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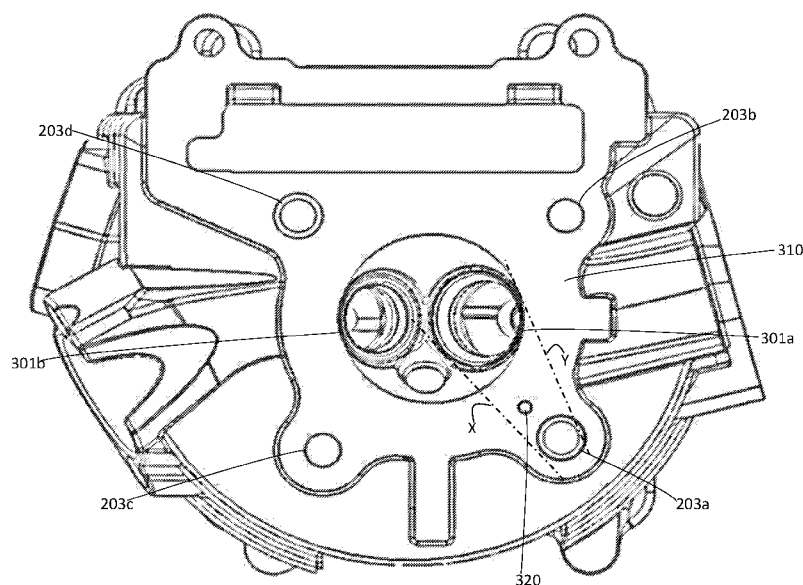


Fig. 3b

(57) Abstract: The present subject matter discloses an internal combustion (IC) engine (101) comprising a cylinder block (140), a cylinder head (130), and combustion chamber (310) between the cylinder head (130) and cylinder block (140). The cylinder head (130) comprises a combustion-chamber face (310), plurality of ports to permit air fuel inside the combustion chamber (302) and gases of combustion to be expelled out, and a valve seat (301) surrounding the opening of each of the plurality of ports. An indentation (320) is disposed on the combustion-chamber face (310) within an area enclosed by two imaginary lines (X & Y), said two imaginary lines (X & Y) are tangential to both the outer circumferential surface of one of the plurality of holes (203) and the outer circumferential surface of the nearest valve seat (301). This prevents the distortion of the valve seat (301) when the cylinder block (140) and cylinder head (130) are securely mounted by connecting members (201).



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A CYLINDER HEAD OF AN INTERNAL COMBUSTION ENGINE

TECHNICAL FIELD

- 5 **[0001]** The present subject matter relates generally to an internal combustion (IC) engine. More particularly, the present subject matter relates to a cylinder head of the IC engine.

BACKGROUND

- 10 **[0002]** An internal combustion engine comprises of a cylinder head, a reciprocating piston on a cylinder block and a connecting rod which connecting the reciprocating piston to a crankshaft mounted inside a crankcase. The rotary motion of the crankshaft is transferred through a transmission system to an output which can be used in a wide range of applications including providing motive force for movement of a vehicle. The cylinder head is mounted on the cylinder
- 15 block to form a combustion chamber therein. A combustion chamber is formed at the junction of the cylinder head and cylinder block where the combustion of the air-fuel mixture occurs. The cylinder head comprises of various ports, including at least one inlet port and at least one outlet port which allow entry of air-fuel mixture and exit of burnt gases from the combustion chamber. The ports
- 20 (including intake port and exhaust port) have there opening to the combustion chamber covered by intake valve and exhaust valve which are capable of performing opening and closing operations. The opening of the ports have a valve seat which are conically shaped surfaces against which the head of intake or exhaust valve rests during that IC engine operating cycle when valve is closed.
- 25 The sealing between the valve head and valve seat in mechanical and if it is distorted or deformed, valve leakage and reduced heat extraction will occur which adversely affects IC engine performance, decreases efficiency, results in improper combustion, and emits increased exhaust gas emissions. Many factors are

responsible for the distortion of valve seat and it is desirable to reduce this valve seat distortions band hence alleviate the above drawbacks.

5

BRIEF DESCRIPTION OF THE DRAWINGS

[0003] The detailed description is described with reference to the accompanying figures. The same numbers are used throughout the drawings to reference like features and components.

10 [0004] **Fig. 1a.** illustrates the side view of a two wheeled vehicle employing an embodiment of the present subject matter.

[0005] **Fig. 1b.** illustrates the side view of an internal combustion (IC) engine employing the embodiment of the present subject matter.

15 [0006] **Fig. 2a.** illustrates the isometric view of the IC engine comprising a cylinder head, mounted over a cylinder block and mounted on a crankcase according to embodiment of the present subject matter.

[0007] **Fig. 2b.** illustrates the exploded view of the cylinder head, cylinder block and crankcase connected together by plurality of connecting members according to embodiment of the present subject matter.

20 [0008] **Fig. 3a.** illustrates a cut section of the cylinder head according to the embodiment of the present subject matter.

[0009] **Fig. 3b.** illustrates a bottom view of the cylinder head according to the embodiment of the present subject matter.

[00010] **Fig. 4a.** illustrates a cross section of the cylinder head and cylinder block of a conventional IC engine, indicating a prior art.

25 [00011] **Fig. 4b.** illustrates a simplified line representation of the conventional IC engine, indicating the prior art.

[00012] Fig. 4c. illustrates another cross section of the cylinder head and cylinder block of a conventional IC engine, indicating the prior art.

[00013] Fig. 5a. illustrates a cross section of the cylinder head and the cylinder block according to the embodiment of the present subject matter.

5 [00014] Fig. 5b. illustrates a simplified line representation of the IC engine according to the embodiment of the present subject matter.

[00015] Fig. 5c. illustrates another cross section of the cylinder head and cylinder block of the IC engine according to the embodiment of the present subject matter.

10 [00016] Fig. 6a. illustrates the bottom view of the cylinder head according to another second embodiment of the present subject matter.

[00017] Fig. 6b. illustrates the bottom view of the cylinder head according to another third embodiment of the present subject matter.

DETAILED DESCRIPTION

15 [00018] Various features and embodiments of the present subject matter here will be discernible from the following further description thereof, set out hereunder. According to an embodiment, an internal combustion engine (IC) described here operates in four cycles. Such an IC engine is installed in a step through type two wheeled vehicle. It is contemplated that the concepts of the present invention may
20 be applied to other types of vehicles within the spirit and scope of this invention. Further "front" and "rear", and "left" and "right" referred to in the ensuing description of the illustrated embodiment refer to front and rear, and left and right directions as seen from a rear portion of the IC engine and looking forward. Furthermore, a longitudinal axis unless otherwise mentioned, refers to a front to
25 rear axis relative to the engine, while a lateral axis unless otherwise mentioned, refers generally to a side to side, or left to right axis relative to the engine. The detailed explanation of the constitution of parts other than the present subject matter which constitutes an essential part has been omitted at suitable places.

[00019] An internal combustion (IC) engine comprises a cylinder block having a cylinder bore, a piston reciprocating in the cylinder bore, a cylinder head located above the cylinder block and a combustion chamber interposed between the cylinder head and the cylinder block. During operation of the internal combustion

5 (IC) engine, the burning of air fuel mixture occurs in the cylinder block. The cylinder head comprises plurality of ports, including at least one inlet port and at least one outlet port. The plurality of ports open into the combustion chamber, and the inlet port directs air and fuel mixture to the combustion chamber and the exhaust port directs the burnt gases of combustion out of the combustion chamber.

10 The openings of the plurality of ports are controlled by tappet valves which are capable of opening and closing corresponding to the relevant engine cycle. The tappet valve head in closing operation is accommodated in a valve seat at the end of each plurality of ports such that the conical section surface of valve seat will mate with a corresponding conical section of the corresponding tappet valve.

15 Typically, the valve seat is a separate component which is in the form of insert which is press fitted into a counter-bore at the exit of the port to the combustion chamber. During the portion of the IC engine operating cycle when the tappet valve is closed, the rear conical section of the head of the tappet valve is abutting the conical section of the valve seat. In most IC engines, the sealing between the

20 rear surface of the tappet valve head abutting the valve seat of cylinder head is mechanical. At tappet valve close position, the head is firmly held in position by force exerted by an elastic member such as a spring and forms an effective seal.

[00020] The seating arrangement between the tappet valve and the valve seat is essential to the efficient performance of the IC engine. The valve seat performs

25 two essential functions namely, sealing and heat extraction. The valve seat and the head of the tappet valve forms a seal to prevent any leakage from port to the combustion chamber and vice versa. Any minor leak significantly affects engine performance, emissions and durability. The valve seat also aids in drawing heat generated in the combustion chamber away from the tappet valve and conduct it

30 into the cylinder head. This prevents the tappet valve from excessive overheating and maintains the temperature of the tappet valve.

[00021] Perfect seating arrangement between the tappet valve and valve seat is very critical to the prevent leakage and improve heat extraction. Leakage between the mating surfaces can reduce the compression of air-fuel mixture thus affecting power, and can also lead to valve burning. Further, reduced heat extraction from the tappet valve (that is, valve seat's ability to cool the tappet valve) can lead to reduced tappet valve life and sudden tappet valve failure. The major causes for leakage and reduced heat extraction is the improper dimensions around the valve seat which prevent proper contact with the head of tappet valve. Hence, the proper seating of the tappet valve on the valve seat depends on the correct width of the valve seat, the valve seat concentricity having a corresponding match with the undersurface of the tappet valve head and the correct location of the cylinder head face. Various factors can cause distortion of the valve seat resulting in changes in one or more parameters highlighted above. Such factors include, improper care during machining of valve seat, heat expansion and resulting distortion due heat generated in the combustion chamber, and incorrect valve train geometry. But, in IC engines operating at smaller volume, the cylinder head face may get deformed due to load by the connecting member. The cylinder head is mounted on the cylinder block and connecting members (such as a stud) is inserted through specifically bored through-holes on the cylinder head and cylinder block and tightened by nuts. A seal is also inserted between the cylinder head and cylinder block. To ensure optimum seal and prevent any oil leakage and also to absorb vibration and reduce engine noise, it is essential to provide certain tightening torque to the nut. Tightening the nut also keeps the combustion chamber hermitically sealed even in the presence of very high cylinder pressures during combustion. This tightening torque applied to fasten the connecting members may cause the cylinder block and cylinder head joint surface gets deformed. This deflection of the joint surface results in distortion of valve seat thus causing leakage and reduced heat extraction.

