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(54) **Piston ring lubrication**

(57) An internal combustion engine has a split piston ring (28) formed in its running surface with a groove (36) extending transversely of the piston ring axis, the groove communicating, by way of at least one duct (40) extending transversely of the peripheral direction, with the piston ring side (42) near the cylinder head. The running surface of the cylinder is formed with lubricating openings. The groove extends around the piston ring periphery as a continuous helix to improve oil distribution peripherally of the piston ring and to improve scavenging of the groove.

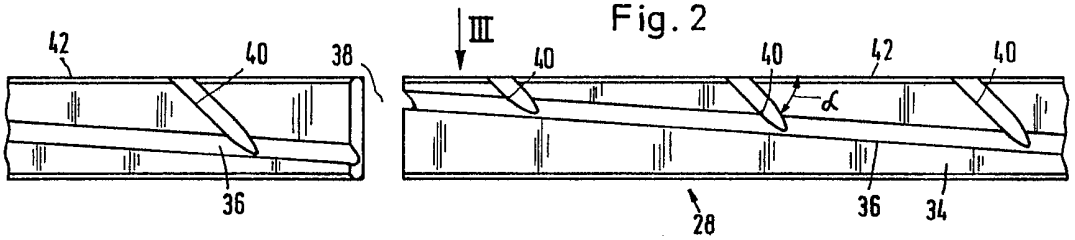


Fig. 2

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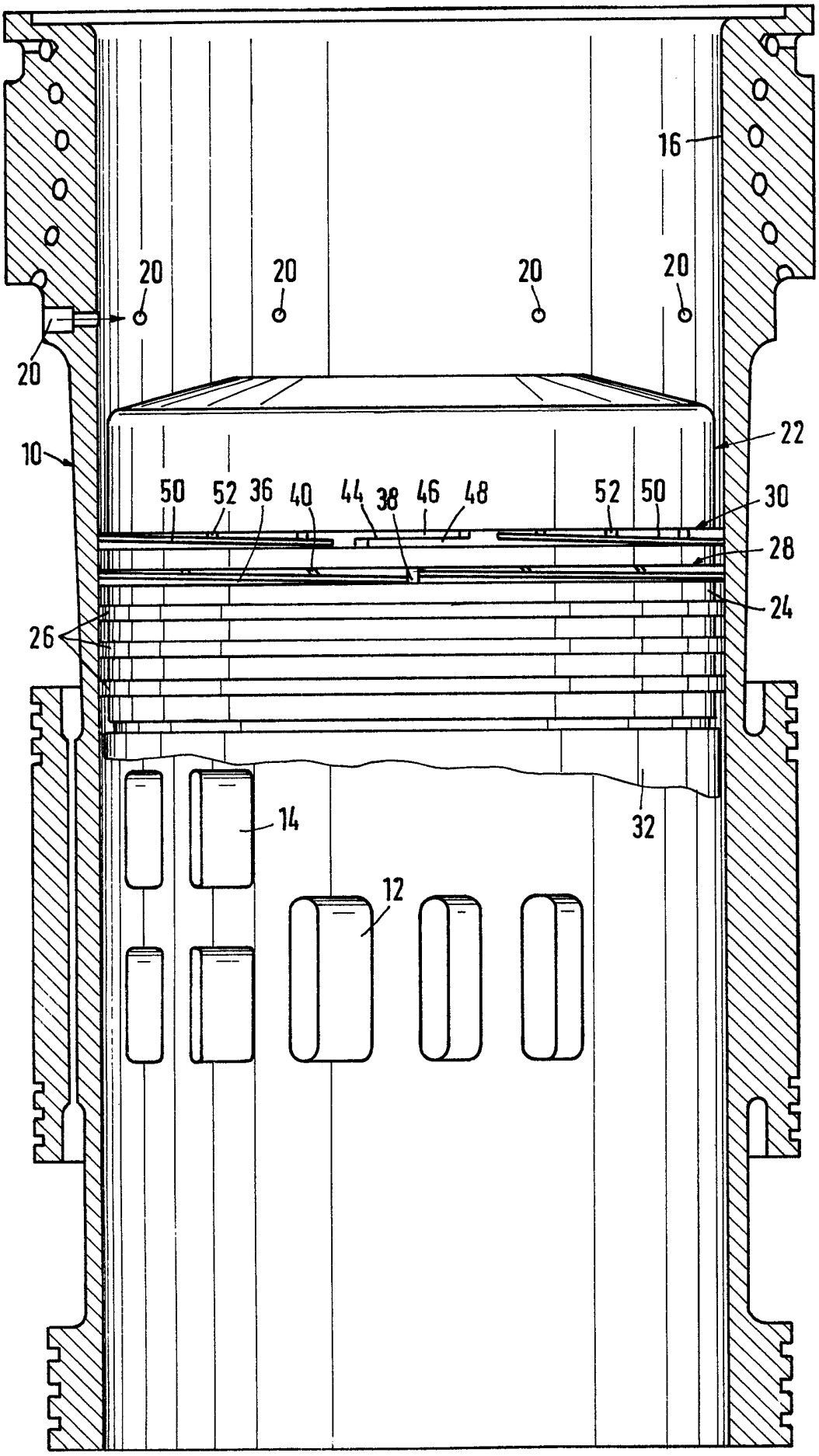
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Fig.1

