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(54) OIL PAN FOR INTERNAL COMBUSTION ENGINE

(57) An oil pan for an internal combustion engine is provided that can be easily detached and attached from and to the body of the internal combustion engine while a capacity capable of storing the total quantity of oil required is secured. An oil pan 10 of an internal combustion engine is mounted on a vehicle provided with a pair of right and left side members provided so as to extend in the front-rear direction of the vehicle and a cross member 5 provided so as to extend in the width direction of the vehicle and fixed to the pair of side members, is of a type divided into two pieces one above the other, formed of an upper oil pan 20 attached to the body of the internal combustion engine and including an opening 23h in a bottom portion 23 and a lower oil pan 30 attached so as to cover the opening 23h of the upper oil pan from below, and includes an overlapping portion 11 situated above the cross member 5 and overlapping the cross member 5; and the lower oil pan 30 is provided so as to be situated in front of or behind the overlapping portion 11 so as to include the overlapping portion 11 in a state of being mounted on the vehicle.

FIG.3(a)

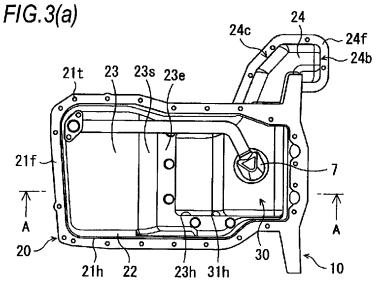


FIG.3(b)

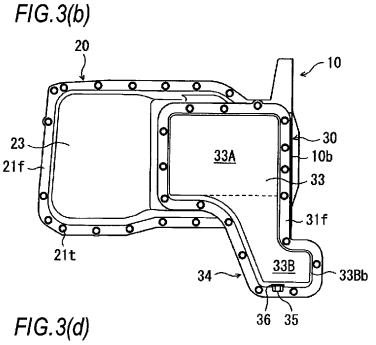


FIG.3(c)

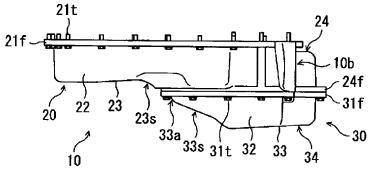
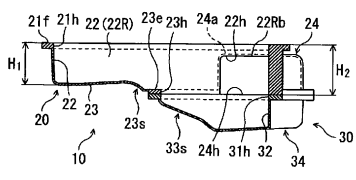


FIG.3(d)



EP 2 863 025 A1

Description

Technical Field

[0001] The present invention relates to an oil pan for an internal combustion engine mounted on a vehicle.

Background Art

[0002] An oil pan for an internal combustion engine (hereinafter, referred to as engine) mounted on a vehicle is provided in the lowermost part of the engine, and has mainly a role of storing the engine oil used in the engine. The engine oil stored in the oil pan is sucked up by an oil pump operating on part of the engine power, is supplied to revolving portions, sliding portions and the like, and lubricates these portions to reduce the frictional resistance. The engine oil having lubricated the inside of the engine becomes oil drops which move along the wall and drop into the oil pan. Then, the engine oil is again sucked up by the oil pump to thereby circulate in the engine. For the oil pan, a capacity sufficient for storing the total quantity of engine oil used in the engine is secured.

[0003] There are cases where it is necessary to detach the oil pan from the engine body such as when an oil leak from the engine occurs or when deterioration, damage or the like occurs on the oil pan. In general vehicles, in order that the detachment and attachment of the oil pan can be performed from below the vehicle body, the vehicle body members and other devices are provided in positions that do not hinder the detachment and attachment of the oil pan, or are structured so as to be detachable from the vehicle body at the time of detachment and attachment of the oil pen. Oil pans include a type where a fin and partitions are provided inside the oil pan and an oil pan of a type divided into two pieces one above the other, formed of an upper oil pan and a lower oil pan (see Patent Document 1).

Prior Art Document

Patent Document

[0004]

Patent Document 1: JP-A-8-74552

Summary of the Invention

Problem that the Invention is to Solve

[0005] However, members and devices provided below the oil pan so as to overlap the oil pan cannot be detached in some vehicles. Therefore, an oil pan detached and attached after vehicle body members and devices are detached cannot be applied to such vehicles. Although it is considered to reduce the size of the oil pan by changing the shape thereof in order to secure applicability to such vehicles, it is necessary that a predetermined capacity sufficient for storing the total quantity of oil required for the engine be secured for the oil pan. Therefore, the size of the oil pan is restricted to some extent and cannot be reduced indiscriminately, and it is difficult to achieve both the detachment/attachment performance and the securing of the capacity.

[0006] An object of the present case is to provide an oil pan for an internal combustion engine that is invented in view of the above-mentioned problem and can be easily detached and attached from and to the body of the internal combustion engine while a capacity capable of storing the total quantity of oil required is secured.

[0007] Not only this object but also producing an operational advantage derived from the structures shown in the later-described mode for carrying out the invention which operational advantage cannot be obtained from the conventional art can be placed as another object of the present case.

Means for Solving the Problem

[0008] (1) An oil pan for an internal combustion engine disclosed herein is an oil pan for an internal combustion engine mounted on a vehicle provided with a pair of right and left side members provided so as to extend in a front-rear direction of the vehicle and a cross member provided so as to extend in a width direction of the vehicle and fixed to the pair of side members, and is characterized by being of a type divided into two pieces one above the other, formed of an upper oil pan attached to a body of the internal combustion engine and including an opening in a bottom portion and a lower oil pan attached so as to cover the opening of the upper oil pan from below, by including an overlapping portion situated above the cross member and overlapping the cross member, and in that the lower oil pan is provided so as to be situated in front of or behind the overlapping portion so as to include the overlapping portion in a state of being mounted on the vehicle.

[0009] The "overlapping portion" referred to here indicates a portion where the oil pan overlaps the cross member in the top-bottom direction.

[0010] (2) It is preferable that an upper surface of the cross member be formed so as to incline upward or downward from a front end portion to a rear end portion and a bottom portion, opposed to the cross member, of the lower oil pan be formed so as to incline upward or downward from a front end side of the overlapping portion to a rear end side of the overlapping portion and have a substantially uniform distance from the upper surface portion of the cross member. In other words, it is preferable that the upper surface of the cross member and the bottom portion of the lower oil pan both incline in the same direction of upward or downward from the front to the rear and these be provided substantially parallel to each other.

[0011] (3) Moreover, it is preferable that at least the lower oil pan be provided so as to extend frontward beyond a front end portion of the internal combustion engine or rearward beyond a rear end portion thereof.

