



(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:
20.10.2004 Bulletin 2004/43

(51) Int Cl.7: F01M 11/00

(21) Application number: 04009042.5

(22) Date of filing: 15.04.2004

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR
HU IE IT LI LU MC NL PL PT RO SE SI SK TR
Designated Extension States:
AL HR LT LV MK

• Hamada, Haruki
Fujisawa-shi Kanagawa (JP)
• Sakai, Shuuichi
Miyamae-ku Kawasaki-shi Kanagawa (JP)

(30) Priority: 18.04.2003 JP 2003114246

(71) Applicant: ISUZU MOTORS LIMITED
Shinagawa-ku, Tokyo (JP)

(74) Representative:
Schaumburg, Thoenes, Thurn, Landskron,
Patentanwälte
Postfach 86 07 48
81634 München (DE)

(72) Inventors:
• Arakawa, Ichirou
Fujisawa-shi Kanagawa (JP)

(54) Oil pan structure

(57) There is provided an oil pan structure which is possible to achieve, with a simple structure, both reduction of an amount of the oil, and preventing sucking air during quick stopping or fast cornering of the vehicle. The oil pan structure comprises an inner oil pan (3), an

outer oil pan (4) located under the inner oil pan (3) to cover the inner oil pan (3), and a first through part (5) for letting the inner oil pan (3) communicate with the outer oil pan (4), which is provided in a rear part of the inner oil pan (3) in an advance direction of a vehicle.

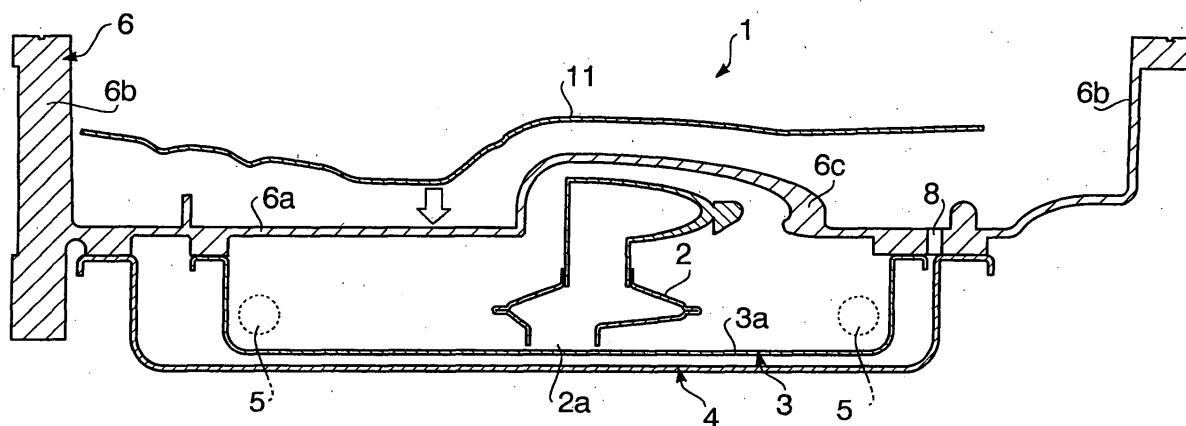


FIG. 1

Description

[0001] This invention relates generally to an oil pan structure, and more particularly concerns an oil pan structure of an engine improved so as to reduce a volume of the oil pan and an amount of the oil, and to prevent sucking air with the oil during quick stopping or fast cornering of a vehicle.

[0002] Various sliding parts or lubrication parts exist in the engine, and each lubrication part is supplied with oil (lubricating oil) for purposes such as reducing mechanical friction, preventing wear and damage, or reducing noise. The oil supplied to each lubrication part falls under gravity to be received into the oil pan provided under the engine, then the oil is sucked up by an oil pump through a suction pipe (an oil strainer) in the oil pan to be supplied again to each lubrication part.

[0003] If there are many lubrication parts, large amount of oil is accordingly needed. If the amount of oil is not enough, oil in the oil pan will run short, air will be sucked with the oil through the oil strainer, a thickness of an oil film at the lubrication part will be too thin, and various problems such as wear, damage, vibration or noise will occur. On the other hand, the oil pan occupies a big space in the engine lower part. Therefore, increasing the amount of the oil causes enlarging the oil pan, enlarging the engine itself and increasing weight. Thus, it is required to secure lubrication performance in each part with a minimum amount of the oil.