[00022] The distortion of the valve seat may have various unpleasant effects on the performance of the IC engine. Such distortion can deviate the valve seat unacceptably from perfect concentricity. It also causes deviation of conical

section of the valve seat thus changing the conical surface angle that matches with the conical surface angle of the rear portion of the tappet valve head. Since, the valve seat is machined perfectly to match with the head of the tappet valve, this leads to improper contact between the surface of the tappet valve and the valve seat. This results in tappet valve leakage as there is no tight compression seal. There is reduced heat extraction from the tappet valve as there is no effective metal to metal contact with the valve seat. This will reduce heat flow from the tappet valve to the valve seat and make it run hot. The distortion may also cause misalignment between valve seat and the guide on which the valve seat is located. This improper alignment may result in the tappet valve subjected to additional forces which can cause tappet valve damage. This valve seat deflection tends to be higher as the distance between the through hole for connecting member insertion and the valve seat reduces and comes closer. Hence, the effect of distortion of valve seat is increasingly profound for IC engines having smaller operating volume. This distortion can be minimized by increasing the stiffness of the cylinder head material and/or cylinder block material, yet the effect is reduced but valve leakage is seen.

[00023] Hence, to obviate the limitations associated when the valve seat is subjected to distortion; the proposed subject matter discloses a cylinder head having an indentation on its combustion chamber face disposed within an area enclosed by two imaginary lines (X and Y) tangential to both the outer circumferential surface of one of the plurality of holes and the outer circumferential surface of the nearest valve seat. This ensures that the force transfer to the valve seat during clamping is isolated at the indentation introduced in the line action of force.

[00024] With the above design changes, the following advantages can be obtained such as Better valve seat sealing and lower load transfer during clamping resulting in lower valve seat distortion, it is possible to reduce and optimize the material of the cylinder head to have reduced stiffness (ex: aluminum block) and make compact block and head without leak. Further, the manufacture and machining of

the indentation is easier as accurate precision machining tools are not required to obtain exact accurate measurements.

[00025] The present subject matter along with all the accompanying embodiments and their other advantages would be described in greater detail in conjunction with the figures in the following paragraphs.

[00026] **Fig. 1a.** illustrates an exemplary two wheeled vehicle, having the IC engine according to the embodiment of the present subject matter. In a one embodiment, the IC engine is a small engine having less volume capacity (below 200cc) and is air cooled. But the present invention can be implemented in other applications (stationary or other automobiles) employing the IC engine having the present invention. In one embodiment of the exemplary two wheeled vehicle (100), it has a single frame structure, which acts as the skeleton for bearing the loads. The single frame structure is a mono-tube type frame structure that includes a head tube (102), a main-tube (not shown), a step-through portion (104) (forming part of the main-tube) and a rear-tube (103). The main-tube (not shown) extends rearwardly downward from the head-tube (102). The step-through portion (104) is a part of the main-tube that extends rearward, along a longitudinal axis of the vehicle (100), from a rear portion of the main-tube. The rear-tube (103) extends inclinedly rearward from a rear portion of the step-through portion (104) towards a rear portion R of the vehicle (100). A handle bar assembly (108) is pivotally disposed through the head-tube (102). The handle bar assembly (108) is connected to a front wheel (105) by one or more front suspension(s) (107). A front fender (110) is disposed above the front wheel (105) for covering at least a portion of the front wheel (105). A fuel tank (112) is mounted to the main-tube of the frame assembly and it is disposed in the front portion F of a step-through structure (104) of the single frame structure. The IC engine (101) is mounted below the step-through portion (104) of the main-tube. The fuel tank (112) is functionally connected to the IC engine (101). A swing arm (not shown) is swingably connected to the frame assembly. A rear wheel (106) is rotatably supported by the swing arm and supported by one or more rear suspension(s) (113). A rear fender

(114) is disposed above the rear wheel (106). A seat assembly (117a, 117b) is disposed at a rear portion R of the step-through portion (104). In an embodiment, the seat assembly (117) includes a rider seat (117a), and a pillion seat (117b). Further, the seat assembly (117a, 117b) is positioned above the rear wheel (106). The vehicle (100) is supported by a centre stand (116) mounted to the single frame structure.

[00027] Fig. 1b. illustrates the side view IC engine (101) according to the embodiment of the present subject matter. The IC engine (101) is made up of a cylinder head (130), a cylinder block (140), a crankcase (150) and a cylinder head cover (120) to prevent the exposure of internal components of the cylinder head (130). The IC engine (101) also comprises a sprocket (118) which is fixed to a transmission system (not shown) inside the IC engine (101) and capable of rotation when it is in operation. In the exemplary embodiment, the IC engine (101) is mounted below the step-through portion by means of two mounting means (121 and 122) disposed on the IC engine (101). The IC engine (101) further includes, an air intake system (not shown), an exhaust system (not shown), and a starter system (not shown) all enclosed within the crankcase (150). The starter system includes an electric starter mechanism or a mechanical starter mechanism. The electrical starter system is powered by an auxiliary power source, for cranking the IC engine (101), while the mechanical starter mechanism comprises a kick-starter system (119) is operatively connected to the transmission system and on rotating a lever by the rider's foot; the rider can start the IC engine (101).

[00028] Fig. 2a and Fig. 2b. illustrates an isometric view and the exploded view of the IC engine (101) with the cylinder head cover (120) removed. The explanation will be provided with respect to both the figures 2a. and 2b. The cylinder head (130) is having the combustion-chamber face (310) is abutted over the cylinder block (140) to form a combustion chamber (310a) therein. The cylinder head (130) and the cylinder block (140) comprises a plurality of through-holes (203a, 203b, 203c and 203d) disposed around the outer surface of the

cylinder head (130) and cylinder block (140). The plurality of through-holes (203a, 203b, 203c and 203d) begins on the top surface of the cylinder head (130) facing the cylinder head cover (120) and extends up to the combustion chamber face (310) of the cylinder head (130). In the embodiment, each of the plurality of
5 through-holes (203a, 203b, 203c and 203d) is equidistantly spaced apart around the outer surface of the cylinder head (130). The corresponding plurality of through-holes in the cylinder block (140) matches exactly in profile, shape and size with the plurality of through-holes (203a, 203b, 203c and 203d) on the cylinder block (140). A plurality of connecting members (201a, 201b, 201c and
10 201d) are capable of being inserted in the plurality of through-holes to connect the cylinder head (130) to the cylinder block (140) such that the combustion chamber face (310) abuts the cylinder block (140). Further, a seal (140a) is disposed between the cylinder head (130) and cylinder block (140) to form a seal and prevent escape of elements of combustion and lubrication oil from the combustion
15 chamber (310a). Additionally, the seal (140a) forms a heat seal, maintaining the temperature inside the combustion chamber (310a). The connection of the cylinder head (130) to the cylinder block (140) is secured by the plurality of connecting members and the same is tightened by a plurality of nut and washer arrangement (202a, 202b, 202c and 202d). A tightening tool is used to apply
20 tightening torque and securely mount and seal the cylinder head (130) over the cylinder block (140).

[00029] Fig. 3a. illustrates a cut section of the exemplary IC engine (101) showing the main components of the cylinder head (130) according to the embodiment of the present subject matter. During operation, the burning of fuel
25 and air occurs in the combustion chamber (310) and transfers mechanical energy to the reciprocating piston (not shown) which transfers the mechanical energy to the rotatable crankshaft (not shown) which generates power due to the slider crank mechanism. The cylinder head assembly (130) comprises of at least one intake valve (304) and at least one outlet valve (305) which are operated by means of
30 rocker arms (307, 308) and a camshaft (306) which consists of at least one inlet cam lobe (306a) and at least one outlet cam lobe (not shown) which actuates the

rocker arms (307, 308) when required. The cylinder head (130) comprises an intake port (302) and an outlet port (303) whose one end opens to the combustion chamber (310a) and whose opening and closing is controlled by the intake valve (304) and outlet valve (305) respectively. The intake port (302) directs the air fuel
5 mixture into the combustion chamber (310a) from an air-intake system (not shown) and the outlet port (303) directs the exhaust gases out of the combustion chamber (310a) to a muffler assembly (not shown). The tappet valve including intake valve (304) and outlet valve (305) are abutted on the surface of the valve seat (301a and 301b) and sealed effectively by the biasing force of an elastic
10 member such as an helical spring (304a and 305a).

[00030] Fig. 3b. illustrates the bottom view of the cylinder head (130) highlighting the combustion chamber face (310) according to the embodiment of the present subject matter. The invention is an indentation (320) which is disposed on the combustion-chamber face (310) within an area enclosed by two imaginary
15 lines (X and Y) tangential to both the outer circumferential surface of one of the plurality of through-holes (203) and the outer circumferential surface of the nearest valve seat (301).

