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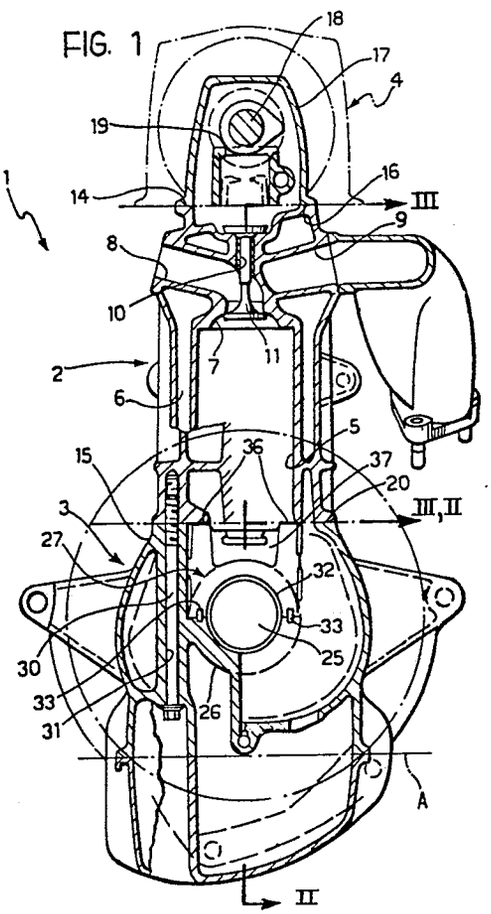
## (54) A multi-cylinder internal combustion engine, particularly for motor vehicles.

(57) A multi-cylinder internal combustion engine has a one-piece cylinder block (2) which incorporates the combustion chambers (7) of the cylinders (5), the intake and exhaust ducts (8,9) and seats (10) for the valves and the spark plugs, and is formed with two continuous integral flanges, in single upper plane and a single lower plane respectively (14,15), for the coupling of corresponding flanges (16,20) formed with a timing control assembly (4) and with an oil sump (3). The oil sump (3) is constituted by a structural body which is formed in one piece with the main bearings (26) of the crankshaft (25) of the engine, the main bearing caps (27) simply bearing thereon and being clamped by the block (2) by spacers (36) of calibrated thickness.

FIG. 1

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# A multi-cylinder internal combustion engine, particularly for motor vehicles

The present invention relates in general to multi-cylinder internal combustion engines, particularly for motor vehicles.

Almost all current multi-cylinder engines are constituted essentially by a cylinder head, a cylinder block in which the cylinders are formed, main bearing caps which clamp the driving shaft to main bearings associated with the cylinder block, and a sump which has the function of containing the oil. These components are fixed together by means of bolts with the interposition of gaskets or sealing material.

The intake and exhaust manifolds and the covers are also fixed to the block and to the head by means of bolts and gaskets.

The connections between the various components are achieved by means of flanges which are not always in one piece. The flange for attaching the oil sump normally carries "cradles" which give rise to oil leaks. The structural deterioration of the materials, due to ageing and to thermal stress, or the incomplete tightening of the bolts connecting the various components are the cause of defects and breakdowns.

The object of the present invention is to provide an engine with a novel architecture, which is formed so as to eliminate fluid leakages, to reduce components which are most subject to defects due to assembly anomalies or structural deterioration, and to rationalise the function of each component and minimise the use of nuts and bolts in order to produce a very strong and reliable unit.

According to the invention, this object is achieved by means of a multi-cylinder internal combustion engine including a cylinder block in which are formed the cylinders, an oil sump situated beneath the block, combustion chambers for the cylinders, intake and exhaust ducts, seats for valves and spark plugs, and a timing control assembly situated above the block, and a crankshaft supported for rotation by means of main bearings and main bearing caps, characterised in that:

- the cylinder block is a single piece which incorporates the combustion chambers, the ducts and the seats and, above the latter and substantially in correspondence with the lower ends of the cylinders, is formed with two continuous integral flanges, in a single upper plane and a single lower plane respectively, for the coupling of corresponding continuous integral flanges formed in single planes and integral with the timing control assembly and the oil sump respectively,
- the oil sump is constituted by a structural body for supporting the crankshaft, which is formed in one piece with the main bearings and is provided with tubular lateral pillars for housing bolts for fixing to the cylinder block,
- the main bearing caps simply bear on the main bearings and are clamped against the latter by the block through spacer means arranged between the main bearing caps and corresponding retaining feet of the block.