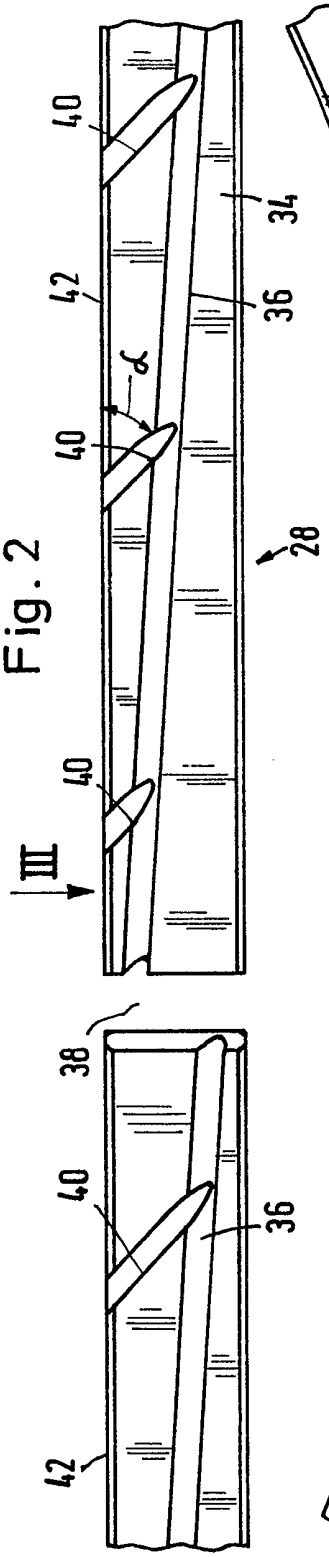


Fig. 2

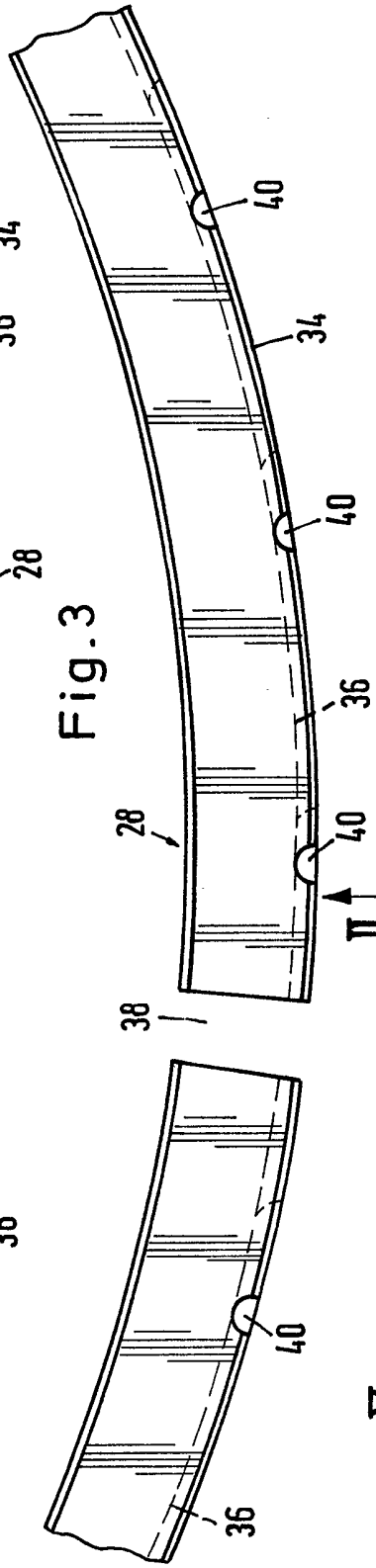


Fig. 3

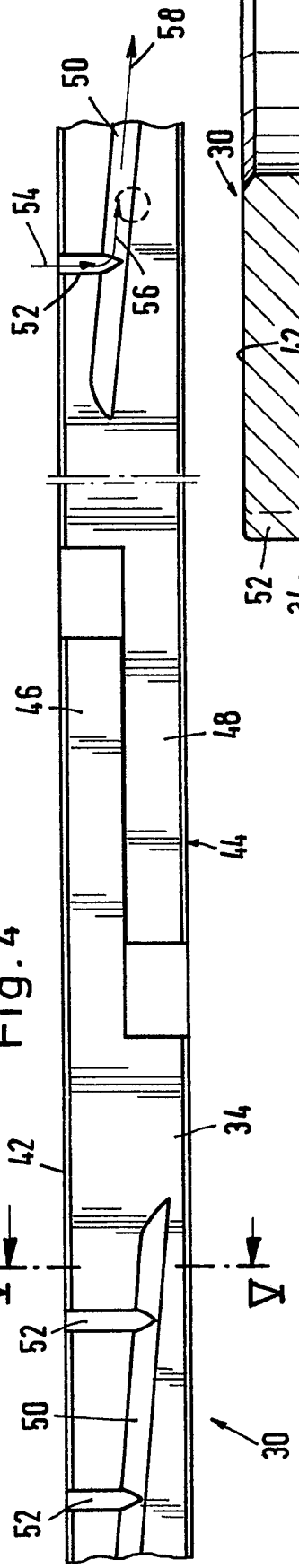


Fig. 4

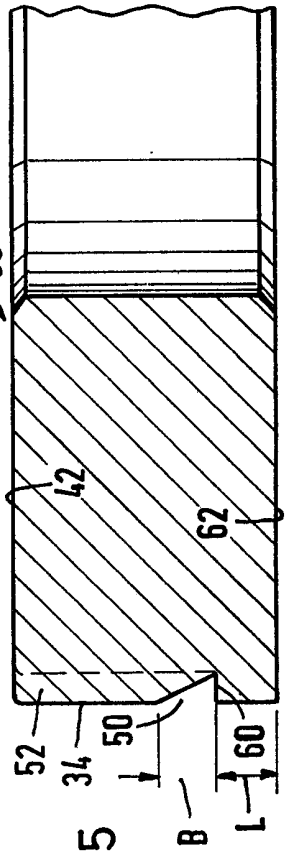


Fig. 5

SPECIFICATION

**Internal combustion engine having a split piston ring**

This invention relates to an internal combustion engine having a cylinder, a piston reciprocatable in the cylinder, a split piston ring on the piston formed in its running surface with a groove extending transversely of the piston ring axis, the groove communicating, by way of at least one duct extending transversely of the peripheral direction, with the piston ring side near the cylinder head, and the surface of the cylinder past which the piston runs being formed with lubricating openings.