Advantage of the Invention

[0012] According to the disclosed oil pan for the internal combustion engine, since the oil pan is of the type divided into two pieces one above the other formed of the upper oil pan and the lower oil pan and the lower oil pan is provided so as to be situated in front of or behind of the overlapping portion, when the oil pan is detached, it is possible to detach the lower oil pan first. This facilitates the detachment of the upper oil pan. On the other hand, when the oil pan is attached, it is possible to attach the upper oil pan first and then, attach the lower oil pan. Consequently, for example, even on a vehicle where the cross member cannot be detached from the vehicle body, the attachment and detachment of the oil pan can be performed. Further, since the lower oil pan is provided so as to include the overlapping portion, the capacity of oil that can be stored can be increased, and a capacity capable of storing the total quantity of oil required can be secured. That is, the detachment/attachment performance and the securing of the capacity of the oil pan can be both achieved.

Brief Description of the Drawings

[0013]

[FIG. 1] A bottom view of a vehicle mounted with an oil pan for an internal combustion engine according to an embodiment.
[FIG. 2] A perspective view, viewed from above, showing the structure of the oil pan for the internal combustion engine according to the embodiment.
[FIG. 3] Views showing the structure of the oil pan for FIG. 2, FIG. 3(a) being a top view, FIG. 3(b) being a bottom view, FIG. 3(c) being a side view, and FIG. 3(d) being a cross-sectional view on arrow A-A of FIG. 3(a).
[FIG. 4] A view explaining the positional relation between the oil pan for the internal combustion engine according to the embodiment and the cross member.
[FIG. 5] Views explaining the procedures of detaching the oil pan for the internal combustion engine according to the embodiment, FIG. 5 (a) being the detachment of a lower oil pan, and FIG. 5(b) being the detachment of an upper oil pan.

Mode for Carrying out the Invention

[0014] Hereinafter, an embodiment will be described by using the drawings. The embodiment shown below is merely illustrative, and it is not intended to exclude various modifications and technical applications not clearly shown in the embodiment shown below. In the following description, the direction of travel of the vehicle is the forward direction, the right and the left are determined with reference to the frontward direction, the direction of the gravity is the downward direction and the direction opposite thereto is the upward direction in giving the description. In the description of devices and parts mounted on a vehicle, the top-bottom direction, the right-left direction and the front-rear direction are determined with reference to the condition where those devices and parts are mounted on the vehicle.

[1. Structure]

[0015] As shown in FIG. 1, an internal combustion engine 1 (hereinafter, referred to as engine 1) according to the present embodiment is mounted on the front side of the vehicle, and disposed between a pair of right and left side members 2 provided so as to extend in the front-rear direction of the vehicle with a distance from each other. Between the side members 2, a clutch housing 3 and a transmission 4 are mounted behind the engine 1. While various devices are mounted on the vehicle in addition to these, they are omitted in FIG. 1.

[0016] A cross member 5 provided so as to extend in the vehicle width direction (right-left direction) is provided below an oil pan 10 provided in the lowermost part of the engine 1. This cross member 5 is a front suspension cross member having, at left and right end portions 5c and 5d, connection portions that receive the springs (not shown) of the suspensions. The cross member 5 is fixed to the pair of side members 2 by welding on the inner side of the left and right end portions 5c and 5d in the vehicle width direction. The cross member 5 is formed of an a hat-shaped upper member 51 whose longitudinal cross section in the front-rear direction has an opening in the lower surface and a sheet-metal-form lower member 55 joined to the lower surface in an intermediate part of the upper member 51 in the vehicle width direction so as to cover the opening (see FIG. 4).

[0017] In this example, the upper member 51 of the cross member 5 has, as shown in FIG. 2 and FIG. 4, an upper surface portion 52 extending in the vehicle width direction, two upright surface portions extending downward from both ends in the width direction of the upper surface portion 52 (that is, the front-rear direction of the vehicle) and two flange portions provided so as to protrude outward in the horizontal direction from both lower ends of the two upright surface portions. The upper surface portion 52 of the upper member 51 (hereinafter, referred to as the upper surface portion 52 of the cross member 5) is formed so as to incline downward from a front end portion 52a to a rear end portion 52b.

[0018] Moreover, in a lower part of the vehicle, a steering linkage 6 which is a rack-and-pinion steering device is provided so as to extend in the vehicle width direction. A steering rack housing 6a of this steering linkage 6 is situated below the oil pan 10, and situated in front of and

above the cross member 5 (see FIG. 4). In the present embodiment, a vehicle where the cross member 5 situated below the oil pan 10 cannot be detached from the vehicle body (vehicle body such as the side members 2) is shown as an example.

[0019] The oil pan 10 is situated above the cross member 5 and the steering rack housing 6a, and has an overlapping portion (the dotted part in FIG. 1) that overlaps the cross member 5. The overlapping portion 11 referred to here is a superposing portion of the oil pan 10 and the upper surface portion 52 of the cross member 5. This superposing portion is a portion where the oil pan 10 and the upper surface portion 52 of the cross member 5 overlap in the top-bottom direction.

[0020] The oil pan 10 is a container (receiving pan) storing the engine oil (hereinafter, sometimes referred to as oil) used in the engine 1, and is attached to the bottom of the main body of the engine 1 (hereinafter, referred to as engine body). The oil stored in the oil pan 10 is sucked up through an oil strainer 7 [see FIG. 3(a)] by a non-illustrated oil pump operating on part of the power of the engine 1, is sent to revolving portions, sliding portions and the like to lubricate and reduce frictional resistance. The oil also has a role of cooling the revolving portions, the sliding portions and the like, and after lubricating and cooling the inside of the engine 1, becomes oil drops which move along the cylinder wall and the like and drop into the oil pan 10. By this being repeated, the oil circulates in the engine 1. The engine body referred to here indicates an engine block excluding the oil pan 10 (a cylinder head and a cylinder block are included).

[0021] The oil strainer 7 is a filter provided at an end of the intake of the oil pump, and is provided slightly above the bottom surface of a later-described lowermost portion 23e in the oil pan 10. To the oil strainer 7, a rather coarse net is attached to prevent large foreign substances mixed in the oil from being sucked in when the oil is sucked in. Moreover, a filter for removing finer foreign substances is provided on the circulation route of the oil. The capacity of the oil pan 10 corresponds to the total amount of oil used (required) in the engine 1.

[0022] Next, the structure of the oil pan 10 will be described by using FIG. 2, FIGS. 3(a) to 3(d) and FIG. 4. As shown in FIG. 4, the oil pan 10 is of the type divided into two pieces one above the other, formed of an upper oil pan 20 on the upper side and a lower oil pan 30 on the lower side, and a combination of these upper oil pan 20 and lower oil pan 30 constitutes one oil pan 10. The upper oil pan 20 is formed, for example, of a casting, and the lower oil pan 30 is formed, for example, of a sheet metal. The broken line in FIG. 4 illustrates the water surface of oil when oil is stored in the oil pan 10.

