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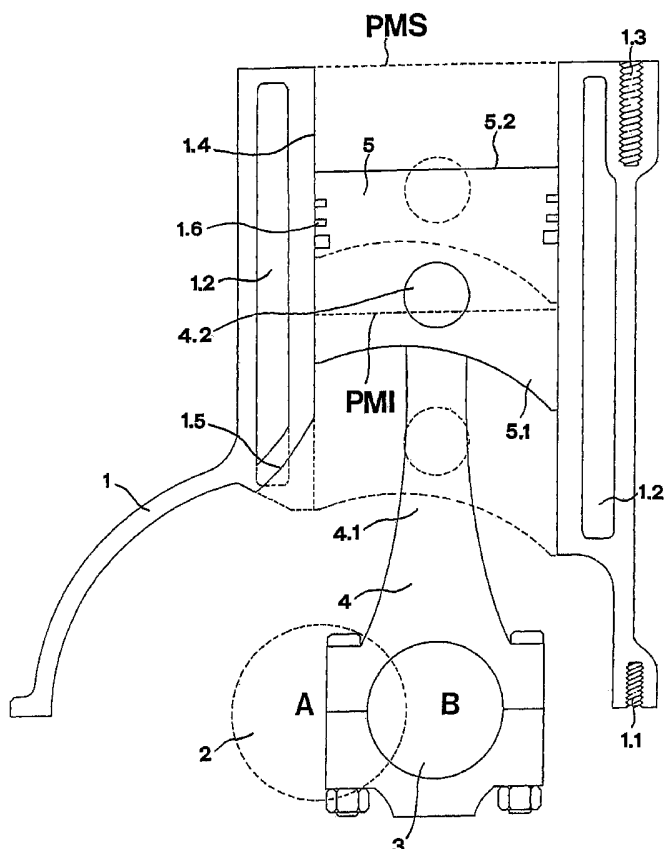
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(54) Title: INTERNAL COMBUSTION ENGINE WITH THE TRAVEL LINES OF THE PISTONS OUTSIDE OF THE RADIAL AXLE



(57) Abstract: The engine has the upper part of the engine block (1) shifted in comparison with traditional engines by a value given by the amplitude of the segment A-B, where A is the centre of journal pin (2) of the crankshaft and B the centre of the crank pin (3); the engine block (1) has notches (1.5) in the lower margin of the liners (1.4) within which the elongated bodies (4.1) of the connecting rods (4) move; part of the sleeve (5.1) of the piston (5), is shortened whereas on the opposite side it is lengthened; the longitudinal axis of the connecting rod (4) forms a right angle with the crank (axis a-B) and is perpendicular to the crown (5.2) of the piston (5) since at this periodic point it is on the same travel axis as the piston (5) itself; from the crank pin (3.2) a shallow layer two eighths of the total perimeter in length is removed and in which a channel (3.21) is made.

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Internal combustion engine with the travel lines of the pistons outside the radial axle.

Field of application

5 This invention regards an internal combustion engine with a particular construction geometry.

State of the art

As known in the internal combustion engine the piston and the connecting rod are at a radial right angle to the crankshaft when the piston is at the upper dead point. The
10 rectilinear movement of the piston is transmitted to the pin at the small end of the connecting rod and transformed into a rotary movement by the large end of the connecting rod and by the crank pin of the crankshaft. The crank pins, via the crank arms, transmit the movement to the flywheel (power take-up).

Although this is a good configuration of the engine there is a certain degree of
15 waste.

Summary of the invention

This invention sets out to build an internal combustion engine using a new geometry which, as it is based on setting different angles, reduces energy being wasted by being scattered in different directions.

20 This goal, in addition to others, is attained in the engine in question, as is fully explained in the claims.

Although the engine block is similar to the traditional block it differs in two important features: the upper part of the block, which contains the liners, is shifted by a value given by the amplitude of the segment A-B, where A is the centre of the main
25 journal of the crankshaft and B the centre of the crank pin. In addition, notches are made in the lower margin of the liners, within which the elongated bodies of the connecting rods move during the downward stroke (compression and discharge phases).

The part of the piston sleeve situated in the liner is substantially shortened on the
30 side which touches the liner notch whereas the lower part of the piston sleeve on

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the opposite side is effectively lengthened and enlarged.

