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(54) Title: A NOVEL CRANK CASE FOR INLINE TWO CYLINDER IC ENGINE

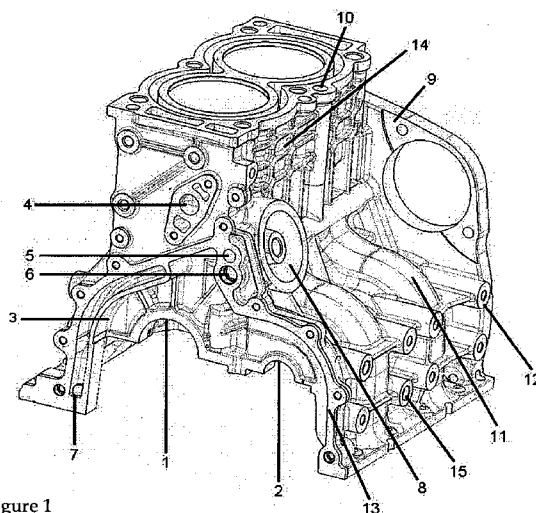


Figure 1

(57) Abstract: This invention relates to a crankcase structure for an internal combustion engine comprises a deep skirt defining said crankcase inner chamber, plurality of bearing walls supported on said skirt, crank shaft bearings and balancer shaft bearings located on said bearing walls, a blow by gas passage located at rear or front side of said crankcase, an oil return passage located on opposite side of said blow by passage, and an interface for locating an integrated water and oil pump.

A NOVEL CRANK CASE FOR INLINE TWO CYLINDER IC ENGINE

FIELD OF INVENTION

- 5 This invention relates to Internal combustion engine and more particularly this relates to Crank case for inline two cylinder internal combustion engine and further more particularly to a two cylinder inline, four stroke, Gasoline / Diesel / LPG / CNG / Ethanol / Methanol / Gasohol, Multi Point Fuel Injection / Gasoline and Diesel Direct Injection, reciprocating pistons, naturally aspirated / supercharged / Turbocharged /
- 10 Turbocharged intercooled, and single / double overhead camshaft engine intended for passenger car, light commercial vehicle and other transport / mobility / stationary applications.

BACKGROUND OF INVENTION

- Conventionally most of the passenger cars and light commercial vehicles are
- 15 powered by 3 or 4 cylinder, internal combustion, four stroke, and reciprocating piston engines with diesel, gasoline or other suitable alternate fuel having conventional cylinder crankcase. Whereas no engine in two cylinder inline configuration along with primary balancer shaft having inline two cylinder open deck, deep skirt, high pressure die cast crankcase housing single primary balancer shaft, with suitable
- 20 interface at front for integral oil & water pump and separate blow by and oil return passage at rear and or front of cylinder crankcase used on cars and or for stationary application. This invention will serve the diverse requirements of latest engines at the least possible cost by leveraging the expertise available and applying lean manufacturing methods, which previously were not used.

PRIOR ART

US 20050061284 describes high pressure die-cast cylinder crankcase with as cast cylinder liners and the process for producing it. The cylinder crankcase may in principle consist of all alloys which are suitable for this process, in particular
5 aluminum alloys but also magnesium alloys.

The above prior art describes the high pressure die casting manufacturing process for a cylinder crankcase and not the design of cylinder crankcase.

US 6662773 discloses the cylinder crankcase with base body material different than the cylinder wall. The base body 1 of the engine consisting of material A and the
10 cylinder walls 2 of the engine of a second material B, and the lattice-like reinforcement 3 provided between the two materials A and B.

This prior art doesn't cover the design aspects of crankcase and focuses on the material structure aspects of crankcase.

US 7073492 describes a light metal cylinder crankcase for combustion engines has
15 cylinder bushings with a running layer that forms the running surface and a rough, external bonding layer for bonding the cylinder bushings to the cylinder crankcase while pouring the cylinder crankcase. At least 60% of the bonding layer relative to the jacket surface of the bonding layer is connected with the casting material of the cylinder crankcase in a material tight manner.

20 This prior art also related to the manufacturing process and doesn't give insight into design of crankcase.

OBJECTS OF THE INVENTION

A) The main object of the invention is to have high pressure die cast aluminium two cylinder crankcase with following features.

- 5 1) Suitable for inline two cylinder application.
- 2) Suitable for having single primary balancer shaft.
- 3) Capable of supporting balancer shaft either on two / three bearings.
- 10 4) Front side interface suitable for using integrated oil and water pump which can also act as a volute cavity of the water pump.
- 5) With provision for driving water pump by balancer shaft.
- 15 6) Having as cast cylinder liners with 2-4 mm aluminium on top of liner, for ease of machining and avoiding machining of two dissimilar material (as in conventional case).
- 20 7) Single main oil gallery supplying oil to balancer shaft and crank shaft bearings.
- 8) Open deck cylinder crankcase suitable for high pressure die cast process.
- 9) Deep skirt, no bed plate, oil sump directly mounted on crankcase, low cost design.
- 25 10) Dedicated oil return and blow by passage at front and or rear sides.

- 11) Oil return passages dipped into oil sump, below oil level there by preventing crankcase ventilation gases to pass through it, & crankcase pressure being applied to cylinder head. It also avoids return oil to be mixed into crankcase gases.
- 5 12) Cylinder crankcase width is reduced by providing blow by passage at the rear side of crankcase, simultaneously maintaining the rear cover position closer to crankcase by providing flange directed inside for oil sump mounting onto rear cover.
- 13) Suitable for housing drive gears for balancer shaft.
- 10 14) Housing dipstick and tube for measuring oil levels in oil sump.
- 15) Having separate / combined caps for main bearing and balancer bearing.
- 16) Having two shell bearings and one bush bearing for balancer shaft.
- 15 17) Having starter motor mounted on cylinder block, crankcase.
- 18) Having provision for mounting oil filter.
- 20 19) Having provision for mounting alternator along with brackets.
- 20) Having provision for mounting AC compressor along with brackets.
- 21) Having provision for TDC locking pin.
- 25 22) Having optimized shape of skirt following locus of crank shaft and connecting rod for low cost and high stiffness design of better NVH.

23) Having optimized shape of skirt following locus of balancer shaft for low cost and high stiffness design of better NVH.

B) A further object is to have cylinder crankcase for an internal combustion 2
5 cylinder engine suitable for various transmissions viz. manual gearbox, Continuously Variable Transmission (mechanical as well as electronic), infinitely variable transmission, and automatic transmission.

C) A further object is to have cylinder crankcase stiffened for better NVH
10 properties by suitable contouring and ribs.

D) A further object is to have cylinder crankcase for an internal combustion
engine with reduced NVH and low pass by noise level when assembled on passenger
cars, light commercial vehicles and other transport / mobility / stationary
applications.

E) A further object is to have cylinder crankcase for an internal combustion
15 engine adoptable for various alternate fuels viz. ethanol, methanol, gasohol, Diesel, Gasoline, Liquid Petroleum Gas (LPG), Compressed Natural Gas (CNG) and suitable for single fuel / bi-fuel operation.

