

(12) **EUROPEAN PATENT APPLICATION**

(21) Application number: **87301382.5**

(51) Int. Cl.³: **F 02 F 7/00**

(22) Date of filing: **18.02.87**

(30) Priority: **15.03.86 GB 8606449**

(43) Date of publication of application:
07.10.87 Bulletin 87/41

(84) Designated Contracting States:
DE FR GB IT

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(54) **Internal combustion engine.**

(57) An internal combustion engine has long steel tensile members which secure the cylinder head and are also secured to a retaining member (4) for the crankshaft bearing (12), so that pressure pulsations in the cylinders on the ignition strokes are reacted by the tensile members (16, 17) allowing the use of light low-tensile materials for the block and crankcase.

The tensile members extend along passageways (18, 19) which extend through the block and communicate with the valve gear region of the head and the crankcase region, via apertures (20, 21). The passageways allow crankcase ventilation and, in a suitable orientation, oil return from the head.

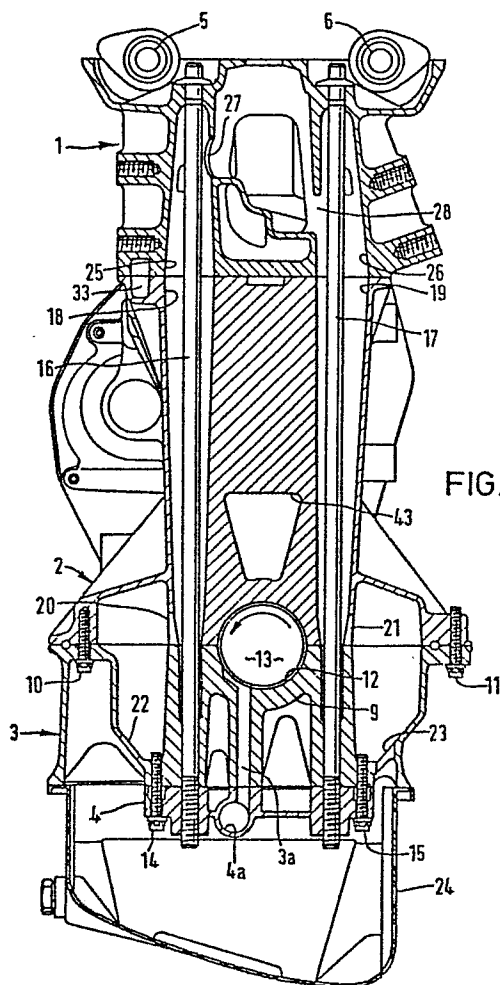


FIG. 1

INTERNAL COMBUSTION ENGINE

This invention relates to internal combustion engines.

In the interests of being able to use light low-tensile material for the engine block, it is known to use tensile members such as steel bolts extending from the cylinder head to the crankshaft bearing housing (the Applicants UK Patent Specification No. 2150635) to react the pressure pulsations produced between the head and crankshaft on the ignition strokes.

The invention provides an internal combustion engine having tensile members for securing the cylinder head to the cylinder block, the tensile members extending to and being secured to retaining means for the crankshaft bearings, and having passageways extending through the block surrounding each tensile member, the passageways communicating both with the valve gear region of the cylinder head and with the crankcase region of the engine.

The passageways permit crankcase ventilation and, in a suitable engine orientation, permit lubricating oil to return from the valve gear cover to the sump.

Advantageously, the diameter of the passageways at the head/block interface is at least twice the diameter of the tensile members: the reduced contact area between the head and the block increases the pressure at the interface and hence the sealing ability between the head and the block. Preferably, each passageway is surrounded at the head/block interface by a wall which extends around a part of the periphery of a cylinder. Preferably, the walls of passageways between cylinders extend around part of the periphery of each cylinder.