[0023] As shown in FIG. 2 and FIGS. 3(a) and 3(d), the upper oil pan 20 is provided with an upper surface open portion 21h in an upper part, and has a peripheral wall portion 22 provided so as to extend downward from the perimeter of the upper surface open portion 21h and a bottom portion 23 formed in a shape substantially the same as the upper surface open portion 21h when viewed from above. Around the upper surface open portion 21h (that is, on the upper end portion of the peripheral wall portion 22), a flange portion 21f provided so as to protrude outward substantially horizontally is provided. The upper surface open portion 21h is formed in a shape substantially the same as the opening provided in the lower surface of the cylinder block. The inside of the engine 1 and the inside of the oil pan 10 communicate with each other through the opening in the lower surface of the cylinder block and the upper surface open portion 21h.

[0024] Into the flange portion 21f, a plurality of bolts 21t are inserted from below in the peripheral direction (around the upper surface open portion 21h). These bolts 21t are screwed into holes (not shown) formed in the lower end surface of the cylinder block, thereby fixing the upper oil pan 20 and the engine body. When the upper oil pan 20 is attached to the engine body, a seal member such as a liquid gasket is sandwiched between the upper surface of the flange portion 21f and the lower end surface of the cylinder block, thereby sealing the joint surfaces of the cylinder block and the upper oil pan 20.

[0025] As shown in FIGS. 3 (c) and 3 (d), an inclined portion 23s provided so as to extend in the vehicle width direction and inclined downward more smoothly as it approaches the rear side is formed substantially in a central part, in the front-rear direction, of the bottom portion 23 of the upper oil pan 20. That is, the bottom portion 23 is formed so that the surface behind the inclined portion 23s is situated lower than the surface of the front side thereof. The upper oil pan 20 is formed so that the vertical length H_2 behind the inclined portion 23s is larger than the vertical length H_1 on the front side.

[0026] Hereinafter, a bottom portion behind the inclined portion 23s (that is, of the bottom portion 23 of the upper oil pan 20, a portion situated in the lowermost position) will be specifically referred to as the lowermost portion 23e. As shown in FIG. 2 and FIGS. 3(a) and 3(b), a substantially rectangular bottom open portion (opening) 23h passing through the bottom portion 23 is formed in the lowermost portion 23e. The area of opening of the bottom open portion 23h is smaller than that of the upper surface open portion 21h.

[0027] As shown in FIG. 3(d), the upper oil pan 20 has, in a rear portion 22Rb of a portion of the peripheral wall portion 22 extending in the front-rear direction on the right side (hereinafter, referred to as right wall portion 22R), a wall open portion 22h passing through the right wall portion 22R. The wall open portion 22h is situated above the bottom open portion 23h, and communicates with the bottom open portion 23h. That is, the upper oil pan 20 has the open portions 21h, 23h and 22h in an upper part, in the lowermost portion 23e of the bottom portion 23 and in the rear portion 22Rb, respectively.

[0028] Moreover, the upper oil pan 20 has, as shown in FIG. 2 and FIGS. 3(a) and 3(d), a lid 24 provided so as to cover the wall open portion 22h from the outside. The lid 24 is provided so that an opened one end portion

24a is connected to the outer side of the right wall portion 22R and that a closed other end portion 24b protrudes to the rear side of a rear end portion 10b of the oil pan 10 (that is, a rear end portion 1b of the engine 1). Moreover, an intermediate portion 24c (between the one end portion 24a and the other end portion 24b) of the lid 24 is formed so as to be bent. The lid 24 is formed so that a longitudinal cross section in a direction orthogonal to a direction extending from the one end portion 24a to the other end portion 24b has a hat shape the lower surface of which is opened. On the lower surface of the lid 24, a lid open portion 24h is formed, and further, around the lid open portion 24h except for the one end portion 24a, a flange portion 24f provided so as to protrude outward substantially horizontally is formed.

[0029] The lower surface of the lid 24 (that is, the surface of the lid open portion 24h and the flange portion 24f) is provided so as to be flush with the lower surface of the lowermost portion 23e of the upper oil pan 20, and the lid open portion 24h and the bottom open portion 23h communicate with each other through the wall open portion 22h. The upper surface of the lid 24 is provided slightly below the surface where the upper surface open portion 21h of the upper oil pan 20 is provided. The shape of the lid 24 when viewed from above is the same as the shape of a later-described extended portion 34 of the lower oil pan 30 when viewed from above.

[0030] The lower oil pan 30 is, as shown in FIGS. 3(b) to 3(d), attached to the upper oil pan 20 so as to cover the bottom open portion 23h and the 24h of the upper oil pan 20 from below. That is, the lower oil pan 30 is provided in a lower part of the oil pan 10 (below the upper oil pan 20) and in a rear part of the oil pan 10 (behind the inclined portion 23s of the upper oil pan 20).

[0031] The lower oil pan 30 is provided with a lower side open portion 31h in an upper part, and has a lower side peripheral wall portion 32 provided so as to extend downward from the perimeter of the lower side open portion 31h and a lower side bottom portion 33 formed in a shape substantially the same as the lower side open portion 31h when viewed from above. Around the lower side open portion 31h (that is, on the upper end portion of the lower side peripheral wall portion 32), a lower side flange portion 31f provided so as to protrude outward substantially horizontally is provided. The lower side open portion 31h is formed in a shape the same as a shape which is a combination of the bottom open portion 23h, the lid open portion 24h and the length portion, in the right-left direction, of the wall open portion 22h (part corresponding to the thickness of the peripheral wall portion 22) of the upper oil pan 20.

[0032] In the lower side flange portion 31f, a plurality of lower side bolts 31t are inserted from below in the peripheral direction (around the lower side open portion 31h). These lower side bolts 31t are screwed into holes provided on the side of the upper oil pan 20 and nuts and the like embedded therein (none of these are shown). Thereby, the lower oil pan 30 is attached to the upper oil pan 20. When these are joined, a seal member such as a liquid gasket is sandwiched between the joint surfaces to seal the joint surfaces.

[0033] When the lower oil pan 30 is attached to the upper oil pan 20, the bottom open portion 23h, the lid open portion 24h and the length portion, in the right-left direction, of the wall open portion 22h on the side of the upper oil pan 20 coincide with the lower side open portion 31h on the side of the lower oil pan 30, so that one opening through which the upper oil pan 20 and the lower oil pan 30 communicate with each other is formed.