F) A further object is to have cylinder crankcase for an internal combustion
20 engine that can be naturally aspirated, selectively supercharged / turbocharged and/or intercooled depending on the application requirements.

G) A further object is to have cylinder crankcase for an internal combustion
25 engine that can be adoptable for hybrid vehicle applications / operation.

STATEMENT OF INVENTION

The inline two cylinder open deck, high pressure die cast aluminum crankcase according to this invention is suitable for housing the primary balancer shaft with either two bearing supports on cylinder crankcase or two bearing support on the crankcase and for housing the primary balancer shaft with either two bearing supports on cylinder crankcase or two bearing support on the crankcase is made with high pressure die casting and provided with "in situ" casted liners

The inline two cylinder open deck, high pressure die cast aluminum crankcase according to this invention is suitable for housing the primary balancer shaft with either two bearing supports on cylinder crankcase or two bearing support on the crankcase is provided with a deep skirt for better NVH characteristics and better structural rigidity which are attained in conventional engines by adding either bed plate or ladder frame below crankcase as an additional member.

The invention is also suitable for housing the primary balancer shaft with either two bearing supports on cylinder crankcase or two bearing support on the crankcase is designed to have provision for mounting both oil pump and water pump at the front. The invention is suitable for housing the primary balancer shaft with either two bearing supports on cylinder crankcase or two bearing support on the crankcase is designed with dedicated oil return passage at the front of the cylinder crankcase which directs the return oil through cylinder block which in turn directed to the sump through an oil drain tube which is press fitted into cylinder crankcase.

The inline two cylinder open deck, high pressure die cast aluminum crankcase according to this invention is suitable for housing the primary balancer shaft with either two bearing supports on cylinder crankcase or two bearing support on the

crankcase is designed with blow-by passage at the front which directs the blow-by gases to an innovative blow-by separation system provided at the cylinder head.

SUMMARY OF INVENTION

5 The invention discloses an inline two cylinder open deck, deep skirt, high pressure die cast aluminium crankcase housing single primary balancer shaft with front side interface suitable for adopting integral oil and water pump for four-stroke reciprocating piston internal combustion spark ignition engine.

10 The cylinder crankcase is designed for high pressure die cast (aluminium) process for high volume production. The crankcase is designed in such a way that the die does not have complex cores and too many moving sides. There are one fixed side die, four side dies moving in perpendicular direction to fixed die and one top die moving in the direction of bottom die. The cylinder crankcase design is optimized for mold filling & solidification. In this design cylinder liners are casted in situ. At top of liner, aluminium wall is provided. This avoids machining of two dissimilar materials as is
15 in conventional design. The only aluminium at top deck of cylinder liner helps in better sealing and improved reliability by avoiding expansion of dissimilar material as in conventional designs. Cooling water jacket surrounding cylinder liners are open deck for ease of manufacturing.

20 The shape of crankcase follows the locus of connecting rod and crankshaft on one side and it follows the locus of balancer shaft on the other side. The special counterweight on crankcase provide the high stiffness and reduced material content.

In this invention crankcase is with deep skirt design and does not require bed plate or ladder frame. The oil sump can be sheet metal or aluminum. Oil sump is directly mounted on bottom of block.

In this invention wall thickness and ribs are optimized using structural and NVH analysis.

The cylinder crankcase is designed for low cost by optimizing wall thicknesses, removing the material from non functional area.

- 5 The cylinder crankcase is designed to house single primary balancer shaft & drive gears for the balancer shaft. the design is such that balancer shaft can be supported on two bearings for low cost design, and for high speed, design balancer shaft can be supported on three bearings. Ttwo bearings out of the three bearings are preferably shell bearings and the third bearing is housed in rear wall and is a bush bearing.
- 10 The cylinder crankcase front end is designed to have interface with integral oil and water pump. The oil pump is driven by crankshaft & water pump is balancer shaft.

To reduce oil consumption separate passages are provided for crankcase ventilation and oil return from cylinder head. The ventilation path in cylinder crankcase houses the innovative oil separation device. The provision is made at front side of cylinder

- 15 crankcase for return oil to be delivered at bottom of crankcase.

In this cylinder crankcase design very simple lubrication passages are provided for ease of manufacturing and low cost machining. The main oil gallery is as cast, only drill is passed to clear flashes or burr generated due to cross hole drilling for lubrication to main bearing and balancer bearing from said single main oil gallery.

- 20 Cross drills are made for lubrication to main bearing and balancer bearing from single main oil gallery. As cast oil passage is provided in cylinder crankcase from main gallery matching to oil passage in cylinder head. Return oil from cylinder head is connected to cylinder crankcase as cast passage at front side. Part of oil return passage is split between cylinder crankcase and integral oil pump which is sealed by

liquid or paper gasket. At crankcase bottom provision is made for connecting oil drain to be which delivers return oil at bottom of oil sump.

The cylinder crankcase has innovative provision of dipstick which passes through oil return passage in to oil sump.

- 5 The cylinder crankcase has provision for mounting starter motor, oil filter, alternator, compressor etc. auxiliaries.

BRIEF DESCRIPTION OF DRAWINGS

Figure 1 shows an isometric view looking from the front & right hand side of the cylinder crankcase,

- 10 Figure 2 shows an isometric view from the front & left hand side of the cylinder crankcase,

Figure 3 shows an isometric view of the rear & left hand side of the cylinder crankcase,

Figure 4 shows an isometric view of the cylinder crankcase from bottom side,

- 15 Figure 5 shows an isometric view of the cylinder crankcase from top side,

Figure 6 shows sectional view of the cylinder crankcase showing lubrication to main bearing and balancer bearing,

Figure 7 shows passages for crankcase ventilation & oil return passages,

Figure 8 shows delivery of return oil below oil level in oil sump,

Figure 9 shows right hand side view of crankcase for continuously variable transmission version,

Figure 10 shows mounting arrangement for dipstick and dipstick tube,

Figure 11 shows separate caps for main bearing and balancer bearing,

5 Figure 12 shows combined caps for main bearing and balancer bearing,

Figure 13 shows arrangement for supporting balancer shaft on two bearings and

Figure 14 shows arrangement for supporting balancer shaft on three bearings.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to the drawings wherein the showings are for the purpose of
10 illustrating a preferred embodiment of the invention only, and not for the purpose of limiting the same,

Now with reference to figures,

Figure 1 shows front side view, with bearings (1 &2) for crank shaft (1) and balancer shaft respectively located on bearing wall supported on skirt. Interface for integral oil
15 and water pump (3), water entry to cylinder block (4), unfiltered pressurized oil entry to oil gallery (5), main oil gallery (6), oil return passage (7), provision for oil filter mounting (8), provision for starter motor mounting (9), As cast oil gallery for supplying oil to cylinder head (10), shows contoured profile for balancer shaft locus (11), skirt (13) below crankshaft centerline (deep skirt), ribs (14) for stiffness and
20 better NVH provision for AC compressor mounting bosses (15), provision for 'C' arm (12).

Figure 2 shows front and left hand side view, it shows mounting bosses (16) for A arm, used for engine mounting through rubber isolation, three bosses (17) on left side are for alternator mounting, (18) shows contoured profile for crankshaft and connecting rod locus. Provisions (39) are provided for mounting other accessories.