[00031] The working of the present subject matter will be explained with reference to comparing the prior art (see Fig. 4a, Fig. 4b and Fig. 4c) and the
20 features of the present subject matter (see Fig. 5a, Fig. 5b and Fig. 5c). Fig. 4a illustrates a cut-sectional view of a typical IC engine having a cylinder head (130) and cylinder block (140) abutting each other and secured by plurality of connecting members (201a, 201b, 201c and 201d) disposed on its outer periphery and applying a tightening torque to the nut and washer arrangement (202a, 202b,
25 202c and 202d). Due to the application of high tightening torque by a tool on the nut and washer arrangement (202a, 202b, 202c and 202d) to secure the connection and provide a tight fit, this exerts compressive forces on the cylinder head (130) and cylinder block (140) represented by a force cone (401) showing the application of compressive forces and its intensity in magnitude. The force
30 cone (401) is generated due to application of high tightening torque. As it can be

seen from the figure, the force exerted by the tightening torque is maximum around the junction of the cylinder head (130) and cylinder block (140). This force can cause the combustion chamber face (310) of the cylinder head (130) to deform and take a curved shape. Fig. 4b illustrates representatively the curve of the combustion chamber face (310) of the cylinder head (130). Here, the due to the application of compressive force, the combustion chamber deforms (see 403) from original straight profile (see 310). This phenomenon is especially profound in smaller IC engines of lesser combustion chamber volume capacity. This is due lesser distances between plurality of through-holes, and lesser stiffness of material of cylinder head which magnifies the deformation above an unacceptable level. Fig. 4c illustrates the effect of compressive forces acting on the valve seat (301) around the tappet valve (304 and 305) according to the embodiment of the present invention. The deformations of the combustion chamber face (310) due to the compressive forces will also act on the valve seat (301) and deform it as shown in the figure. This deformation of valve seat (301) will distort it to unacceptable levels (deformation up to order of 10 microns) resulting in improper dimensions around the valve seat (301) which prevent proper contact with the head of tappet valve (304 and 305). Such improper dimensions include effect on valve seat concentricity, width of valve seat and proper seating on the cylinder head. This results in drawbacks such as valve leakage and reduced heat extraction. It is to noted that, the distortions of the valve seat (301) and combustion chamber face (310) illustrated in Fig. 4b and Fig. 4c are in the order of 10 microns, and the deflections shown are exaggerated for illustrative and explanatory purposes only.

[00032] Fig. 5a illustrates the cross-section of the cylinder head (130) and cylinder block (140) according to the embodiment, with the indentation (320) disposed on the combustion-chamber face (310) within an area enclosed by two imaginary lines (X and Y) tangential to both the outer circumferential surface of one of the plurality of through holes and the outer circumferential surface of the valve seat (301). The indentation (320) is located on the line of action of compressive forces acting on the combustion chamber face which falls within the area described above. The presence of the indentation (320) forms a least resistive

path for the compressive force which is applied and prevents the compressive forces from acting on the valve seat (301). Hence, the indentation isolates the compressive forces and transfers the forces to itself to get deformed and prevents the compressive forces from acting on the valve seat (301). **Fig. 5b** illustrates representatively the deformation of the combustion chamber face (310) of the cylinder head (130) after application of tightening torque through the connecting member. Here, it is seen that with the introduction of the indentation (320), the deformation of the combustion chamber face (310) is minimal and within acceptable tolerance limits. **Fig. 5c** illustrates the deformation of the indentation (320) thus preventing the compressive force acting on the valve seat (301). It is seen that the compressive forces take the least resistive path and act on the indentation thus safeguarding the critical components such as the valve seat and prevent it from getting deformed. It is to be noted that, the figures **4a**, **4b** and **4c** illustrate the indentation present in on corner of the combustion chamber face (310) of the cylinder head (130). But, the present subject matter is applicable to all the four corners or any two or three corners in any combination depending on the direction of compressive forces generated in the IC engine (101).

[00033] **Fig. 6a** illustrates the front view of the combustion chamber face (310) of the cylinder head (130) according to a second embodiment of the present subject matter. In this embodiment, the circular indentation is replaced by a rectangle indentation (320a) which is disposed within an area enclosed by two imaginary lines (X and Y) tangential to both the outer circumferential surface of one of the plurality of through holes and the outer circumferential surface of the nearest valve seat (301). **Fig. 6b** illustrates another third embodiment of the present subject matter. Here, the indentation is a circular groove (320b) running throughout the combustion chamber face (310) such that, the sector of the circular groove (320b) is disposed within an area enclosed by two imaginary lines (X and Y) tangential to both the outer circumferential surface of one of the plurality of through holes and the outer circumferential surface of the nearest valve seat (301). The third embodiment has an advantage that, the machining process of making a

circular groove (**320b**) is easier and is applicable when equal compressive forces are acting on all regions around the combustion chamber face (**310**).

[00034] Many modifications and variations of the present subject matter are possible in the light of above disclosure. Therefore, within the scope of claims of
5 the present subject matter, the present disclosure may be practiced other than as specifically described.

We Claim:

1. An internal combustion (IC) engine (101) comprising:
 - a cylinder block (140);
 - a cylinder head (130) comprising a combustion-chamber face (310)
 - 5 abutting the cylinder block (140) to form a combustion chamber (310) therein;
 - said cylinder head (130) comprising plurality of ports with at least one port (302) permitting air fuel inside the combustion chamber (310a) and at least one port (303) permitting gases of combustion to be expelled out, and
 - 10 said plurality of ports opening to the combustion-chamber face (310) facing the combustion chamber (310a), and a valve seat (301) surrounding the opening of each of the plurality of ports;
 - said cylinder block (140) and said cylinder head (130) securely mounted by plurality of connecting members (201), said cylinder block (140) and
 - 15 said cylinder head (130) comprising plurality of holes (203) to accommodate the plurality of connecting members (201) to secure the cylinder head (130) to the cylinder block (140) on application of tightening torque;
 - an indentation (320) disposed on the combustion-chamber face (310)
 - 20 within an area enclosed by two imaginary lines (X & Y), said two imaginary lines (X & Y) are tangential to both the outer circumferential surface of one of the plurality of holes (203) and the outer circumferential surface of the nearest valve seat (301) to form a least resistive path for the compressive force exerted due to application of tightening torque to said
 - 25 plurality of connecting members (201).
2. The IC engine (101) as claimed in claim 1, wherein the cylinder head (130) further comprises at least one intake valve (304) covering the intake port (302) and at least one outlet valve (305) covering the outlet port (303) which are

operated by means of rocker arms (**307, 308**), and said intake valve (**304**) and outlet valve (**305**) configured to abut on the surface of the intake valve seat (**301a**) and outlet valve seat (**301b**) respectively to form an effective seal by the biasing force of an elastic member (**304a** and **305a**).

- 5 3. The IC engine (**101**) as claimed in claim 1, wherein the plurality of through-holes are four in number (**203a, 203b, 203c** and **203d**), said each of plurality of through-holes (**203a, 203b, 203c** and **203d**) spaced apart around the outer surface of the cylinder head (**130**) matching with corresponding holes on the cylinder block (**140**).
- 10 4. The IC engine (**101**) as claimed in claim 3, wherein said plurality of connecting members (**201a, 201b, 201c** and **201d**) are capable of being inserted in the plurality of through-holes (**203a, 203b, 203c** and **203d**) to connect the cylinder head (**130**) to the cylinder block (**140**) such that the combustion chamber face (**310**) abuts the cylinder block (**140**).
- 15 5. The IC engine (**101**) as claimed in claim 3, wherein said plurality of connecting members is tightened by a plurality of nut and washer arrangement (**202a, 202b, 202c** and **202d**) by applying tightening torque by a tightening tool.
6. The IC engine (**101**) as claimed in claim 1, wherein the indentation (**320**) is disposed at any one or more of the four area quadrants formed by said two
20 imaginary lines (**X & Y**) tangential to both the outer circumferential surface of one of the plurality of holes (**203**) and the outer circumferential surface of the nearest valve seat (**301**).
7. The IC engine (**101**) as claimed in claim 1, wherein said cylinder head (**130**) and said cylinder block (**140**) are assembled and a seal (**140a**) is disposed there
25 between to prevent escape of elements of combustion and lubrication oil from the combustion chamber (**310a**).
8. The IC engine (**101**) as claimed in claim 1, wherein said IC engine is air cooled and operating at lower volume capacities of below 200 cubic centimetres.

9. The IC engine (**101**) as claimed in claim 1, wherein said indentation (**320**) is disposed in more than one quadrant of said combustion chamber face (**310**).
10. The IC engine (**101**) as claimed in claim 1, wherein the shape of the indentation (**320**) is circular.
- 5 11. The IC engine (**101**) as claimed in claim 1, wherein the shape of the indentation (**320**) is rectangular.
12. The IC engine (**101**) as claimed in claim 1, wherein the shape of the indentation (**320**) is a continuous circular groove around the entire combustion chamber face (**310**).
- 10 13. A two wheeled vehicle (**100**) comprising the IC engine (**101**) as claimed in any of the preceding claims.

