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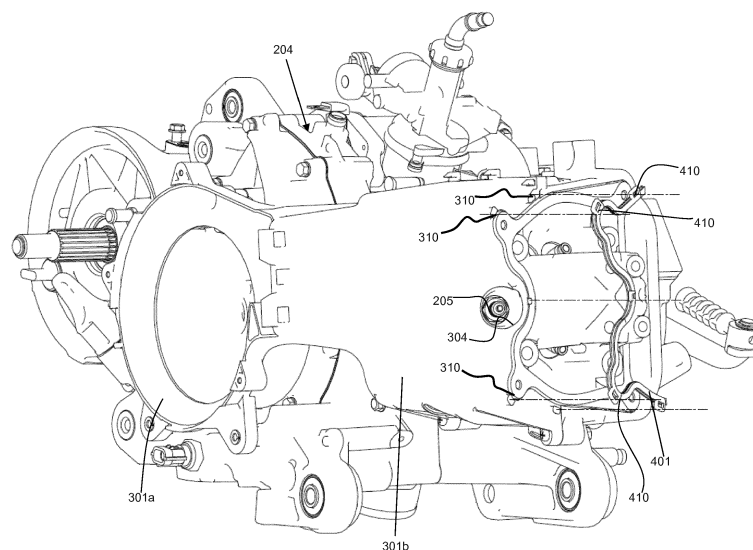
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**(54) A COOLING SYSTEM FOR AN INTERNAL COMBUSTION ENGINE**

(57) The present subject matter discloses an internal combustion (IC) engine (101). The internal combustion (IC) engine (101) comprising a forced cooling system (200). The forced cooling system (200) wherein a sealing member (401) is mounted on an outer periphery of a shroud assembly (301,302) by means of plurality of projections (310) placed at regular intervals, and the sealing member (401) is provided with plurality of slots (410) which accommodate the plurality of projections (310) for

its assembly on to the shroud assembly (301,302). This subject matter provides simplicity in mounting the sealing member (401) during engine assembly, and there is lesser probability of error. Such an assembly results in better attachment of the sealing member (401) and hence provides effective air sealing capability. Ultimately, the performance of the IC engine (101) improves through effective cooling.

**Fig. 3****EP 3 385 521 A1**

## Description

### TECHNICAL FIELD

[0001] The present invention relates generally to a saddle vehicle. More particularly, the present invention relates to a cooling system employed to cool the internal combustion engine of the saddle vehicle.

### BACKGROUND

[0002] An internal combustion engine converts thermal energy obtained from burning of a fuel with an oxidizer (air) into mechanical energy, which can be employed to do a wide variety of mechanical work. It is used in a wide range of applications including providing motive force for movement of an automobile. One such type of automobile powered by an internal combustion engine is a step-through type two wheeled vehicle, typically called scooter. The main parts of the internal combustion engine include a cylinder head, a reciprocating piston on a cylinder block and a connecting rod which connects the piston to the reciprocating crankshaft. During operation of the internal combustion engine, the burning of fuel and oxidizer occurs in the cylinder block and transfers mechanical energy to the reciprocating piston. This operation generates lot of thermal energy in and around the cylinder block. This thermal energy increases the temperature of the cylinder block and the atmospheric air surrounding it. Hence, it is necessary to cool the cylinder block, its associated components and the surrounding air. IC engines of step-through type two wheeled vehicle such as scooter, usually employ a cooling fan which is operably connected to the crankshaft, and the fan forces air flow through a shroud surrounding the internal combustion engine. During circulation of the air through the shroud, a sealing member is employed which is disposed above the shroud and enclosing the air-gap between the shroud and the cylinder head surface. But, the design and mounting of the sealing member is crucial and ineffective sealing permits leakage of air from the upper portion of the shroud. This is undesirable as targeted critical hot zones are not cooled and this reduces engine performance and decreases cooling efficiency of the internal combustion engine.

### 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.

**Fig. 1.** illustrates the RH view of a two wheeled vehicle employing an embodiment of the present subject matter.

**Fig. 2.** illustrates the side view of an internal com-

bustion engine and a forced air cooling system employing the embodiment of the present subject matter.

**Fig. 3** illustrates the exploded view of the internal combustion engine, a shroud assembly and a sealing member according to the embodiment of the present subject matter.

**Fig. 4.** illustrates the isometric view of the shroud assembly according to the embodiment of the present subject matter.

**Fig. 5.** illustrates an enlarged perspective view of the assembly of the sealing member over a projection according to the embodiment of the present subject matter.