[0004] In the meantime, an oil level in the oil pan considerably differs between an engine stopping condition and an engine running condition. The oil level is high in the engine stopping condition. Once the engine is started to run, the oil level gets lower according to being carried away to each part. It will be no problem if sufficient amount of the oil is in the oil pan. However, the above problem will occur if amount of the oil is relatively small due to requirement of reducing as much amount of oil as possible. Because, for example, when acceleration is large in the case of such as quick stopping or fast cornering of the vehicle, the oil level inclines in the oil pan then air is sucked into the oil strainer. This problem occurs more often during the case such as quick stopping or fast cornering than during start of the vehicle.

[0005] If there is sufficient height space in the engine lower part, it is possible to cope with both the volume of the oil pan and the inclination of the oil level by making a shallow portion and a deep portion in the oil pan as described in Japanese Utility Model Application published with No.6-53744 and Japanese Patent Application published with No.6-101568. However, in recent years, needs for space-saving is increasing, so there are some cases that the height or depth of the oil pan cannot be secured, and the deep portion cannot be provided.

[0006] In the case that the depth of the oil pan cannot be secured, such technology is possible that the oil pan is made as double pan structure, oil level is detected by

an oil level sensor, and a valve is controlled to open or close a through part between an inner oil pan and an outer oil pan, as described in Japanese Patent Application published with No.62-78423. However, it is difficult to implement the technology, as the device becomes complicated and it is difficult to secure reliability of each sensors and actuator soaked in the oil and to reduce the cost.

[0007] This invention is originated in consideration of the above-mentioned circumstances. An object of this invention is to provide an oil pan structure which is simple but can reduce an amount of the oil, and can prevent sucking air during quick stopping or fast cornering of the vehicle.

[0008] According to a first aspect of this invention, there is provided an oil pan structure of an engine installed to a vehicle comprising an inner oil pan, an outer oil pan located under the inner oil pan to cover the inner oil pan, and a first through part for letting the inner oil pan communicate with the outer oil pan, which is provided in a rear part of the inner oil pan in an advance direction of the vehicle.

[0009] The first through part letting the inner and outer oil pans communicate with each other is provided in the rear part of the inner oil pan, and is not provided in the front part of the inner oil pan, in the advance direction of the vehicle if the oil pan structure is attached to the vehicle. Therefore, during quick stopping or fast cornering of the vehicle in when the oil level inclination comes into question, it is prevented that the oil in the inner oil pan goes out to the outer oil pan.

[0010] Preferably, the first through part consists of a first through hole provided in the inner oil pan.

[0011] Preferably, the first through part is located in at least one corner part of the inner oil pan which is defined by at least one of a right side wall and a left side wall, and a rear wall of the inner oil pan.

[0012] Preferably, a suction pipe for sucking oil is contained in the inner oil pan, an inlet of the suction pipe is located at higher level than a bottom part of the inner oil pan, and the first through part is located at higher level than the inlet of the suction pipe.

[0013] Preferably, an oil pan upper member is attached to the inner oil pan to cover an upper surface of the inner oil pan and to mostly close an upper opening of the inner oil pan.

[0014] As the inner oil pan is mostly closed by the oil pan upper member, outflow of the oil from the inner oil pan is prevented when the vehicle rocks, thereby the oil level is kept high.

[0015] Preferably, a second through part for opening the inner oil pan is provided in the oil pan upper member.

[0016] Preferably, the second through part consists of a second through hole.

[0017] Preferably, the second through part is provided in a rear part of the oil pan upper member in the advance direction of the vehicle.

[0018] Preferably, a guide plate is located above the

oil pan upper member to collect the oil falling and then lead it to the second through part.

[0019] The oil falling from each sliding part is guided by the guide plate, passes through the second through part and then is led to the inner oil pan.

[0020] Therefore, the oil is securely led to the inner oil pan when the vehicle rocks.

[0021] These and other object of this invention, and their preferred embodiments, shall become clear by consideration of the specification, claims and drawings taken as a whole.

Fig. 1 is a cross sectional view taken along lines I-I of Fig. 2 of the oil pan structure relating to a preferred embodiment of this invention.

Fig. 2 is a perspective view of the oil pan structure when given slightly sidelong glance.

Fig. 3 is a perspective view of the oil pan structure when given slightly sidelong glance, in which the guide plate is removed from the oil pan structure shown in Fig. 2.

Fig. 4 is a perspective view of the oil pan structure when looked up from rear if the oil pan structure is attached to the vehicle, in which the outer oil pan is removed.

[0022] A preferred embodiment of this invention is described hereinbelow with reference to the accompanied drawings.