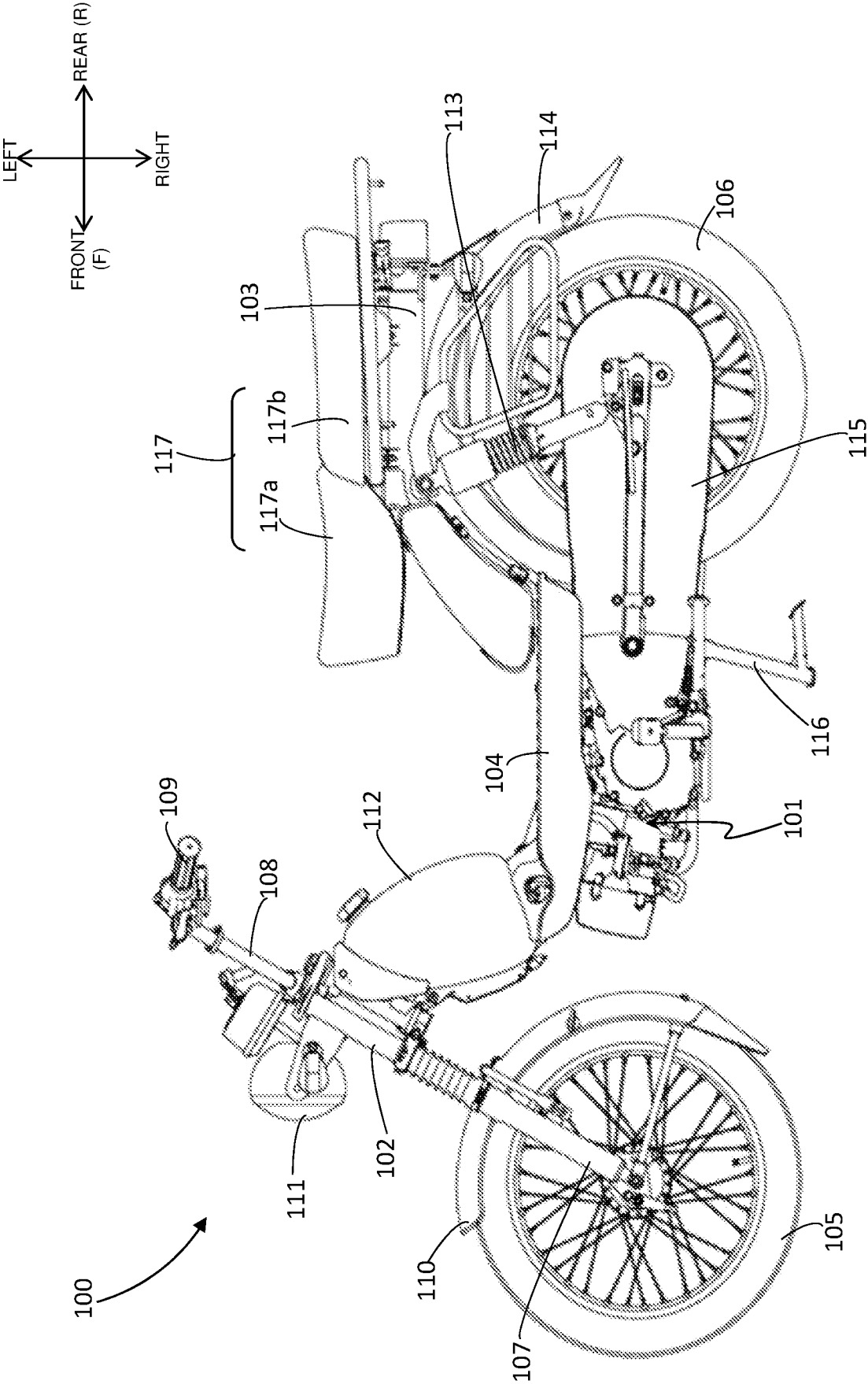


Fig. 1a

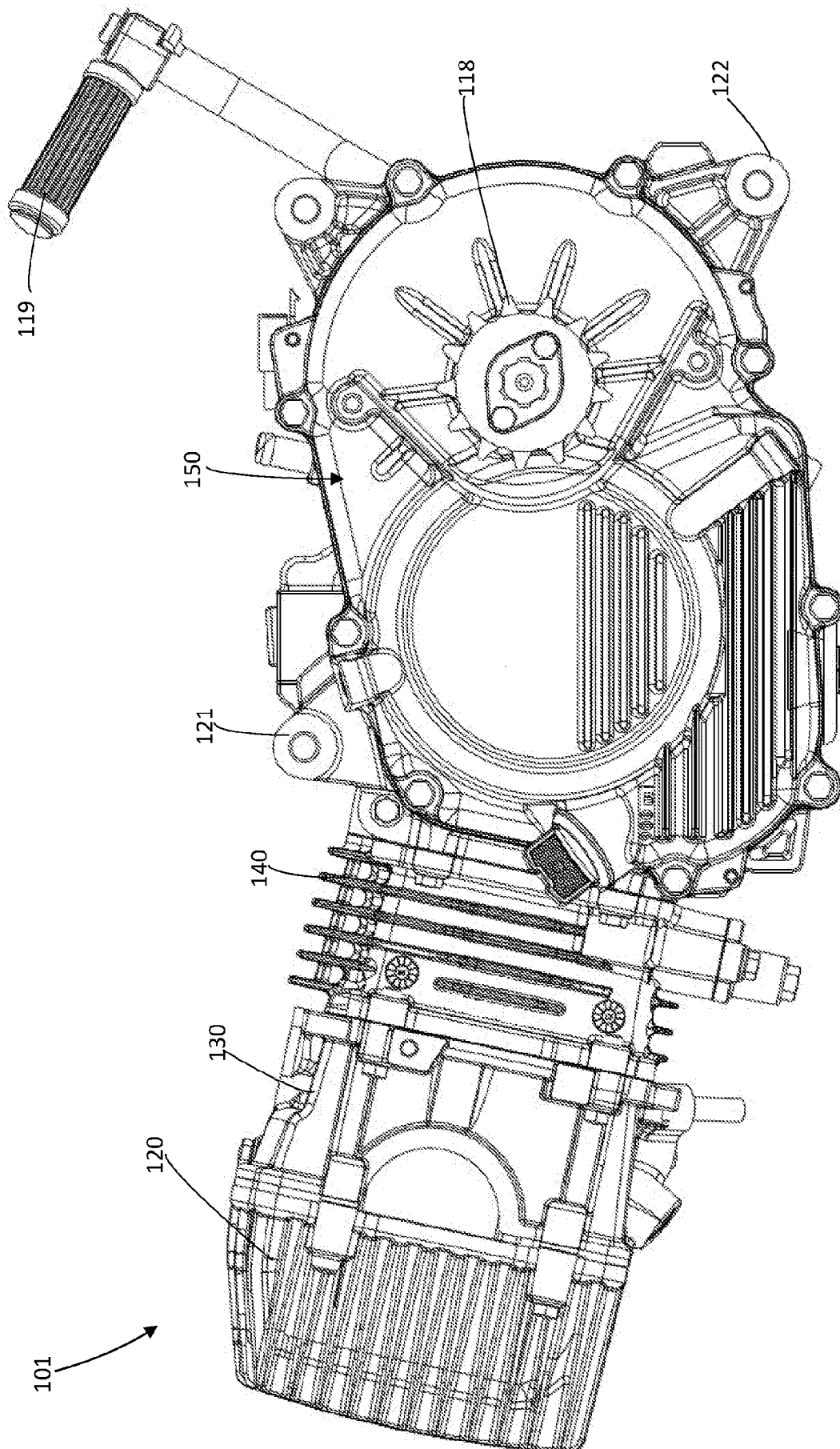


Fig. 1b

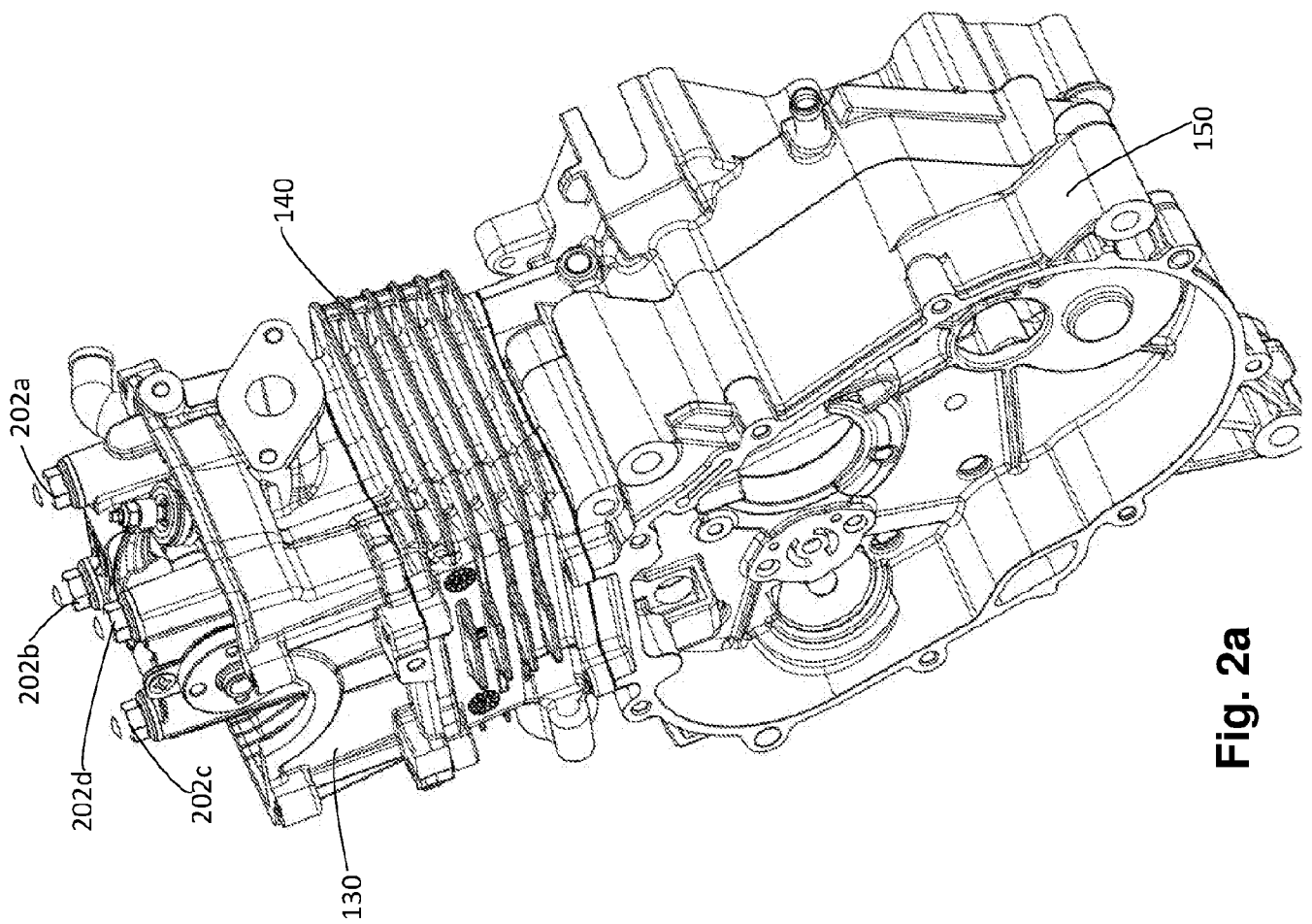