### DETAILED DESCRIPTION

[0004] Various features and embodiments of the present invention here will be discernible from the following further description thereof, set out hereunder. According to an embodiment, the internal combustion (IC) engine described here operates in four cycles. Such kind of the IC engine is installed in a step through type two wheeled vehicle. It is pertinent to note that the IC engine may be mounted in two wheeled vehicles in different arrangements such as in transverse and longitudinal fashion. However, in the ensuing description, such engine is transversely mounted at a lower portion of the step through type two wheeled vehicle. It is contemplated that the concepts of the present invention may 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. The detailed explanation of the constitution of parts other than the present invention which constitutes an essential part has been omitted at suitable places.

[0005] During operation of the IC engine, the burning of air fuel mixture occurs in a combustion chamber formed between a cylinder head and cylinder block. This operation generates lot of thermal energy in and around the cylinder head and cylinder block and increases the temperature of the space surrounding it. Hence, it is necessary to cool the cylinder block, its associated components and the surrounding air. Generally, a cooling system is required to cool the IC engine components.

[0006] Typically, in a step-through type vehicle such as a scooter, a swinging IC engine is located below the seat at a lower rear portion of the vehicle. There are two side body panels surrounding the IC engine on right and left side of the vehicle. The IC engine is swingably supported by rear suspension system and attached to the frame of the vehicle. Cylinder block of such IC engines

are enclosed by the body panels and are heated up during their operation. Since, proper air circulation is lacking around the enclosed cylinder block, such IC engines are typically cooled by employing forced air cooling system. In this system, atmospheric air is drawn inside the cooling system from the outer atmosphere through an inlet by using a cooling fan. The rotation of the cooling fan is integrated to the rotation of the engine crankshaft. A shroud surrounding the cylinder block and the IC engine guides the atmospheric air thereby cooling the cylinder block. Fins are provided around the cylinder head and cylinder block which increases the contact area exposed to the circulating air. When the air flows over the fins, heat will be dissipated to the cooling air. The shroud can be made up of multiple parts and usually houses the cooling fan. The shroud will also have a cutout for exit of hot air.

**[0007]** Although cooling of the cylinder block of the IC engine is necessary, in conventional forced cooling systems there is generally leakage of air from the shroud and this leakage of air can significantly affect the cooling effectiveness of the forced air cooling system. The leakage of air is significant around the upper region of the shroud in the air-gap between the shroud and the periphery of the cylinder head cover. Hence, it is necessary to prevent this leakage. Typically sealing members such as rubber seals are used. But, mounting the sealing member is a challenge as there is potential for detaching. During engine assembly, the mounting of the sealing member require special tools and workbenches. Further, there is a tendency of misalignment and improper mounting of the sealing member may potentially cause leak and sometimes even detach from the shroud.

**[0008]** The present invention aims to address the above drawbacks by providing a forced cooling system wherein the sealing member is mounted on the outer periphery of the shroud by means of a series of projections placed at regular intervals, and said sealing member is provided with slots which accommodate the projections for its assembly on to the shroud. Further, the sealing member can be split into two halves to assemble on two halves of the shroud. This solution provides simplicity in mounting the sealing member during engine assembly, and there is lesser probability of error. Such an assembly can result in better attachment of the sealing member and hence provide effective air sealing capability.

**[0009]** The present subject matter also provides a forced cooling system with better serviceability and less maintenance cost without leading to leakage of air.

**[0010]** The present invention 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.

**[0011]** Fig. 1 illustrates the two wheeled vehicle (100) in accordance with one embodiment of the present invention. The vehicle comprises of a frame which is conventionally a U-shaped frame which provides a generally

open central area to permit "step-through" mounting by a rider. Typically, the frame comprises of a head tube (102), a main tube (107), and a pair of side-tubes (109) (only one shown). One end of the main tube (107) extends downwardly and rearwardly in a horizontal direction to form a step-through portion (117) which then connects with the pair of side-tubes (109). At the other end there is the head tube (102) which is configured to rotatably support a steering tube (111) and further connected to the front suspension system (121) at the lower end. A handlebar support member (not shown) is connected to an upper end of the steering tube (111) and supports a handlebar assembly (106). Two telescopic front suspension system (121) (only one is shown) is attached to a bracket (not shown) on the lower part of the steering tube (111) on which is supported a front wheel (119). The upper portion of the front wheel (119) is covered by a front fender (103) mounted to the lower portion of the steering shaft (111). The pair of side-tubes (109) includes a down frame section inclined downwards and connected to the main tube (107) at one end of the step-through portion (117). A plurality of cross pipes (not shown) is secured in between the pair of side-tubes (109) to support vehicular attachments including a utility box (not shown), a seat assembly (108) and a fuel tank assembly (not shown) with a fuel tank cap (112). A pillion handle (118) is present in the periphery of the rear end of the seat assembly (108) and above the fuel tank cap (112). The IC engine (101) is swingably connected to the step-through type frame having the rear wheel (113) at its other end. A rear fender (110) is disposed above the rear wheel (113). The IC engine (101) is further supported on the frame through one or more rear suspension(s) (not shown).