[0023] As shown in Fig. 1, an oil pan structure 1 comprises an inner oil pan 3 which contains a suction pipe (oil strainer) 2 for sucking oil (lubricating oil) in the inner oil pan and supplying the oil to each lubrication part of an engine, and an outer oil pan 4 located under the inner oil pan 3 to cover the inner oil pan 3. The oil pan structure forms a double pan structure. Both the inner oil pan 3 and the outer oil pan 4 are shallow and have relatively small sizes in height. Difference of the depths between both pans 3 and 4 is relatively small.

[0024] As shown in Figs. 1 and 4, an inlet 2a of the suction pipe 2 is directed to a bottom part 3a of the inner oil pan 3, and is located at slightly higher position than the bottom part 3a. The inner oil pan 3 has right and left side wall parts 3b, 3b and a rear wall part 3c. If the oil pan structure is attached to a vehicle, the right and left side wall parts 3b, 3b are parallel to the advance direction of the vehicle, and the rear side wall part 3c is located rearward in the advance direction. The inner oil pan 3 is provided with two first through holes 5. These holes 5 are located in two corner parts which are defined by the left and side wall parts 3b, 3b and the rear wall part 3c, and let the inner oil pan 3 and the outer oil pan 4 communicate with each other. This first through hole 5 serves as a first through part. Thus, two first through holes 5 are located in backmost part and in left and right

ends of the inner oil pan 3 in width direction of the vehicle. The first through hole 5 is located at higher position in some degree than the inlet 2a of the oil strainer 2.

[0025] However, this invention is not limited to such positions and numbers. For example, one first through hole 5 may be positioned at approximate center in the width direction. And the first through hole 5 may be provided in a bottom part 3b of the inner oil pan 3. In short, it is sufficient that the first through hole 5 as the first through part is provided in the rear part of the inner oil pan in the advance direction of the vehicle.

[0026] As shown in Fig. 1, an oil pan upper member 6 is attached to the inner oil pan 3 and the outer oil pan 4. The oil pan upper member 6 is formed so as to cover upper surfaces of the inner and outer oil pans 3, 4 and mostly close upper openings of the inner and outer oil pans 3. The oil pan upper member 6 is formed like box having a bottom wall 6a, a side wall 6b and an upper opening, and is attached to a lower part of a cylinder body to receive the oil falling from each parts of an engine. The inner oil pan 3 and the outer oil pan 4 are attached to an undersurface of the bottom wall 6a of the oil pan upper member 6.

[0027] As shown in Fig. 3, the bottom wall 6a of the oil pan upper member 6 is provided with a second through hole 7 and a third through hole 8. The second through hole 7 lets the inner oil pan 3 vertically communicate with the oil pan upper member 6, and the third through hole 8 lets the outer oil pan 4 vertically communicate with the oil pan upper member 6. The second through hole 7 serves as a second through part. A plurality (two in this embodiment) of the second through hole 7 are located in the rear part of the oil pan upper member 6 in the advance direction of the vehicle, if the oil pan structure is attached to the vehicle. The third through hole 8 serves as a third through part. A plurality of the third through holes 8 are located in the front part and the side part of the oil pan upper member 6 if the oil pan structure is attached to the vehicle. In this embodiment, three holes 8 are provided in the front part, and two holes 8 are provided in the side part. However, the number or form of the second and third through parts is not limited to the type of the example described above and shown in the drawings.

[0028] As shown in Figs. 1 and 3, a convex part 6c is formed in the oil pan upper member 6 for containing a lug of the oil strainer 2 located below the part 6c. The oil strainer 2 is connected to an opening 9 provided in the bottom wall 6a of the oil pan upper member 6 as shown in Fig. 3. This opening 9 connects with an oil pump connection passage formed in the cylinder body, if the oil pan upper member 6 is attached to the lower part of the cylinder body.

[0029] As shown in Fig. 3, a PCV (positive crankcase ventilation) passage 10 is connected to the bottom wall 6a of the oil pan upper member 6. The PCV passage 10 allows the oil to flow after gas-liquid separation from oil mist. An outlet 10a of the PCV passage 10 is directed

into the inner oil pan 3. The oil after the gas-liquid separation from the oil mist by a blow-by gas reduction device flows through the PCV passage 10. That is, the blow-by gas blowing out through a gap between a cylinder and a piston is gas-liquid separated. Then the gas flows back into an engine intake system, while the oil is led to the inner oil pan 3 through the PCV passage 10.

[0030] As shown in Figs. 1 and 2, a guide plate (baffle plate) 11 is located above the bottom wall 6a of the oil pan upper member 6, which collects the oil falling from each parts of the engine and lead the collected oil to the second through hole 7. The guide plate 11 has area to generally cover the bottom wall 6a of the oil pan upper member 6, and is attached to the oil pan upper member 6 apart from the bottom wall 6a. The guide plate 11 is inclined in general such that its rear part is lower than its front part, and is formed such that an edge part of it located above the second through hole 7 is lowest.