Fig. 2a

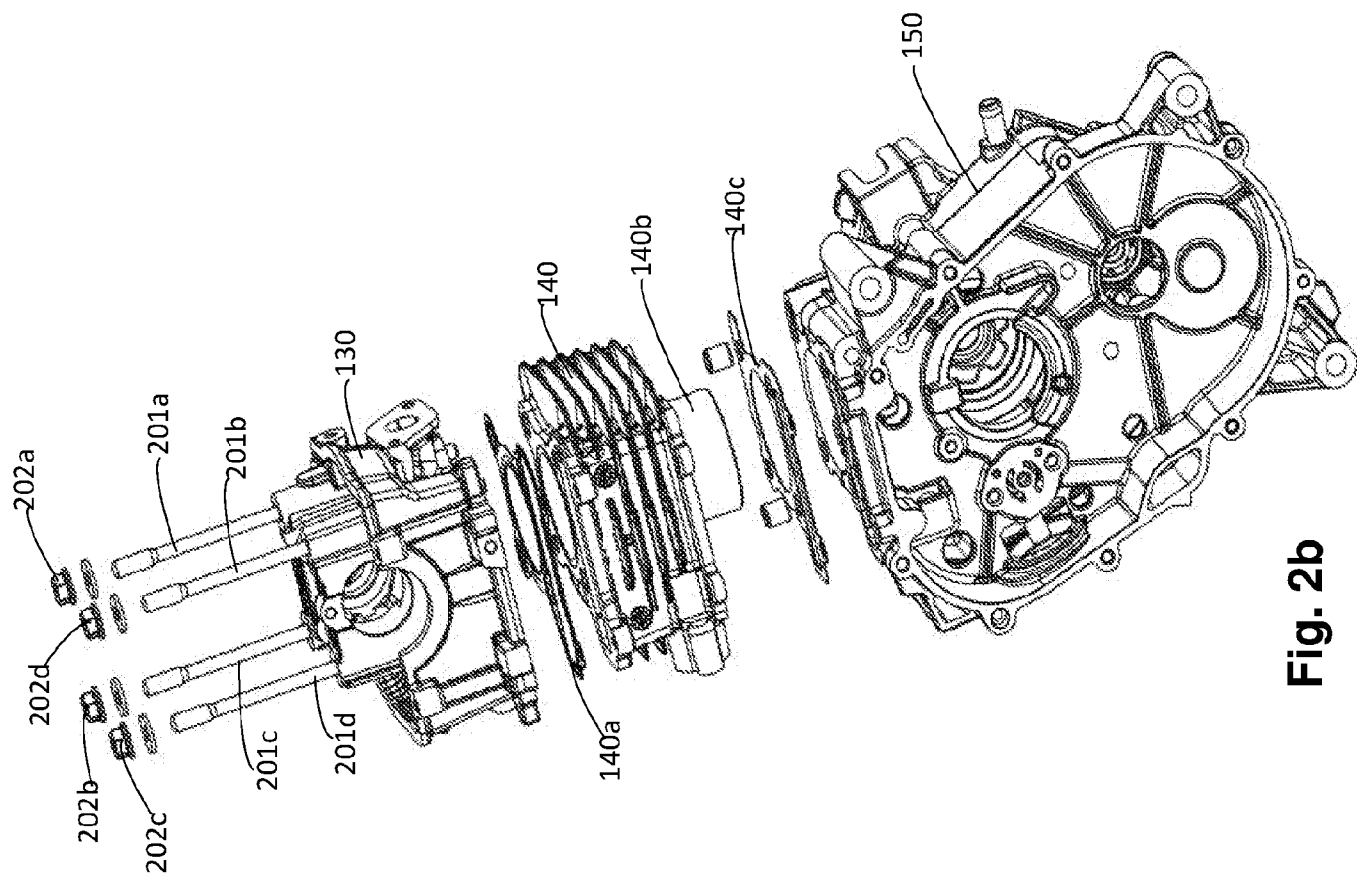


Fig. 2b

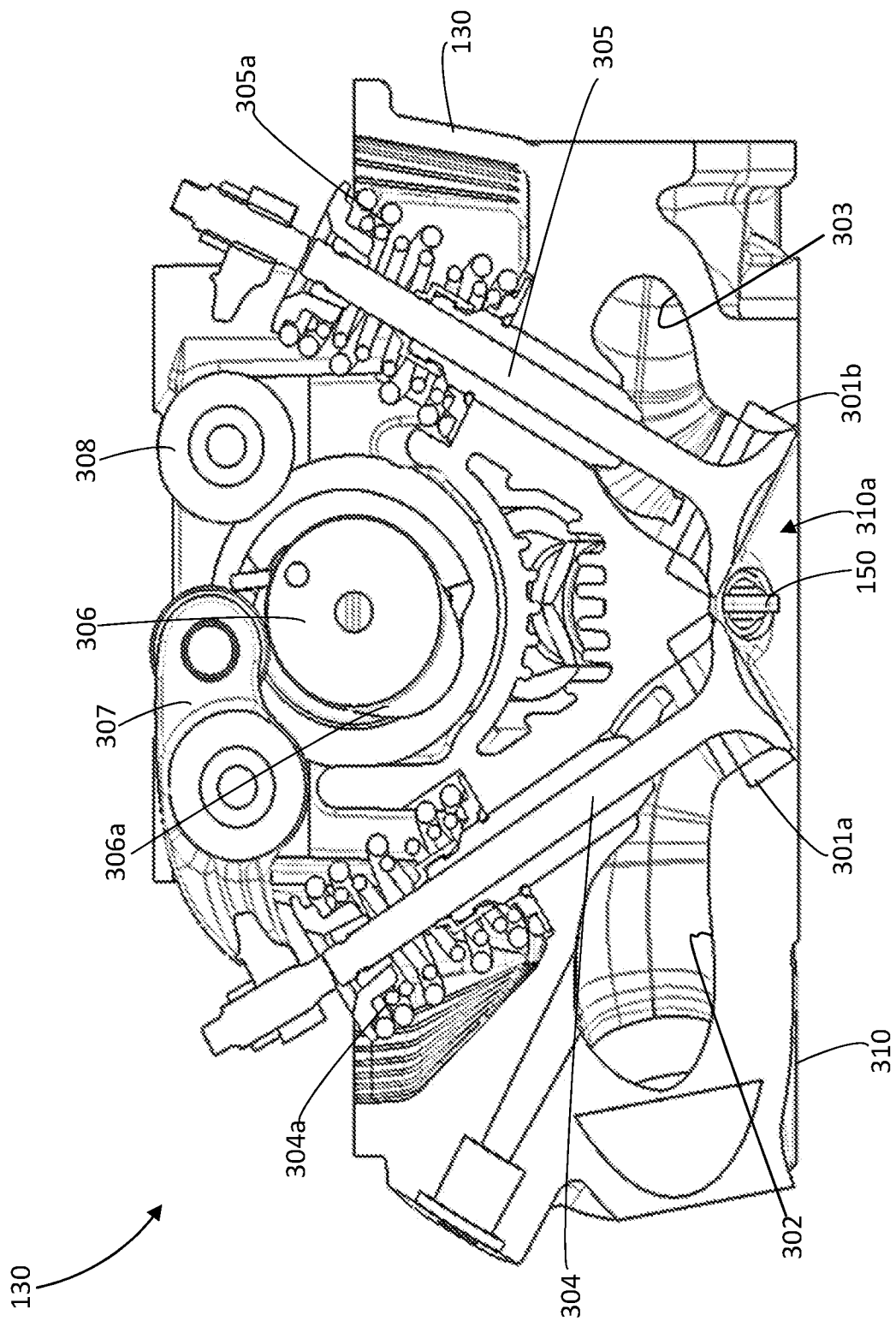


Fig. 3a

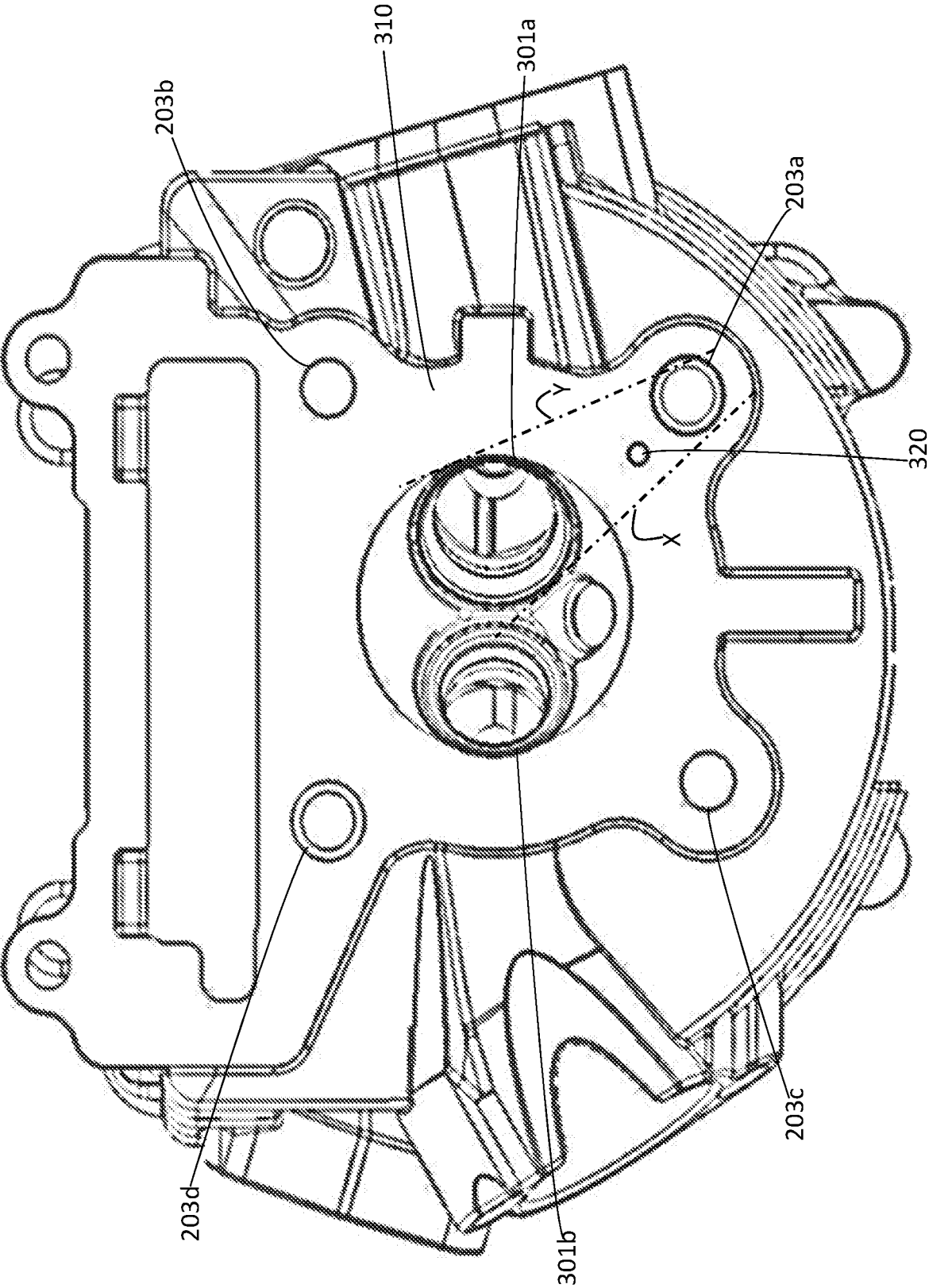