In addition to considerable structural simplification, this concept affords notable advantages in terms of the bending and torsional strength of the engine and of the reduction of its tendency to vibrate and of the leakage of fluids to the outside.

The spacer means conveniently comprise spacers of calibrated thickness which are interposed between the mutually facing surfaces of the main bearing caps and the retaining feet of the block and are held on the caps by means of resilient bridge members formed integrally with the spacers and provided with parts for engaging complementary fixing recesses in the caps.

To advantage, the main bearing caps have lateral projections which bear against complementary lateral shoulders of the lateral pillars of the sump.

Thus, as a result of the tightening of the fixing bolts between the sump and the block, the resilient deformation of the sump/block/caps/calibrated spacers system gives rise to axial and transverse forces which can ensure the stability of the caps during the stresses of use.

According to another advantageous characteristic of the invention, the sump has box-like front and rear walls provided with respective apertures for the drive from the driving shaft, the front one being formed with a flange which constitutes a seat for the oil pump and the rear one defining a seat for the rear seal of the driving shaft.

Further characteristic and advantages of the invention will become clear from the detailed description which follows with reference to the appended drawings, provided by way of non-limiting example, in which:

Figure 1 is a schematic vertical section of a multi-cylinder internal combustion engine according to the invention,

Figure 2 is a schematic longitudinal section taken on the line II-II of Figure 1,

Figure 3 is a longitudinal section taken on the line III-III of Figure 1,

Figure 4 shows a detail of Figure 1 on an enlarged scale,

Figure 5 is a section taken on the line V-V of Figure 4 on an enlarged scale, and

Figure 6 is a perspective view of a detail indicated by the arrow VI of Figure 4.

With reference initially to Figure 1, a four-cylinder internal combustion engine for a motor car is generally indicated 1.

The engine 1 is composed essentially of three elements: a cylinder block 2, a sump structure 3 fitted beneath the block 2, and a timing control assembly 4 fitted above the block 2.

As shown in greater detail in Figure 3, the block 2 is constituted by a single piece defining the four cylinders 5, a chamber 6 for the circulation of the coolant liquid for the engine 1, as well as all the parts which are formed in the cylinder head in conventional engines, that is, the combustion chambers 7 of the cylinders 5, their intake ducts 8 and exhaust ducts 9, the seats 10 for the inlet and exhaust valves 11 and their springs, and the seats for any spark plugs (not illustrated). The chamber 6 for the coolant of the engine, which is wholly included in the one-piece casting of the block 2, communicates with the outside on one side through a seat, not shown, for the pump for the liquid and on the other side through a lateral connector 12, which is also integral with the block 2 and acts as the casing for a thermostat 13 for regulating the temperature of the coolant liquid.

The engine block 2 is formed with two continuous integral flanges, an upper flange 14 and a lower flange 15, each in a single plane.

The upper flange 14 is coupled to a corresponding continuous flange 16 formed in a single plane and integral with the timing control assembly 4, which is constituted essentially by a body 17 containing the camshaft 18 and the tappets, schematically indicated 19.

The lower flange 15 is situated substantially at the level of the lower ends of the cylinders 5 and is coupled to a corresponding continuous flange formed in a single plane 20 and integral with the sump structure 3. As shown in Figures 1 and 2, the sump 3 is box-like on three sides and on its front and rear faces. These faces define two coaxial holes 21, 22 in correspondence with which an annular flange 23 for the attachment of the oil pump (not shown) and an annular seat 24 for the rear seal of the driving shaft 25 are formed, respectively. The driving shaft 25 (which is inserted from above during assembly) is supported by the sump structure 3 by means of main bearings 26 which are integral therewith, and main bearing caps 27 which bear on the sump 3 and are clamped against it by the block 2 in the manner made clear below.