- 5 Figure 3 shows rear side of cylinder crankcase, ribbed flange (19) is for supporting transmission gear box; it also shows spigot location (20) for starter motor mounting, passage for blow by (21) is sealed by rear cover. The oil filter mounting provision (8) have a central hole (8a) surrounded by a cavity (8b) with an opening (8c) for unfiltered oil entry. The filtered oil from the oil filter is supplied to the main oil
10 gallery (32) through the central hole.

Figure 4 shows bottom side of crankcase, it shows housing for crankshaft (22), housing for balancer shaft (23), oil return passage (24), passage for blow by gases (21) , As cast cylinder liner shown by (25) . (26) Shows holes for mounting oil sump.

- Figure 5 shows inline two cylinders (27), aluminum materials at top of liners (28),
15 shows open deck water jacket surrounding cylinder liner(29) , (24) oil return passage, (21) passage for crankcase gases.

Figure 6 section shows cross drill holes for oil supply to main bearing (30) and balancer bearing (31) from single main oil gallery(32).

- Figure 7 section showing dedicated oil return passage front side of engine and
20 passage for crankcase gases at rear side of engine. The reverse arrangement i.e. passage for blow by at front and oil return passage at rear is also possible option in this design.

Figure 8 shows arrangement for delivery of returned oil below oil level and at bottom of oil sump. Oil return passage connected to an oil collector (34) through an oil drain tube (33). The oil collector is located below oil level in the sump (35).

Figure 9 shows the bosses (36) provided at the right side of crank case for mounting
5 the Continuous variable transmission.

Figure 10 shows mounting arrangement for dipstick (37) and dipstick tube (37a). A provision (38) for mounting dipstick tube provide on the crank case in such way that the dipstick passes through oil return passage into oil sump.

Figure 11 shows separate caps for main bearing and balancer bearing.

10 Figure 12 shows combined caps for main bearing and balancer bearing.

Figure 13 shows arrangement for supporting balancer shaft on two bearings.

Figure 14 shows arrangement for supporting balancer shaft on three bearings. i.e. on two shell bearing and one bush bearing.

The crankcase for inline two cylinder open deck is made of Aluminum or Cast iron
15 and is suitable for housing the primary balancer shaft with either two bearing supports on crankcase or three bearing support on the crankcase. Said crankcase has a front side interface suitable for mounting integrated oil and water pump which is driven by balancer shaft and is designed with dedicated oil return at the front of the crankcase. The interface can be formed in such way that it can also acts as volute
20 cavity of the water pump. A blow-by passage is provided at the rear side of the crankcase. The crankcase has as-cast cylinder liners placed at a distance of about 2-

4mm from the top face of cylinder crankcase to avoid machining of two dissimilar materials at the top.

The crankcase is formed with a single main gallery supplying lubrication oil to both the crankshaft bearings and balancer shaft bearings.

- 5 The crankcase is provided with deep skirt, optimized with connecting rod locus, crankshaft locus and balancer shaft locus for better NVH, better stiffness and structural rigidity at low cost compared with conventional crankcase design. The crankcase is suitable for housing the balancer shaft drive gears at the front.

- 10 The crankcase has provision for mounting dipstick on it for checking the oil level in the oil sump.

The crankcase has reduced width by providing blow-by passages and oil return passages at the rear and front sides of the crankcase, and with the rear cover flanges directed towards the crankcase side.

The cylinder crankcase has separate/integrated caps for crankshaft and balancer shaft.

- 15 The cylinder crankcase has two shell bearings and one bush bearing for the balancer shaft. The cylinder crankcase has a provision for mounting starter motor. The cylinder crankcase also has provision for oil filter mounting.

Provision is also provided to mount alternator and A/C compressor using brackets and for TDC locking pin.

- 20 The crankcase is stiffened for better NVH by suitable contouring and ribs.

The inline two cylinder open deck, high pressure die cast aluminum crankcase according to the present invention is suitable for various transmissions. Viz. Manual

transmission, continuously variable transmission (both mechanical and electronic),
Infinitely variable transmission and automatic transmission.

The inline two cylinder open deck, high pressure die cast aluminum crankcase
according to this invention is suitable for an engine adoptable for various alternate
5 fuels viz. Ethanol, methanol, gasohol, diesel, gasoline, liquid petroleum gas (LPG),
compressed natural gas (CNG) and suitable for single fuel / bi-fuel operation.

The inline two cylinder open deck, high pressure die cast aluminum crankcase
according to this invention is suitable for an internal combustion engine that can be
naturally aspirated, selectively supercharged / turbocharged and/or intercooled
10 depending on the application requirements.

The inline two cylinder open deck, high pressure die cast aluminum crankcase
according to this invention is also suitable for an internal combustion engine that can
be adoptable for hybrid vehicle applications / operation.

The foregoing description is a specific embodiment of the present invention. it should
15 be appreciated that this embodiment is described for purpose of illustration only, and
that numerous alterations and modifications may be practiced by those skilled in the
art without departing from the spirit and scope of the invention. it is intended that all
such modifications and alterations be included insofar as they come within the scope
of the invention as claimed or the equivalents thereof.

CLAIMS

1. A crankcase structure for an internal combustion engine comprises a deep skirt defining said crankcase inner chamber, plurality of bearing walls supported on
5 said skirt, crank shaft bearings and balancer shaft bearings located on said bearing walls, a blow by gas passage located at rear or front side of said crankcase, an oil return passage located on opposite side of said blow by passage, and an interface for locating an integrated water and oil pump.
- 10 2. The crankcase as claimed in claim 1 wherein said interface act as volute cavity of said water pump.
3. The crankcase as claimed in claim 1 wherein said oil and water pump driven by crankshaft and balancer shaft respectively.
- 15 4. The crankcase structure as claimed in claim 1, wherein said crankcase is formed with a single main oil gallery supplying lubrication oil to both the crankshaft bearings and balancer shaft bearings.
- 20 5. The crankcase structure as claimed in claim 1, wherein said blow by gas passage configured to house an oil separation device.
6. A crankcase structure as claimed in claim 1 wherein said rear side having a flange with spigot for supporting a transmission gear box and starter motor mounting.

7. The crankcase structure as claimed in claim 1, wherein cylinder liners are located at distance of 2-4 mm below the top surface of cylinder crankcase which are surrounded by cooling water jackets .

5 8. The crankcase as claimed in claim 1 wherein said balancer shaft supported on two bearings using bearing shells.

9. The crankcase structure as claimed in claim 1, wherein an oil sump is directly mounted on bottom of said crankcase.

10

10. The crankcase structure as claimed in claim 1, wherein said balancer shaft supported on three bearings with two shell bearings and a bush bearing housed in the rear wall..

15 11. The crankcase structure as claimed in claim 4, wherein a single as-cast main oil gallery is provided such that only a drill is passed to clear flashes & burr generated due to cross hole drilling for lubrication to main bearing and balancer bearing from said single main oil gallery.

