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(54) **OIL PAN**

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(57) **ABSTRACT**

An oil pan made from a resin material, the oil pan includes: a bottom wall; and side walls; the bottom wall including a plurality of ribs protruding from the outer wall surface, each of the ribs having; a base end portion protruding from the outer wall surface of the bottom wall, and having a tip end surface, and a tip end portion protruding from the tip end surface, the tip end portion being connected with the base end portion at a connection portion, the connection portion at which the base end portion and the tip end portion are connected with each other, which has a width that is equal to or smaller than a width of a portion at a base end position of the base end portion, and equal to or smaller than a width of a portion at a tip end position of the tip end portion.

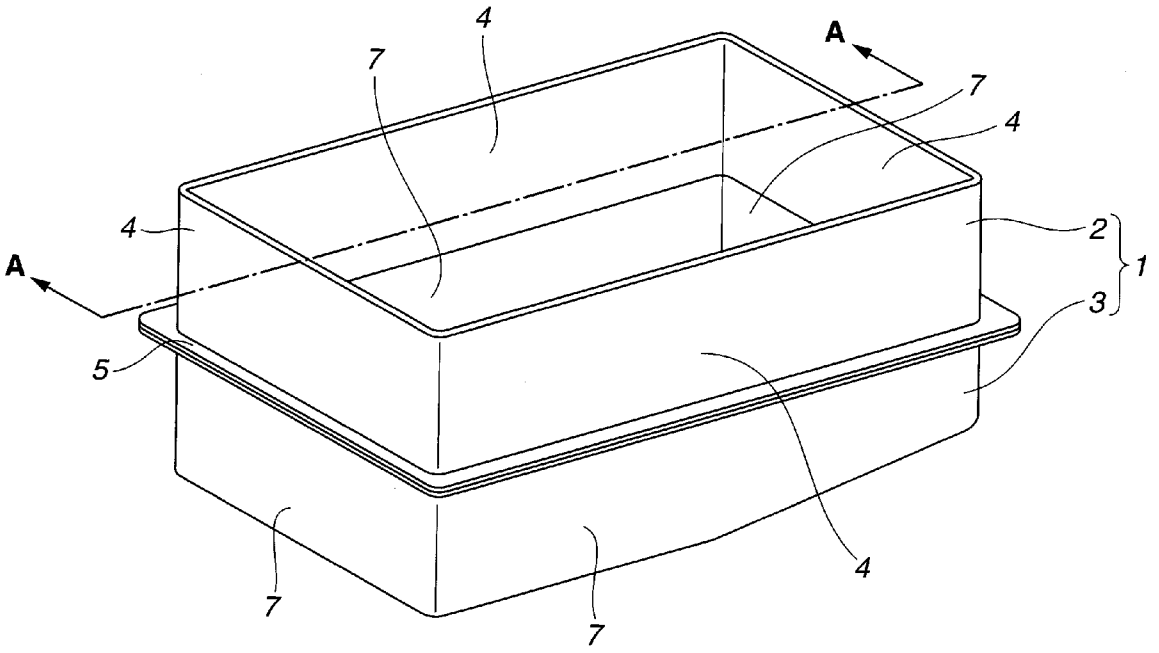


FIG.1

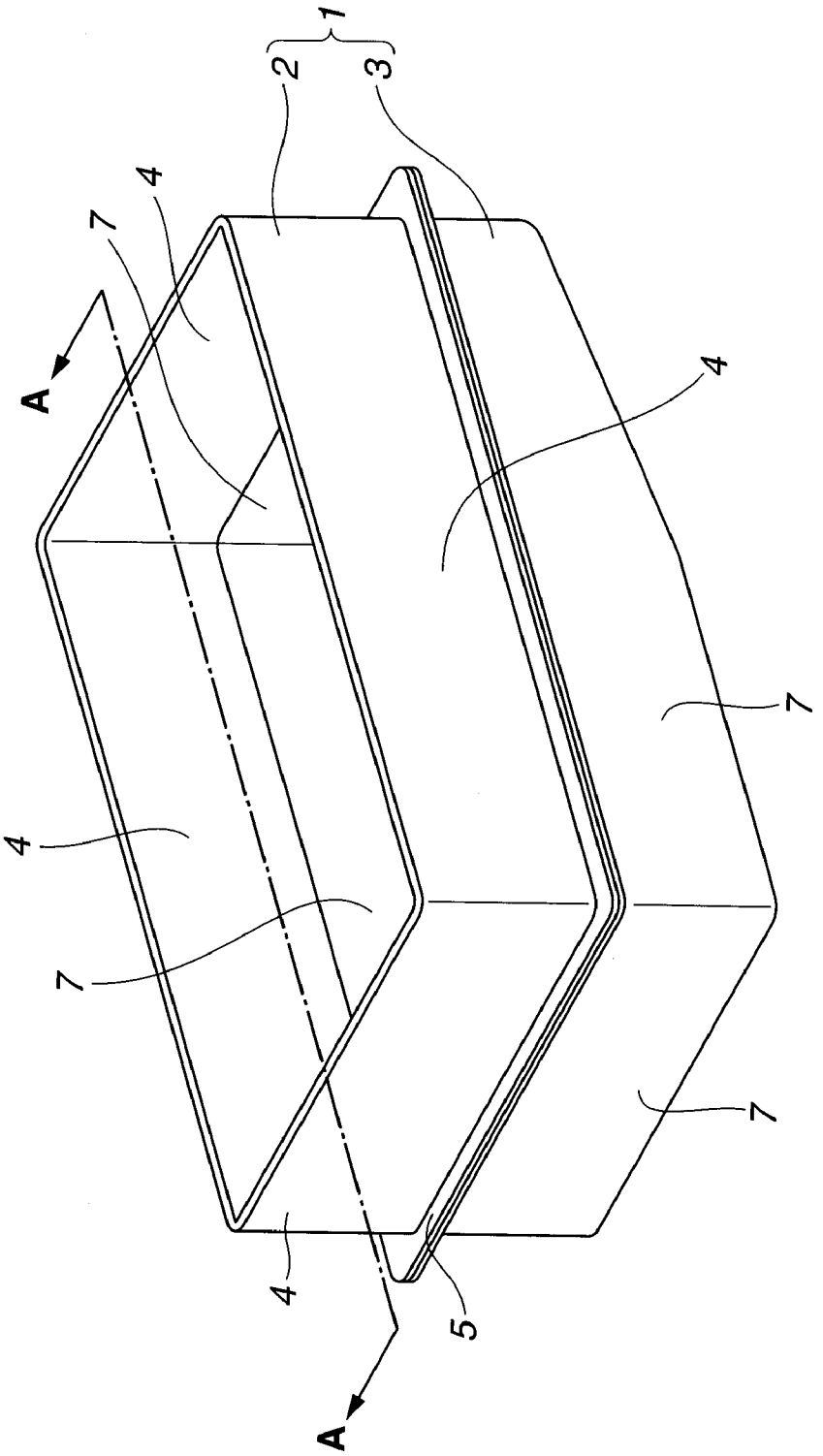


FIG.2

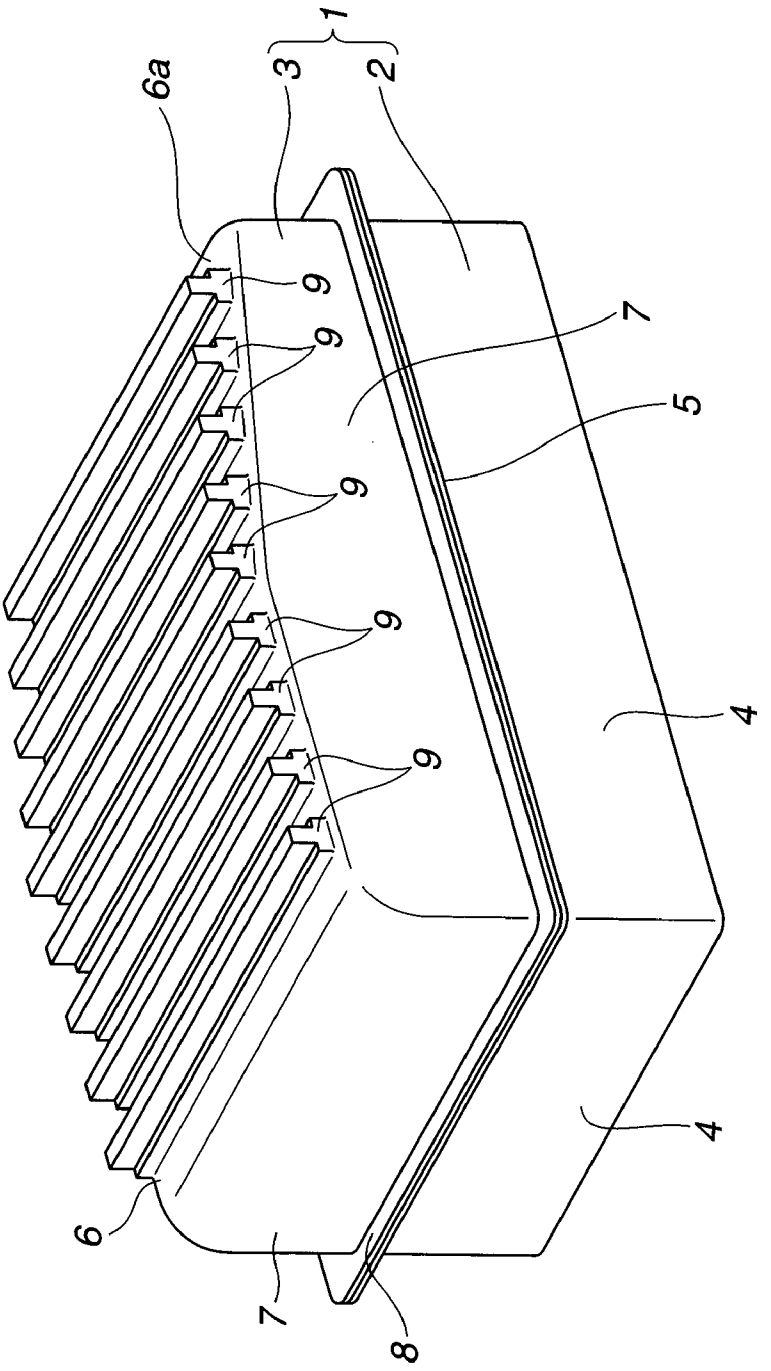


FIG.3

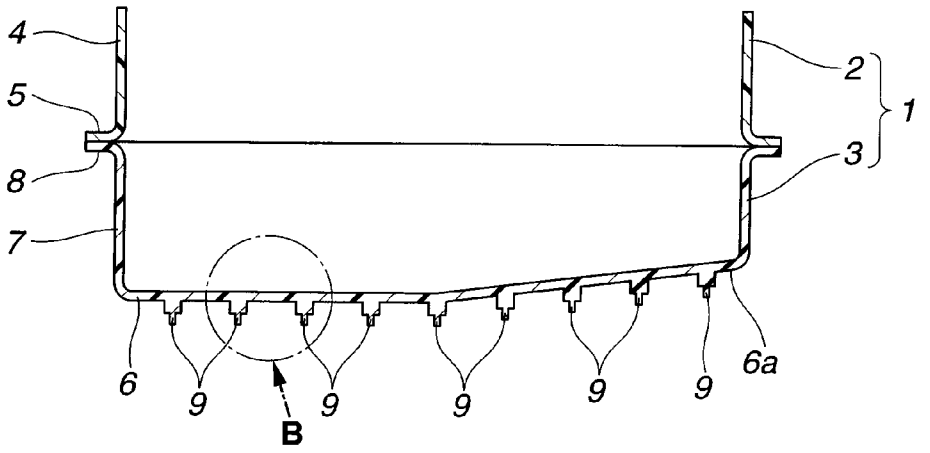

4
5
8
7
2
1