The longitudinal axis of the connecting rod forms a right angle with the crank or handle and is perpendicular to the crown of the piston. In this periodic point, during the combustion phase, all the components in movement are joined perpendicularly
5 or in line with the same axis (connecting rod and piston). The connecting rod forms an angle of 90° with the crank pin.

The axis of the piston stroke, perpendicular to the crank, can be shifted backwards towards lower goniometric angles if - during the compression and discharge phase -
10 friction between the part of the enlarged sleeve and the internal wall of the liner, as a result of the greater incidence of the angles seriously effects performance levels during the combustion phase.

Machining is carried out on the peripheral surface of the crank pin: in detail a layer, which is not very deep and two eighths of the total perimeter in length, is removed. A longitudinal channel, of the same thickness as the pin, is made along the lower
15 margin with respect to the rotary direction of this area of a reduced diameter.

The combustion engine thus conceived can also be used on "V" engines with double beds, radial engines, boxer engines and two stroke engines.

Brief description of the drawings

Further characteristics and advantages of the invention shall result primarily from
20 the description of a preferred but not necessarily sole form of embodiment of the present engine, which is illustrated for indicative and not restrictive purposes in the enclosed drawings, where:

- figure 1 shows a cross section of a liner and an engine block in accordance with the invention and a side view of the piston concerned together with the connecting
25 rod; the tolerance margins between the piston and the internal walls of the liner and the elastic segments usually lodged in the customary notches for this purpose have been omitted;

- figure 2 is an outline of the arrangement of the axis of the piston stroke on a plane parallel to the traditional radial plane; the distance between the two planes is given
30 by the amplitude of the A-B segment of the crank to which the above mentioned

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planes will be perpendicular (90°); the other goniometric angles (7° , 30° , 60°) indicate possible alternatives;

- figure 3 is an outline of the connecting rod and the crank pin of the connecting rod of the crankshaft in the position of upper dead point in a purely theoretical
5 hypothesis using a crank pin with a semi-circular section;

- figure 4 shows, during the combustion phase, the optimal periodic point of the same components as in figure 3 joined to the piston;

- figure 5 again outlines the same components as figures 3 and 4 at the lower dead point;

10 - figure 6 is a cross section, at the upper dead point, of a crank pin of the crankshaft whose peripheral surface has been machined in a particular form;

- figure 7 is a cross section of the same pin as figure 6 in the optimal periodic position;

- figure 8 is a cross section of the same pin as figures 6 and 7 at the lower dead
15 point.

Detailed description a preferred embodiment

In detail, and with reference to figure 1 in particular, the engine in question has an engine block 1 whose base is similar to the traditional base with seats 1.1 for the securing screws of the oil carter and main bearings for the pins of the crankshaft
20 located more or less centrally. Engine block 1 also comprises spaces 1.2 for the passage of cooling liquid and seats 1.3 threaded for the clamping of the head.

The upper part of engine block 1, which comprises liners 1.4, is shifted compared to traditional engines by a value given by the amplitude of the segment A-B comprised in the crank arms, where A is the centre of journal pin 2 of the crankshaft and B the
25 centre of the crank pin 3.

When engine block 1 is founded, notches 1.5 are made in the lower part of liners 1.4 inside which the elongated bodies 4.1 of the connecting rods 4 move during the downward stroke (compression and discharge). The part of sleeve 5.1 of piston 5 lodged in liner 1.4 is substantially shortened on the side which touches notch 1.5 of
30 liner 1.4. This notch 1.5 permits the movement of connecting rod 4 during the

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upward stroke in the alternative movement of piston 5. Part of sleeve 5.1 on the opposite side is, on the contrary, lengthened and effectively enlarged in its lower part in order to distribute over a larger surface the increased pressure caused, during the upward movement, by the greater incidence of the angle of the
5 connecting rod 4 compared to the stroke axis of piston 5 hence avoiding ovalization. Elongated body 4.1 of the connecting rod 4 is lengthened by several millimetres to attenuate the angles during the upward stroke of piston 5.

