



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
01.12.2004 Bulletin 2004/49

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

(21) Application number: **04253170.7**

(22) Date of filing: **28.05.2004**

(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

(72) Inventor: **Osman, Azmi,**
c/o Yamaha Eng. Dev. Co Ltd.
Shizuoka 438-0026 (JP)

(74) Representative: **Murray, Elisabeth Anne et al**
Mathys & Squire,
100 Gray's Inn Road
London WC1X 8AL (GB)

(30) Priority: **28.05.2003 JP 2003150310**

(71) Applicant: **Petroliam Nasional Berhad**
50088 Kuala Lumpur (MY)

(54) **Oil pan structure for an engine**

(57) An engine 1 comprises a crankcase 2, a crankshaft 3 supported on the crankcase 2 for rotation about an axial center 4 extending approximately in the horizontal direction, and an oil pan 9 fixed to the lower end of the crankcase 2. The oil pan 9 comprises a bottom plate 25, and vertical walls 26-29 protruded upwardly from outer edges of the bottom plate 25 and fixed to the crankcase 2 at the protruded ends. The bottom plate 25 and the vertical walls 26-29 are formed integrally with

one another by casting. The bottom plate 25, as viewed as a whole, is formed approximately in agreement in shape with part of a spherical surface 34 with a center 33 at a point above the oil pan 9.

Such an arrangement can prevent vibration in portions of an oil pan during engine operation for the prevention of generation of noise from the oil pan and to achieve with simple structure and without increasing the weight of the oil pan.

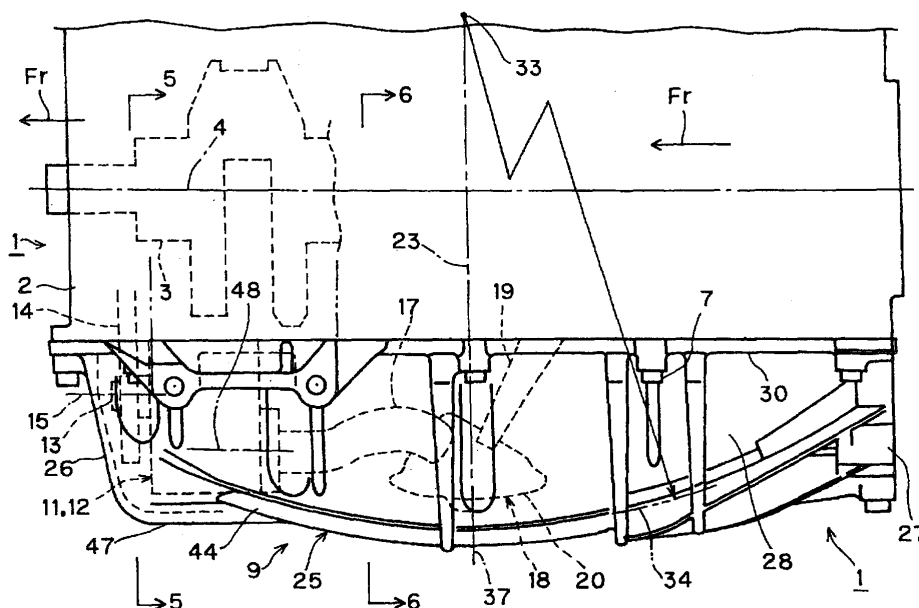


FIG. 1

Description

[0001] This invention relates to an oil pan structure in an engine. In a preferred examples, the structure is for preventing the oil pan from generating noise due to vibration associated with engine operation.

[0002] In JP-A-Hei 7-317600, an engine generally comprises a crankcase, a crankshaft supported on the crankcase for rotation about an axial center extending approximately in the horizontal direction, and an oil pan fixed to the lower end of the crankcase for retaining oil inside; the oil pan comprises a bottom plate, and vertical walls protruded from outer edges of the bottom plate and fixed to the crankcase at the protruded ends; and the bottom plate and the vertical walls are formed integrally with one another by casting.

[0003] When the engine is operated, the oil pan is subjected to impact force from the crankshaft and the like. In this case, if the rigidity of the oil pan is low, a disadvantage arises that vibration is generated in portions of the oil pan, causing noise.

[0004] Therefore, as shown in JP-A-Hei 7-317600, an idea has conventionally been suggested that a vibration absorbing plate is provided inside the oil pan to prevent generation of vibration.

[0005] However, if a vibration absorbing plate is provided in the oil pan, as described above, a problem is posed that engine structure becomes complicated and that the weight of the oil pan is increased.

[0006] Also, for the prevention of vibration in portions of the oil pan, heretofore, some oil pans are provided with numerous ribs throughout the surface, but the weight of the oil pan is apt to be increased in this case as well.

[0007] In view of the foregoing, an object of examples of this invention is to prevent vibration in portions of an oil pan during engine operation for the prevention of generation of noise from the oil pan and aspects of the invention are intended to achieve this object with simple structure and without increasing the weight of the oil pan.

[0008] To seek to achieve the foregoing object, the oil pan structure in an engine of an aspect this invention is as follows. Reference numerals attached to the technical terms in this section should not be construed as limiting the technical scope of this invention to the contents of the described embodiments of the invention described later, or limiting in any other way.

[0009] According to a first aspect of the invention there is provided an oil pan structure in an engine comprising a crankcase 2, a crankshaft 3 supported on the crankcase 2 for rotation about an axial center 4 extending approximately in the horizontal direction, and an oil pan 9 fixed to the lower end of the crankcase 2, the oil pan 9 comprising a bottom plate 25, and vertical walls 26-29 protruded upwardly from outer edges of the bottom plate 25 and fixed to the crankcase 2 at the protruded ends, and the bottom plate 25 and vertical walls

26-29 being formed integrally with one another by casting,

wherein the bottom plate 25, as viewed as a whole, is formed approximately in agreement in shape with part of a spherical surface 34 with a center 33 at a point above the oil pan 9.

[0010] Preferably the center 33 is disposed in the vicinity of a vertical line 23 passing through a laterally central portion 36 of the bottom plate 25, as viewed along the axial center 4 of the crankshaft 3 (Figs. 2, 5, and 6).

[0011] Preferably the center 33 is disposed in the vicinity of the vertical line 23 passing through a central portion 37 of the bottom plate 25 in the axial direction of the crankshaft 3, as the oil pan 9 is viewed in profile (Figs. 1, 3, and 4).

[0012] Preferably, in an oil pan structure in an engine in which part of the bottom plate 25 is formed into a flat plate 40 extending approximately in the horizontal direction, the upper surface of the flat plate 40 is at the inner lowermost end of the oil pan 9, and upwardly of the flat plate 40 is provided a suction section 18 for sucking oil 8,

wherein the flat plate 40 is disposed at a position offset from a central portion 41 of the bottom plate 25, as the oil pan 9 is viewed in plan (Fig. 7).