[0034] As shown in FIGS. 3(c) and 3(d), the lower side bottom portion 33 has a lower side inclined portion 33s inclined downward more smoothly as it approaches the rear side from a front end portion 33a. The lower side inclined portion 33s is, as shown in FIG. 4, provided up to the neighborhood of substantially the central part, in the front-rear direction, of the lower oil pan 30 so as to include the position overlapping the upper surface portion 52 of the cross member 5 in the top-bottom direction (that is, the overlapping portion 11). In other words, the lower side inclined portion 33s is part of the lower side bottom portion 33 formed so as to incline downward from the front end side to the rear end side of the overlapping portion 11. The lower side inclined portion 33s is formed at an inclination angle substantially the same as the inclined portion 23s formed on the bottom portion 23 of the upper oil pan 20. Moreover, the lower side inclined portion 33s is substantially parallel to the upper surface portion 52 of the cross member 5.

[0035] Moreover, as shown by the broken line in FIG. 3(b), the lower side bottom portion 33 is formed of a rectangular bottom portion 33A situated substantially immediately below the bottom open portion 23h of the upper oil pan 20 when viewed from below the oil pan 10, and having substantially the same shape as the bottom open portion 23h and an extended bottom portion 33B provided so as to extend from the right side portion of the rectangular bottom portion 33A outside toward the right and formed so as to bent rearward in an intermediate part. The extended bottom portion 33B has a shape substantially the same as a shape which is a combination of the lid open portion 24h and the length portion, in the right-left direction, of the wall open portion 22h, and a rear end portion 33Bb thereof is situated behind the rear end portion 10b of the oil pan 10.

[0036] The lower oil pan 30 has, as shown in FIG. 2 and FIG. 3(b), an extended portion 34 extended so as to protrude outward from a portion of the lower side peripheral wall portion 32 extending in the front-rear direction on the right side (hereinafter, referred to as lower side right wall portion 32R), behind substantially the central part, in the front-rear direction, of the lower oil pan 30. The extended portion 34 is provided in order to further increase the capacity of the oil pan 10, and the shape thereof is determined by the arrangement relation with various devices and members other than the engine 1 mounted on the vehicle.

[0037] In this example, as shown in FIG. 1, the extended portion 34 is extended so as to be situated below the right front portion of the clutch housing 3. The extended portion 34 is formed of the extended bottom portion 33B of the lower side bottom portion 33 and part of the lower side peripheral wall portion 32 provided upright on the peripheral end portion of the extended bottom portion 33B. The extended portion 34 is a portion joined immediately below the lid 24 when the upper oil pan 20 and the lower oil pan 30 are combined together. The open portion on the upper surface of this extended portion 34 (that is, the portion of the lower side open portion 31h situated at the extended portion 34) is sealed by the above-described lid 24 of the upper oil pan 20.

[0038] As shown in FIG. 2 and FIG. 3(b), to the right end portion of the extended portion 34, a drain bolt 35 is attached with a drain washer 36 in between. The drain bolt 35 is for draining the oil stored in the oil pan 10, and is detached from the oil pan 10 together with the drain washer 36 in cases such as when the oil pan 10 is detached from the engine body and when oil is changed.

[0039] Next, the arrangement relation will be described among the oil pan 10, the cross member 5 and the steering rack housing 6a when the oil pan 10 formed of a combination of the upper oil pan 20 and the lower oil pan 30 structured as described above is mounted on a vehicle. As shown in FIG. 4, the oil pan 10 is provided so as to incline so that the rear end portion 10b is situated slightly below the front end portion 10a.

[0040] As shown in FIG. 4, the lower oil pan 30 is provided so as to be situated behind the overlapping portion 11 so as to include the overlapping portion 11 overlapping the cross member 5. In other words, the lower oil pan 30 is provided in a position where the front end portion of the lower side flange portion 31f substantially overlaps the front end portion of the upper surface portion 52 of the cross member 5 in the top-bottom direction. The upper oil pan 20 is provided so that the bottom portion 23 on the front side including the inclined portion 23s is situated in front of the steering rack housing 6a so as to include the steering rack housing 6a.

[0041] The oil pan 10 is disposed so that the bottom portion 23 of the upper oil pan 20 and the lower side bottom portion 33 of the lower oil pan 30 are at a substantially uniform distance from the steering rack housing 6a and the upper surface portion 52 of the cross member 5. This is done in order not only to prevent contact among the oil pan 10, the cross member 5 and the steering rack housing 6a but also to smoothly detach and attach the oil pan 10 from and to the engine body.

[0042] If this distance can be reduced, the bottom portions 23 and 33 of the oil pan 10 can be provided in lower positions accordingly, so that the capacity of the oil pan 10 can be increased. The oil pan 10 of the present embodiment has a structure as described above by minimizing this distance to increase the capacity and considering the detachment/attachment performance. Hereinafter, the detachment and attachment of the oil pan 10 from and to the engine body will be described.

[2. Oil Pan Detachment and Attachment Procedures]

[0043] Using FIGS. 5 (a) and 5(b), a procedure of detaching the oil pan 10 from the engine body and a procedure of attaching it to the engine body will be described. FIG. 5(a) shows the locus of detachment of the lower oil pan 30, and FIG. 5 (b) shows the locus of detachment of the upper oil pan 20. The loci of attachment of the upper oil pan 20 and the lower oil pan 30 are the reverse of the detachment loci.

[0044] When the oil pan 10 is detached from the engine body, first, the engine 1 is slightly lifted to slightly increase the distance (space) between the bottom portion 23 of the upper oil pan 20 and the lower side bottom portion 33 of the lower oil pan 30, and the steering rack housing 6a and the upper surface portion 52 of the cross member 5. Then, the steering rack housing 6a is detached from the vehicle body. Then, the drain bolt 35 and the drain washer 36 are detached and the oil inside is drained.

[0045] Further, the lower oil pan 30 is detached from the upper oil pan 20, and then, the upper oil pan 20 is detached from the engine body. This is because in the present embodiment, since the cross member 5 cannot be detached from the vehicle body (the vehicle body such as the side members 2), the oil pan 10 cannot be detached only by slightly increasing the space below the oil pan 10.

[0046] As shown in FIG. 5(a), when the lower oil pan 30 is detached from the upper oil pan 20, first, the joint surfaces of the upper oil pan 20 and the lower oil pan 30 are peeled off so that the lower oil pan 30 is movable. Then, as shown by the arrow A, the lower oil pan 30 is moved downward and brought down to the neighborhood of the cross member 5 (chain double-dashed line in the figure). Then, as shown by the arrow B, the lower oil pan 30 is pulled out toward the rear side of the vehicle body under that state (thick solid line in the figure). As described above, by detaching the lower oil pan 30 first, the space below the upper oil pan 20 can be further increased.