**[0012]** Fig. 2. illustrates the side view of the IC engine (101) in accordance with the embodiment of the present subject matter. The IC engine (101) is made up of a cylinder head (not shown), cylinder block (not shown), a cylinder head cover (201) and crankcase (204). A forced air cooling system (200) is disposed on the IC engine (101). The forced air cooling system (200) comprises a cooling fan (not shown), and a shroud assembly (301, see Fig. 4. for 302) for directing and circulating air inside the IC engine (101). The cooling fan (not shown) is mounted on a crankshaft (not shown) on any one end of the IC engine (101) in its width direction. In the present embodiment, the cooling fan (not shown) is mounted on the rightward side of the IC engine (101). The shroud assembly (301, 302) is configured to cover the right part of the crankcase (204), the cylinder head (not shown), the cylinder block (not shown) and the cooling fan. The shroud assembly (301, 302) is made up by assembling two parts, namely attaching the RH shroud (301) with the LH shroud (302) enclosing the IC engine (101). The LH shroud (302) covers a left part of the portion of the cylinder block (not shown) and cylinder head (202). The RH shroud (301) comprises two portion, one portion is a crankcase portion (301a) having a grilled circular opening

(303) and a cylinder portion (301b) enclosing the cylinder head (202) and the cylinder block (not shown). When the RH shroud (301) is assembled to enclose the right side of the IC engine (101), the cooling fan is enclosed by the crankcase portion (301a). When the RH shroud (301) and LH shroud (302) are assembled around the cylinder head (202) and the cylinder block (not shown), an air-gap (210) is formed between the upper region of the shroud assembly (301, 302) and the cylinder head cover (201) around the entire periphery of the shroud assembly (301, 302). Covering this air-gap (210) is critical to prevent the escape of air circulating around the shroud assembly (301, 302). The zone of connection between the RH shroud (301) and the LH shroud (not shown) on the bottom direction of the IC engine (101) forms an exhaust connection zone (250) on which an exhaust pipe (251) is attached to the cylinder head (202).

[0013] Fig. 3. illustrates the exploded view of the shroud assembly (301, 302), the sealing member (401) assembled on the IC engine (101) according to the embodiment of the present subject matter. During operation, the burning of fuel and oxidizer occurs in the cylinder block (not shown) and transfers mechanical energy to the rotatable crankshaft (not shown). The cooling fan (not shown) is attached to the rotatable crankshaft on the right side of the IC engine (101) and the RH shroud (301) encloses the IC engine (101) on the right side over the cooling fan (not shown) such that, during rotation of the rotatable crankshaft (401), the cooling fan (not shown) which is integrally mounted on it rotates along with it drawing cooling air inside the RH shroud (301) through the grilled circular opening (303). The grilled circular opening (303) is exposed to the atmosphere through the lower half of the vehicle (see Fig. 1) such that during operation of the cooling fan (not shown) the atmospheric air gets drawn through the grilled circular opening (303) to be guided by the shroud assembly (301, 302). The cylinder portion (301b) encloses the other half portion of the cylinder block (not shown) and cylinder head (not shown) and connects to the LH shroud (302) by means of bosses. The RH shroud (301) has another circular opening (304) through which surrounds a spark plug (205) is mounted on the cylinder head (202). A sealing member (401) is securely attached over the junction of the shroud assembly (301, 302) and cylinder head cover (201). The sealing member (401) is mounted on the outer periphery of the shroud assembly (301, 302) and performs sealing of the shroud assembly (301, 302) to prevent leakage of air circulating inside. The flat area around the outer axial surface comprises one or more plurality of projections (310) disposed at regular intervals throughout the outer periphery. The sealing member (401) comprises one or more plurality of slots (410) matching the plurality of projections (310) on the shroud assembly (301, 302).

[0014] Fig. 4 the isometric view of the RH shroud (301) and LH shroud (302) according to the embodiment of the present subject matter. The sealing member (401) is dis-

posed on an upper portion on a flat area around the shroud assembly (301, 302) outer axial surface. The circular opening (304) facilitates the removal and attachment of the spark plug (205) without the need for removal of the RH shroud (301). Fig. 5 an enlarged perspective view of the assembly of the sealing member (401) over the plurality of projections (310) according to the embodiment of the present subject matter. The sealing member (401) has plurality of slots (410) whose internal dimensions matching exactly with the dimensions of the projection (310). Given the elastic nature of rubber material forming part of the sealing member (401), when the sealing member (401) is assembled by inserting the plurality of slots (410) over said plurality of projections (310), it forms a press fit and can be secured rigidly over the shroud assembly. The plurality of projections (310) comprises a shoulder portion (310a) disposed on the free end of the plurality of projections (310). The shoulder portion (310a) comprises an area of enlarged cross-section as compared to the dimensions of the rest of the plurality of projections (310). The shoulder portion (310a) is configured to prevent movement of the sealing member after insertion of plurality of slots (410) to the plurality of projections (310) and enables a suitably shape conforming snag fit between the two parts.