[0013] Preferably grooves 45 are formed in the upper surface of the bottom plate 25 at other portions, the grooves 45 are formed, at ends on the side of the flat plate 40, to be in communication with a region above the flat plate 40, and the grooves 45 are formed to be inclined gradually downwardly toward the ends.

[0014] Preferably, the oil pan structure in an engine is provided with a component 11 of an engine 1 disposed inside the oil pan 9 and interlockingly connected to the crankshaft 3,

wherein a portion of the bottom plate 25 below the component 11 bulges downwardly to be a bulging portion 47, the bulging portion 47 is formed approximately in agreement in shape with part of a cylinder 49 with an axial center 48 approximately parallel to the axial center 4 of the crankshaft 3, and one end of the bulging portion 47 in the axial direction is connected to the outer edge of the flat plate 40.

[0015] In a broad aspect of the invention there is provided an oil pan having a bottom plate, wherein said bottom plate, as viewed as a whole is formed approximately in agreement in shape with part of a substantially spherical surface with a centre above said oil pan.

[0016] A further aspect of the invention provides an oil pan for an engine, the oil pan being configured to reduce vibration in the bottom plate of the oil pan.

[0017] Preferably a part of the bottom plate is curved.

[0018] The invention extends to methods and/or apparatus substantially as herein described with reference to the accompanying drawings.

[0019] Any feature in one aspect of the invention may be applied to other aspects of the invention, in any appropriate combination. In particular, method aspects may be applied to apparatus aspects, and vice versa.

[0020] Preferred features of the present invention will now be described, purely by way of example, with reference to the accompanying drawings, in which:

Fig. 1 is a partial enlarged view of Fig. 3.

Fig. 2 is a front view of an engine.

Fig. 3 is a side view of the engine.

Fig. 4 is a sectional view corresponding to Fig. 1.

Fig. 5 is a sectional view taken in the direction of arrows 5-5 of Fig. 1.

Fig. 6 is a sectional view taken in the direction of arrows 6-6 of Fig. 1.

Fig. 7 is a plan view of an oil pan.

Fig. 8 is a bottom view of the oil pan.

Fig. 9 is a perspective view of the interior of the oil pan.

Fig. 10 is a perspective view of the bottom of the oil pan.

[0021] In Figs. 1-5, reference numeral 1 designates a multiple-cylinder (four-cylinder), four-stroke engine (internal combustion engine) mounted on a vehicle such as an automobile. For the convenience of explanation, the direction of an arrow Fr in the drawings shows the front of the vehicle, and terms left and right in the following description mean the horizontal direction toward the front. The front in the advancing direction of the vehicle is the left.

[0022] The engine 1 comprises a crankcase 2 supported on a body of the vehicle, and a crankshaft 3 disposed inside the crankcase 2; the crankshaft 3 has its axial center 4 extending longitudinally and approximately in the horizontal direction; and the crankshaft 3 is supported on the crankcase 2 for rotation about the axial center 4. Also, the engine 1 comprises a cylinder 6 fixed to the upper end of the crankcase 2, and an oil pan 9 fixed to the lower end of the crankcase 2 with a fastening member 7 and for retaining lubricating oil 8 inside.

[0023] The engine 1 also comprises an engine component 11 disposed inside the oil pan 9 at one end thereof (at the forward end, the same shall apply hereinafter) and interlockingly connected to one end of the crankshaft 3. Specifically, the component 11 is an oil pump 12 fixed to the under surface of the crankcase 2 at one end, and an input shaft 13 of the oil pump 12 is interlockingly connected to one end of the crankshaft 3 by chain-wound power transmission means 14. An axial center 15 of the input shaft 13 extends parallel to the axial center 4 of the crankshaft 3, and the oil pump 12 has an approximately columnar shape with the axial center 15 in its center.

[0024] Inside the oil pan 9 are provided a suction pipe 17 extending from the oil pump 12, a suction section 18 attached to the extending end of the suction pipe 17 for sucking the oil 8, and a bracket 19 for supporting the suction section 18 on the crankcase 2 at the lower end. The suction section 18 has a circular shape, as the oil pan 9 is viewed in plan. Also, in the under surface of the

suction section 18 is formed an inlet 20 of the oil 8, and inside the suction section 18 is provided an unillustrated oil filter.

[0025] When the engine 1 is operated, the oil pump 12 is operated in association with the crankshaft 3, the oil 8 in the oil pan 9 is drawn into the oil pump 12 from the inlet 20 through the suction section 18 and suction pipe 17, and thereafter, supplied to lubricated portions of the engine 1, for given lubrication.

[0026] The engine 1 is slightly inclined toward the right with respect to a vertical line 23, as viewed from the front (Fig. 2).

[0027] In all the drawings, the oil pan 9 comprises a bottom plate 25, front and rear vertical walls 26, 27 protruded upwardly from outer edges of the bottom plate 25 in the axial direction of the crankshaft 3, respectively, left and right vertical walls 28, 29 protruded upwardly from left and right outer edges of the bottom plate 25, respectively, and outwardly extending flanges 30 provided at upper edges of the vertical walls 26-29 to be fixed to the crankcase 2. These bottom plate 25, vertical walls 26-29, and outwardly extending flanges 30 are made by aluminum casting and formed integrally with one another. Upper end faces of the vertical walls 26-29 and the outwardly extending flanges 30 are flat surfaces extending continuously adjacent to one another and constitute the upper end face of the oil pan 9 to be mated with the bottom surface of the cylinder 6.

[0028] The bottom plate 25 of the oil pan 9, as viewed as a whole, is formed approximately in agreement in shape with part of a spherical surface 34 with a center 33 at a point vertically above the bottom plate 25 in the oil pan 9.

[0029] Therefore, the rigidity of the bottom plate 25 is improved compared with when the bottom plate 25 is formed simply in the shape of a flat plate. Thus, vibration in portions of the bottom plate 25 of the oil pan 9 due to impact force during operation of the engine 1, is prevented, which prevents generation of noise from the oil pan 9.

[0030] Also, noise generation from the oil pan 9 described above is prevented because of the bottom plate 25 being formed approximately in agreement in shape with part of the spherical surface 34 and not because of a vibration absorbing plate or numerous ribs being separately provided, and therefore the prevention of noise generation from the oil pan 9 can be achieved with simple structure and without increasing the weight of the oil pan 9.

[0031] The center 33 is disposed in the vicinity of the vertical line 23 passing through a laterally central portion 36 of the bottom plate 25, as viewed along the axial center 4 of the crankshaft 3 (Figs. 2, 5, and 6).