Fig. 3b

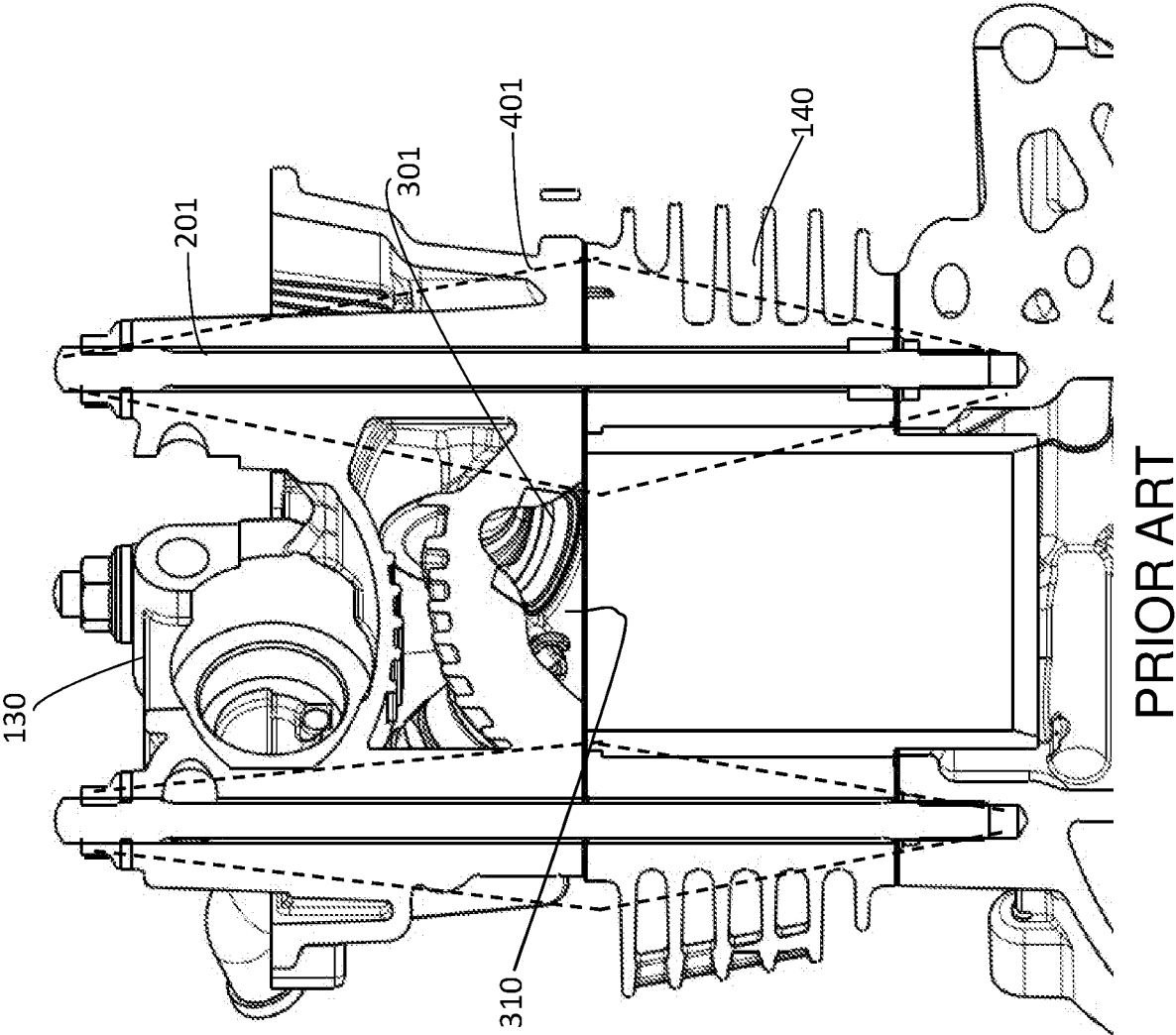


Fig. 4a

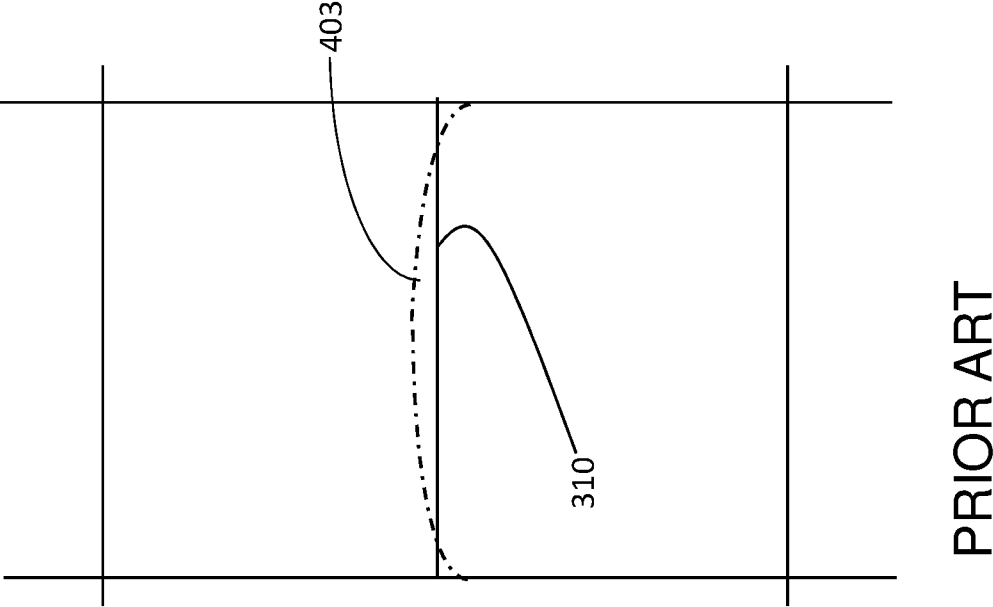
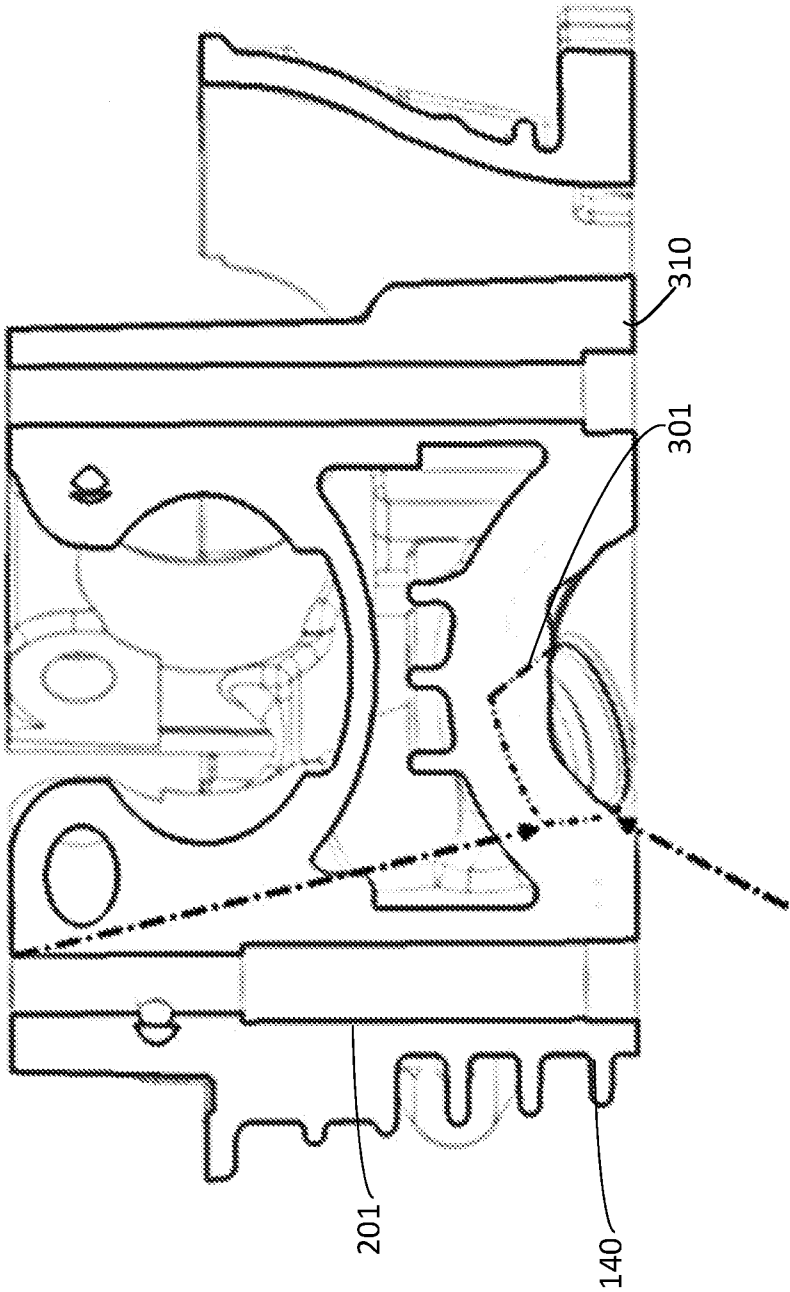