[0031] Functions and effects of this embodiment that consists of the above elements are described hereinbelow.

[0032] As shown in Figs. 1 and 2, the oil falls from each parts of the engine towards the oil pan upper member 6. Most of the oil is collected by the guide plate 11 to be guided to the second through hole 7 then the inner oil pan 3. The rest of the oil is led to the outer oil pan 8 through the third through hole 8 shown in Figs. 1 and 3.

[0033] As shown in Figs. 1 and 4, the first through hole 5 letting the inner and outer oil pans 3, 4 communicate with each other is provided in the rear part of the inner oil pan 3, and is not provided in the front part of the inner oil pan 3, in the advance direction of the vehicle if the oil pan structure is attached to the vehicle. Therefore, during quick stopping or fast cornering of the vehicle in when oil level inclination comes into question, it is prevented that the oil in the inner oil pan 3 goes out to the outer oil pan 4.

[0034] That is, if the first through hole 5 is provided in the front part of the inner oil pan 3 in the advance direction of the vehicle, this causes a problem of sucking air when the oil strainer 2 sucks the oil in the inner oil pan 3. Because, as acceleration becomes high during quick stopping or fast cornering of the vehicle, the oil in the inner oil pan 3 flows out through the first through hole 5 to the outer oil pan 4 by inertia force of the oil.

[0035] On the contrary, in this embodiment, the first through hole 5 is provided only in the rear part of the inner oil pan 3 in the advance direction of the vehicle, whereas any through part is not provided in the front part of the inner oil pan 3 which might cause decreasing the oil level. Therefore, the oil in the inner oil pan 3 does not flow into the outer oil pan 4 during quick stopping or fast cornering of the vehicle in when acceleration becomes high.

[0036] Furthermore, when the vehicle decelerates, the oil in the outer oil pan 4 comes into the inner oil pan 3 through the first through hole 5 by inertia force of itself. In this embodiment, difference of the depths between

the inner oil pan 3 and the outer oil pan 4 is small, and the first through hole 5 is located in a relatively low part of the inner oil pan 3.

[0037] And also, the first through hole 5 is located at higher level in some degree than the inlet 2a of the oil strainer 2. Therefore, the oil is rather sucked into the inlet 2a of the oil strainer 2 than flows out to the outer oil pan 4 through the first through hole 5.

[0038] Thus, sufficient amount of the oil can be stored in the inner oil pan 3 in any time of vehicle running with simple structure. In addition, sucking air with the oil by the oil strainer 2 can be prevented even if the oil level inclines during quick stopping or fast cornering of the vehicle in when acceleration becomes high.

[0039] As a volume of the inner oil pan 3 is smaller than a volume of a single pan structure when only the outer oil pan 4 is used, the oil level in the inner oil pan 3 can be relatively high and the amount of the oil can be small. Therefore, even if the amount of the oil is small, sucking air with the oil by the oil strainer 2 can securely be prevented.

[0040] In the meantime, when the vehicle accelerates forward, the oil in the inner oil pan 3 flows out into the outer oil pan 4 through the first through hole 5. However, an amount of the oil flowing out is small because, in general, magnitude of acceleration when the vehicle accelerates forward is less than that when the vehicle decelerates by brake operation.

[0041] In particular, with regard to vehicles such as track or bus on which a diesel engine is mounted, as the magnitude of acceleration when the vehicle accelerates forward is less than that when the vehicle decelerates by brake operation, the amount of the oil flowing into the inner oil pan 3 is larger than the amount of the oil flowing out from it, considering total time of the vehicle running in when the vehicle repeatedly accelerates and decelerates.

[0042] The magnitude of acceleration being relatively small when the vehicle accelerates forward means the inclination angle of the oil level in the inner oil pan 3 being relatively small in that time. Combined with the fact that the amount of the oil flowing out is small, the problem of sucking air with the oil by the oil strainer 2 hardly appears, even if the oil level inclines in the inner oil pan 3 when the vehicle accelerates forward.

[0043] Furthermore, during the vehicle stopping, as the oil in the inner oil pan 3 and the oil in the outer oil pan 4 communicates with each other via the first through hole 5, the volume of the outer oil pan 4 defines total volume of the oil pan structure so that required amount of oil is securable.

[0044] In this embodiment, the upper opening of the inner oil pan 3 is mostly closed by the oil pan upper member 6. Therefore, even if the vehicle rocks during running, the oil stored in the inner oil pan 3 does not overflow, thus the oil level is kept high.