[0047] As shown in FIG. 5(b), when the upper oil pan 20 is detached from the engine body, first, the joint surfaces of the lower oil pan 30 and the cylinder block are peeled off so that the upper oil pan 20 is movable. Then, as shown by the arrow C, the upper oil pan 20 is moved downward and brought down to the neighborhood of the cross member 5 (chain double-dashed line in the figure). Then, as shown by the arrow D, the rear end of the upper oil pan 20 is slightly inclined downward (broken line in the figure). Then, as shown by the arrow E, the upper oil pan 20 is pulled out toward the rear side of the vehicle body under that state (thick solid line in the figure).

[0048] The vertical length H_2 behind the inclined portion 23s of the upper oil pan 20 is a length where the upper oil pan 20 can be pulled out in the inclined state toward the rear side of the vehicle from the space be-

tween the cross member 5 and the clutch housing 3.

[0049] On the other hand, when the oil pan 10 is attached to the engine body, the attachment is performed by a procedure reverse to the procedure of detachment of the oil pan 10. That is, first, the upper oil pan 20 is pushed in toward the front side of the vehicle from the space between the cross member 5 and the clutch housing 3, the upper oil pan 20 is inclined for attachment to the engine body, moved upward, and attached to the engine body with the seal member in between.

[0050] Then, the lower oil pan 30 to which the drain bolt 35 and the drain washer 36 are attached is pushed in up to below the upper oil pan 20 from the rear side of the vehicle, moved upward, and attached to the upper oil pan 20 with the seal member in between. Then, engine oil is poured into the engine body, the steering rack housing 6a is attached to the vehicle body, and the position of the engine 1 is returned to the original position.

[3. Advantage]

[0051] Consequently, according to the oil pan 10 of the present embodiment, since it is structured as the type divided into two pieces one above the other of the upper oil pan 20 and the lower oil pan 30 and the lower oil pan 30 is provided so as to be situated behind the overlapping portion 11 so as to include the overlapping portion 11, it is possible to detach only the lower oil pan 30 first in the detachment of the oil pan 10. This facilitates the detachment of the upper oil pan 20.

[0052] On the other hand, in the attachment of the oil pan 10, it is possible to attach the upper oil pan 20 first and then, attach the lower oil pan 30. Thereby, the oil pan 10 can be detached and attached even from and to a vehicle where the cross member 5 cannot be detached from the vehicle body as described above. Further, since the lower oil pan 30 is provided so as to include the overlapping portion 11, the capacity of the storable oil can be increased, so that the total quantity of oil required by the engine 1 can be secured. Consequently, the detachment/attachment performance and the securing of the capacity of the oil pan 10 can be both achieved.

[0053] Moreover, since the upper surface portion 52 of the cross member 5 is formed so as to incline downward from the front end portion 52a to the rear end portion 52b, the lower side bottom portion 33 of the lower oil pan 30 is formed so as to incline downward from the front end side to the rear end side of the overlapping portion 11 and there is a substantially uniform distance from the upper surface portion 52, the lower oil pan 30 can be smoothly pulled out toward the rear side of the vehicle. When the lower oil pan 30 is attached, contact with the cross member 5 can be easily avoided. Consequently, the detachment/attachment performance of the oil pan 10 can be further improved.

[0054] Moreover, since the lower oil pan 30 has the extended portion 34 provided so as to extend up to the rear side of the rear end portion 1b of the engine 1, the total quantity of oil that can be stored in the oil pan 10 can be increased. Thereby, the capacity of the oil pan 10 can be easily secured.

[0055] Since the oil pan 10 is of the type divided into two pieces one above the other, formed of the upper oil pan 20 and the lower oil pan 30, the degree of freedom of the shape is high compared with an integral oil pan. Moreover, since the lower oil pan 30 is formed of a sheet metal, a shape that does not interfere with surrounding devices and members can be easily formed. Moreover, by changing the shape of the lower oil pan 30, the capacity of the oil pan 10 can be easily changed.

[0056] Moreover, in this example, since the wall open portion 22h is formed on part of the peripheral wall portion 22 of the upper oil pan 20 and the lid 24 whose longitudinal cross section in the direction orthogonal to the direction extending from the one end portion 24a to the other end portion 24b is hat-shaped is provided, the capacity of the oil pan 10 can be further increased.

[4. Modifications]

[0057] While an embodiment of the present invention has been described above, the present invention is not limited to the above-described embodiment, and may be modified variously without departing from the gist of the present invention.

[0058] While in the above-described embodiment, the extended portion 34 of the lower oil pan 30 is provided so as to extend rearward beyond the rear end portion 1b of the engine 1, the shape and position of the extended portion 34 are not limited thereto, and the shape and position thereof are determined by the arrangement relation with various devices and members other than the engine 1 mounted on the vehicle. For example, the extended portion 34 may be provided so as to extend further behind the rear end portion 1b of the engine 1 or conversely, may be provided so as to extend only sideward. When the capacity of the oil pan 10 is sufficiently secured, the extended portion 34 may be omitted.

[0059] The wall open portion 22h is not necessarily formed in the upper oil pan 20, and the lid 24 is not necessarily hat-shaped in cross section. For example, a planar lid member may be provided at the open portion on the upper surface of the extended portion 34 provided on the lower oil pan 30 (that is, the part of the lower side open portion 31h situated at the extended portion 34) to seal this open portion. In this case, since the lid member sealing the extended portion 34 has a simple shape, the structure of the oil pan 10 can be simplified.

[0060] Moreover, the position where the lower oil pan 30 is attached is not limited to the above-described one since it is determined according to the position of the cross member 5. Moreover, while in the above-described embodiment, the lower oil pan 30 is provided so as to be situated behind the overlapping portion 11 so as to include the overlapping portion 11 since the steering linkage 6 is provided in front of the cross member 5, when

the position of the steering linkage 6 is different from the above-mentioned one, the lower oil pan 30 may be provided so as to be situated in front of the overlapping portion 11 so as to include the overlapping portion 11.

[0061] Moreover, in this case, it is preferable that the upper surface portion 52 of the cross member 5 be formed so as to incline upward from the front end portion 52a to the rear end portion 52b and it is preferable that the part of the lower side bottom portion 33 of the lower oil pan 30 opposed to the cross member 5 be formed so as to incline upward from the front end side to the rear end side of the overlapping portion 11. The upper surface of the cross member 5 and the bottom portion of the lower oil pan 30 are not necessarily formed so as to incline.

[0062] While the present oil pan 10 is suitable for use in vehicles where the cross member 5 cannot be detached from the vehicle body, it is to be noted that it is also applicable to vehicles where the cross member 5 is detachable from the vehicle body.