[0032] Therefore, the bottom plate 25, as viewed in the foregoing direction (Figs. 2, 5, and 6), is formed approximately laterally symmetrical with respect to the vertical line 23, so that imbalance in the rigidity of the bottom plate 25 is prevented. Thus, vibration in portions of

the bottom plate 25 is prevented more reliably, which prevents generation of noise from the oil pan 9 more reliably.

[0033] The center 33 is disposed in the vicinity of the vertical line 23 passing through a central portion 37 of the bottom plate 25 in the axial direction of the crankshaft 3, as the oil pan 9 is viewed in profile (Figs. 1, 3, and 4).

[0034] Therefore, the bottom plate 25, as the oil pan 9 is viewed in profile (Figs. 1, 3, and 4), is formed approximately longitudinally symmetrical with respect to the vertical line 23, so that imbalance in the rigidity of the bottom plate 25 is prevented. Thus, vibration in portions of the bottom plate 25 is prevented more reliably, which prevents generation of noise from the oil pan 9 more reliably.

[0035] In this case, it is preferable that the dimension from the center 33 to the under surface of the bottom plate 25 in the shape approximately in agreement with part of the spherical surface 34 is 35-45 cm. If it is less than 35 cm, the vertical dimension of the engine 1 is apt to be too large because of the central portions 36, 37 of the bottom plate 25 being protruded downwardly to a large extent, and if it is over 45 cm, improvement in rigidity is hindered because of the bottom plate 25 being too flat.

[0036] In Figs. 2, 4, and 7-10, part of the bottom plate 25 is formed to be a circular flat plate 40 extending approximately in the horizontal direction. The upper surface of the flat plate 40 is at the inner lowermost end of the oil pan 9, and approximately upwardly of the flat plate 40 is disposed the inlet 20 of the suction section 18. The diameter of the flat plate 40 is approximately 8-10 cm.

[0037] The flat plate 40 is disposed such that its central portion 42 is located at a position in the vicinity of and offset from a central portion 41 of the bottom plate 25, as the oil pan 9 is viewed in plan (Fig. 7).

[0038] In this case, the upper surface of the flat plate 40 is at the lowermost end of the oil pan 9, the flat plate 40 is disposed in the vicinity of the central portion 41 as the oil pan 9 is viewed in plan, and further, approximately upwardly of the flat plate 40 is disposed the suction section 18. Therefore, even if the inclination of the liquid surface of the oil 8 in the oil pan 9 changes back and forth or leftwardly and rightwardly while the vehicle is running, for example, the suction section 18 is located more reliably in the oil 8 at all times. Thus, the oil 8 is sucked more reliably into the oil pump 12 through the suction section 18, securing given lubrication by the oil 8.

[0039] Here, when the bottom plate 25 of the oil pan 9 vibrates in association with the operation of the engine 1, its amplitude is apt to be maximum at the central portion 41 of the bottom plate 25 viewed in plan. Also, because of the structure of the flat plate 40 being low in rigidity, its amplitude is apt to be large.

[0040] For this reason, the flat plate 40 is disposed at

a position offset from the central portion 41 of the bottom plate 25, as described above, which suppresses vibration of large amplitude in the flat plate 40. Thus, noise generation from the oil pan 9 is prevented also in this respect.

[0041] In Figs. 7-10, in portions of the bottom plate 25 other than the flat plate 40 are formed a plurality of beads 44 extending in the axial direction of the crankshaft 3 and bulging downwardly. Ends of the beads 44 at the side of the central portion 41, as the bottom plate 25 is viewed in plan, are each connected to the outer edge of the flat plate 40.

[0042] Therefore, the beads 44 causes the rigidity of other portions of the bottom plate 25 to be improved, and the less rigid flat plate 40 is reinforced by the beads 44. Thus, vibration in portions of the bottom plate 25 including the flat plate 40 is suppressed further, which prevents noise generation from the oil pan 9 further.

[0043] In the upper surface of the bottom plate 25 at other portions are formed grooves 45 by the inside surfaces (upper surfaces) of the beads 44, and ends of the grooves 45 on the side of the flat plate 40 are formed in communication with a region above the flat plate 40. Also, the grooves 45 are each formed to be inclined gradually downwardly toward the ends.

[0044] Therefore, even when the liquid surface of the oil 8 in the oil pan 9 lowers, the oil 8 is guided onto the flat plate 40 by the grooves 45, so that the suction section 18 is located more reliably in the oil 8. Thus, the oil 8 is sucked more reliably into the oil pump 12 through the suction section 18, securing given lubrication by the oil 8.

[0045] In Figs. 1, 4, 5, 7, 8, and 10, a portion of the bottom plate 25 below the oil pump 12 of the component 11 bulges downwardly and forms a bulging portion 47. The bulging portion 47 is formed approximately in the shape of part of a cylinder located in the oil pan 9 and having an axial center 48, approximately parallel to the axial center 4 of the crankshaft 3, in its center. The bulging portion 47 is connected, at one end in the axial direction, to the front vertical wall 26 and, at the other end, to the outer edge of the flat plate 40.

[0046] Therefore, since the bulging portion 47 of large rigidity is provided approximately in agreement in shape with part of the cylinder, the rigidity of the bottom plate 25 is improved. In addition, the end of the bulging portion 47 is connected to the outer edge of the less rigid flat plate 40, and the flat plate 40 is reinforced by the bulging portion 47. Thus, vibration in portions of the bottom plate 25 including the flat plate 40 is prevented.

[0047] Also, the inner bottom of the bulging portion 47 is inclined, in its axial direction, gradually downwardly toward the flat plate 40, therefore the oil 8 is prevented from remaining in the bulging portion 47.

[0048] Also, the lower part of the oil pump 12 of the component 11 is fitted inside the bulging portion 47, and therefore the oil pump 12 of the component 11 and the oil pan 9 are arranged compactly together with each oth-

er, effecting size reduction of the engine 1.

[0049] Although this invention has been described as related to an embodiment shown in the drawings, the center 33 of the spherical surface 34 may be offset from the vertical line 23 to some extent either in the longitudinal or the lateral direction.

[0050] Effects of preferred features of this invention are as follows.

[0051] An aspect of the present invention provides an oil pan structure in an engine comprising a crankcase, a crankshaft supported on the crankcase for rotation about an axial center extending approximately in the horizontal direction, and an oil pan fixed to the lower end of the crankcase, the oil pan comprising a bottom plate, and vertical walls protruded upwardly from outer edges of the bottom plate and fixed to the crankcase at the protruded ends, and the bottom plate and vertical walls being formed integrally with one another by casting,

wherein the bottom plate, as viewed as a whole, is formed approximately in agreement in shape with part of a spherical surface with a center at a point above the oil pan.