[0045] As the guide plate 11 is inclined rearward, even if the vehicle stops quickly or is in inclined condition, the

oil collected by the plate 11 can be securely led to the inner oil pan 3 via the second through hole 7.

[0046] As almost of the oil falling from each parts in the engine is collected by the guide plate 11 and then led to the inner oil pan 3 rather than the outer oil pan 4, the oil level in the inner oil pan 3 is normally kept to be higher than the oil level in the outer oil pan 4.

[0047] As the outlet 10a of the PCV passage 10 communicates with the inner oil pan 3, the oil level in the inner oil pan 3 is priorly raised higher than that in the outer oil pan 4.

[0048] Thus, as the oil level in the inner oil pan 3 can be positively raised, sucking air with the oil by the oil strainer 2 is effectively prevented.

[0049] In the case such as the oil level inclined, if the oil level in the inner oil pan 3 becomes higher than the first through hole 5, the oil in the inner oil pan 3 flows out into the outer oil pan 4 through the first through hole 5. However, if the oil level in the inner oil pan 3 is lower than the first through hole 5, the oil level (liquid level) in the inner oil pan 3 does not become lower. Therefore, a height distance from the bottom part 3b to the first through hole 5 is determined by how degree of inclination (inclination when the vehicle accelerates, inclination when the vehicle stops on a slope, etc.) is assumed.

[0050] As described above, according to the oil pan structure concerning this invention, it is possible to achieve, with a simple structure, both reduction of the amount of the oil, and preventing sucking air during quick stopping or fast cornering of the vehicle.

[0051] Although this invention is applied suitably for the engine which is an internal-combustion engine, it is applicable to all motors such as an electric motor. This invention is also applicable to all vehicles.

[0052] As a modification, each of the first, second, and third through parts may be embodied by a pipe etc. other than a hole as described above.

[0053] While the invention had been described with reference to the preferred embodiments, it will be understood by those skilled in the art that various obvious changes may be made, and equivalents may be substituted for elements thereof, without departing from the essential scope of this invention. Therefore, it is intended that the invention not be limited to the particular embodiments disclosed, but that the invention includes all embodiments falling within the scope of the appended claims.

Claims

1. An oil pan structure of an engine installed to a vehicle comprising an inner oil pan, an outer oil pan located under the inner oil pan to cover the inner oil pan, and a first through part for letting the inner oil pan communicate with the outer oil pan, which is provided in a rear part of the inner oil pan in an advance direction of the vehicle.

2. The oil pan structure as defined in claim 1, **characterized in that** the first through part consists of a first through hole provided in the inner oil pan.

3. The oil pan structure as defined in claim 1 or 2, **characterized in that** the first through part is located in at least one corner part of the inner oil pan which is defined by at least one of a right side wall and a left side wall of the inner oil pan, and a rear side wall of the inner oil pan.

4. The oil pan structure as defined in any one of claims 1 to 3, **characterized in that** a suction pipe for sucking oil is contained in the inner oil pan, an inlet of the suction pipe is located at higher level than a bottom part of the inner oil pan, and the first through part is located at higher level than the inlet of the suction pipe.

5. The oil pan structure as defined in any one of claims 1 to 4, **characterized in that** an oil pan upper member is attached to the inner oil pan to cover an upper surface of the inner oil pan and to mostly close an upper opening of the inner oil pan.

6. The oil pan structure as defined in claim 5, **characterized in that** a second through part for opening the inner oil pan is provided in the oil pan upper member.

7. The oil pan structure as defined in claim 6, **characterized in that** the second through part is provided in a rear part of the oil pan upper member in the advance direction of the vehicle.

8. The oil pan structure as defined in claim 6 or 7, **characterized in that** a guide plate is located above the oil pan upper member to collect the oil falling and then lead it to the second through part.