Internal combustion engines having rings of the kind described are known; for instance, the 8th edition of the Koppers Company, Inc., "Engineer's Handbook of Piston Rings, Seal Rings, Mechanical Shaft Seals" discloses on page 55 a piston ring formed with a peripheral groove which extends perpendicularly to the piston ring axis and which is associated with ducts extending parallel to such axis.

However, a disadvantage of such a ring is that oil distribution along the groove is not particularly satisfactory since the gas flow has to make a kinetically unsatisfactory right-angled deflection at its entry into the peripheral groove, so that much of the kinetic energy of the gas flow is lost. The results are unsatisfactory peripheral distribution and unsatisfactory scavenging of the peripheral groove, so that combustion residues accumulate therein and it soon becomes clogged. Another disadvantage is that it is impossible with this construction of piston ring to determine its position relatively to the piston in the peripheral direction or to detect piston wear.

It is the object of the invention to provide an internal combustion engine of the construction specified in which the oil distribution peripherally of the piston ring is improved, with resultant improved running properties, and in which piston ring position and wear can be determined.

According to the present invention, therefore, an internal combustion engine has a piston, a cylinder in which the piston is reciprocatable, lubricating openings formed in the surface of the cylinder past which the piston runs, and a split piston ring on the piston, the piston ring being formed in its outer cylindrical surface with a groove which extends as a continuous helix around the periphery of the piston ring, the groove communicating, by way of at least one duct extending in a direction which has at least a component transverse to the peripheral direction, with the piston ring side near the cylinder head.

Consequently, as the piston ring passes over the lubricating openings, the gas pressure produces a flow of oil peripherally and axially of the helical groove in the piston ring, thus ensuring not only satisfactory peripheral oil distribution but also thorough scavenging of the piston-ring groove to remove abraded material and combustion residues.

Also, the helical groove is a means of determining piston ring position and wear in the manner disclosed by German Patent Specification DE-PS-2 517 751. However, the groove described therein is filled with a non-magnetizable solid substance and is therefore of no use for lubricating purposes.

Very advantageously, the duct communicating with the groove can extend diagonally of the peripheral direction. This enables the oil flow in the groove to be accelerated substantially by means of the gas flow operative in the flow direction, with the additional production of a whirling effect which considerably improves distribution of the oil in a particular peripheral direction at a predetermined direction of inclination.

The groove can have a cross-section of a width which decreases with increasing distance from the running surface of the piston ring. This simple feature makes it possible to determine wear of the piston ring running surface quickly and easily.

The groove cross-section can be triangular. This imparts to the groove a very advantageous oil storage capacity.

The bottom groove flank can extend perpendicularly to the running surface of the piston ring. This simplifies the determination of the axial position and the rotational position of the piston ring.

Preferably, the lubricating openings are afforded by the open ends of lubricant bores. This greatly simplifies the supply of lubricating oil to the cylinder. However, the openings may take other forms such as grooves or blind pockets.

The invention may be carried into practice in various way but one internal combustion engine embodying the invention and two piston rings from the engine will now be described by way of example with reference to the accompanying drawings, in which:

Figure 1 is a longitudinal section through the cylinder of an internal combustion engine, with a piston having piston rings disposed in the cylinder;

Figure 2 is a view to an enlarged scale of a part of one of the rings shown in Figure 1, the view being from the front as considered in the plane of the piston ring;

Figure 3 is a plan view corresponding to Figure 2;

Figure 4 shows a portion of another of the piston rings of the engine, in this case a gas-tight piston ring, the view being similar to Figure 2; and

Figure 5 is a section on the line V—V of Figure 4.