The bore and stroke in this example are approximately the same as those most frequently used in four cylinder 1,300 cc engines. The stroke of piston 5 is
10 comprised between the upper dead point UDP and the lower dead point LDP, and, since it is outside the radial axis, will no longer respect the formula "amplitude of the crank multiplied by two". As can be seen in figure 1 the longitudinal axis of connecting rod 4 forms a right angle with the crank (axes A-B) and is perpendicular to the crown 5.2 of piston 5 as, in this periodic point, it is on the same travel axis as
15 piston 5 itself. In this point, during the combustion phase, all the components in movement are joined perpendicularly or in line on the same axis, a configuration which is never found in radial engines.

Piston 5, as a result of combustion, transmits all the energy, via pin 4.2, to
20 connecting rod 4 which is on the same axis. Connecting rod 4 transfers, without wastage, the energy to crank pin 3 with which it forms an angle of 90° as it is perpendicular to the length of the crank itself. This ideal combination of components in movement occurs in the periodic moment in which the crown 5.2 of piston 5, as a result of the energy of the explosion, finds itself in the neighbourhood of the point in which the detonation reaches its maximum dynamics: when the last layer of the
25 explosive mass is detonated (explosive wave) and all the gasses are expanding. This ideal combination can take place within the margins of the maximum coupling of the revolutions of the engine, suitably regulating the ignition, volume and the form of the combustion chamber, modifying the boring of the cylinders and the stroke of the pistons. This new arrangement, designed to better direct forces in function of
30 the rotation of the crankshaft, might have some disadvantages in the discharge

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phase and especially in the compression phase given that the angles between connecting rod 4 and piston 5 during the upward stroke are not ideal.

Resistance to compression will increase as a result of the greater incidence of the angle between connecting rod 4 and piston 5 and between connecting rod 4 and the
5 crank of the crankshaft. There will also be greater friction between the enlarged part of the sleeve 5.1 of piston 5 and the internal wall of liner 1.4. Should these resistances cause vibrations or impact seriously on performance levels during the combustion phase it would be necessary to find an alternative. Accordingly, as indicated in figure 2, the axis of the stroke of piston 5, perpendicular to the crank, is
10 moved backwards towards lower goniometric angles; the angles of 60° and 30° indicate possible alternatives although they are not defined. The angle of 7° is in line with a logic which aims for an appreciable improvement during the combustion phase without effecting the compression phase: a substantial improvement in the combustion phase, and a negligible effect in the compression phase.

15 An engine with piston travel liners outside the radial axis thus described is in a critical situation in the initial combustion phase in the proximity of the upper dead point. The pressure of connecting rod 4 on crank pin 3, caused by the accentuated angle between connecting rod 4 and piston 5, is contrary to the direction of the rotation of crank pin 3 itself in the points indicated by arrows in figure 3.

20 To resolve this problem it is possible to remove the contact in these points using a pin 3.1 with a semi-circular section. This pin, which is illustrated in figures 3, 4 and 5, is functional in the initial part of the combustion phase, excellent in the point of maximum coupling (figure 4) and precarious at the lower dead point (figure 5). Before the lower dead point the discharge valves open and from that moment it is
25 no longer connecting rod 4 that pushes on pin 3.1 but it is pin 3.1 itself which pulls connecting rod 4 and piston 5.

However, the corners at the edges of the semi-circular section pin 3.1 would, in any case, cause a strong, anomalous friction on the bearing between the coupling connecting rod large end which, moreover, since it is not possible to make much
30 increase in either the diameter or the thickness of pin 3.1. it would be weakened too

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much.

Figures 6, 7 and 8 show the solution to these two problems. A crank pin 3.2 is used whose peripheral surface is machined to remove a shallow layer of a length of two eighths of the total perimeter. Channel 3.21, which is longitudinal to the pin, is made
5 along the upper edge with respect to the rotation of this area of lower diameter.

Figure 6 illustrates crank pin 3.2 in the position of upper dead point. Pin 3.2 is in close contact with connecting rod 4 for six eighths less half channel 3.21: two eighths plus half channel 3.21, thanks to the above-mentioned machining, no longer adhere to connecting rod 4. In the position shown in figure 6 pin 3.2 has sufficient
10 space to avoid contact with connecting rod 4 thus preventing opposing pressures.