20 12. The crankcase structure as claimed in claim1 wherein said crankcase provided with a provision for mounting an oil filter, said provision having a central hole for supplying filtered oil to the mail gallery surrounded by a cavity with an opening for unfiltered oil entry.

13. The crankcase structure as claimed in any one of the preceding claims, wherein said crankcase has a provision for dipstick which passes through said oil return passage into said oil sump.

5 14.. The crankcase structure as claimed in claim 1, wherein said crankcase has separate or integrated caps for crankshaft and balancer shaft

15. The crankcase structure as claimed in claim 1, wherein contouring and ribs are provided for strengthening said crankcase.

10

16. A crankcase structure for an inline two cylinder internal combustion engine substantially as hereinabove described with reference to the accompanying drawings.

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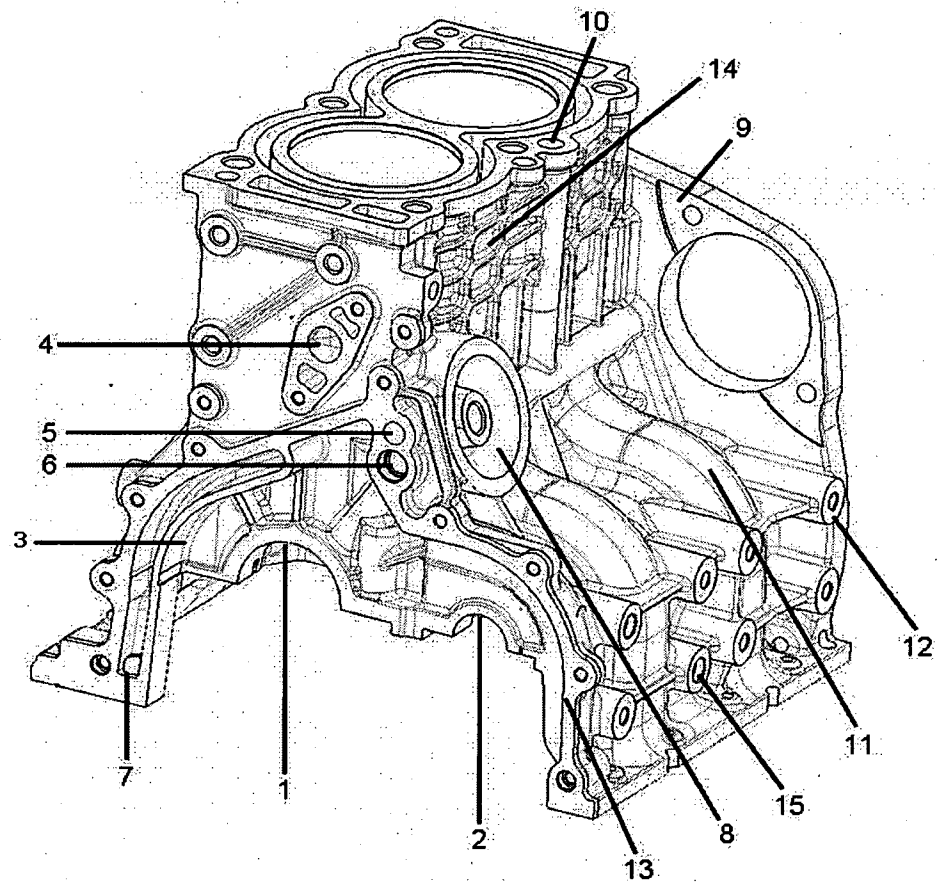


Figure 1

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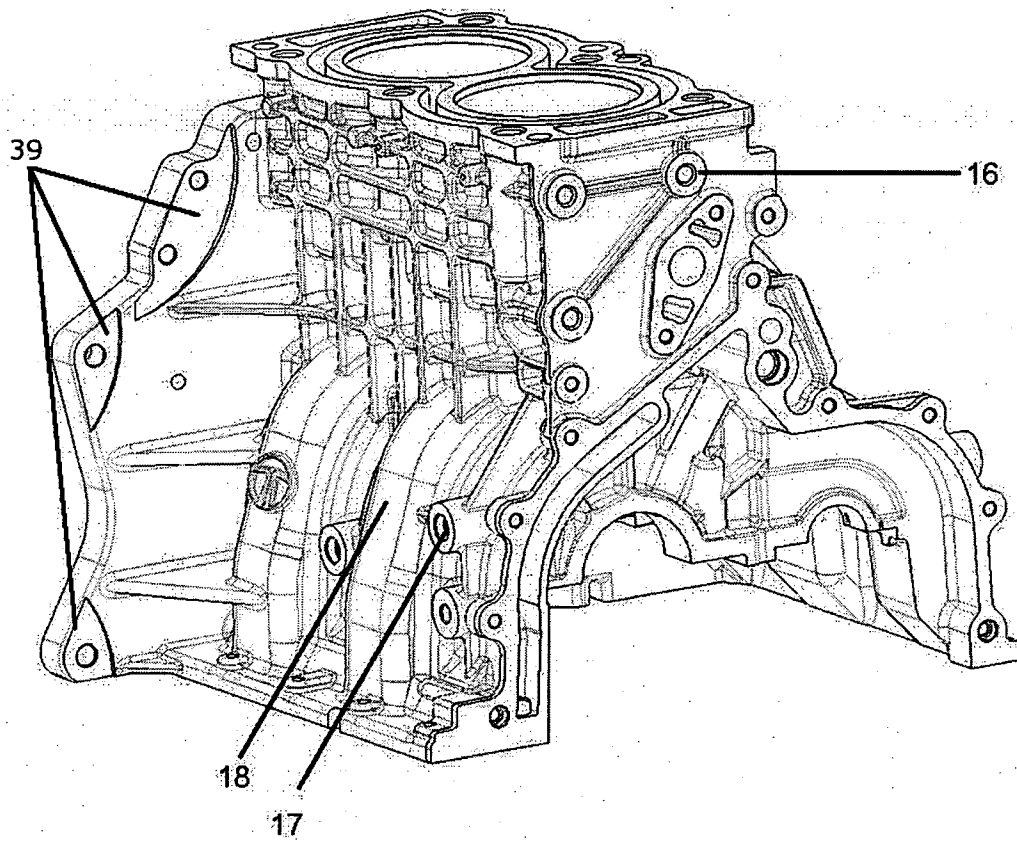