3
6
9
9
B
9
9
9
6a

FIG.4

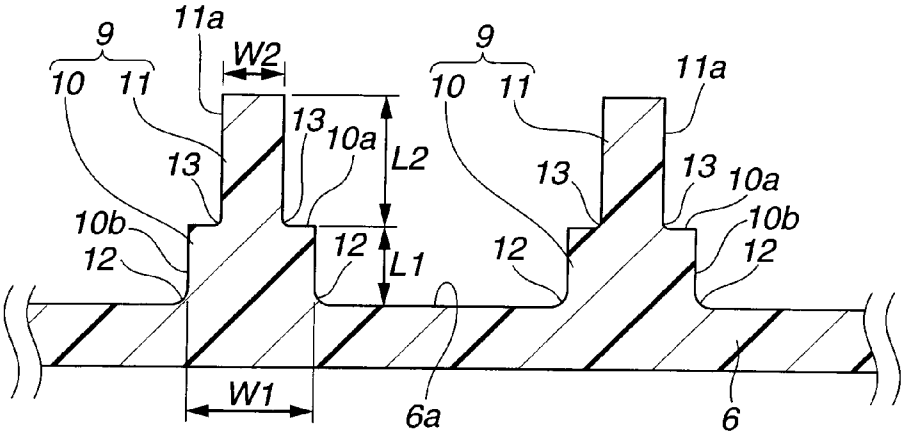

9
10
11
11a
W2
13
10a
L2
13
10b
12
12
L1
W1
6a
9
10
11
11a
13
13
10a
10b
12
12
6

FIG.5

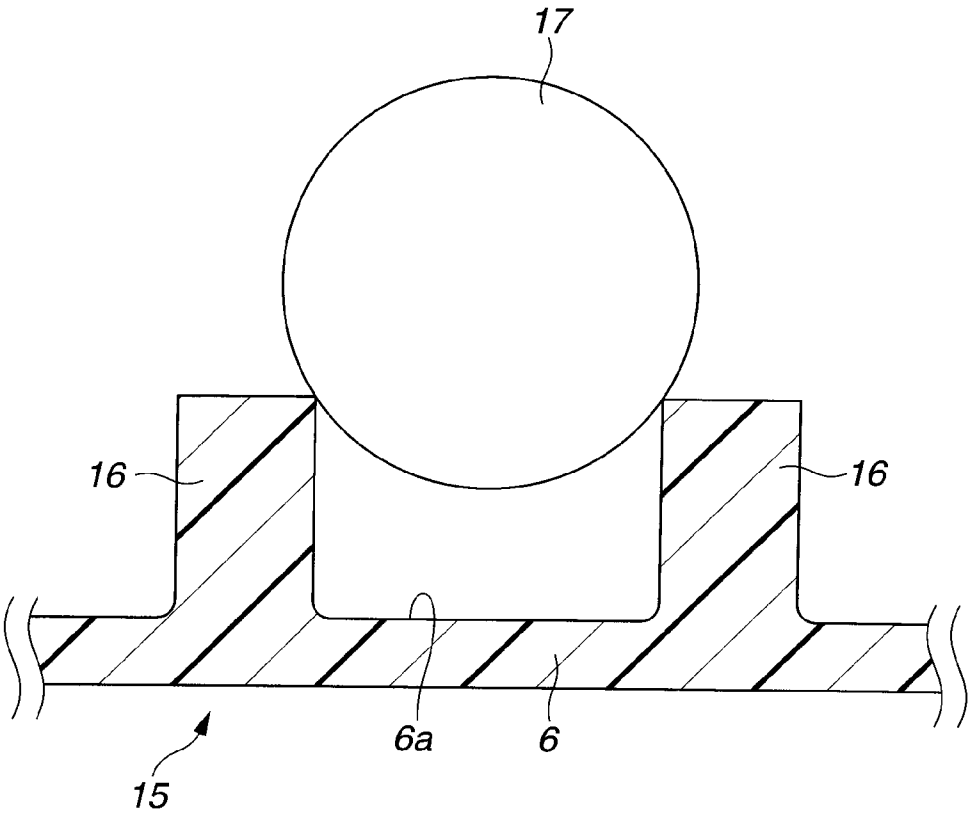


FIG.6

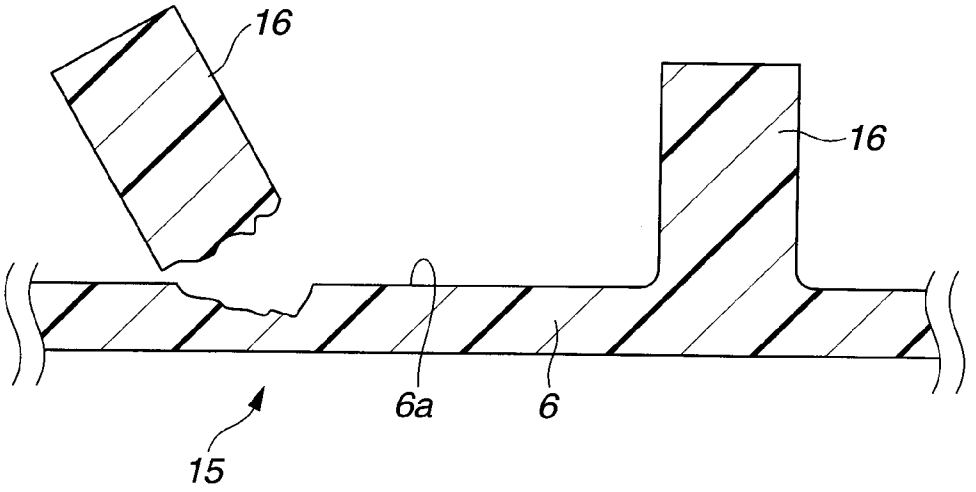


FIG.7

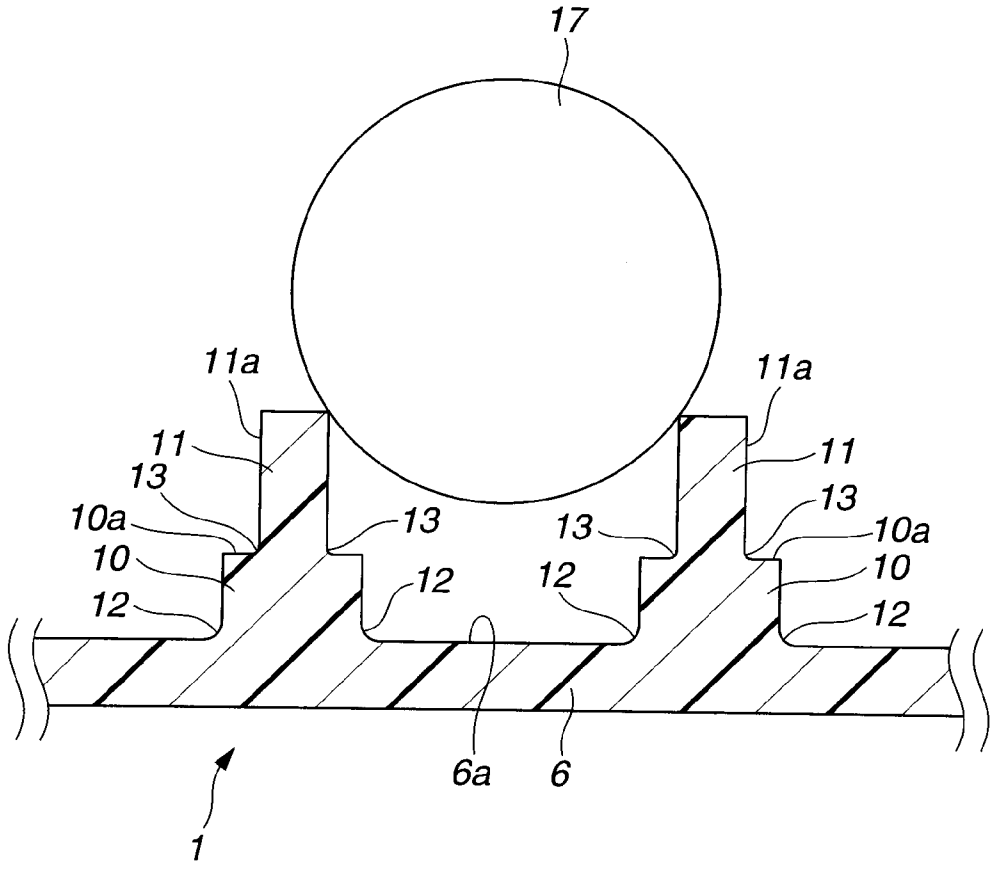