[0052] Therefore, the rigidity of the bottom plate is improved compared with when the bottom plate is formed simply in the shape of a flat plate. Thus, vibration in portions of the bottom plate of the oil pan due to impact force during operation of the engine, is prevented, which prevents generation of noise from the oil pan.

[0053] Also, noise generation from the oil pan described above is prevented because of the bottom plate being formed approximately in agreement in shape with part of the spherical surface and not because of a vibration absorbing plate or numerous ribs being separately provided, and therefore the prevention of noise generation from the oil pan can be achieved with simple structure and without increasing the weight of the oil pan.

[0054] Preferably, the center is disposed in the vicinity of a vertical line passing through a laterally central portion of the bottom plate, as viewed along the axial center of the crankshaft.

[0055] Therefore, the bottom plate, as viewed in the foregoing direction is formed approximately symmetrical with respect to the vertical line, so that imbalance in the rigidity of the bottom plate is prevented. Thus, vibration in portions of the bottom plate is prevented more reliably, which prevents generation of noise from the oil pan more reliably.

[0056] Preferably, the center is disposed in the vicinity of the vertical line passing through a central portion of the bottom plate in the axial direction of the crankshaft, as the oil pan is viewed in profile.

[0057] Therefore, the bottom plate, as the oil pan is viewed in profile, is formed approximately symmetrical with respect to the vertical line, so that imbalance in the rigidity of the bottom plate is prevented. Thus, vibration in portions of the bottom plate is prevented more reliably, which prevents generation of noise from the oil pan more reliably.

[0058] Preferably, in an oil pan structure in an engine, in which part of the bottom plate is formed into a flat plate extending approximately in the horizontal direction, the upper surface of the flat plate is at the inner lowermost end of the oil pan, and upwardly of the flat plate is provided a suction section for sucking oil,

wherein the flat plate is disposed at a position offset from a central portion of the bottom plate, as the oil pan is viewed in plan.

[0059] Here, when the bottom plate of the oil pan vibrates in association with engine operation, its amplitude is apt to be maximum at the central portion of the bottom plate viewed in plan. Also, because of the structure of the flat plate being low in rigidity, its amplitude is apt to be large.

[0060] For this reason, the flat plate is disposed at a position offset from the central portion of the bottom plate, as described above, which suppresses vibration of large amplitude in the flat plate. Thus, noise generation from the oil pan is prevented.

[0061] Preferably, grooves are formed in the upper surface of the bottom plate at other portions, the grooves are formed, at ends on the side of the flat plate, to be in communication with a region above the flat plate, and the grooves are formed to be inclined gradually downwardly toward the ends.

[0062] Therefore, even when the liquid surface of the oil in the oil pan lowers, the oil is guided onto the flat plate by the grooves, so that the suction section is located more reliably in the oil. Thus, the oil is sucked more reliably into the oil pump through the suction section, securing given lubrication by the oil.

[0063] Preferably the oil pan structure in an engine is provided with an engine component disposed inside the oil pan and interlockingly connected to the crankshaft,

wherein a portion of the bottom plate below the component bulges downwardly to be a bulging portion, the bulging portion is formed approximately in agreement in shape with part of a cylinder with an axial center approximately parallel to the axial center of the crankshaft, and one end of the bulging portion in the axial direction is connected to the outer edge of the flat plate.

[0064] Therefore, since the bulging portion of large rigidity is provided approximately in agreement in shape with part of the cylinder, the rigidity of the bottom plate is improved. In addition, the end of the bulging portion is connected to the outer edge of the less rigid flat plate, and the flat plate is reinforced by the bulging portion. Thus, vibration in portions of the bottom plate including the flat plate is prevented.

[0065] In a preferred example, an engine 1 comprises a crankcase 2, a crankshaft 3 supported on the crankcase 2 for rotation about an axial center 4 extending approximately in the horizontal direction, and an oil pan 9 fixed to the lower end of the crankcase 2. The oil pan 9 comprises a bottom plate 25, and vertical walls 26-29 protruded upwardly from outer edges of the bottom plate 25 and fixed to the crankcase 2 at the protruded ends.

The bottom plate 25 and the vertical walls 26-29 are formed integrally with one another by casting. The bottom plate 25, as viewed as a whole, is formed approximately in agreement in shape with part of a spherical surface 34 with a center 33 at a point above the oil pan 9.

[0066] Such an arrangement can prevent vibration in portions of an oil pan during engine operation for the prevention of generation of noise from the oil pan and to achieve with simple structure and without increasing the weight of the oil pan.

[0067] It will be understood that the present invention has been described above purely by way of example, and modification of detail can be made within the scope of the invention.

[0068] Each feature disclosed in the description, and (where appropriate) the claims and drawings may be provided independently or in any appropriate combination.

Explanation of Reference Numerals

[0069]

- 1: engine
- 2: crankcase
- 3: crankshaft
- 4: axial center
- 8: oil
- 9: oil pan
- 11: component
- 12: oil pump
- 17: suction pipe
- 18: suction section
- 20: inlet
- 23: vertical line
- 25: bottom plate
- 26: vertical wall
- 27: vertical wall
- 28: vertical wall
- 29: vertical wall
- 33: center
- 34: spherical surface
- 36: central portion
- 37: central portion
- 40: flat plate
- 41: central portion
- 42: central portion
- 44: bead
- 45: groove
- 47: bulging portion
- 48: axial center
- 49: cylinder

Claims

1. An oil pan structure for an engine comprising a crankcase, a crankshaft supported on said crank-

case for rotation about an axial center extending approximately in the horizontal direction, and an oil pan fixed to the lower end of said crankcase, said oil pan comprising a bottom plate, and vertical walls protruded substantially upwardly from outer edges of the bottom plate and fixed to said crankcase at the protruded ends, and said bottom plate and vertical walls being formed integrally with one another by casting,

wherein said bottom plate, as viewed as a whole, is formed approximately in agreement in shape with part of a substantially spherical surface with a center at a point above said oil pan.