Figure 2

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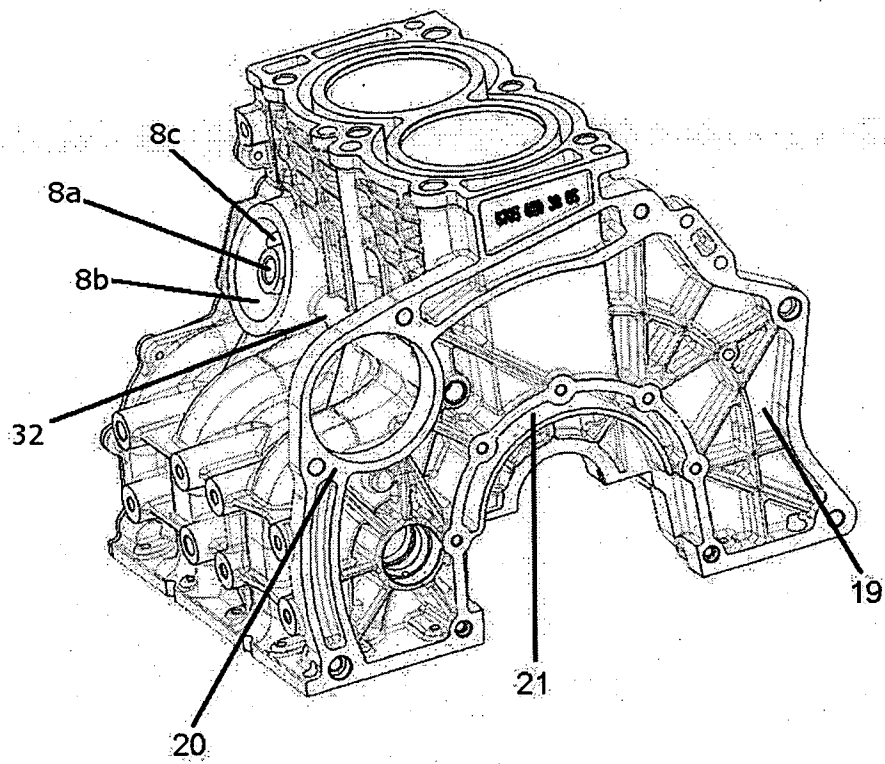


Figure 3

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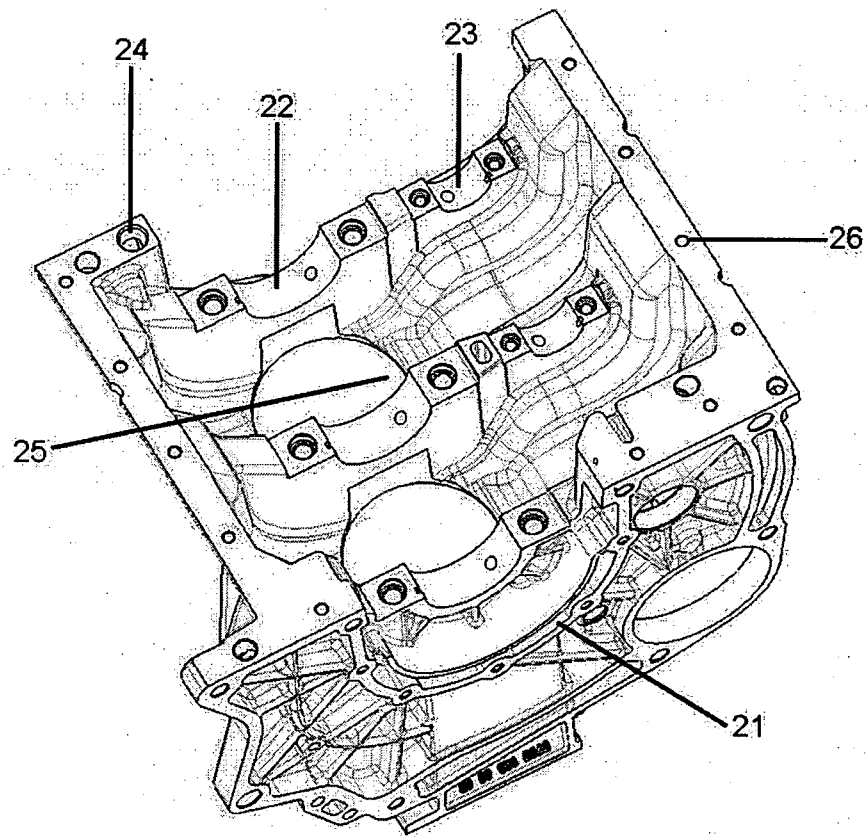


Figure 4

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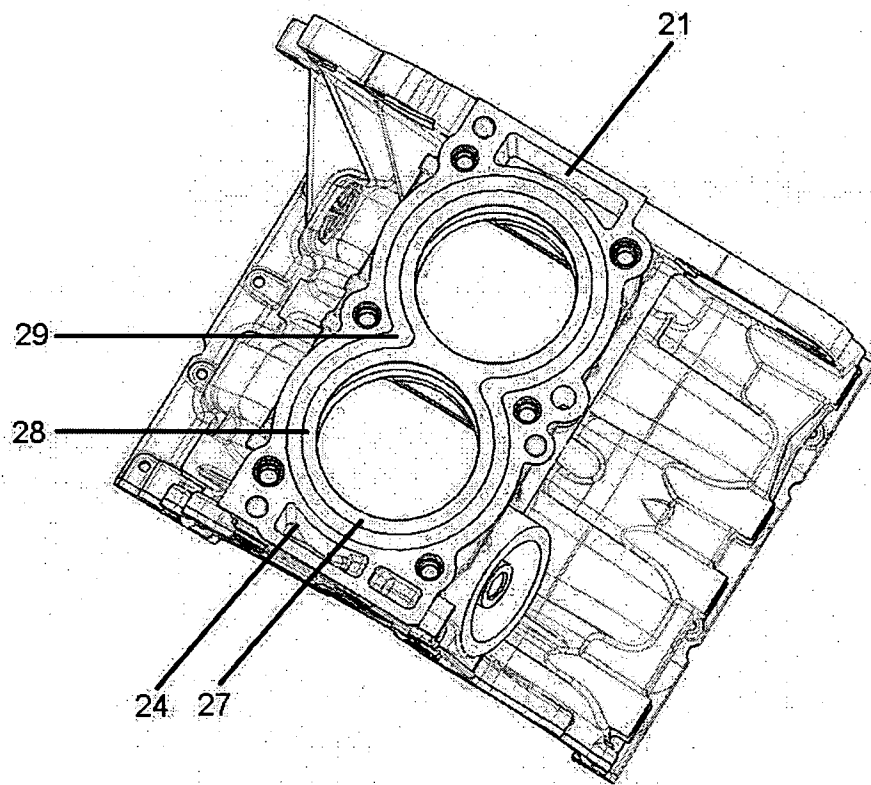