Fig. 4b



PRIOR ART

Fig. 4c

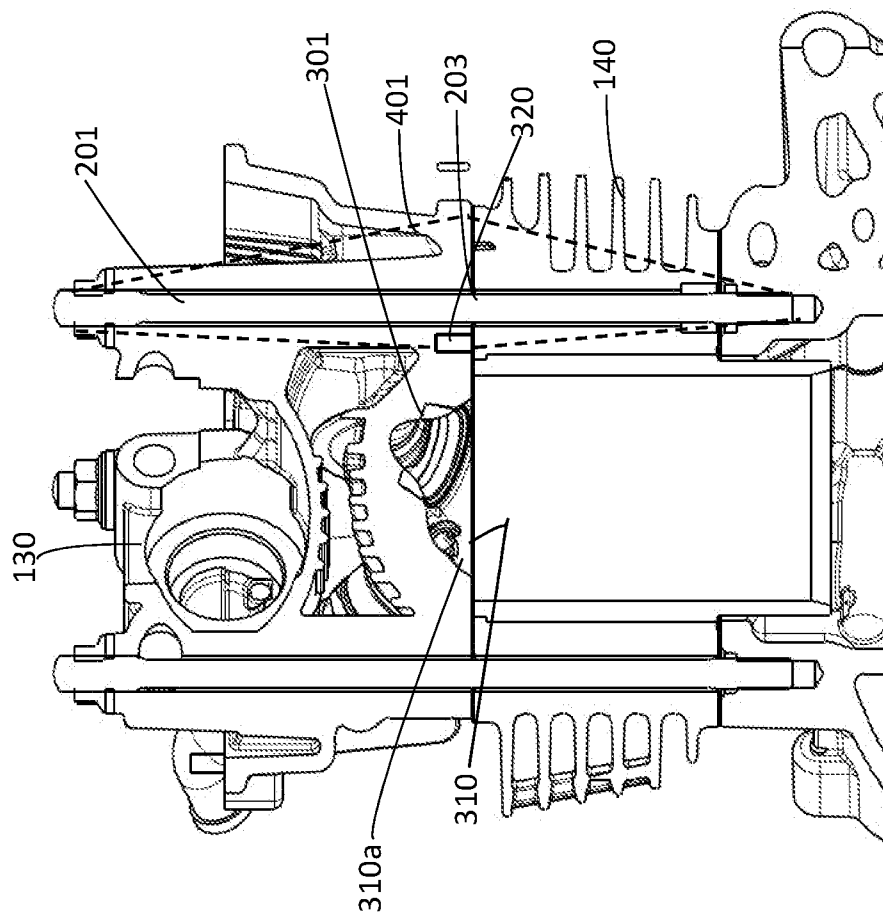


Fig. 5a

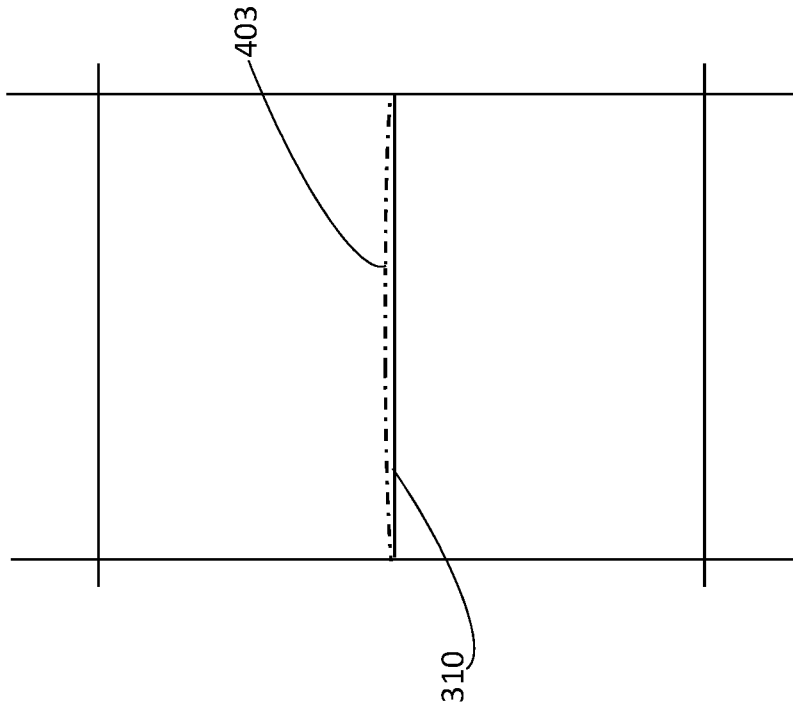


Fig. 5b

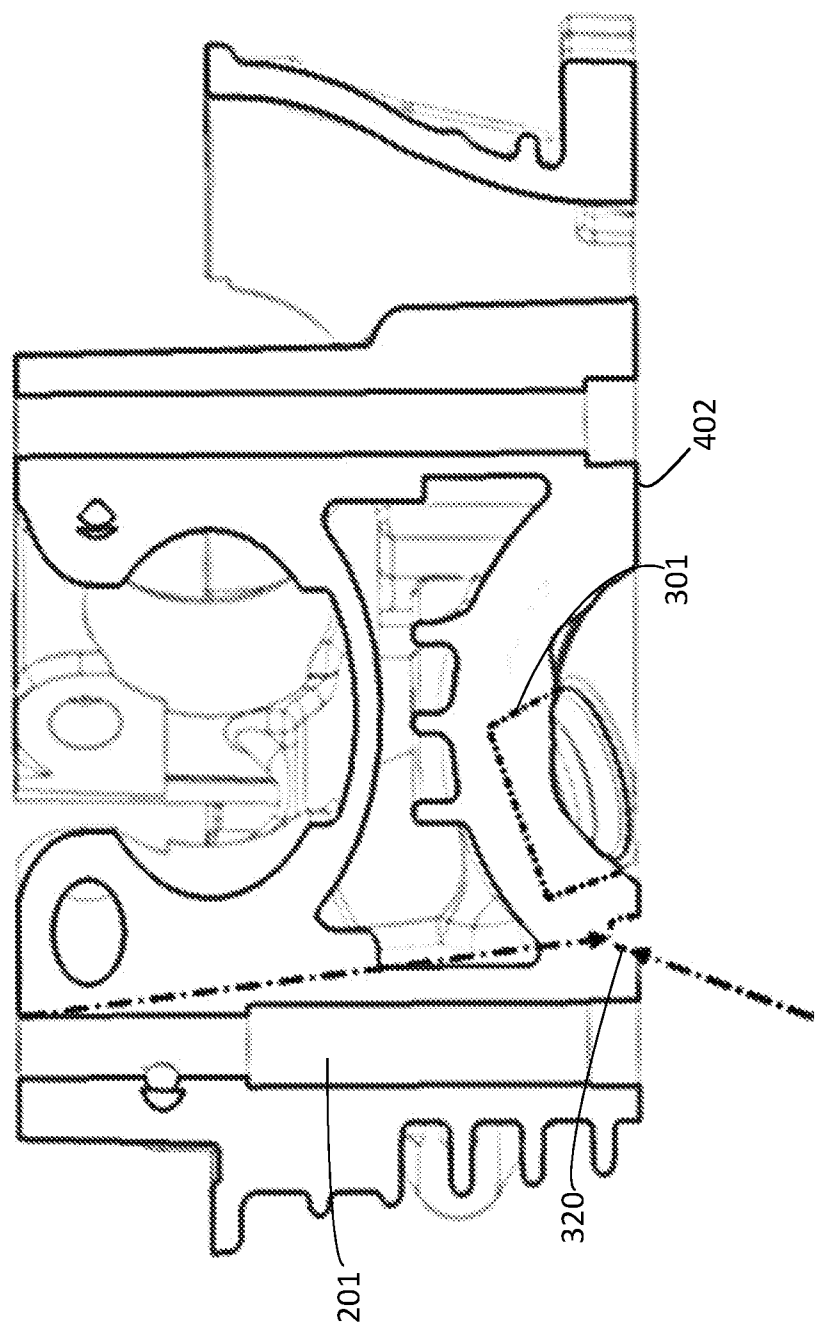


Fig. 5c

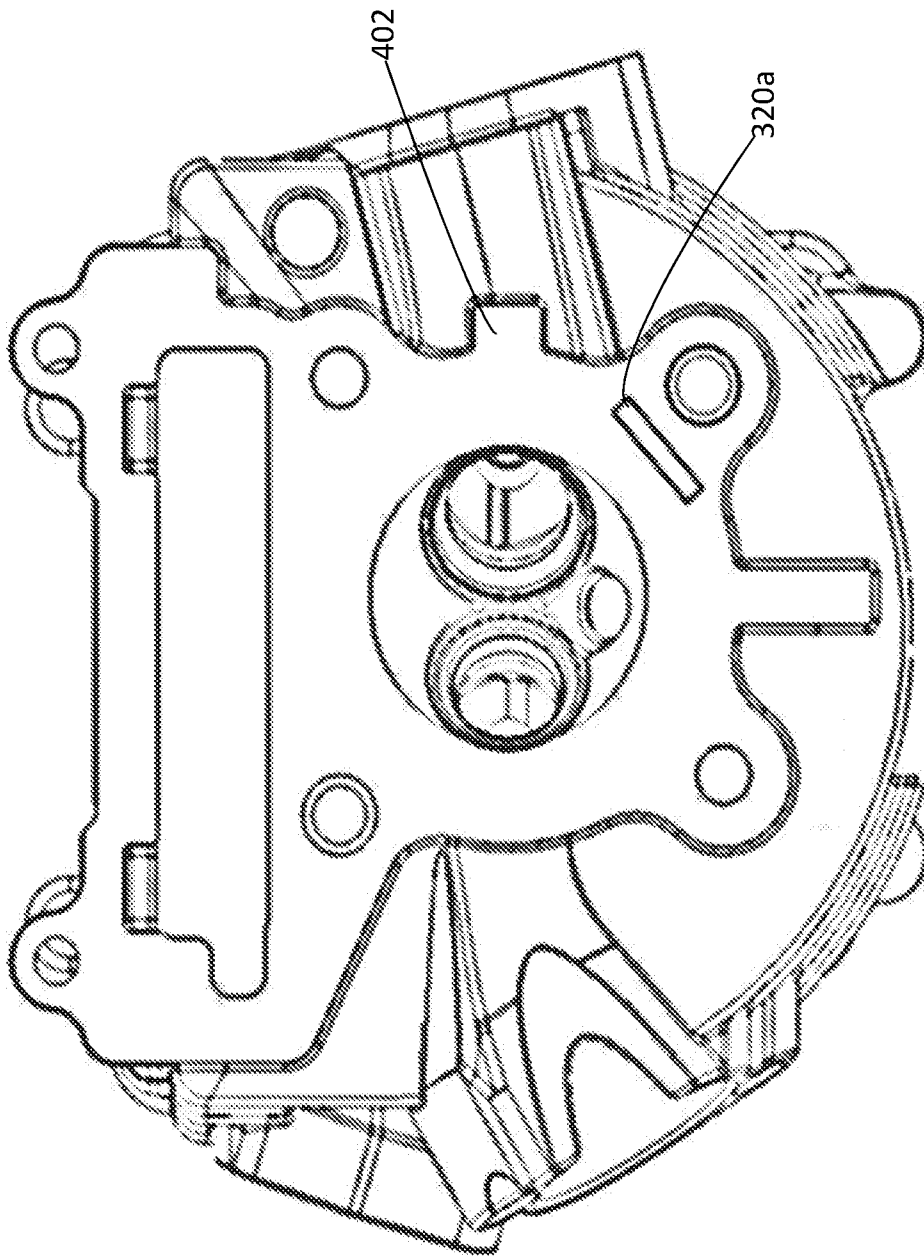


Fig. 6a

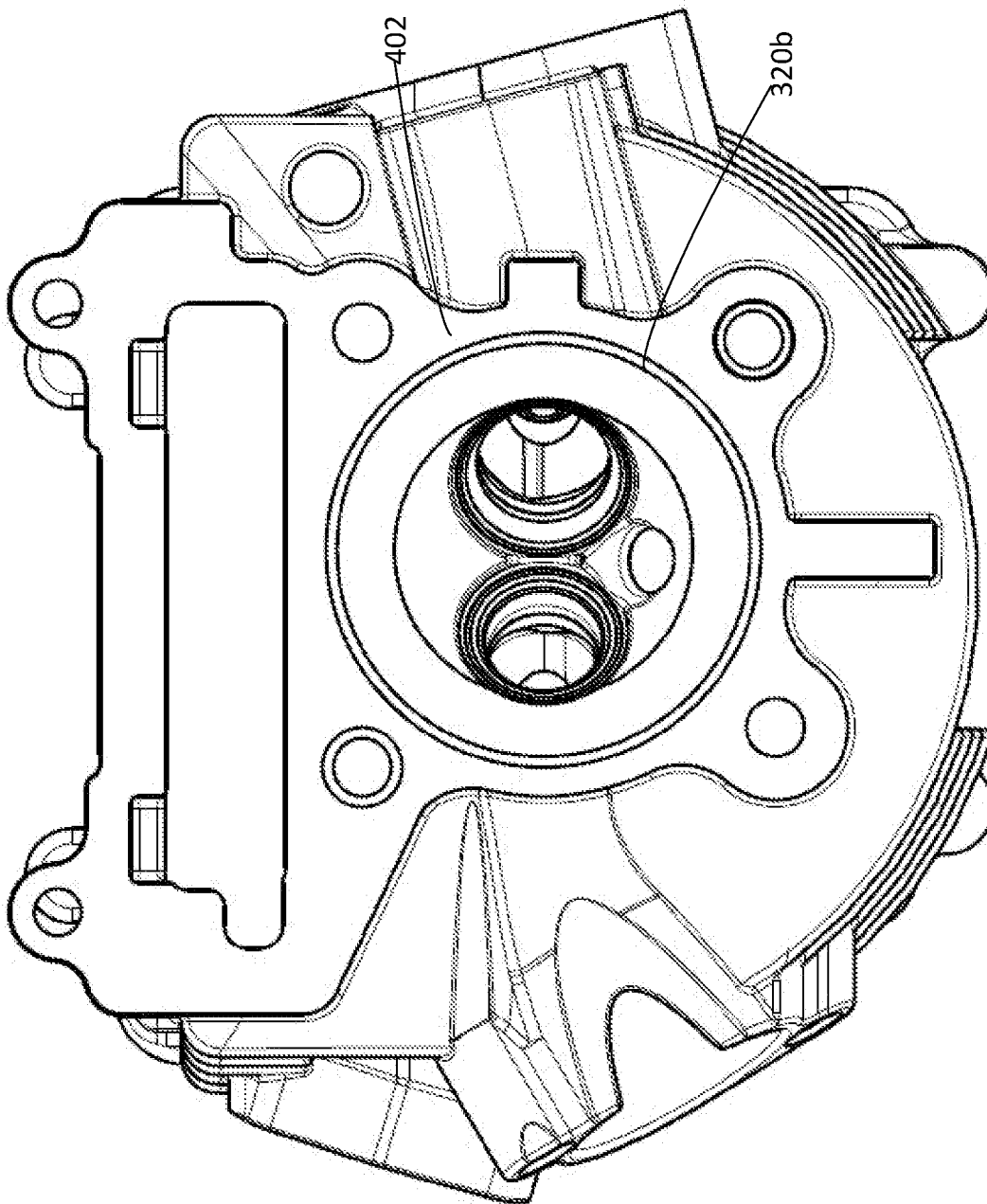


Fig. 6b

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2017/054992

A. CLASSIFICATION OF SUBJECT MATTER
F02F1/00 Version=2017.01

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)

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 practicable, search terms used)

Patseer, IPO Internal Database, J-Plat Pat

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP2004092620A (TOYOTA MOTOR CORP) 25 Mar 2004 Title; abstract; paragraph [0015],[0016]; figure.	1-13
A	JP2001132535A ((HONDA MOTOR CO LTD) 15 May 2001 Figure; paragraph [0036].	1-13
A	JP2000161128A (TOYOTA MOTOR CORP) 13 Jun 2000 Title; abstract; figure.	1-13

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

21-11-2017

Date of mailing of the international search report

21-11-2017

Name and mailing address of the ISA/

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IB2017/054992

Citation	Pub.Date	Family	Pub.Date
JP 2000161128 A	13-06-2006	EP 1004765 A1	31-05-2000