2. The oil pan structure for an engine according to claim 1, wherein said center is disposed in the vicinity of a vertical line passing through a laterally central portion of said bottom plate, as viewed along the axial center of said crankshaft.
3. The oil pan structure for an engine according to claim 1 or 2, wherein said center is disposed in the vicinity of the vertical line passing through a central portion of said bottom plate in the axial direction of said crankshaft, as said oil pan is viewed in profile.
4. The oil pan structure for an engine according to any one of claims 1-3, in which part of said bottom plate is formed into a flat plate extending approximately in the horizontal direction, the upper surface of the flat plate is at the inner lowermost end of said oil pan, and upwardly of said flat plate is provided a suction section for sucking oil,

wherein said flat plate is disposed at a position offset from a central portion of said bottom plate, as said oil pan is viewed in plan.
5. The oil pan structure for an engine according to claim 4, wherein grooves are formed in the upper surface of said bottom plate at other portions, the grooves are formed, at ends on the side of said flat plate, to be in communication with a region above the flat plate, and said grooves are formed to be inclined gradually downwardly toward said ends.
6. The oil pan structure for an engine according to claim 4 or 5, provided with an engine component disposed inside said oil pan and interlockingly connected to said crankshaft,

wherein a portion of said bottom plate below said component bulges downwardly to be a bulging portion, the bulging portion is formed approximately in agreement in shape with part of a cylinder with an axial center approximately parallel to said axial center of the crankshaft, and one end of said bulging portion in the axial direction is connected to the outer edge of said flat plate.

7. An oil pan having a bottom plate, wherein said bottom plate, as viewed as a whole is formed approximately in agreement in shape with part of a substantially spherical surface with a centre above said oil pan.

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8. An oil pan for an engine, the oil pan being configured to reduce vibration in the bottom plate of the oil pan.

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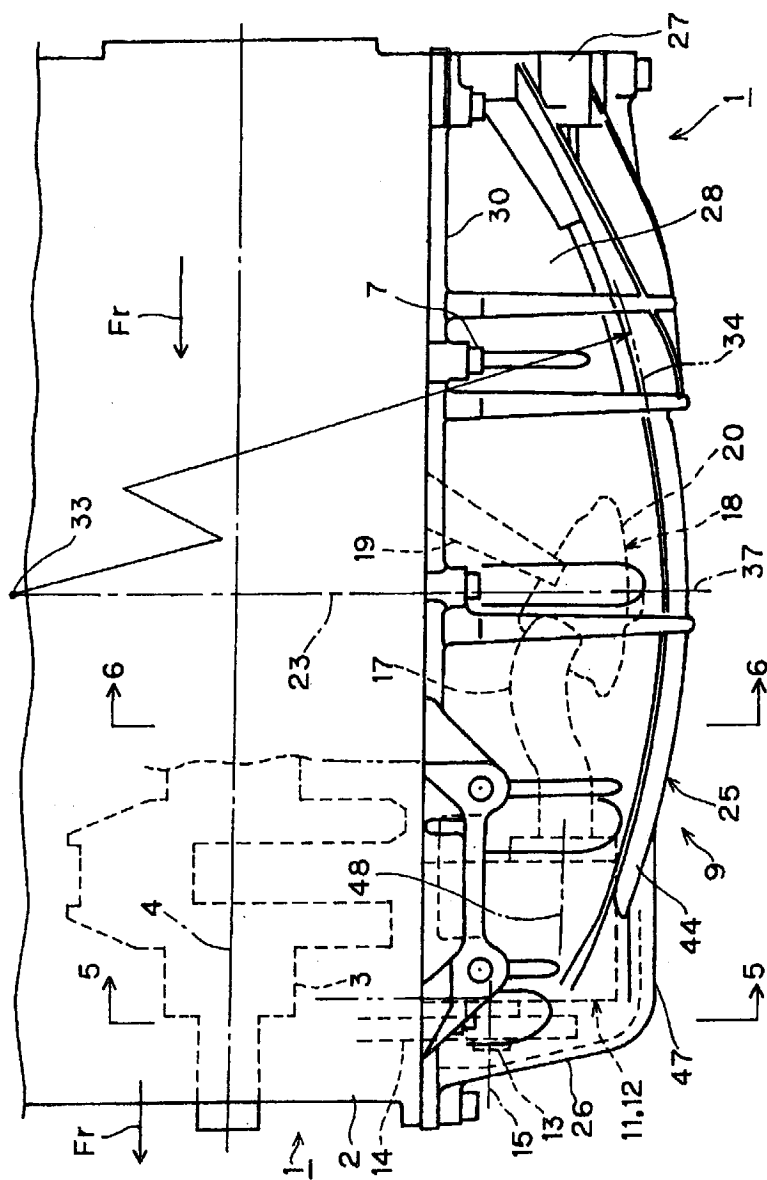