A four cylinder in-line spark-ignition internal combustion engine will now be described by way of example with reference to the accompanying drawings, in which:

Figure 1 is a section through the engine taken at right angles to the crankshaft axis and between a pair of cylinders;

Figure 2 shows a plan view of the cylinder block seen from the block/head interface; and

Figure 3 shows a plan view of the head seen from the block/head interface.

Referring to the drawings the engine comprises a cylinder head indicated generally by the reference numeral 1, a block formed integrally with the upper part of the crankcase indicated generally by the reference numeral 2, the lower part of the

crankcase indicated generally by the reference numeral 3, and a retaining member 4. Valve gear (not shown) operated by twin overhead camshafts 5 and 6 is provided. A valve gear cover (not shown) is provided. The block is designed to receive wet cylinder liners (not shown).

The head and sections 2, 3, 4 of the engine are made of aluminium. The lower part of the crankcase 3 is formed integrally with the main bearing caps 9 and is secured to the upper parts by bolts 10 and 11. The two parts of the crankcase are split about a plane perpendicular to the cylinder axes and passing through the centre of the crankshaft. The bearing caps house the usual bearing bushes 12 forming the main bearing for the crankshaft 13. The retaining member 4 is secured to the lower part of the crankcase 3 by means of bolts 14, 15. The heads of tensile members in the form of steel bolts 16, 17 attach the cylinder head 1 to the block 2, and the other end of the tensile members are in threaded engagement with the retaining member 4.

Pressure pulsations on the combustion stroke, which tends to force the head 1 and crankshaft 13 apart, are reacted by the tensile members 16, 17, and the stresses do not pass through the wall of the block or crankcase, permitting the use of light low tensile materials such as aluminium for these parts.

The integral block and upper part of the crankcase 2 has a passageway 18, 19 surrounding each tensile member 16, 17. The passageways are tapered to facilitate their manufacture and, at the block/head interface are wide. At the lower end, slots 20, 21 connect the passageways with the crankcase region beneath the cylinders (not shown) and (via slots 22, 23) above the sump 24.

At the upper end, the passageways 18, 19 connect with corresponding tapered passageways 25, 26 in the head. Via openings 27, 28, these passageways communicate with the valve gear region of the head.

Thus, the passageways 18, 19 each provide for crankcase ventilation of the volume beneath the pistons (which can be forced ventilation using the induction tract depression) from the crankcase to the valve gear region of the head, and also for the return of lubricating oil from the valve gear cover to the sump 24. Additional drain and breathing passages are also provided at one end of the cylinder block.

The passageways 18, 19 are defined at the head/block interface by walls 29, 30 which engage with corresponding walls 31, 32 in the head surrounding the passageways 25, 26. Two sections out of the five sections of each of the walls 29, 30, 31, 32 extend

around the top of the cylinder itself. The diameter of the passageways 18, 19, 25, 26 at the head/block interface is at least twice the diameter of the tensile members 16, 17. Thus, not only is the pressure on the interfacing head/block surfaces increased because the passageways are so wide, but the contact areas are concentrated around the region at which sealing is important i.e. the periphery of the combustion chamber. A large cooling channel 33 runs along one side of the block. Water is fed into the channel 33 from the left hand end as seen in Figure 2 and flows (a) down the block through passages 34a, 35a, 36a, 37a, around the respective cylinder liners and up through the passages 34b, 35b, 36b, 37b and (b) through breaks in the head/block gasket 38, up through passages 39a, 40a, 41a, 42a in the head and down through passages 39b, 40a, 41b, 42b. The contact areas between the head and the block are reduced because of the large area of the passageways, assisting the proper sealing of the block and head.

Compared to the usual cylinder head attachment by means of bolts secured to bosses on the block, the arrangement of the invention does not rely on shear forces from the boss through the adjoining material for transmitting the load to the cylinder periphery. Because of the use of the tensile members secured to the retaining member, the block and head are compressively loaded, and the forces are fed along the walls of the tapered passageways to the cylinder peripheries.