Description of Reference Numerals and Signs

[0063]

1 Engine (internal combustion engine)
2 Side member
5 Cross member
52 Upper surface portion
10 Oil pan
11 Overlapping portion
20 Upper oil pan
23 Bottom portion
23e Lowermost portion
23h Bottom open portion (opening)
30 Lower oil pan
33 Lower side bottom portion
33s Lower side inclined portion
34 Extended portion

Claims

1. An oil pan for an internal combustion engine mounted on a vehicle provided with a pair of right and left side members provided so as to extend in a front-rear direction of the vehicle and a cross member provided so as to extend in a width direction of the vehicle and fixed to the pair of side members,
characterized by being of a type divided into two pieces one above the other, formed of an upper oil pan attached to a body of the internal combustion engine and including an opening in a bottom portion and a lower oil pan attached so as to cover the opening of the upper oil pan from below,
by including an overlapping portion situated above the cross member and overlapping the cross member, and
in that the lower oil pan is provided so as to be situated in front of or behind the overlapping portion so as to include the overlapping portion in a state of being mounted on the vehicle.

2. The oil pan for the internal combustion engine according to claim 1, **characterized in that**
an upper surface of the cross member is formed so as to incline upward or downward from a front end portion to a rear end portion, and
a bottom portion, opposed to the cross member, of the lower oil pan is formed so as to incline upward or downward from a front end side of the overlapping portion to a rear end side of the overlapping portion, and has a substantially uniform distance from the upper surface portion of the cross member.

3. The oil pan for the internal combustion engine according to claim 1 or 2, **characterized in that**
at least the lower oil pan is provided so as to extend frontward beyond a front end portion of the internal combustion engine or rearward beyond a rear end portion of the internal combustion engine.

Amended claims under Art. 19.1 PCT

1. An oil pan for an internal combustion engine mounted on a vehicle provided with a pair of right and left side members provided so as to extend in a front-rear direction of the vehicle and a cross member provided so as to extend in a width direction of the vehicle and fixed to the pair of side members,
characterized by being formed of an upper oil pan attached to a body of the internal combustion engine and including an opening in a bottom portion and a lower oil pan attached so as to cover the opening of the upper oil pan from below,
by including an overlapping portion situated above the cross member and overlapping the cross member, and
in that the lower oil pan is provided so as to be situated in front of or behind the overlapping portion so as to include the overlapping portion.

2. The oil pan for the internal combustion engine according to claim 1, **characterized in that**
a bottom portion, opposed to the cross member, of the lower oil pan is formed so as to incline upward or downward from a front end side of the overlapping portion to a rear end side of the overlapping portion, and has a substantially uniform distance from the upper surface portion of the cross member.

3. The oil pan for the internal combustion engine according to claim 1 or 2, **characterized in that**
at least the lower oil pan is provided so as to extend frontward beyond a front end portion of the internal combustion engine or rearward beyond a rear end

portion of the internal combustion engine.

4. The oil pan for the internal combustion engine according to claim 1 or 2, **characterized in that** an inclined portion is formed substantially in a central part, in the front-rear direction, of a bottom portion of the upper oil pan, and the bottom portion is formed so that a surface behind the inclined portion is situated lower than a surface of a front side of the inclined portion.

5. The oil pan for the internal combustion engine according to claim 4, **characterized in that** the upper oil pan is formed so that a vertical length behind the inclined portion is larger than a vertical length on the front side of the inclined portion.

6. The oil pan for the internal combustion engine according to any one of claims 1 to 3, **characterized in that** a lowermost portion is provided at a portion situated in a lowermost position in the bottom portion of the upper oil pan, the opening passing through the bottom portion is formed in the lowermost portion, and an area of opening of the opening is smaller than that of an upper surface open portion.

7. The oil pan for the internal combustion engine according to any one of claims 1 to 3, **characterized in that** the lower oil pan has an extended portion extended so as to protrude outward from a lower side peripheral wall portion.

8. The oil pan for the internal combustion engine according to claim 7 further including a lid member sealing an open portion on an upper surface of the extended portion.