[0015] Many modifications and variations of the present subject matter are possible in the light of above disclosure. Therefore, within the scope of claims of the present subject matter, the present disclosure may be practiced other than as specifically described.

## Claims

### 1. A vehicle (100) comprising:

an internal combustion (IC) engine (101), said  
an internal combustion (IC) engine (101) comprising:

a forced air cooling system (200) disposed  
on said IC engine (101), said forced air cooling  
system (200) comprises a shroud assembly (301, 302) disposed on the IC engine (101) to cover at least a portion of said IC engine (101); and

an air-gap (210) between the upper region  
of the shroud assembly (301, 302) and a  
cylinder head cover (201) of said IC engine  
(101);

wherein,

a sealing member (401) disposed on the outer  
periphery of said shroud assembly (301, 302) to  
prevent the leakage of air through said air-gap  
(210);

said sealing member (401) comprising a plurality  
of slots (410);

said shroud assembly (301, 302) comprising a plurality of projection (310), and said plurality of projections (310) is configured to receive said plurality of slots (410) disposed on said sealing member (401).

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2. The vehicle (100) as claimed in claim 1, wherein the shroud assembly comprises an RH shroud (301) enclosing substantially the right-hand side of the IC engine (101) and a LH shroud (302) substantially enclosing the lefthand side of the IC engine (101). 10
3. The vehicle (100) as claimed in claim 1, wherein the plurality of slots (410) on the sealing member (401) is disposed at regular intervals. 15
4. The vehicle (100) as claimed in claim 1, wherein the plurality of projection (310) disposed at regular intervals on outer periphery of the shroud assembly (301, 302) adjacent to the air-gap (210). 20
5. The vehicle (100) as claimed in claim 1 or claim 3 or claim 4, wherein the plurality of projection (310) have same dimensions as that of the plurality of slots (410) on the sealing member (401). 25
6. The vehicle (100) as claimed in claim 1 or claim 2, wherein the sealing member (401) is split into two halves, and said RH shroud (301) and LH shroud (302) configured to receive each of said two halves of the sealing member (401). 30
7. The vehicle (100) as claimed in claim 1, wherein the sealing member (401) is disposed on an upper portion on a flat area around the shroud assembly (301, 302) outer axial surface. 35
8. The vehicle (100) as claimed in claim 1, wherein the RH shroud (301) comprises a crankcase portion (301a) having a grided circular opening (303) and a cylinder portion (301b) enclosing cylinder head and cylinder block. 40
9. The vehicle (100) as claimed in claim 1, wherein the plurality of projections comprises (310) a shoulder portion (310a) disposed on the free end of said plurality of projections (310), configured to prevent movement of the sealing member (401) after insertion of plurality of slots (410) to the plurality of projections (310). 45 50
10. The vehicle (100) as claimed in claim 1 or claim 9, wherein the shoulder portion (310a) comprises an area of enlarged cross-section as compared to the dimensions of the rest of the plurality of projections (310). 55