The main bearings are lubricated by oil fed along gallery 4a and a series of drillings 3a. The gallery 4a is supplied by a drilling into the gallery from the oil filter (not shown).

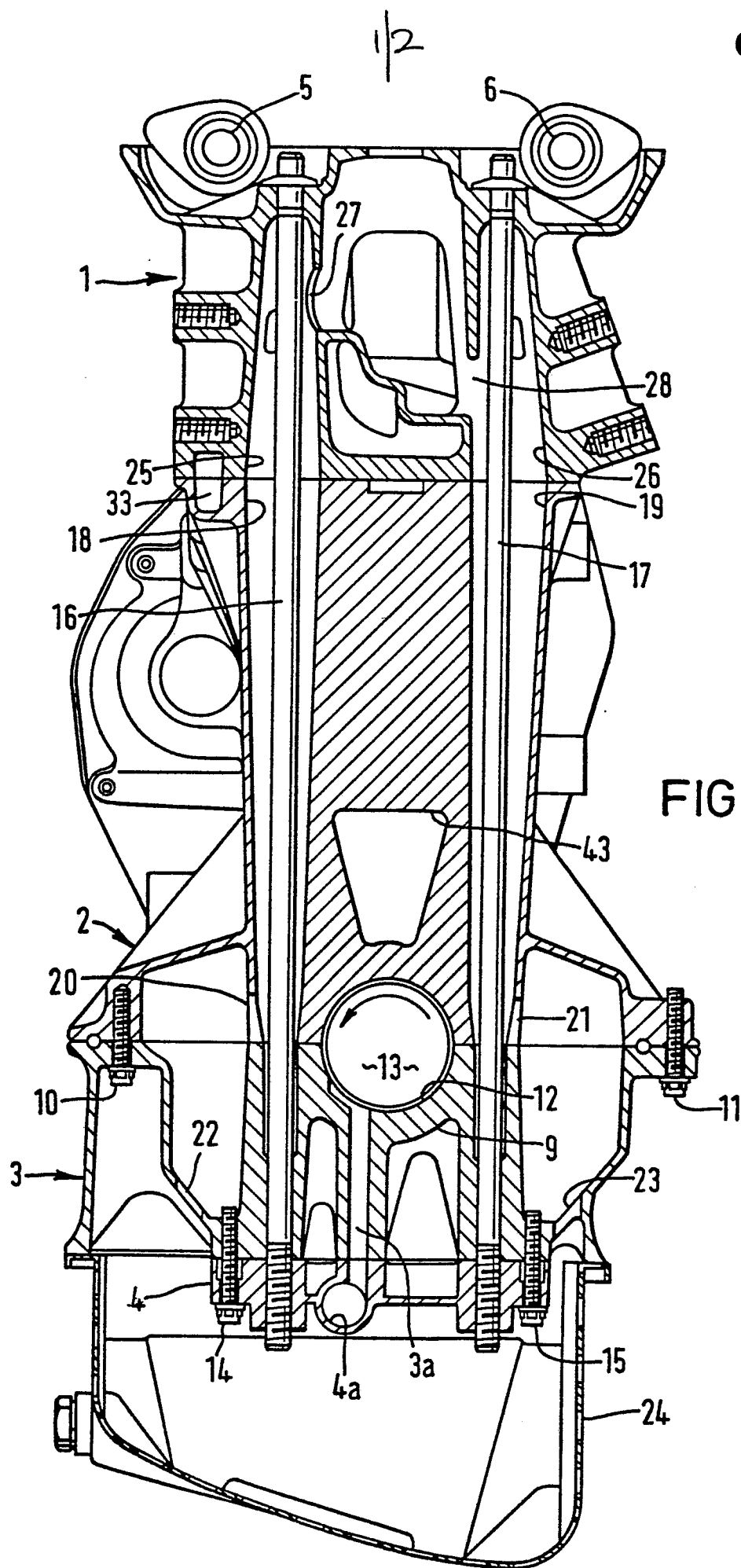
The part 1, 2, 3, 4 are all designed to be die cast, and the tapering of the passageways 18, 19 and 25, 26 assists in this regard. Apertures 43, which connect the spaces under the piston to relieve the internal pumping pressure to reduce pumping losses, may be produced using sliders. Parts 2, 3, 4 may be high pressure die cast, gravity die cast, or cast using low pressure sand casting. Part 1 may be gravity die cast or low pressure sand cast. Nevertheless, the parts could be cast in the conventional way using sand cores if desired or in any other suitable way. While parts 1 to 4 are described as being made of aluminium, the parts could be made of other materials and parts 2 - 4 in particular could be made of polymer. The threaded portions in the member 4 may if desired be formed by inserts in the member 4 to provide greater strength at the threads. The invention is applicable to other numbers of in-line cylinders apart from four, and is also applicable to opposed-piston configurations, V-configurations and to diesel engines. Obviously, in other engine configurations or orientations from that described, the oil might not necessarily drain down each passageway 18, 19 eg. in a slant in-line engine configuration, oil will preferentially drain down one row of passageways rather than the other row.