FIG. 1

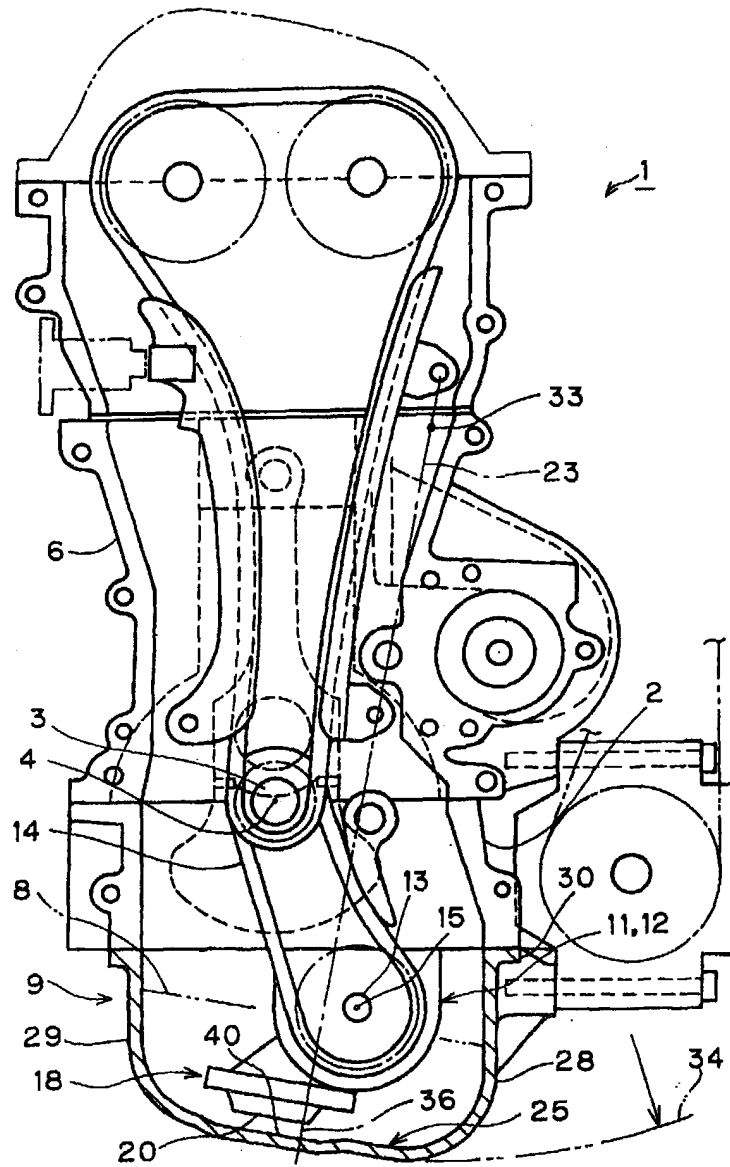


FIG. 2

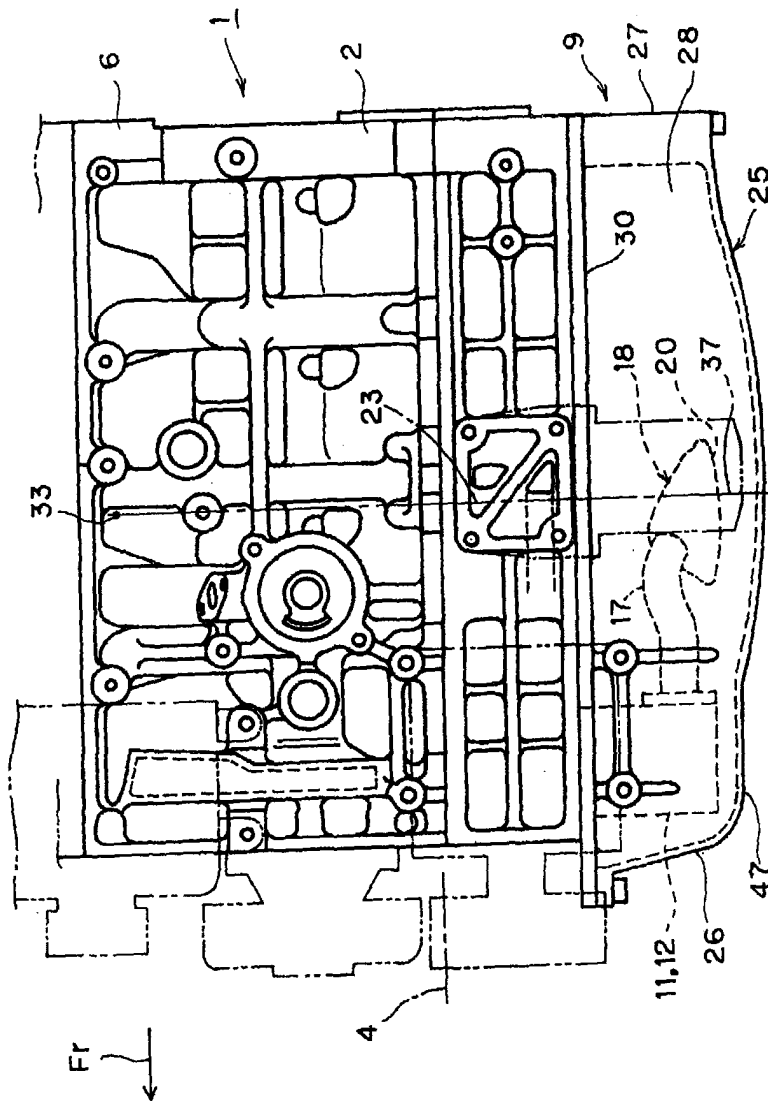


FIG. 3

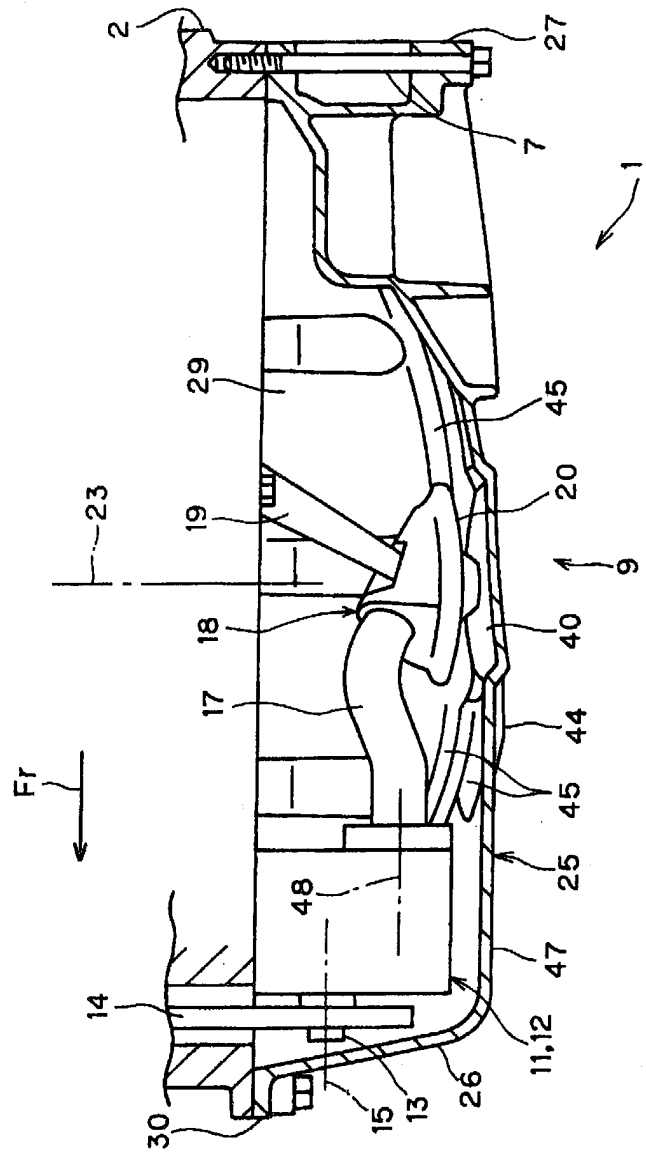