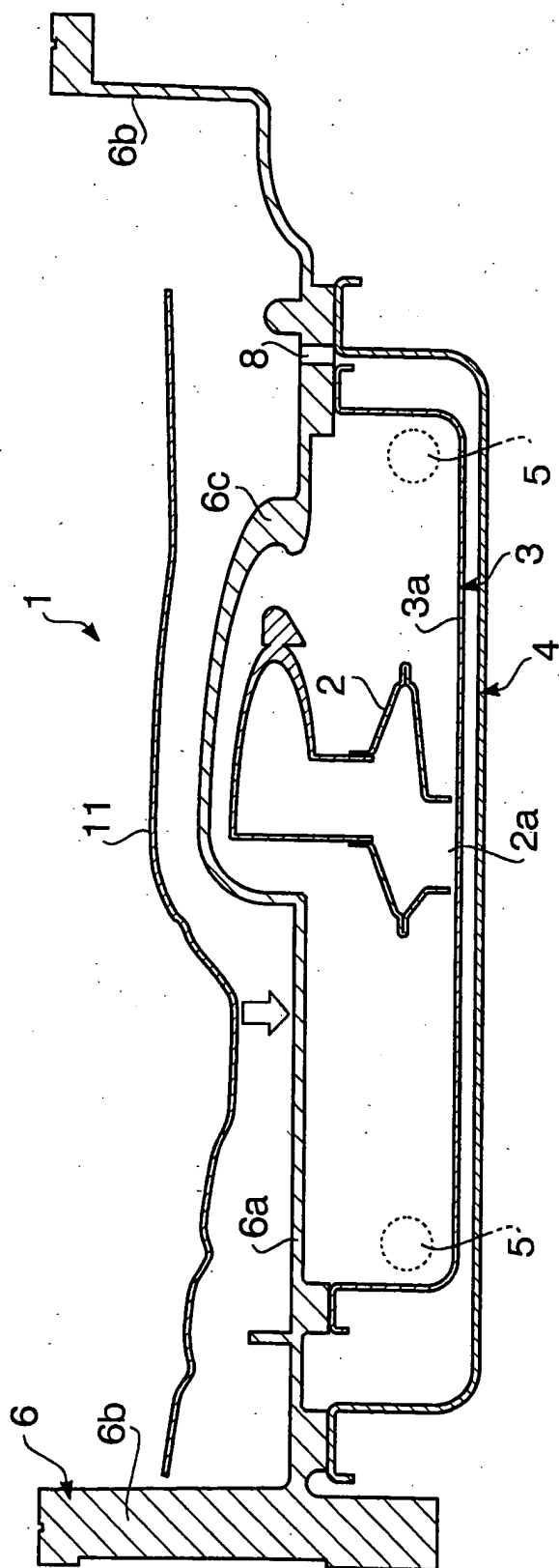


FIG. 1

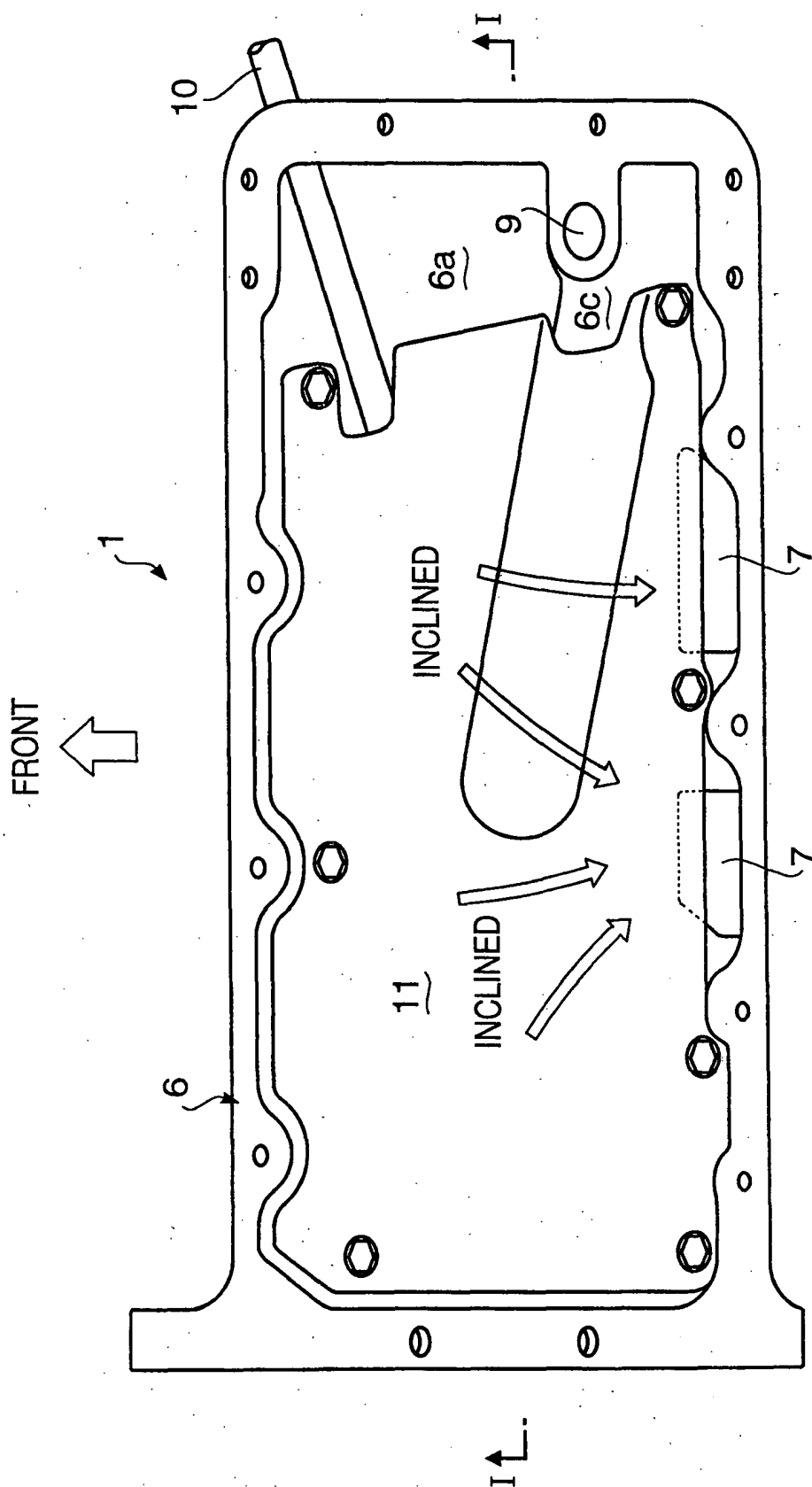