Four pistons 29 are sealingly slidable in the respective cylinders 5 and are connected to the crankshaft 25 in conventional manner, by means of connecting rods 28.

The sump 3 is connected to the block 2 by means of axial bolts 30 (Figures 1 and 4) inserted in tubular pillars 31 formed integrally with the sump 3 beside the main bearing caps 26. The sump 3/block 2 assembly thus forms an egg-shaped chamber which has very high bending and torsional strength and is insensitive to vibrations.

As well as fulfilling the function of a support for the driving shaft 25, the sump 3 also acts as a reservoir for the lubricating oil and contains all the ducts which take the oil to the pump and thence to the filter and the crankshaft bearings, indicated 32. Alternatively, the function of the reservoir for the lubricating oil may be carried out by a lower sump bolted to the sump structure, with continuous integral flanges lying in a single plane for the coupling of the sump and the lower sump. The plane is, for example, the one identified by the line A in Figure 1.

With reference now in greater detail to Figures 4 to 6, each main bearing cap 27 simply bears on the respective main bearing 26 and is aligned therewith by means of centring pins 33. Each main bearing cap has at least two separate appendages 34 which face the block 2 and are situated opposite corresponding feet 35 thereof. Spacers 36 of calibrated thickness are interposed between the mutually facing surfaces of the appendages 34 and the corresponding feet 35. As shown in detail in Figures 5 and 6, the two spacers 36 associated with each main bearing cap 27 are formed integrally with a resilient plate-shaped bridge member 37 provided with side parts 38 for engaging complementary fixing recesses 39 in the main bearing cap 27. Thus, during the assembly of the engine 1, the spacers 36 are fitted onto the main bearing caps 27 beforehand and are held firmly thereon during the connection of the block 2 to the sump 3 and the tightening of the bolts 30. Under the action of the latter, the resilient deformation of the sump 3/block 2/main bearing caps 27/calibrated spacers 36 system ensures the axial loading for clamping the caps 27 between the feet 35 and the main bearings 26. Returning again to Figure 4, it can be seen that lateral projections 40 are formed on the opposite sides of each main bearing cap 27 and bear against complementary lateral shoulders 41 of the corresponding tubular pillars 31 of the sump 3. By virtue of this bearing, in addition to the axial loading, the resilient deformation of the sump/block/caps/calibrated-spacers system caused by the tightening of the bolts 30 also achieves lateral loading, ensuring the necessary transverse stability of the caps 27 during the stresses of use.

It is obvious from the above that, compared with conventional engines of the same type, the engine according to the invention achieves a considerable structural simplification as a result of the reduction of the number of components and the minimising of the use of nuts and bolts. Moreover, the elimination of parts and materials which are

subject to ageing enables the risks of liquid and gas leakages to be eliminated, leading to the production of an extremely strong and reliable unit.

## Claims

1. A multi-cylinder internal combustion engine including a cylinder block in which are formed the cylinders, an oil sump situated beneath the block, combustion chambers for the cylinders, intake and exhaust ducts, seats for valves and spark plugs, and a timing control assembly situated above the block, and a crankshaft supported for rotation by means of main bearings and main bearing caps, characterised in that:
- the cylinder block (2) is a single piece which incorporates the combustion chambers (7), the ducts (8, 9) and the seats (10) and, above the latter and substantially in correspondence with the lower ends of the cylinders (5), is formed with two continuous integral flanges (14, 15), in a single upper plane and a single lower plane respectively, for the coupling of corresponding continuous flanges (16, 20) formed in single planes and integral with the timing control assembly (4) and with the oil sump (3) respectively,
- the oil sump (3) is constituted by a structural body for supporting the crankshaft (25), which is formed in one piece with the main bearings (26) and is provided with tubular lateral pillars (31) for housing bolts (30) fixing to the cylinder block (2),
- the main bearing caps (27) simply bear on the main bearings (26) and are clamped against the latter by the block (2) through spacer means (36) arranged between the main bearing caps (27) and corresponding retaining feet (35) of the block (2).