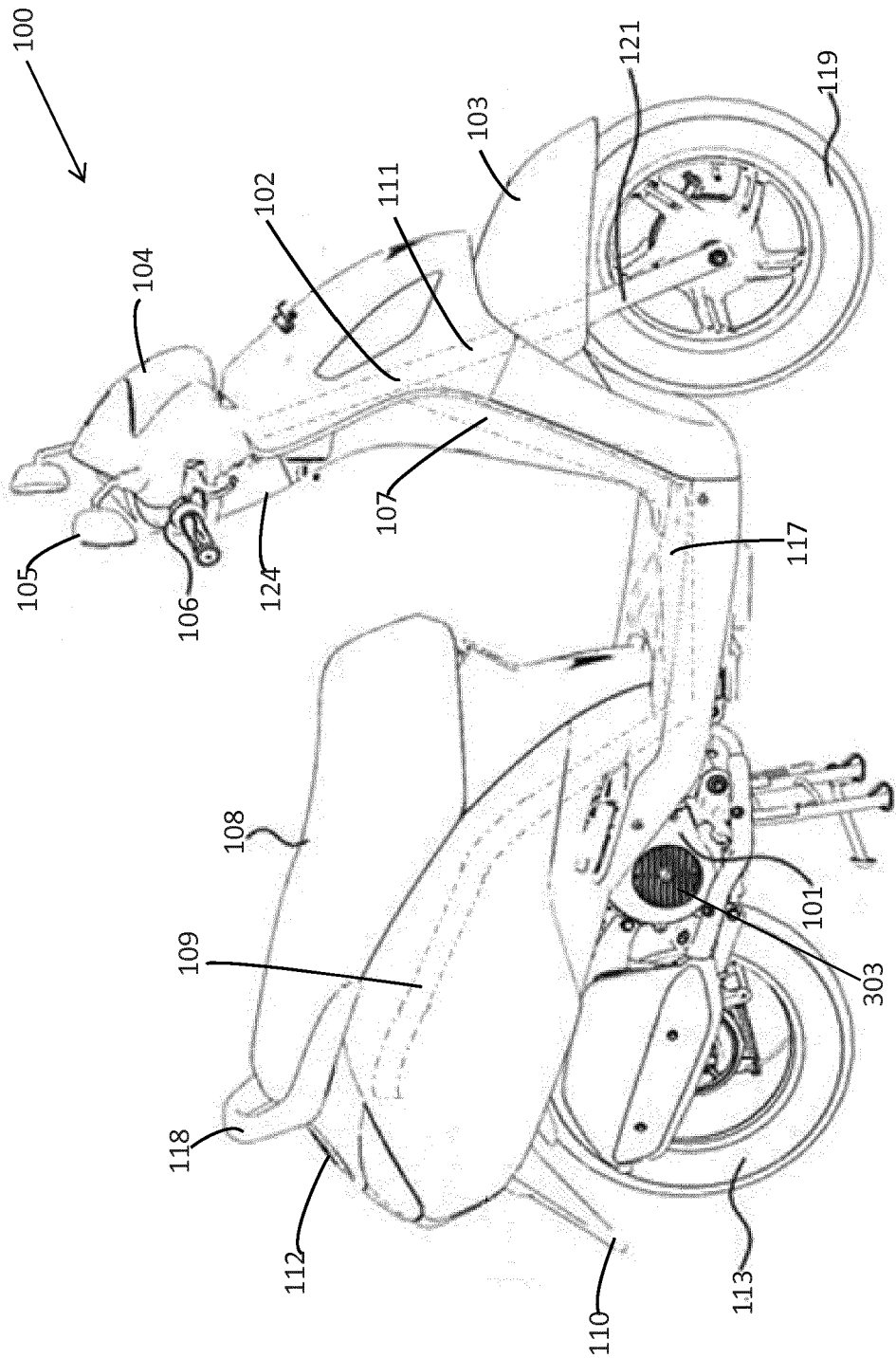


Fig. 1