FIG. 2

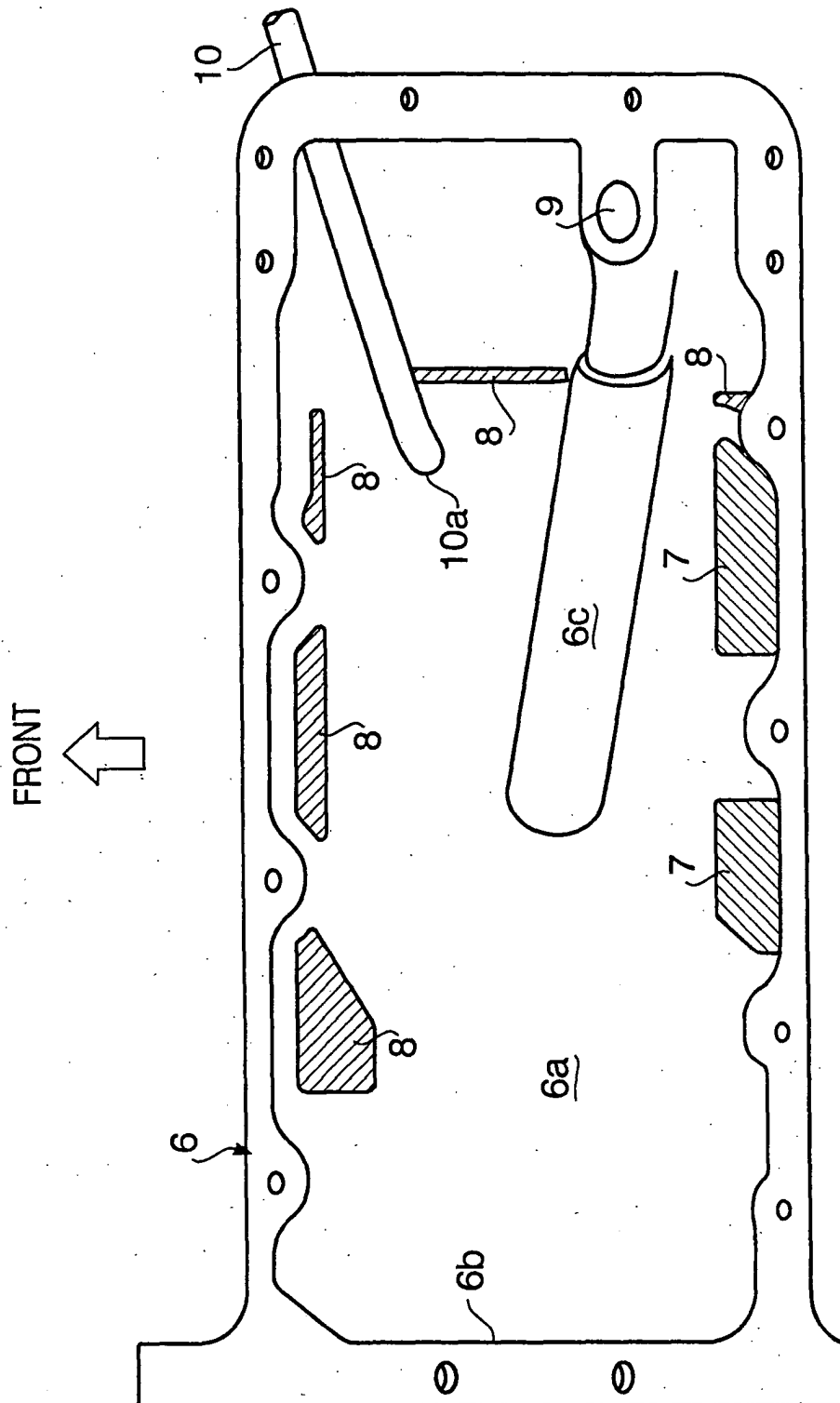


FIG. 3