FIG. 4

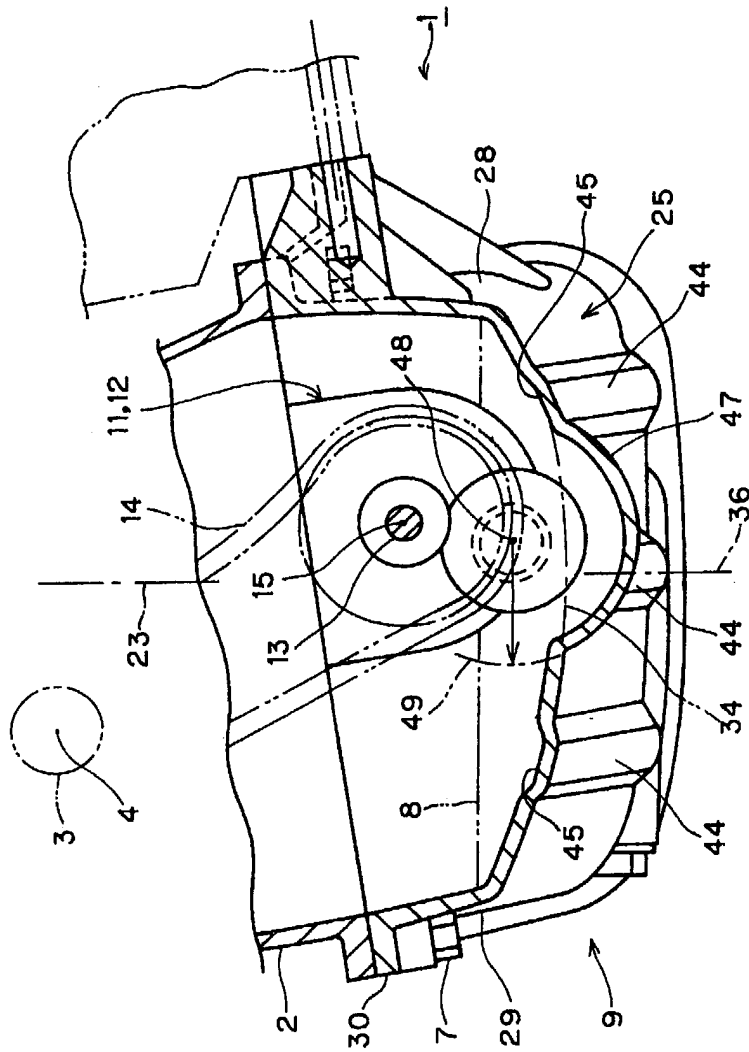


FIG. 5

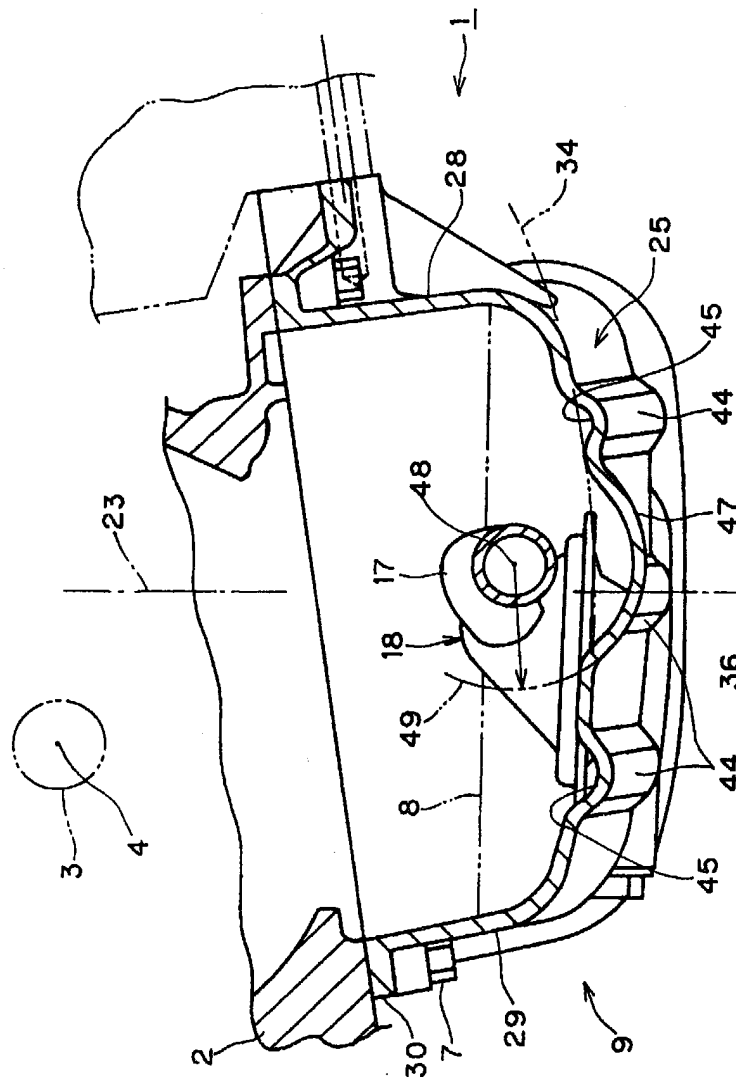


FIG. 6

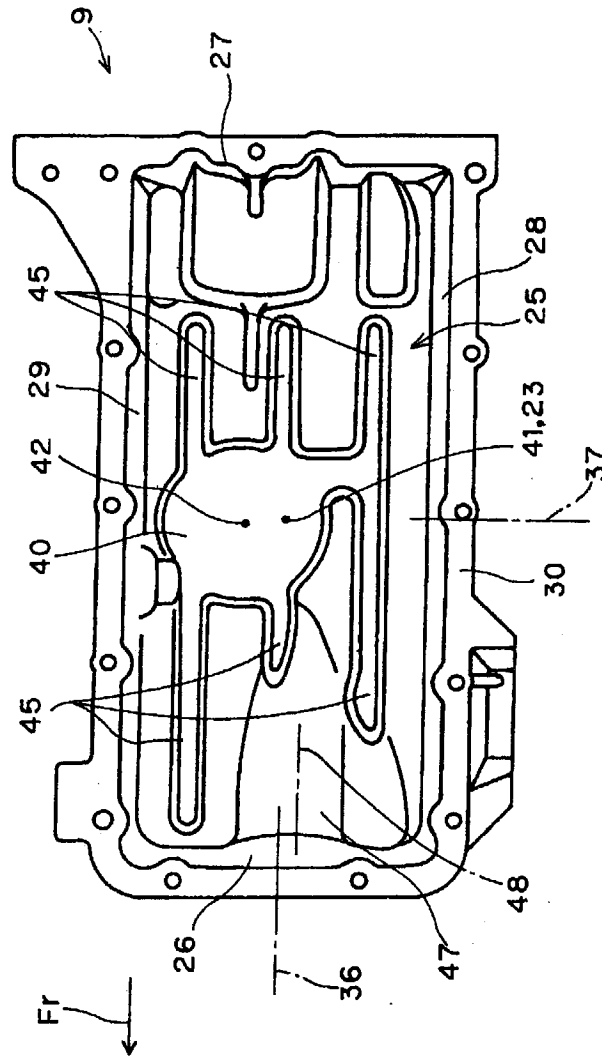


FIG. 7