Figure 7 shows pin 3.2 in optimal position and figure 8 shows, at the lower dead point, pin 3.2 with the drag surface of connecting rod 4 of two eighths compared to the critical situation shown in figure 5. The contact-drag surface of two eighths will be preserved during the rotation up to the upper dead point. Channel 3.21, besides
15 removing contact in a point where the pressure of connecting rod 4 is not really favourable, is useful as an outflow for lubricating oil in order to avoid even a minimum pressure of oil between the surfaces inhibited by pin 3.2 with connecting rod 4.

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CLAIMS

1 - Internal combustion engine with the travel lines of the pistons outside the radial axle, designed for use both on two stroke engines and on four stroke engines with pistons inline, "V" with double beds, radial engines or boxer engines, where each engine block (1) comprises the customary seats (1.1) for the securing screws of the oil carter, spaces for the passage of cooling liquid, threaded seats (1.3) for the clamping of the head and liners (1.4) within which the pistons (5) move; this engine is characterised by the fact that the upper part of the engine block (1), in which there are the liners (1.4) is shifted compared to traditional engines by a value given by the amplitude of the segment A-B where A is the centre of the journal pin (2) of the crankshaft and B the centre of the crank pin (3.2); this engine block (1) has notches (1.5) in the lower edge of the liners (1.4), within which the elongated bodies (4.1) of the connecting rod (4) moves during the downward stroke (compression and discharge phase); the elongated body (4.1) of the the connecting rod (4) is lengthened by several millimetres in order to alternate the angles in the upward stroke of the piston (5); the main bearings for the pins of the crankshaft are in approximately central position with respect to the transversal edges of the engine block (1); the part of the sleeve (5.1) of the piston (5) lodged in the liner (1.4) is substantially shortened on the side touching said notch (1.5) of the liner (1.4) whereas the lower part of the sleeve (5.1) of the piston (5) is lengthened and effectively enlarged on the opposite side; the longitudinal axis of the connecting rod (4) forms a right-angle with the crank (A-B axis) and is perpendicular to the crown (5.2) of the piston (5) as in this periodic point it is on the same axis of travel as the piston (5) itself; in this periodic point, in the combustion phase, all the components in movement are joined perpendicularly or in line on the same axis (connecting rod (4) and piston (5)); the crank pin (3.2) has its peripheral surface machined to remove a shallow layer and in length two eighths of the total perimeter and in which there is made a channel (3.21) longitudinal to the thickness of the pin itself; said crank pin (3.2) is in close contact with the connecting rod (4) for six eighths less half channel (3.21): two eighths plus half channel (3.21), thanks to the machining, no

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longer adhere to the connecting rod (4); this channel (3.21), besides removing contact in a point where the pressure of the connecting rod (4) is not especially favourable, is useful as an outflow for lubricating oil to avoid even minimum oil pressure between the inhibited surfaces of the pin (3.2) with the connecting rod (4).

- 5 2 - Internal combustion engine, in accordance with claim 1, characterised by the fact that the axis of the piston stroke (5), periodically perpendicular to the crank, can be shifted backwards towards lower goniometric angles if - during the compression and discharge phase - friction between the enlarged part of the sleeve (5.1) of the piston (5) and the internal part of the liner (1.4), due to the greater incidence of angle
- 10 between the connecting rod (4) and the piston (5) and between the connecting rod (4) and the crank of the crankshaft, seriously effects performance levels during the combustion phase.