CLAIMS

1. An internal combustion engine having tensile members for securing the cylinder head to the cylinder block, the tensile members extending to and being secured to retaining means for the crankshaft bearings, and having passageways extending through the block surrounding each tensile member, the passageways communicating both with the valve gear region of the cylinder head and with the crankcase region of the engine.
2. An internal combustion engine as claimed in claim 1, wherein the diameter of the passageways at the head/block interface is at least twice the diameter of the tensile members.
3. An internal combustion engine as claimed in claim 1 or 2, wherein each passageway is surrounded at the head/block interface by a wall which extends around a part of the periphery of a cylinder.
4. An internal combustion engine as claimed in claim 3 in which the wall for passageways lying between cylinders extends around a part of the periphery of each of those cylinders.

5. An internal combustion engine as claimed in claim 4, wherein the thickness of the walls is less than the diameter of the tensile members.
6. An internal combustion engine as claimed in any one of the preceding claims, wherein the head is provided with passageways surrounding each tensile member, the diameter of the passageways at the head/block interface being at least twice the diameter of the tensile members.
7. An internal combustion engine as claimed in claim 6, wherein the passageways in the head taper in a direction away from the head/block interface.
8. An internal combustion engine as claimed in any one of the preceding claims, wherein the passageways in the block taper in a direction from the head/block interface.
9. An internal combustion engine as claimed in any one of the preceding claims, wherein the retaining means comprises bearing caps for each crankshaft bearing and a retaining member which extends the length of the engine to which the tensile members are secured and which holds the bearing caps in position.

10. An internal combustion engine as claimed in claim 9, wherein the bearing caps are integrally formed as part of one member which extends the length of the engine.
11. An internal combustion engine as claimed in claim 9 or claim 10, wherein the retaining member includes an oil gallery for lubricating the main bearings.