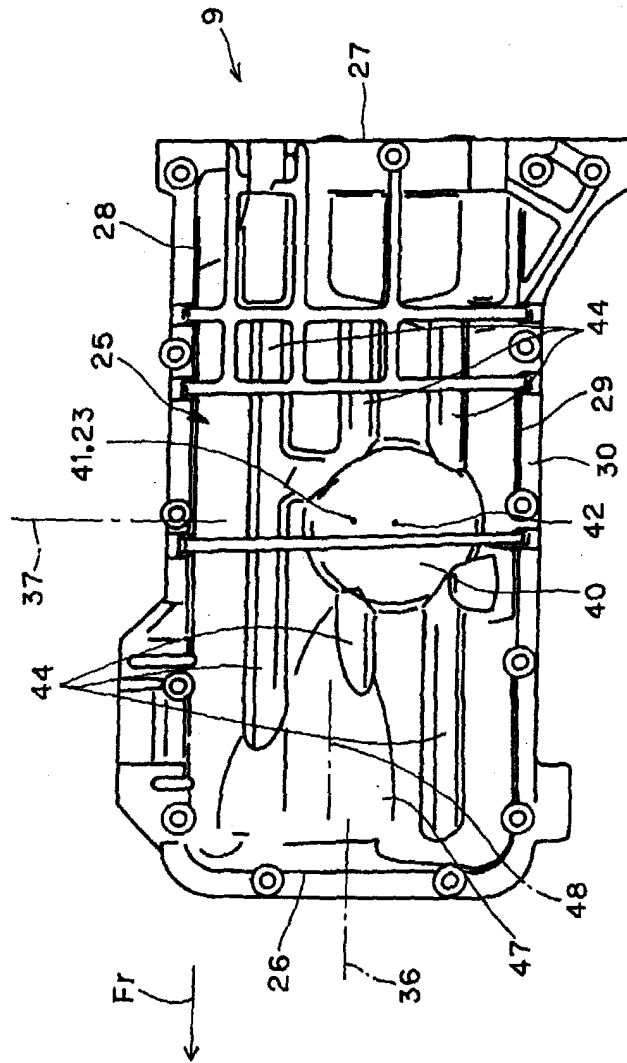


FIG. 8

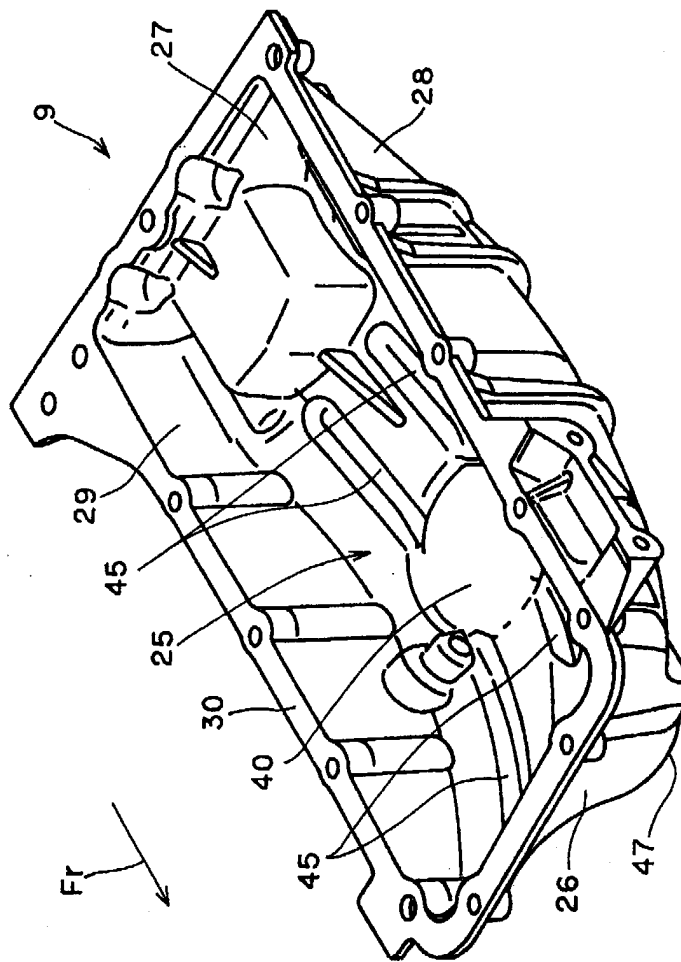


FIG. 9

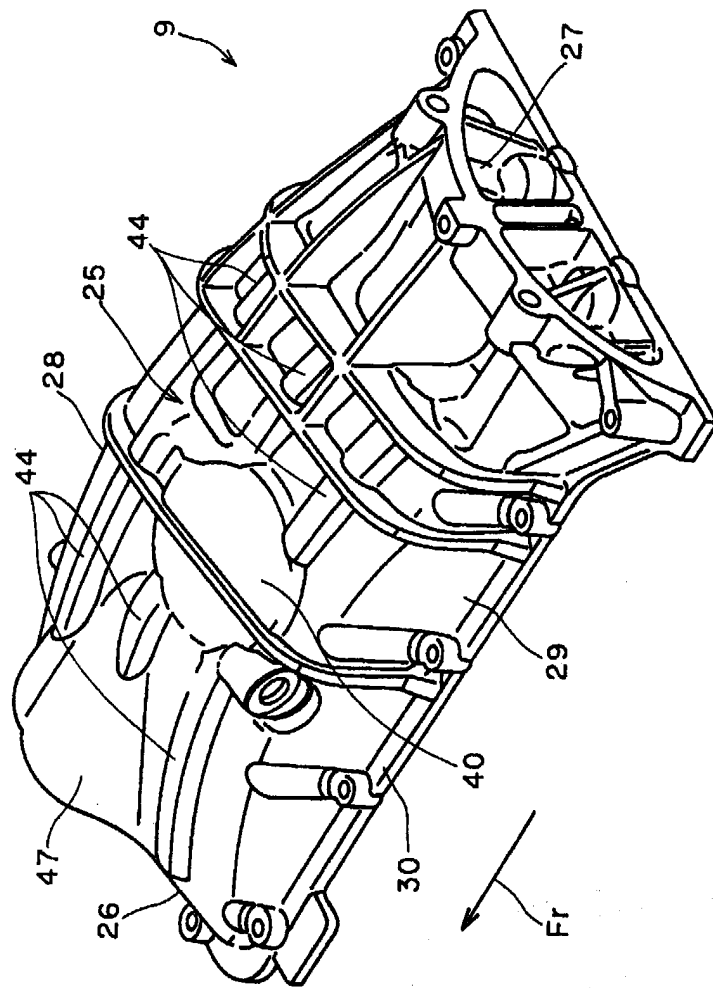


FIG. 10