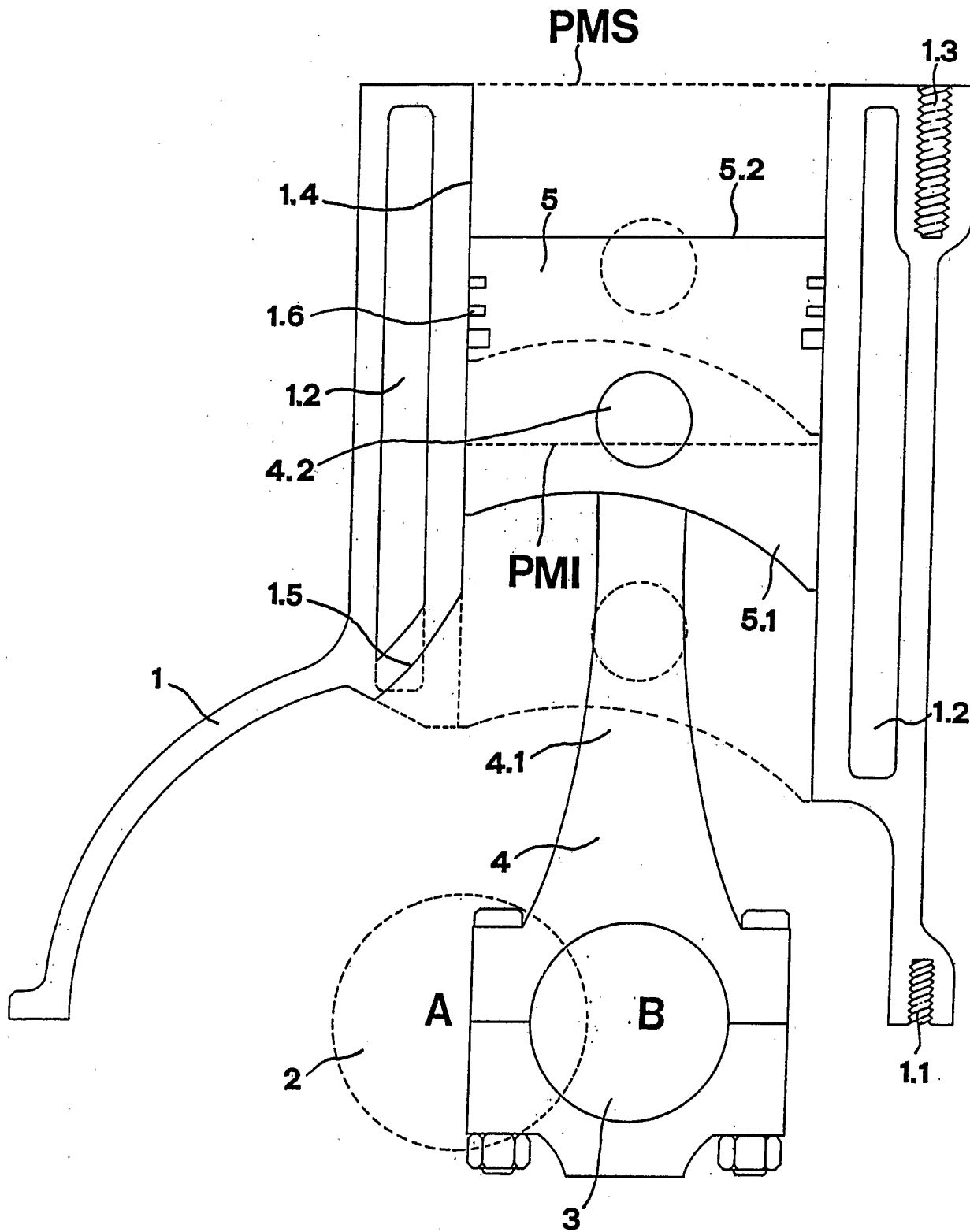


FIG. 1

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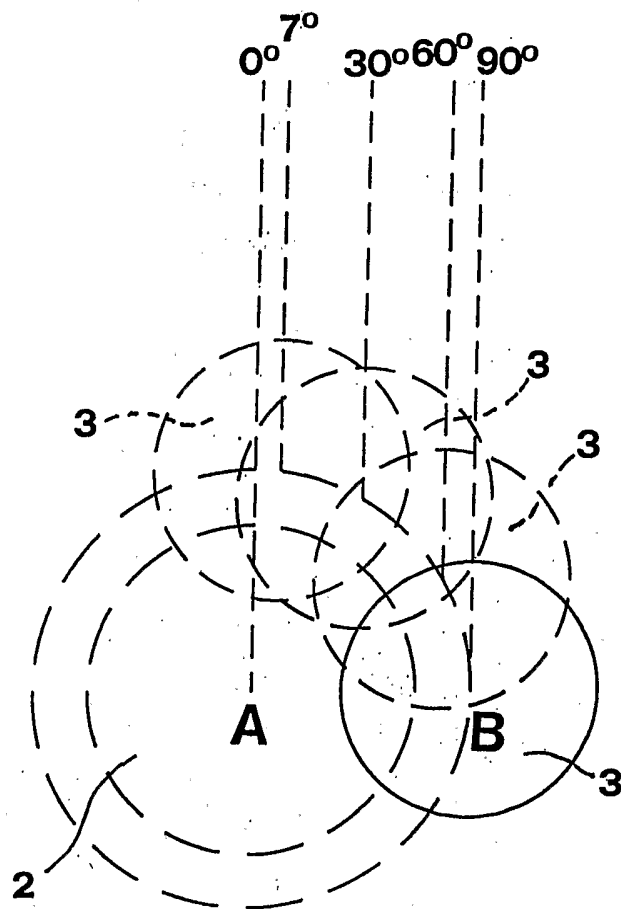