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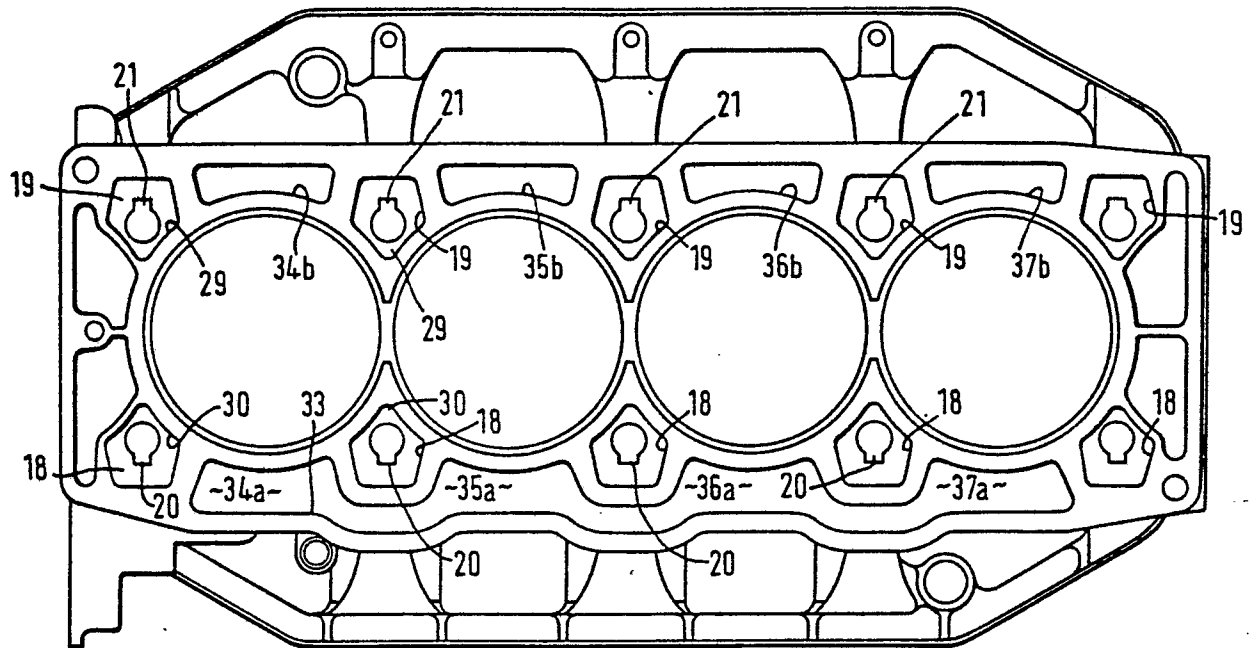


FIG. 2

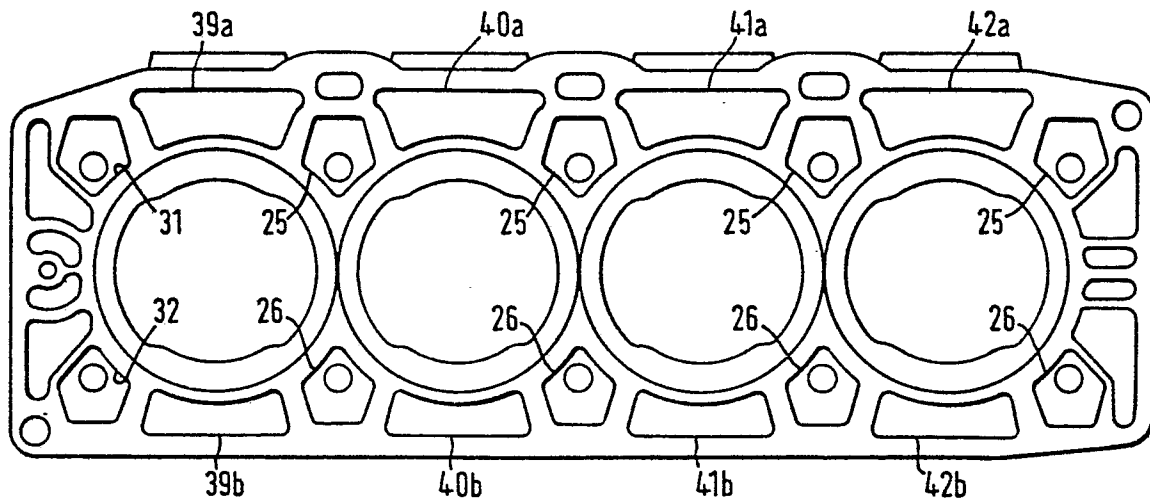


FIG. 3