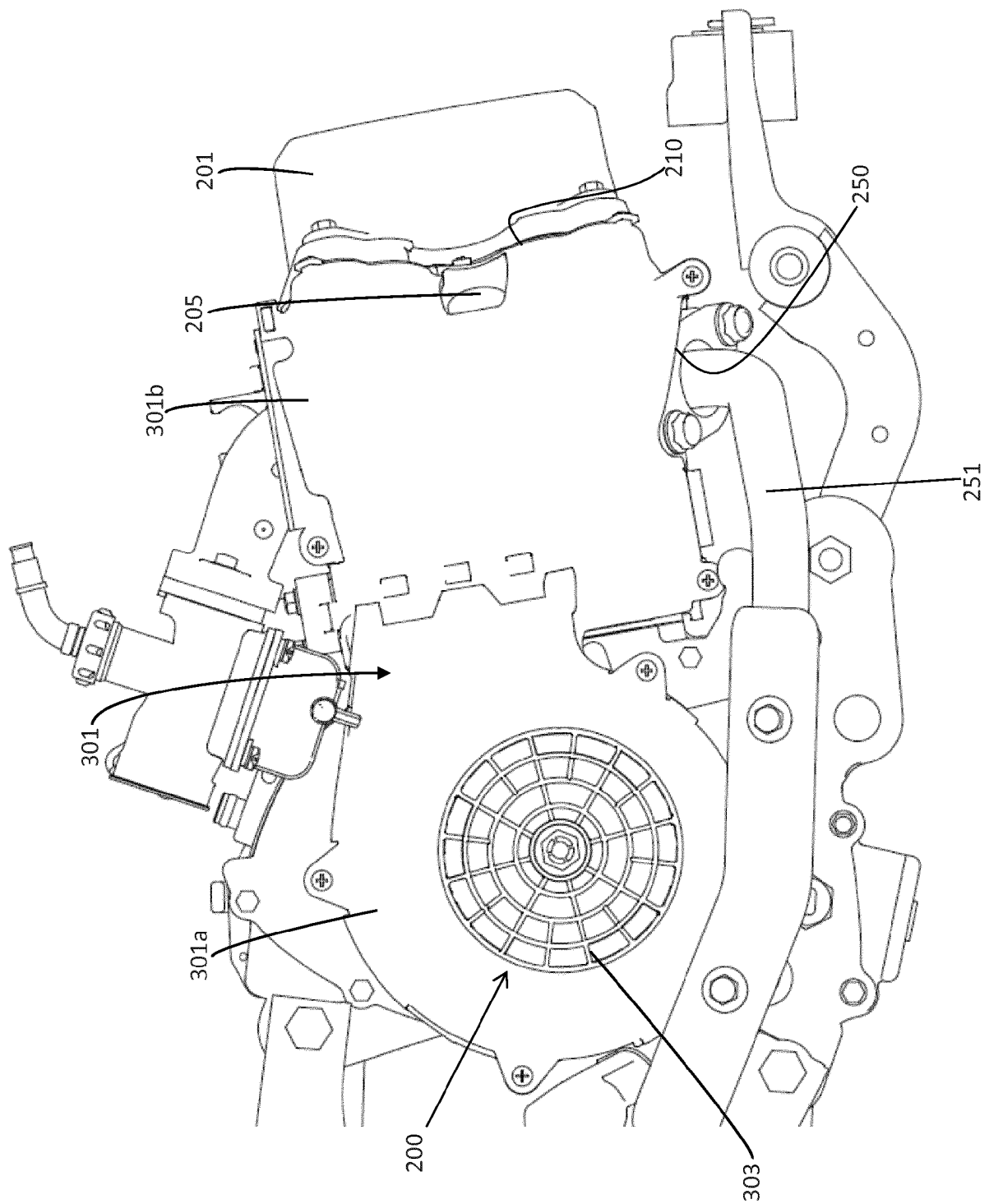
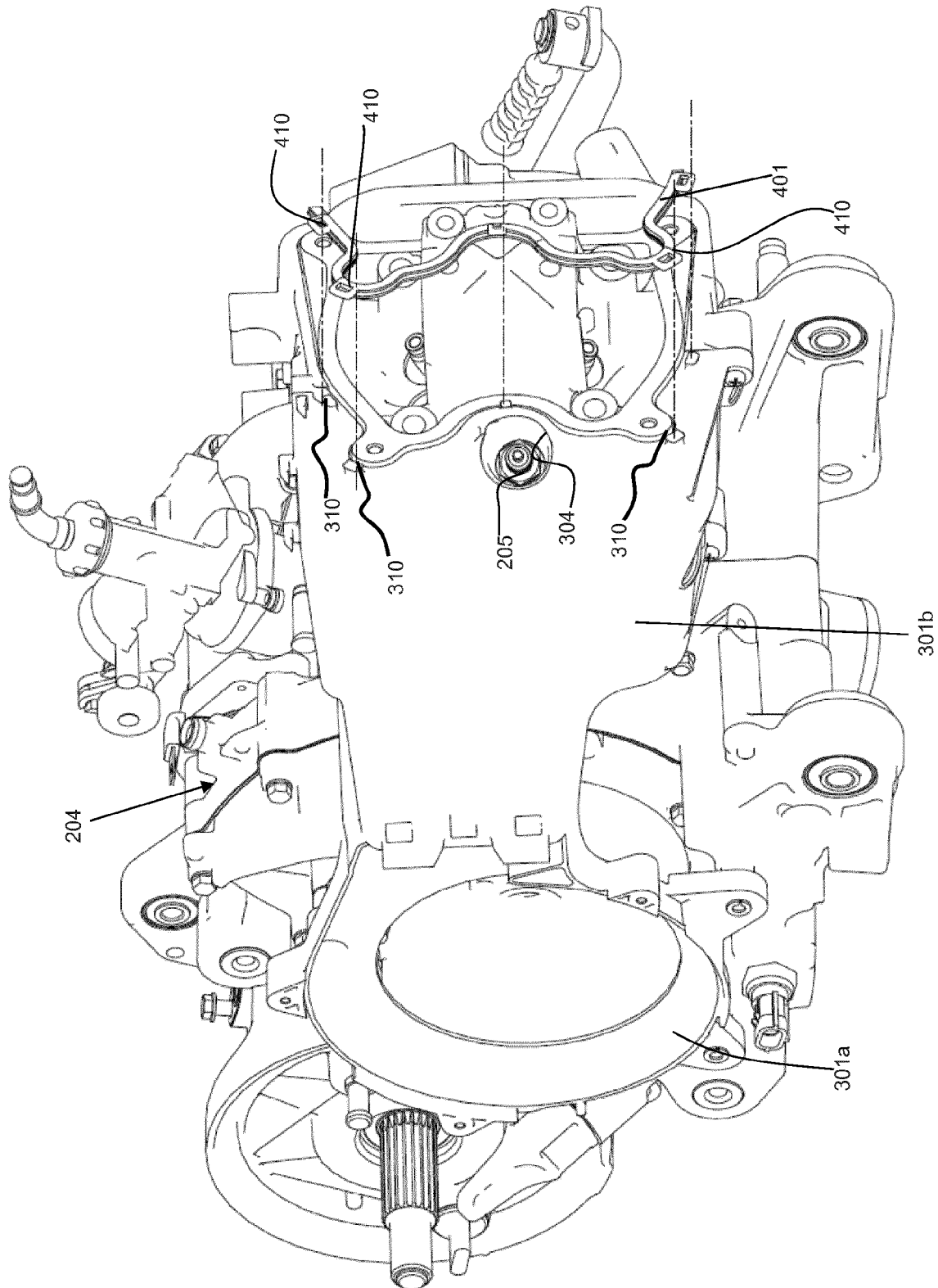