FIG. 2

FIG.3

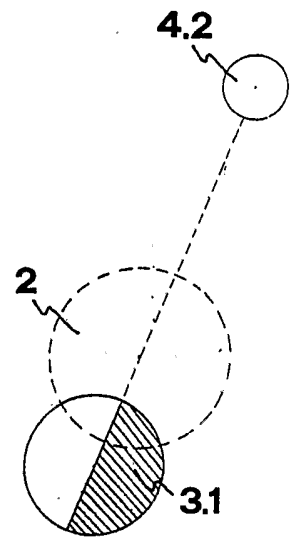
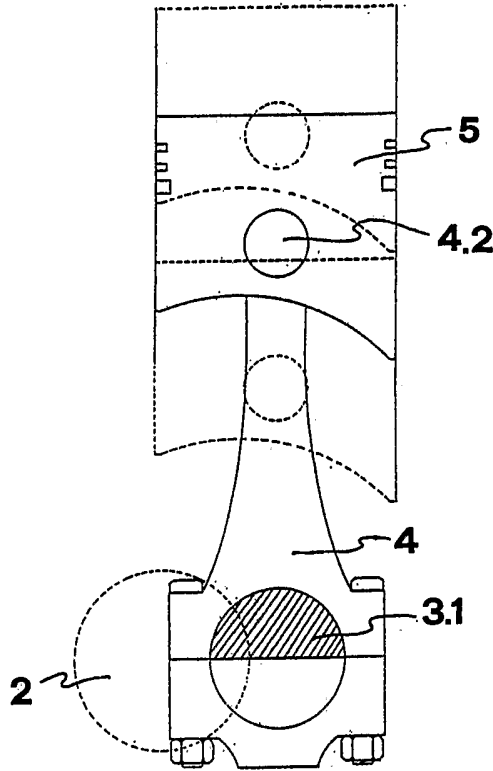
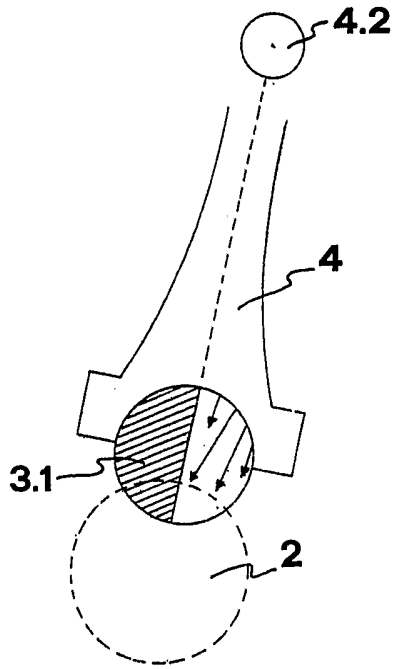