REAR VIEW WHEN ATTACHED TO THE VEHICLE

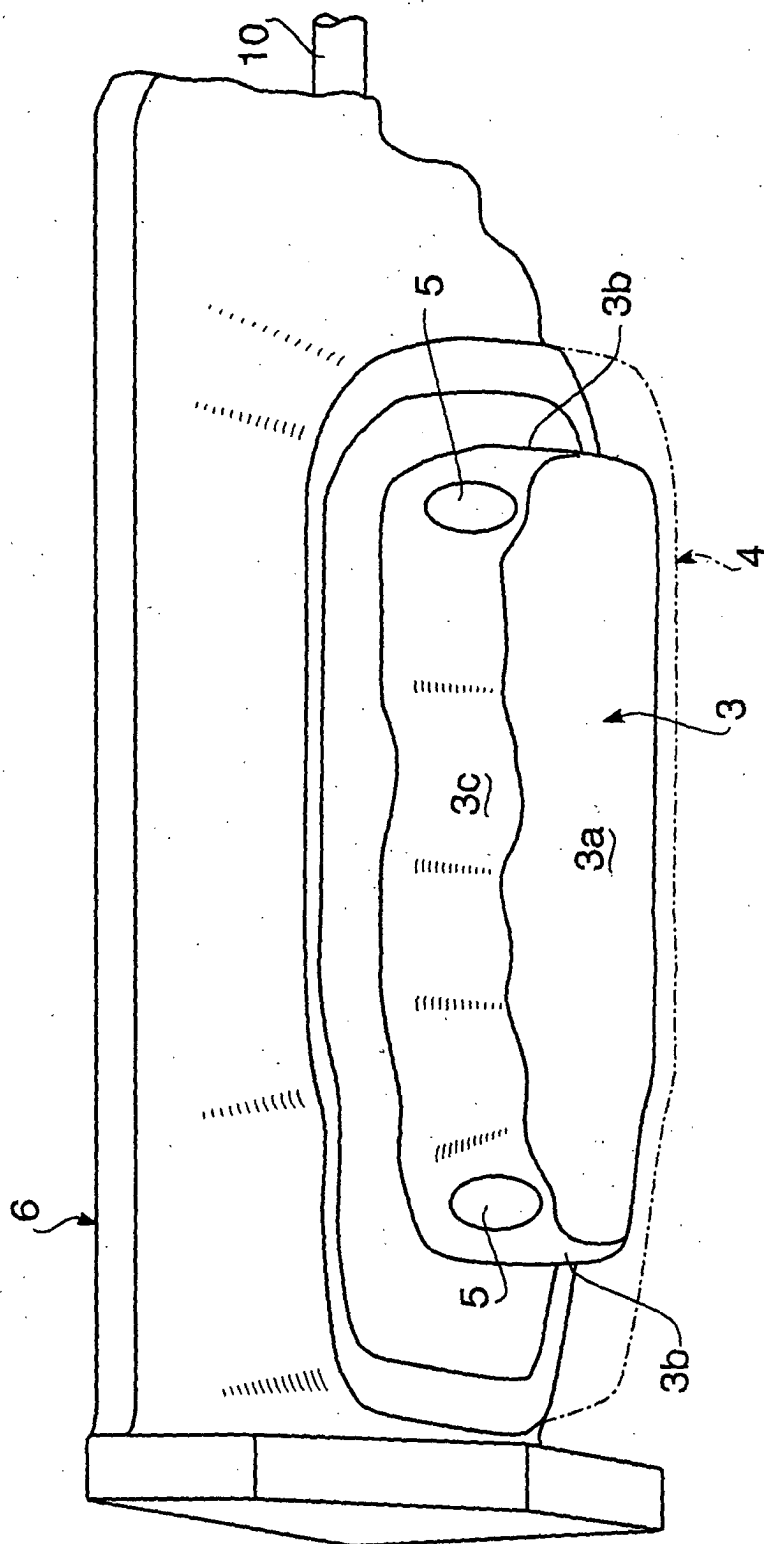


FIG. 4