FIG.1

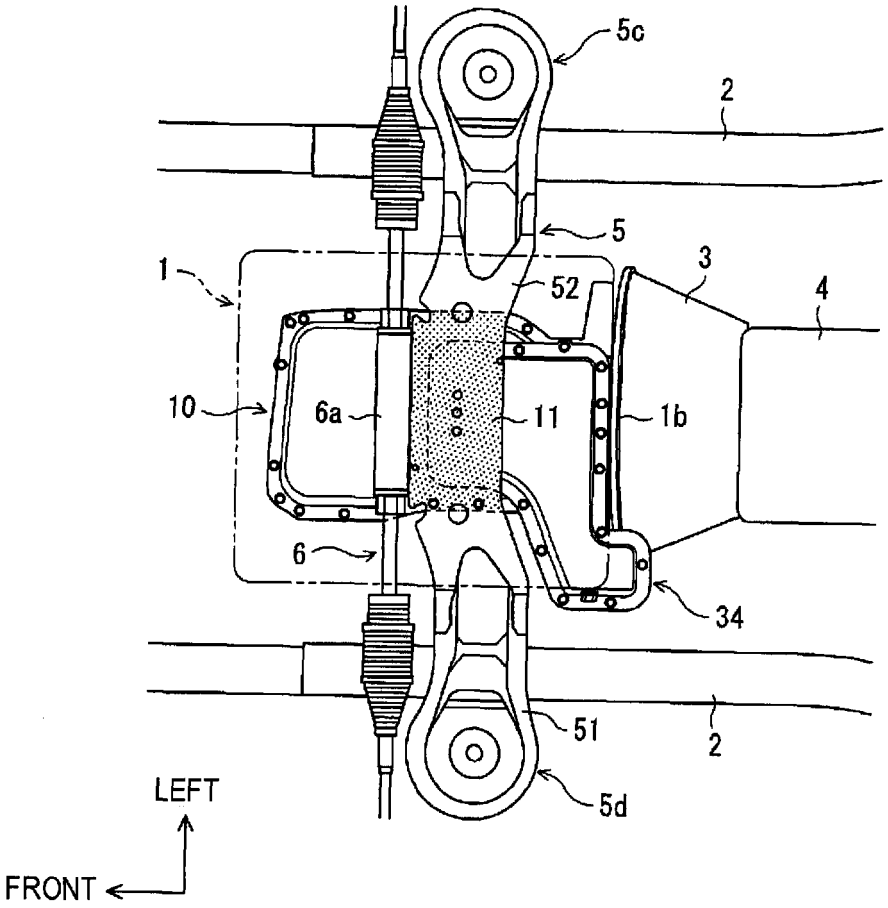


FIG.2

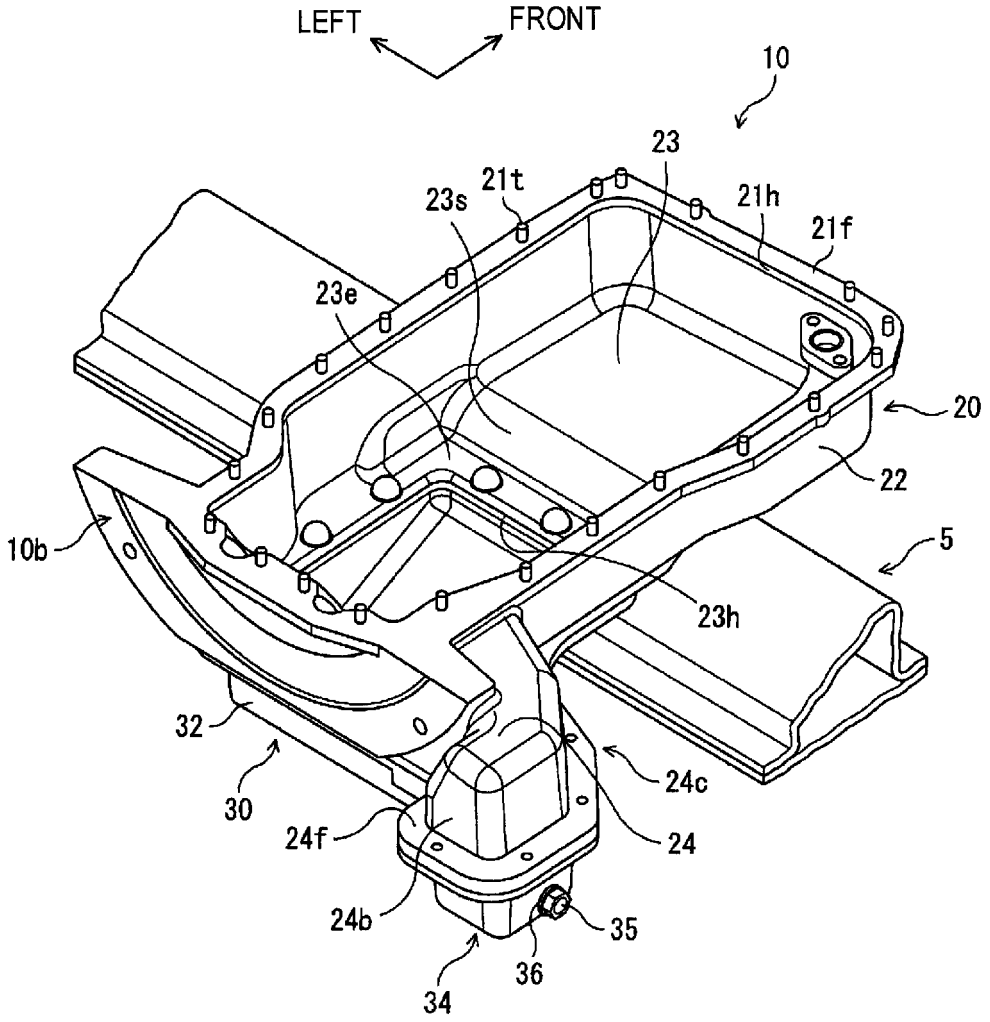

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FIG.3(a)

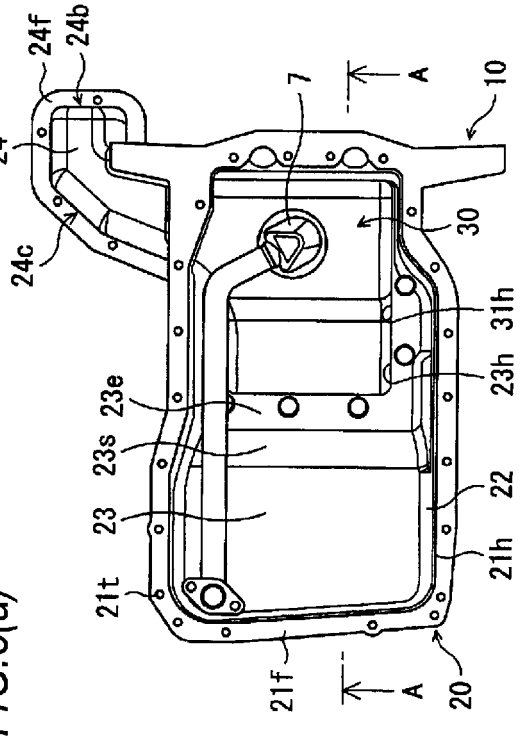


FIG.3(b)

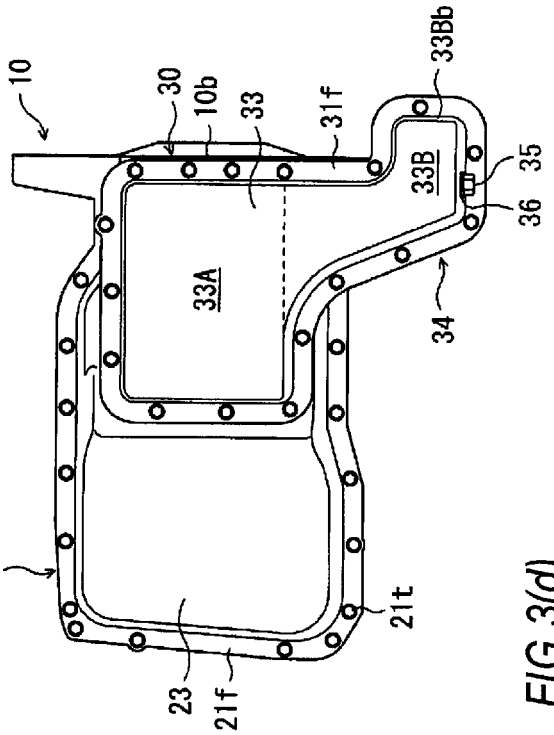
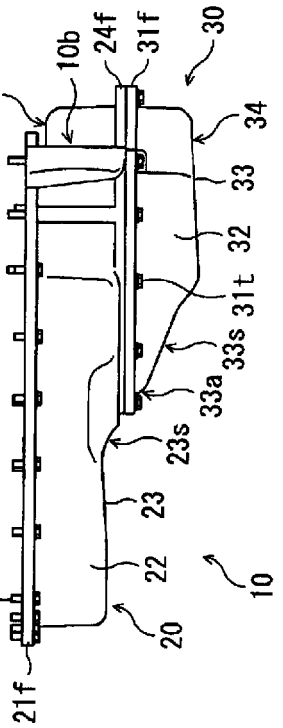


FIG.3(c)