FIG.4

FIG.5

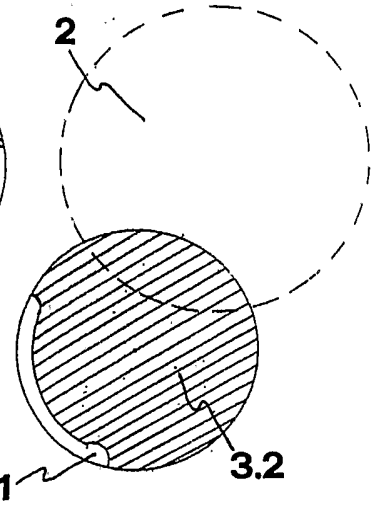
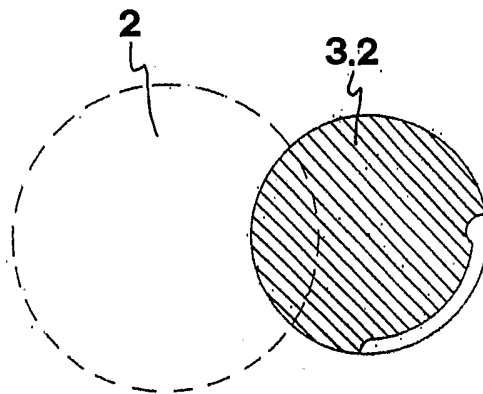
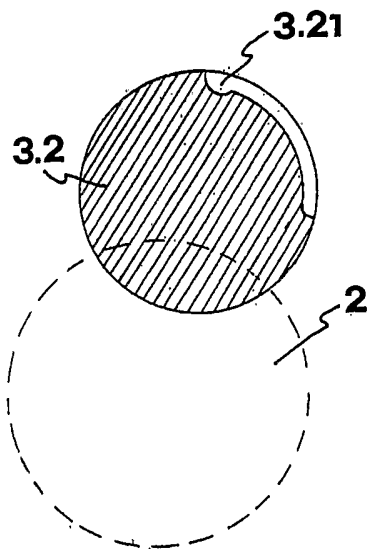


FIG.6

FIG.7

FIG.8

INTERNATIONAL SEARCH REPORT

International Application No
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A. CLASSIFICATION OF SUBJECT MATTER IPC 7 F02F7/00		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) IPC 7 F02F		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practical, search terms used) EPO-Internal, WPI Data, PAJ		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 89 14 968 U (HÄBERLE) 5 April 1990 (1990-04-05) the whole document	1,2
A	EP 0 569 630 A (MERKEL RONALD F) 18 November 1993 (1993-11-18) figures 2,3 abstract; claims 1-11	1,2
A	GB 1 133 618 A (HENRY JOHN MARTIN CLARK) 13 November 1968 (1968-11-13) the whole document	1,2
A	US 2003/015171 A1 (SCUDERI CARMELO J) 23 January 2003 (2003-01-23) figures 1,8,9 abstract claims 1,2	1,2
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<input checked="" type="checkbox"/> Further documents are listed in the continuation of box C. <input checked="" type="checkbox"/> Patent family members are listed in annex.		
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	PATENT ABSTRACTS OF JAPAN vol. 2003, no. 06, 3 June 2003 (2003-06-03) & JP 2003 035146 A (TOYOTA MOTOR CORP), 7 February 2003 (2003-02-07) abstract -----	1,2
A	US 5 816 201 A (GARVIN EDWARD A) 6 October 1998 (1998-10-06) figure 1 abstract claims 1-3 -----	1,2
A	K}NZEL R: "DIE KOLBENBEWEGUNG IN MOTORQUER UND MOTORL{NGSRICHTUNG TEIL 2: EINFLUSS DER KOLBENBOLZENDESACHSIERUNG UND DER KOLBENFORM" MTZ MOTORTECHNISCHE ZEITSCHRIFT, FRANCKH'SCHE VERLAGSHANDLUNG, ABTEILUNG TECHNIK. STUTTGART, DE, vol. 56, no. 9, 1 September 1995 (1995-09-01), pages 534-536, 538, 54, XP000527167 ISSN: 0024-8525 the whole document -----	1,2

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/IT2004/000338

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
DE 8914968	U	05-04-1990	DE 8914968 U1	05-04-1990
EP 0569630	A	18-11-1993	US 5146884 A EP 0569630 A1	15-09-1992 18-11-1993
GB 1133618	A	13-11-1968	NONE	
US 2003015171	A1	23-01-2003	US 2003014971 A1 US 2004050046 A1 BR 0211335 A EP 1417403 A1 TW 539800 B WO 03008785 A1 US 2003070635 A1	23-01-2003 18-03-2004 28-09-2004 12-05-2004 01-07-2003 30-01-2003 17-04-2003
JP 2003035146	A	07-02-2003	NONE	
US 5816201	A	06-10-1998	NONE	