Figure 5

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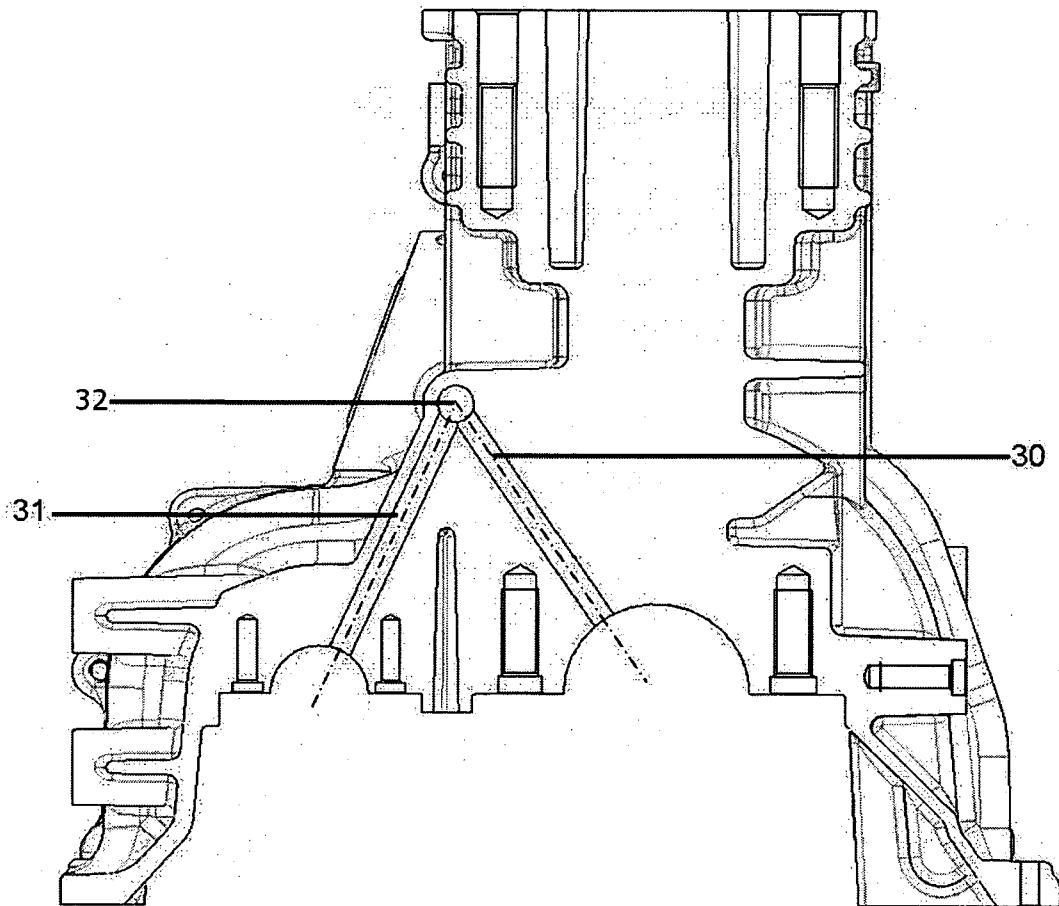


Figure 6

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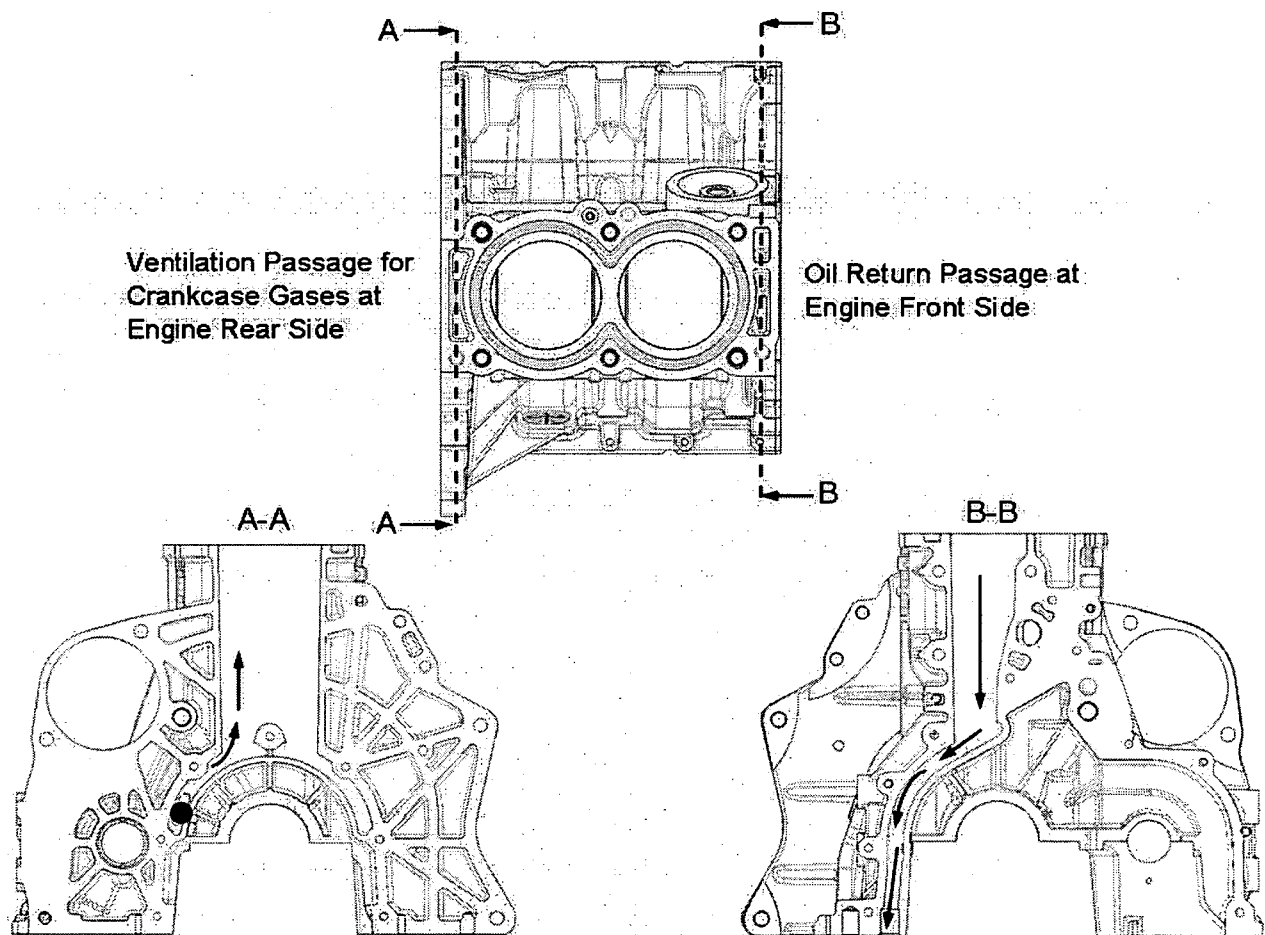