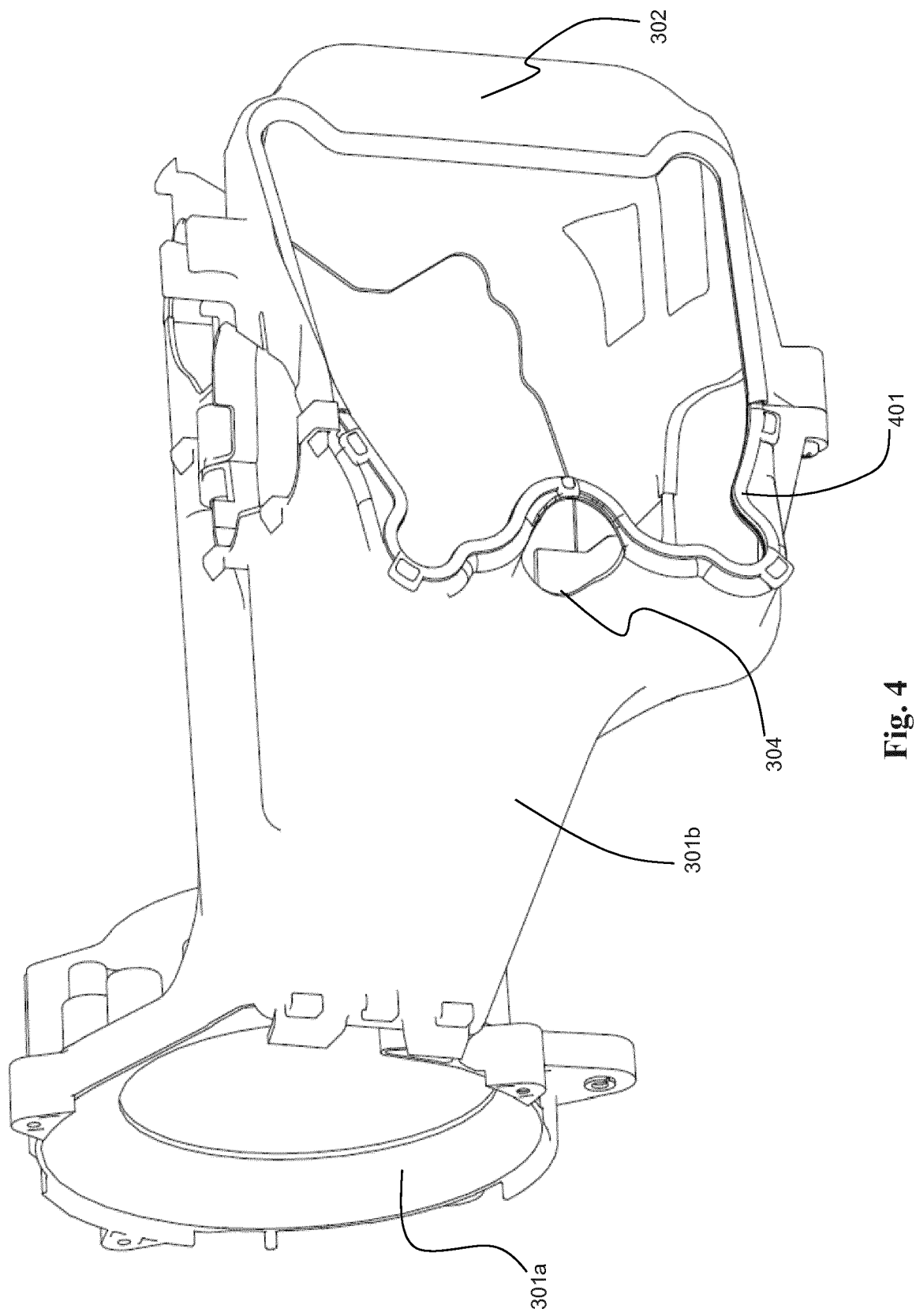