2. An engine according to Claim 1, characterised in that the spacer means comprise spacers (36) of calibrated thickness which are interposed between the mutually facing surfaces of the main bearing caps (27) and the retaining feet (35) of the cylinder block (2) and are held on the main bearing caps (27) by means of resilient bridge members (37) formed integrally with the spacers (36) and provided with parts (38) for engaging complementary fixing recesses (39) in the main bearing caps (27).

3. An engine according to Claim 1 or Claim 2, characterised in that the main bearing caps (27) have at least two separate lateral projections (40) which bear against complementary lateral shoulders (41) of the tubular pillars (31) of the sump (2).

4. An engine according to any one of the preceding claims, characterised in that the sump (3) has box-like front and rear walls provided with respective apertures (21, 22) for the insertion of the driving shaft (25), of which the front one is formed with a flange (23) constituting a seat for the oil pump and the rear one defines a seat (24) for the rear seal of the driving shaft (25).

5. An engine according to one or more of the preceding claims, characterised in that the cylinder block (2) is in one piece with a chamber (6) for the coolant liquid of the engine (1), the chamber (6) communicating with the outside through a connector (12) which is integral with the block (2) and acts as a body for a regulating thermostat (13).

6. An engine according to any one of the preceding claims, characterised in that a lower sump is fixed to the sump (3) and acts as a reservoir for the librating oil.

FIG. 1

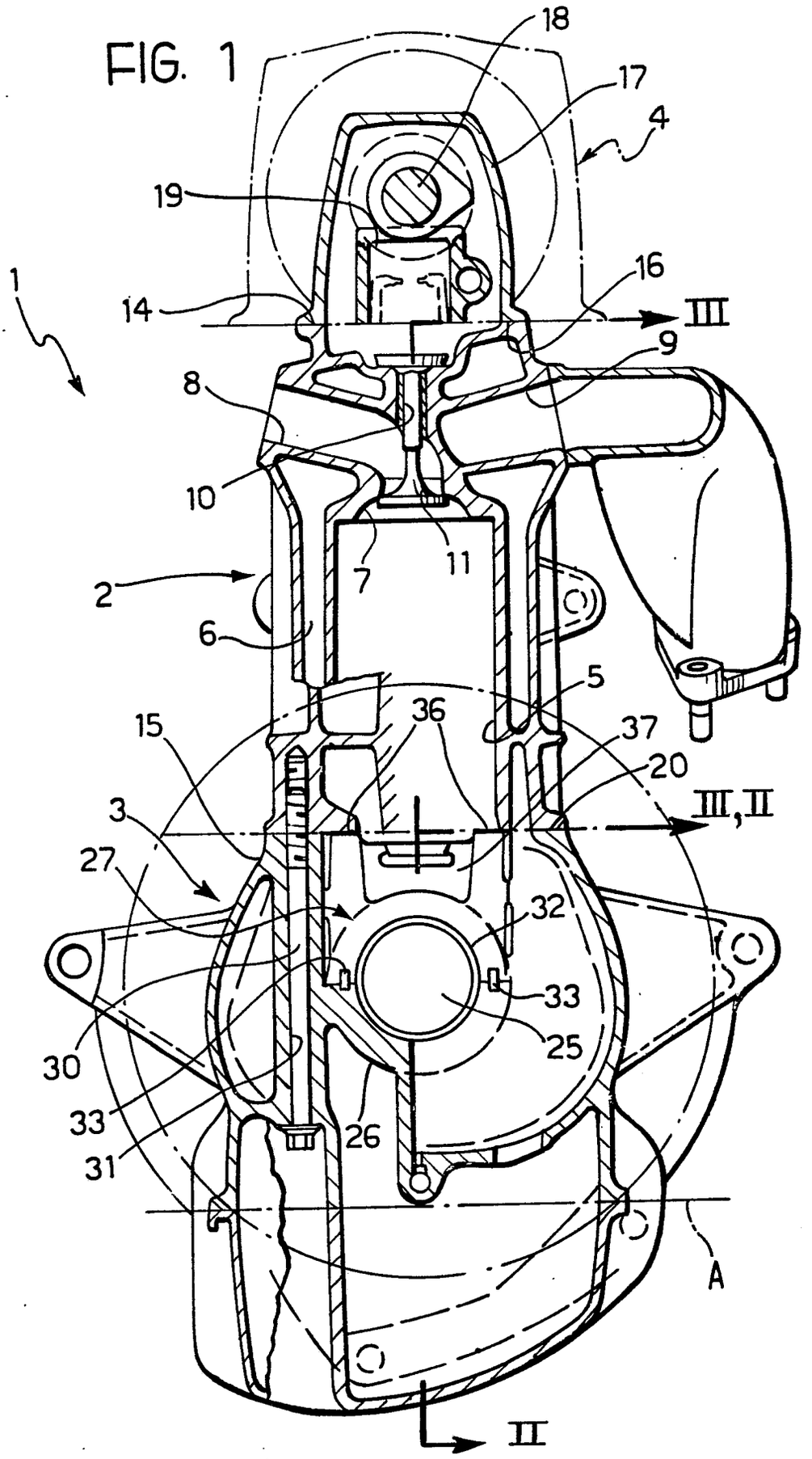
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FIG. 2