Figure 7

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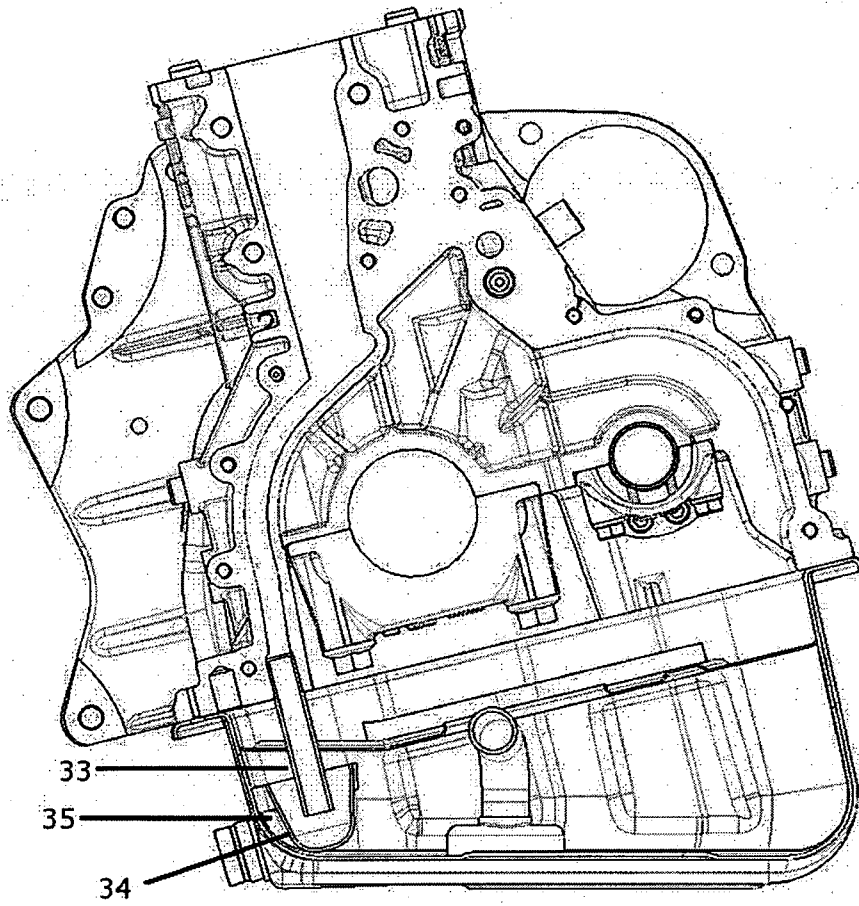


Figure 8

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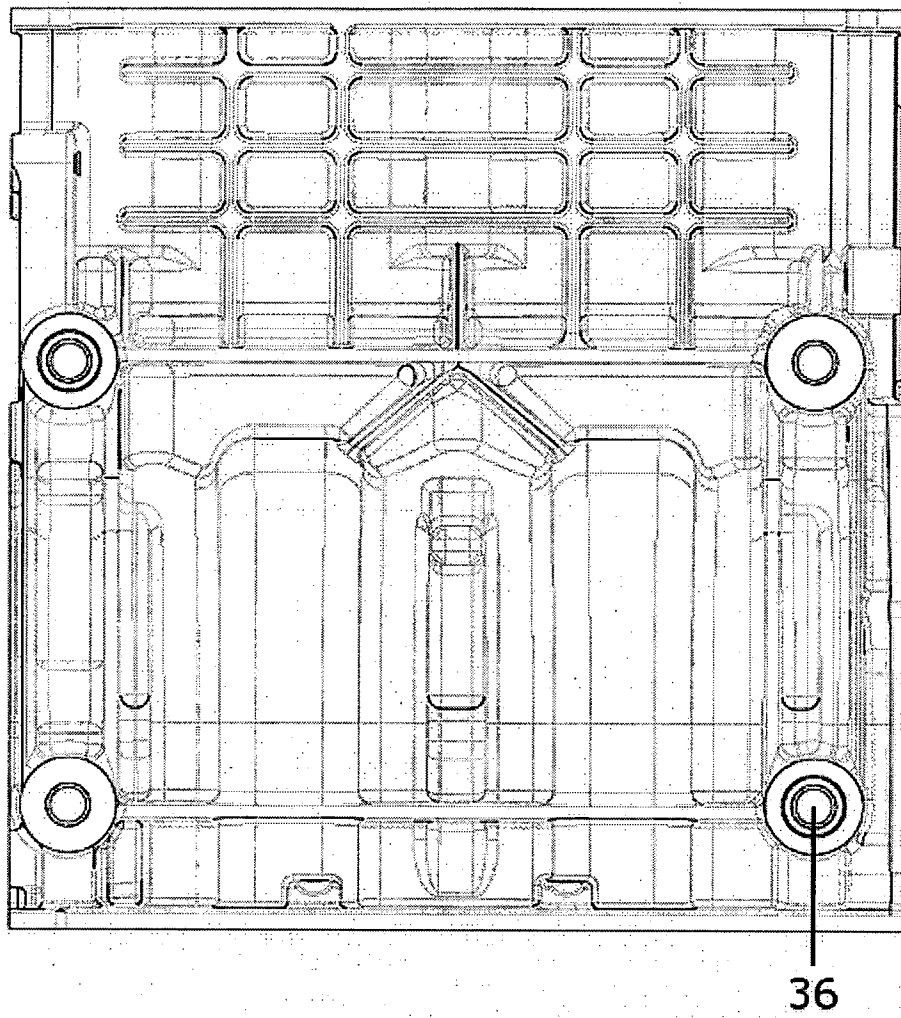


Figure 9

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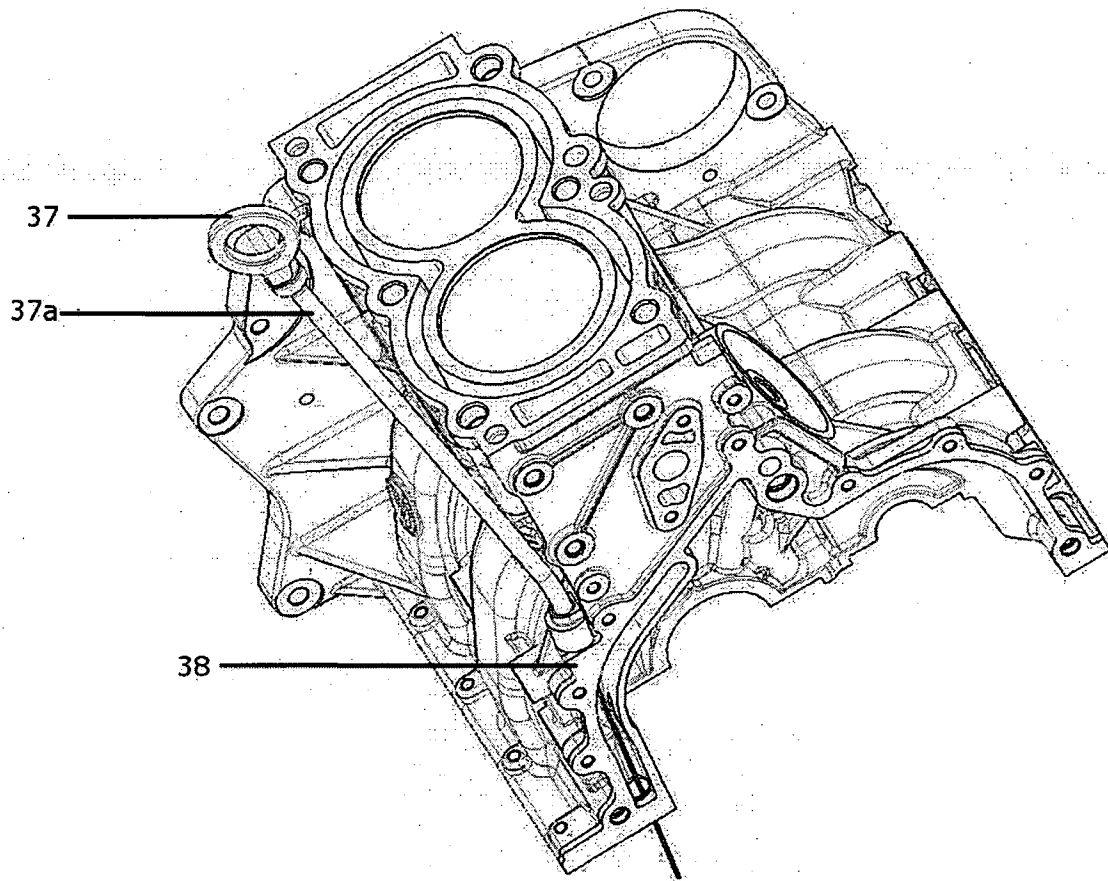