Figure 1 shows a cylinder liner 10 of a two-stroke diesel engine, for instance, for marine use. The liner has inlet ports 12 and exhaust ports 14 and is formed on its inner surface 16 with lubricating openings afforded by lubricant bores 20 which are supplied with lubricating oil. A piston 22 which reciprocates in the liner 10 has a top part 24 receiving in piston ring grooves conventional piston rings 26 and piston rings 28, 30 formed with peripheral helical grooves. The top

part 24 merges into a bottom part 32 having a substantially cylindrical external surface of an outer diameter less than the outer diameter of the top part 24. The piston 22 is secured to one end of a piston rod which is not shown and whose other end is pivotally connected to a cross-head (not shown).

The piston ring 28 (Figures 2, 3) has a running surface 34 adapted to engage with the cylinder liner wall 16 and, as latch, a slit 38 which provides resilience and enables the surface 34 to be pressed on to the cylinder wall 16.

The piston ring 28 is formed with a groove 36 extending as a continuous helical groove around the piston ring periphery and has ducts 40 which extend at an inclination to the peripheral direction, open into the groove 36 and extend at an angle $\alpha$ to the top end face 42 of the ring or its peripheral direction; conveniently, the angle $\alpha$ is more than approximately 30° but less than 90°.

Referring to Figures 4 and 5, a gas-tight piston ring 30 has as latch 44 tabs or fingers 46, 48 which engage with one another at the ring ends, in the manner known, for instance, from Swiss Patent specification CH-A-482 954. In this case the helical groove 15 terminates before the latch 44 and ducts 52 which extend perpendicularly to the top end face 42 — i.e., to the peripheral direction — open into the helical groove 50.

As an example of how the engine operates, it will be assumed that the gas pressure is moving the piston 22 from its top dead centre position towards the crankshaft; Figure 4 shows the situation when a diagrammatically illustrated lubrication bore 20 is registering with the groove 50. Gas flows through the duct 52 and groove 50 in the direction indicated by an arrow 54; gas flows past the lubricating bore 20 in the direction indicated by arrow 56 and accelerates the flow of lubricating oil through the groove 50. The gas flow also scavenges or cleans the peripheral groove as indicated by an arrow 58; the ducts 40, 52 also serve in association with the respective grooves 36, 50 for pressure equalization.

As will be apparent from Figure 5, the bottom flank 60 of the groove 50 extends perpendicularly to the running surface 34 of the piston ring 30. The distance L to the bottom end face 62 of the piston ring indicates the position of the point of measurement around the periphery of the piston ring 22 and hence the rotational position of the piston ring relative to the piston 20. Measurement of the width B is a means of determining the wear of the surface 34.

The ducts 40, 52 can of course be at least to some extent bores.

## CLAIMS

1. An internal combustion engine having a piston, a cylinder in which the piston is reciprocatable, lubricating openings formed in the surface of the cylinder past which the piston runs, and a split piston ring on the piston, the piston ring being formed in its outer cylindrical surface with a groove which extends as a continuous helix around the periphery of the piston ring, the groove communicating, by way of at least one duct extending in a direction which has at least a component transverse to the peripheral direction, with the piston ring side near the cylinder head.

2. An engine as claimed in Claim 1 in which the duct communicating with the groove extends in a direction which is inclined to the peripheral direction.

3. An engine as claimed in Claim 1 or Claim 2 in which the groove has a cross-section of a width which decreases with increasing distance from the running surface of the piston ring.

4. An engine as claimed in Claim 3 in which the groove cross-section is triangular.

5. An engine as claimed in any of the preceding claims in which the bottom groove flank extends perpendicularly to the running surface of the piston ring.

6. An engine as claimed in any of the preceding claims in which the lubricating openings are afforded by the open ends of lubricant bores.

7. An internal combustion engine substantially as described herein with reference to Figure 1 and having a piston ring substantially as described herein with reference to Figures 2, 3 and 5 and/or a piston ring substantially as described herein with reference to Figures 4 and 5 of the accompanying drawings.

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