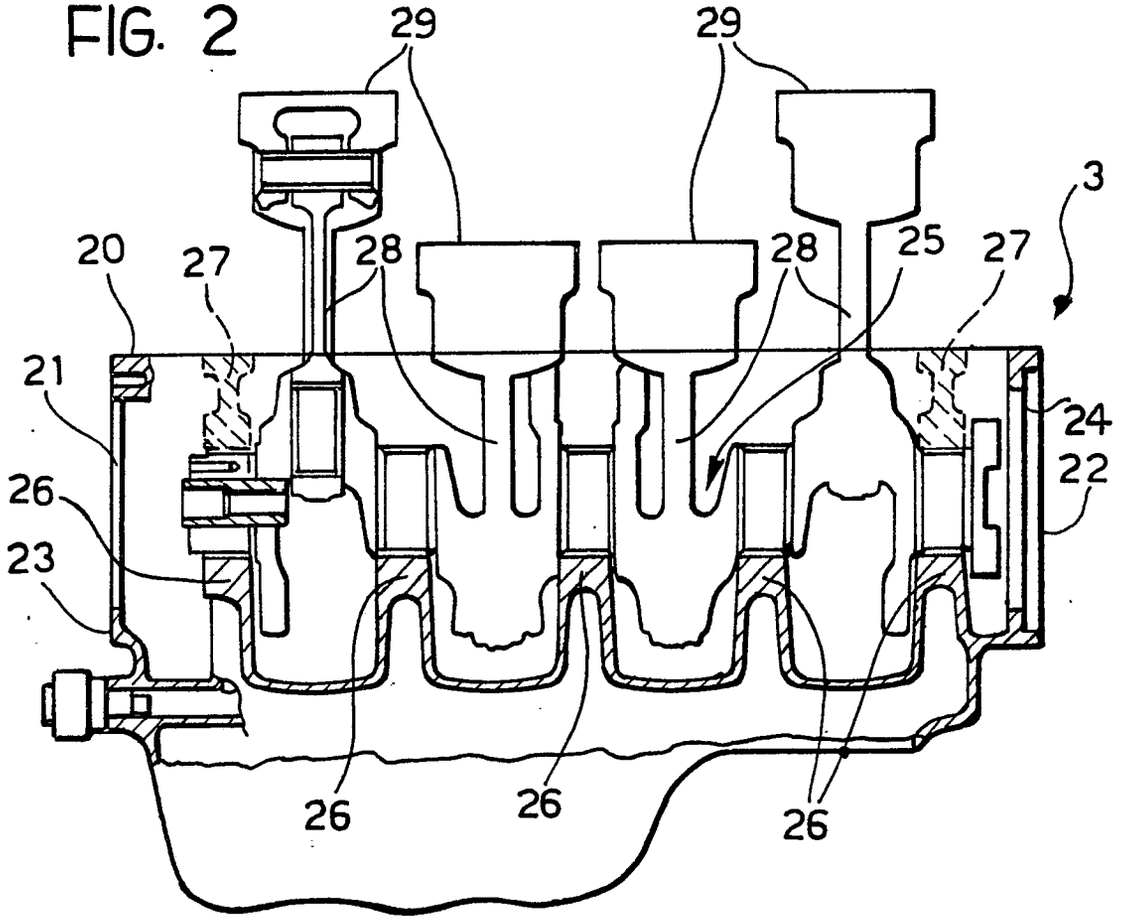
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FIG. 3