Figure - 10

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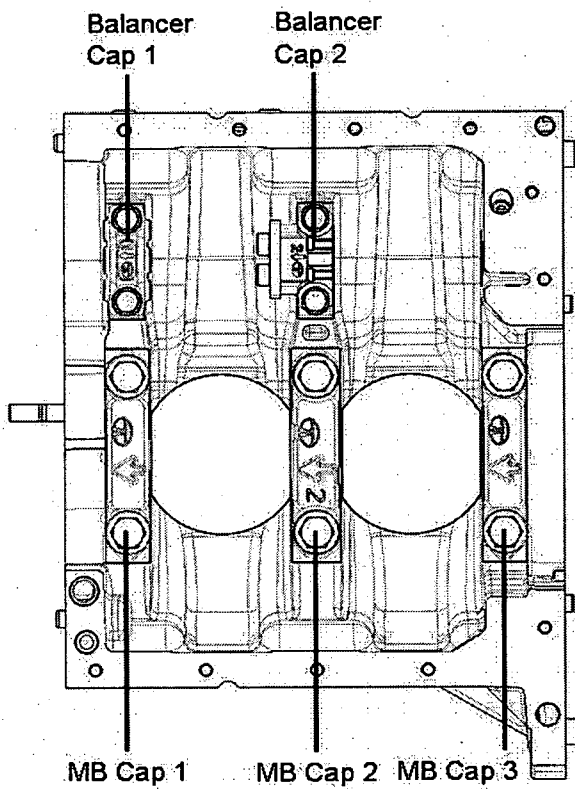


Figure 11

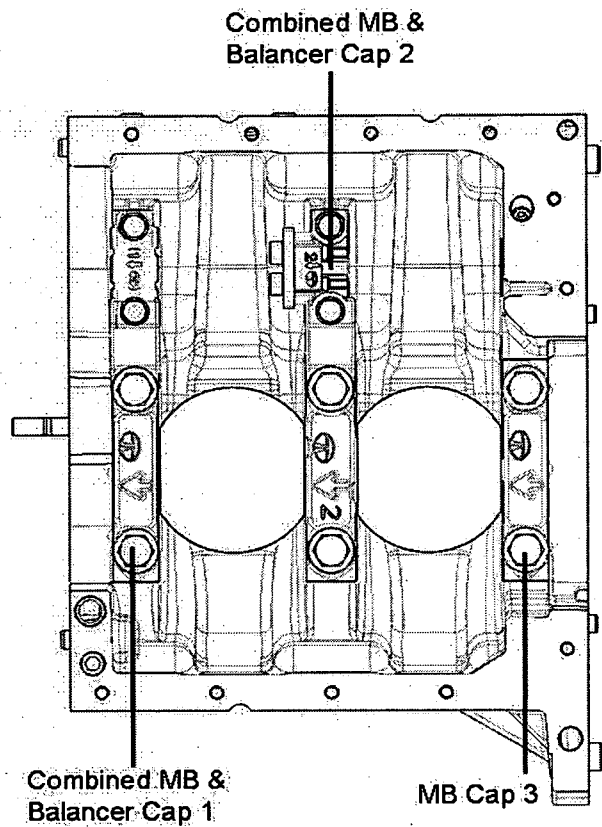


Figure 12

Seperate caps for main bearing & balancer bearing. Combined caps for main bearing & balancer bearing

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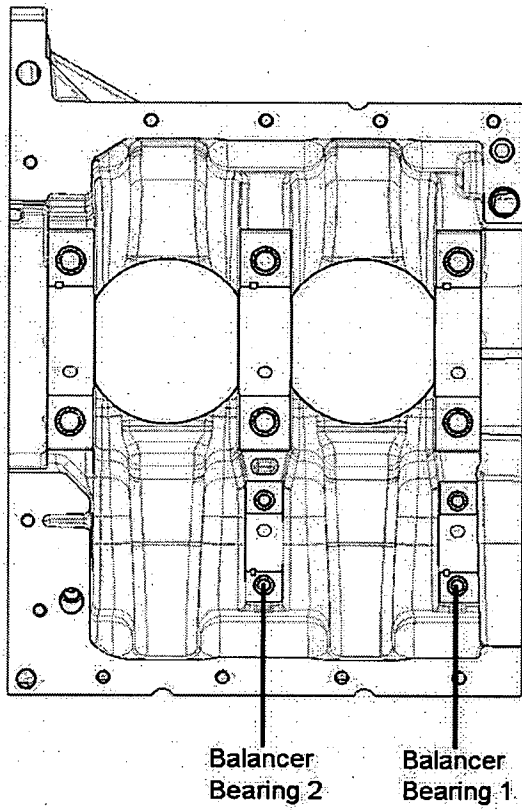


Figure 13
Arrangement for supporting
Balancer shaft on two bearings

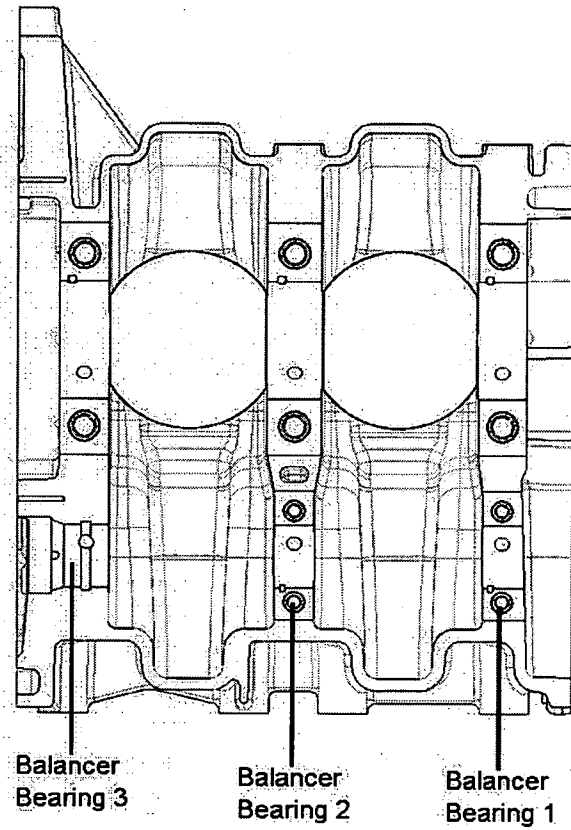


Figure 14
Arrangement for supporting
Balancer shaft on three bearings