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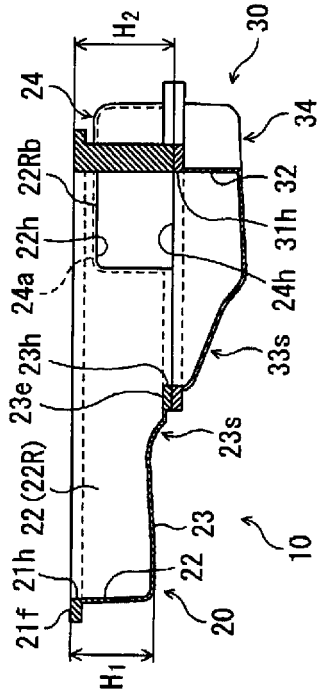
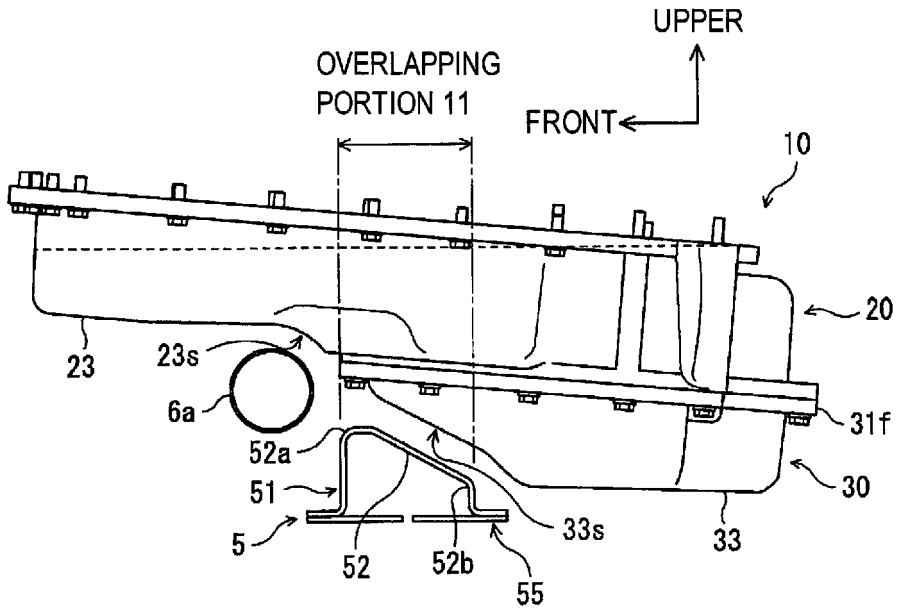


FIG.4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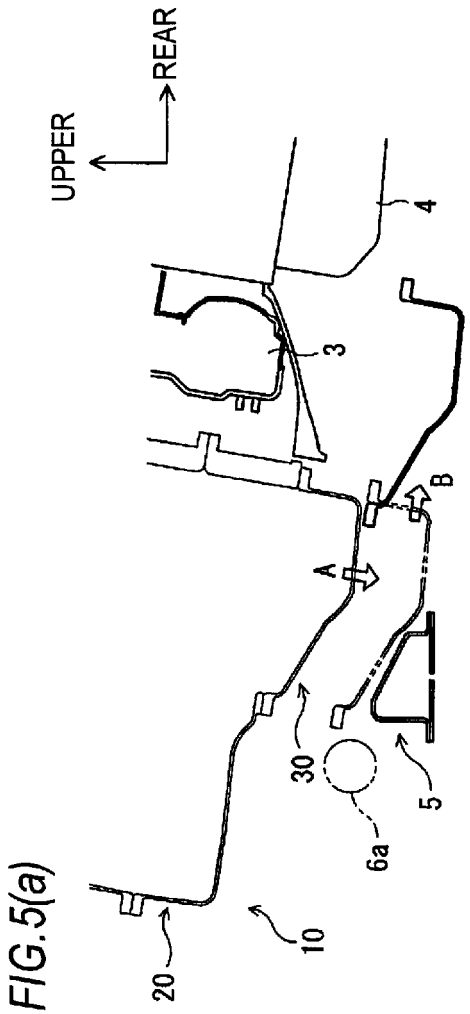

FIG.5(a)

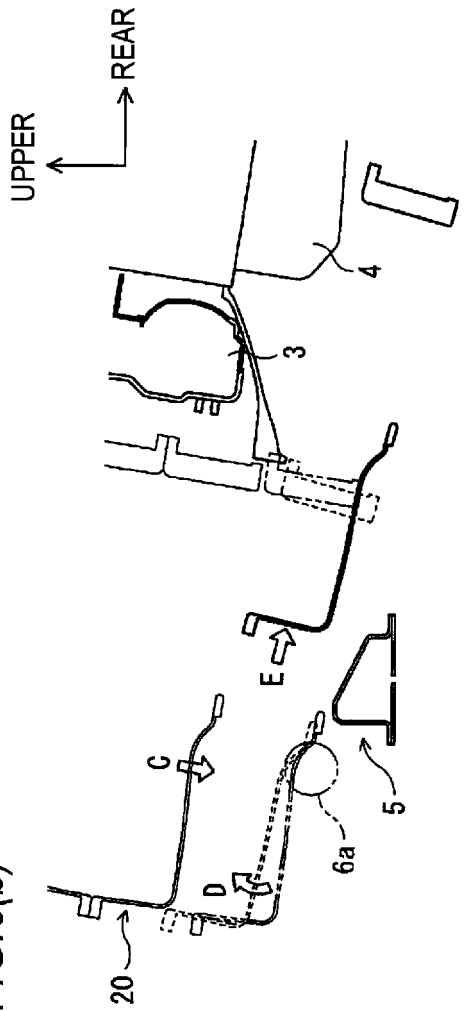

FIG.5(b)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2013/063810

A. CLASSIFICATION OF SUBJECT MATTER
F01M11/00(2006.01)i, *F02F7/00*(2006.01)i

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)
F01M11/00, F02F7/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2013
Kokai Jitsuyo Shinan Koho	1971-2013	Toroku Jitsuyo Shinan Koho	1994-2013

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 8-144848 A (Toyota Motor Corp.), 04 June 1996 (04.06.1996), entire text; fig. 2 (Family: none)	1-3
Y	JP 2000-199416 A (Toyota Motor Corp.), 18 July 2000 (18.07.2000), entire text; fig. 2 (Family: none)	1-3

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

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"&" document member of the same patent family

Date of the actual completion of the international search 25 June, 2013 (25.06.13)	Date of mailing of the international search report 09 July, 2013 (09.07.13)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2013/063810

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 131381/1985(Laid-open No. 40246/1987) (Hino Motors, Ltd.), 10 March 1987 (10.03.1987), entire text; fig. 3 (Family: none)	1-3
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 87210/1989(Laid-open No. 25806/1991) (Mazda Motor Corp.), 18 March 1991 (18.03.1991), entire text; fig. 1 (Family: none)	2

Form PCT/ISA/210 (continuation of second sheet) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 8074552 A **[0004]**