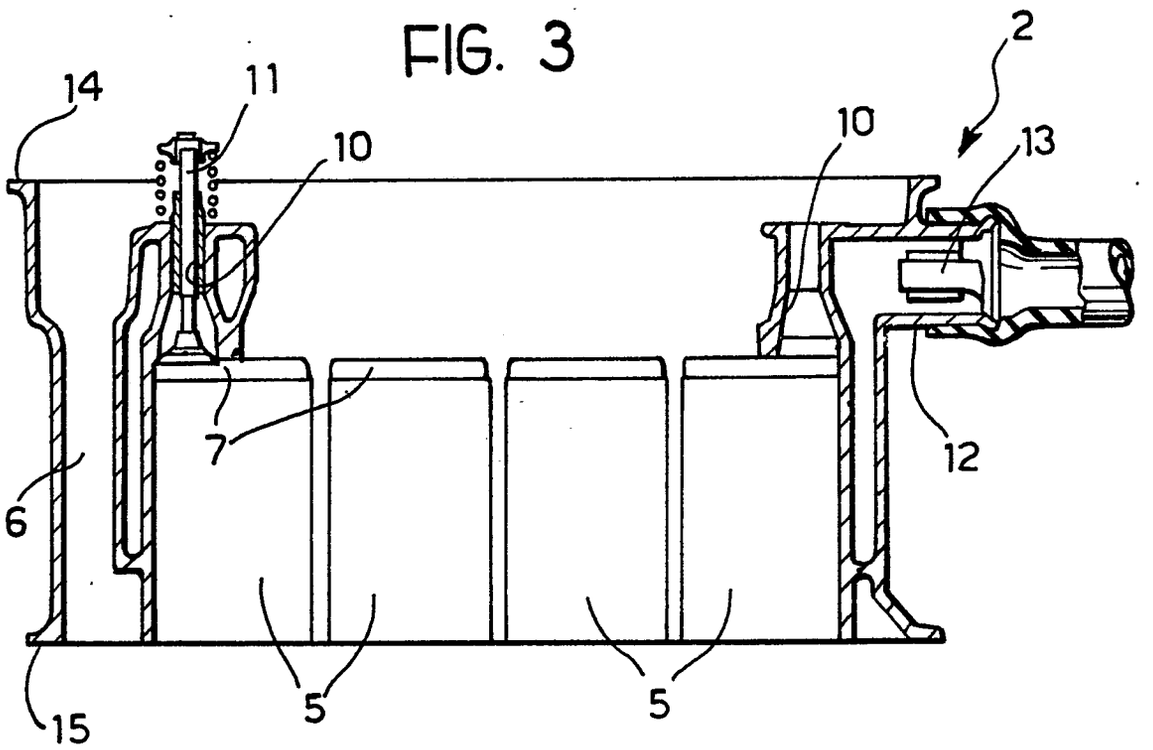
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FIG. 4

