflection from the piston axis.

4. Piston in accordance with claim 1, in which the control means consists of a control cam on the connecting rod head.

5. Piston in accordance with claim 1, in which the control means is hydraulically operated.

6. Piston in accordance with claim 5, in which the control means takes the form of an excess pressure relief valve actuated by pressure oil, the said pressure oil being present in a chamber of variable volume, formed by the seat and by the piston skirt which is axially displaceable in respect of the said seat, and communicating with the excess pressure relief valve via a boring in the seat.

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