Fig. 2



**Fig. 3**



**Fig. 4**

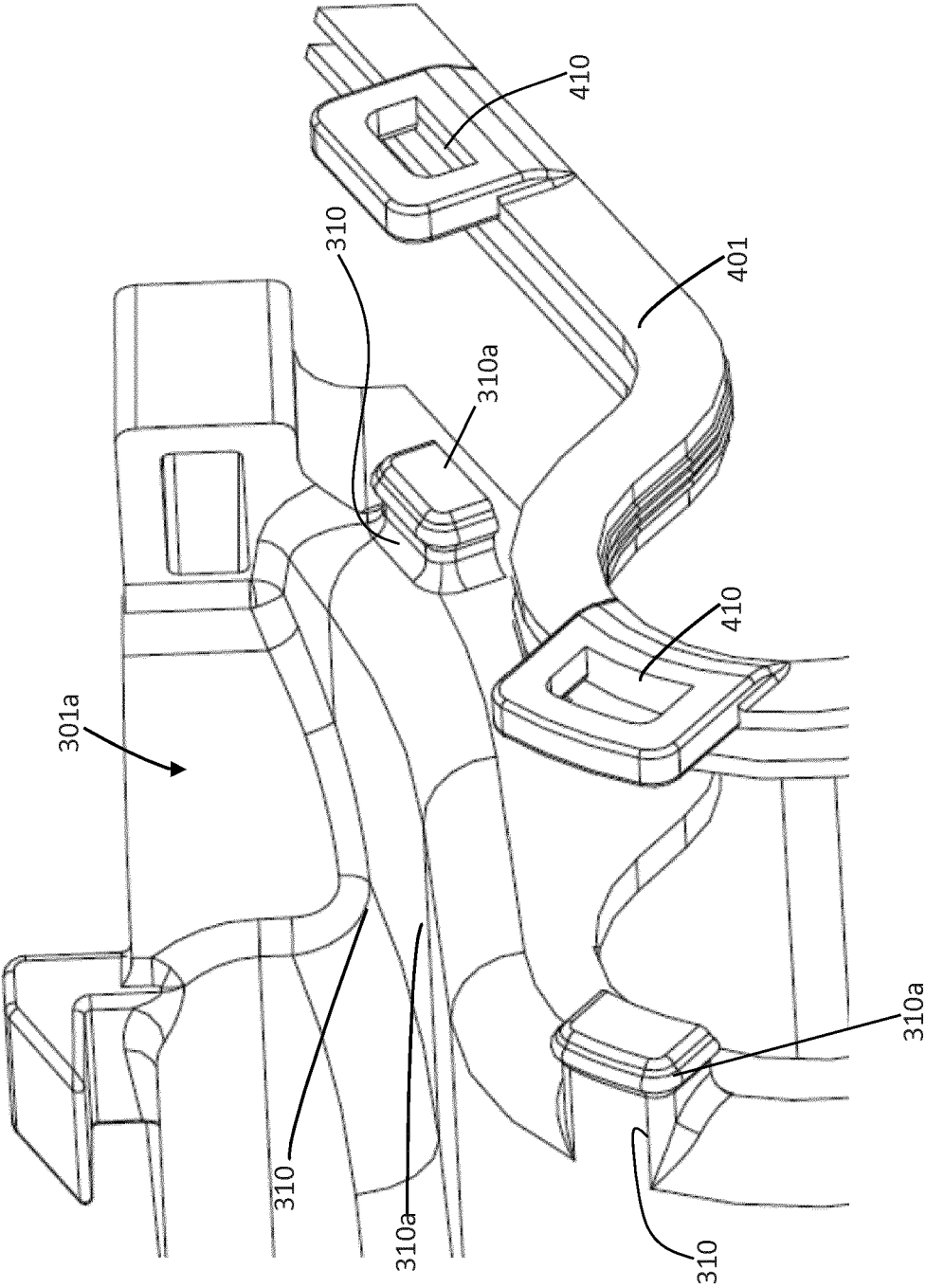


Fig. 5



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Application Number  
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| DOCUMENTS CONSIDERED TO BE RELEVANT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                           |                                                        |                                                                   |
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