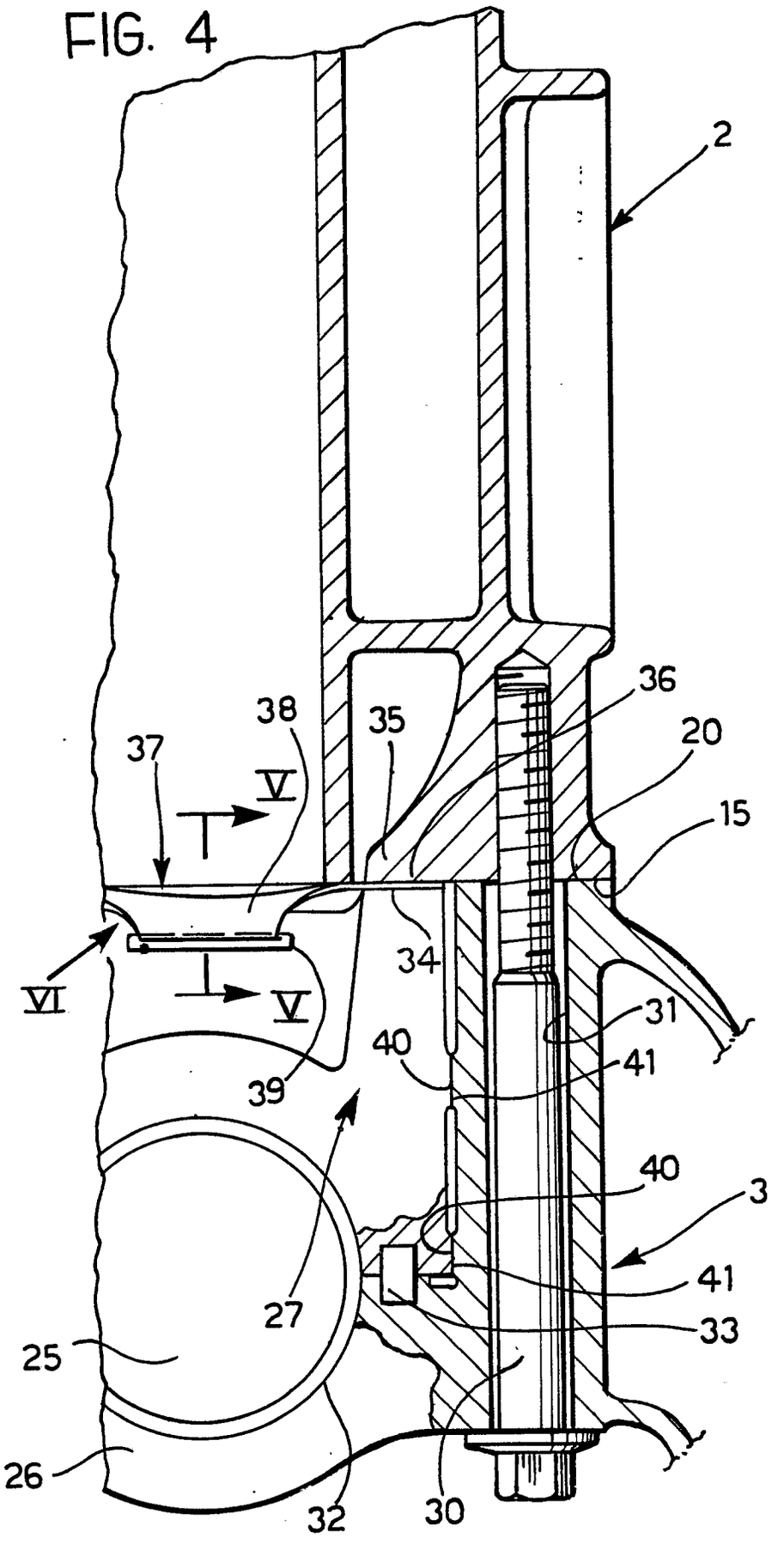


FIG. 5

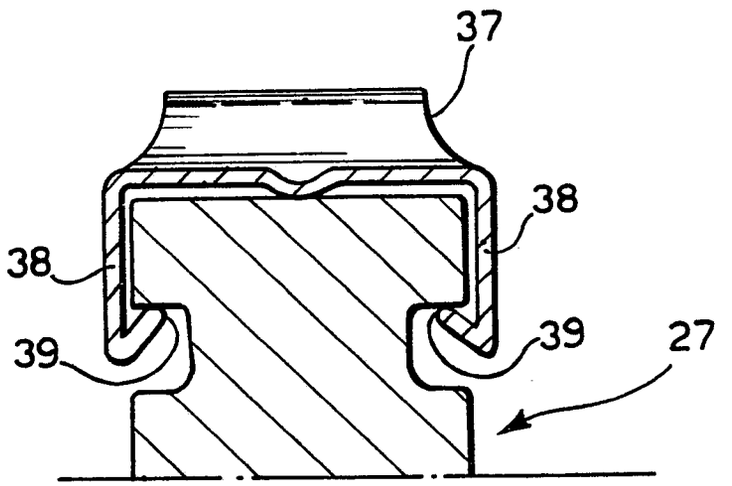
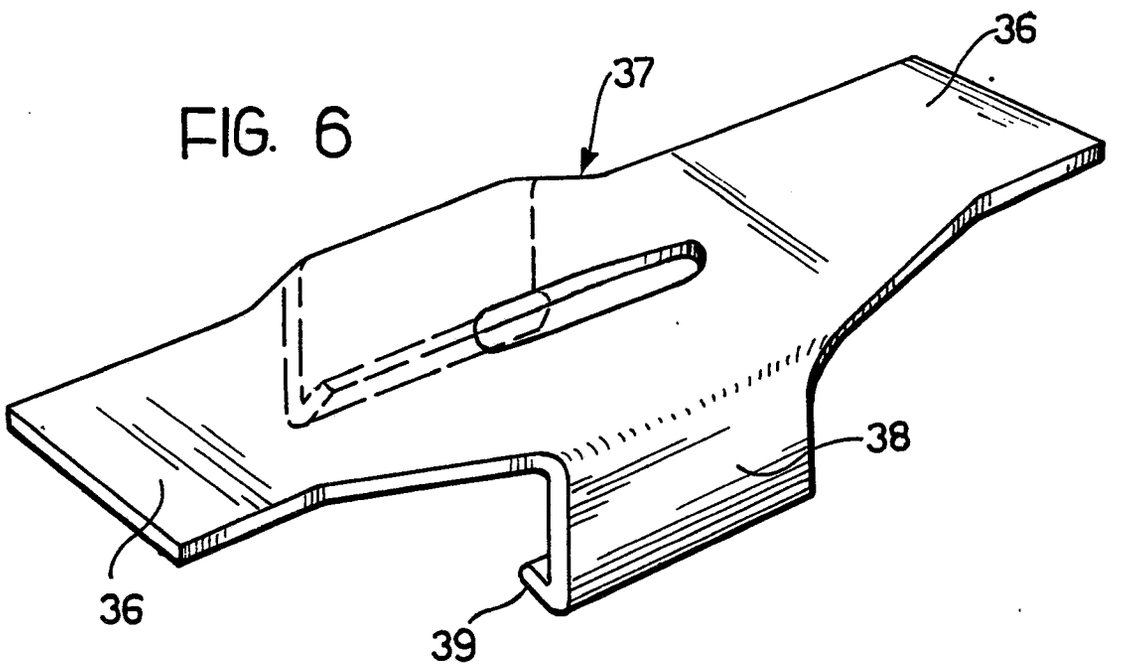



FIG. 6



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# EUROPEAN SEARCH REPORT

Application Number

EP 89 83 0550

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (Int. Cl.5 ) |
|---|---|---|---|
| Y | FR-A-862709 (MAN)<br>* page 2, line 20 - page 2, line 52; figure 1 * | 1 | F02F1/00<br>F02F7/00 |
| A | | 4, 5, 6 | |
| Y | DE-A-3801715 (MAZDA)<br>* column 14, line 16 - column 16, line 59; figures 7, 8 * | 1 | |
| A | | 4 | |
| A | AT-B-376018 (LIST)<br>* page 3, line 33 - page 3, line 53; figure 1 * | 1 | |
| A | GB-A-1040793 (BRITISH ALUMINIUM)<br>* page 2, line 114 - page 1, line 128; figure 1 * | 1 | |

| TECHNICAL FIELDS SEARCHED (Int. Cl.5 ) |
|---|
| F02F |

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| THE HAGUE | 21 FEBRUARY 1990 | WASSENAAR G. |

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