17
11a
11a
11
11
13
13
13
13
10a
10a
10
10
12
12
12
12
6a
6
1

FIG.8

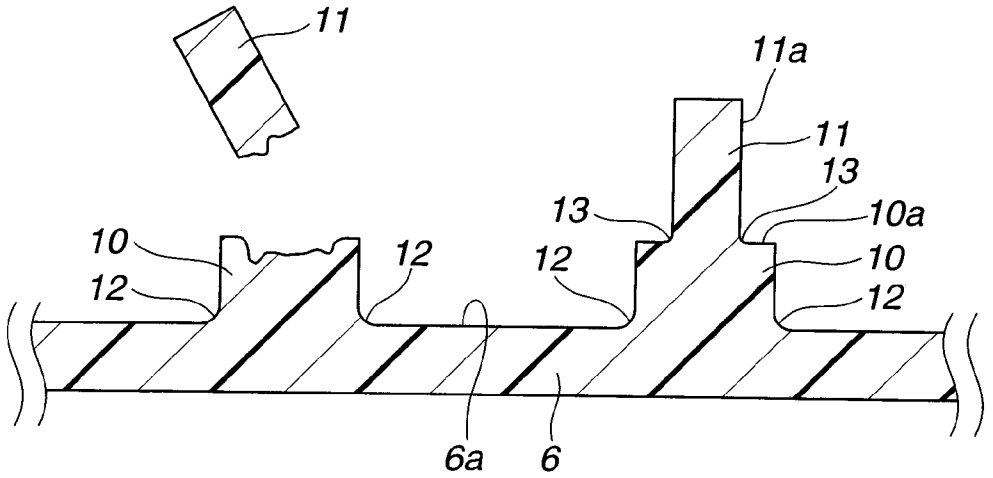

11
11a
11
13
13
10a
10
10
12
12
12
12
6a
6

FIG.9

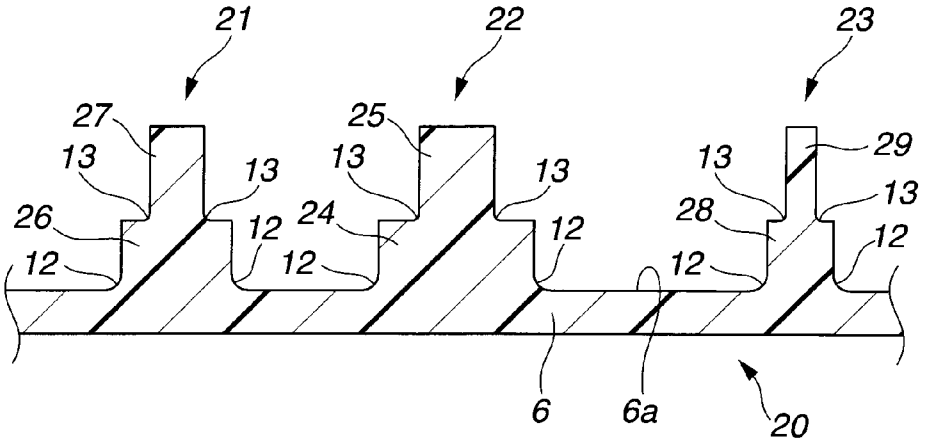


FIG.10

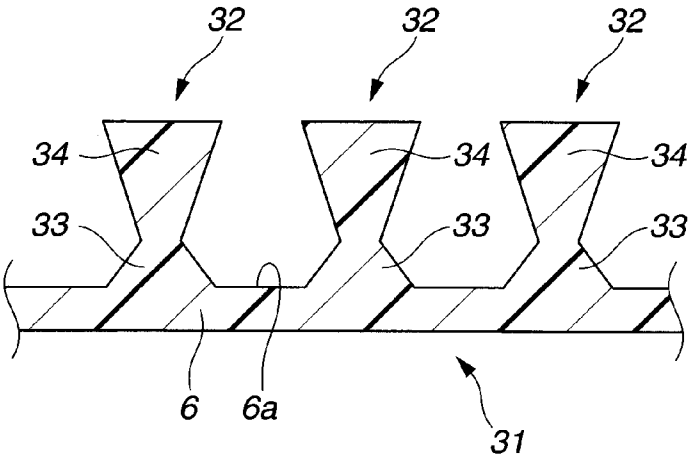


FIG.11

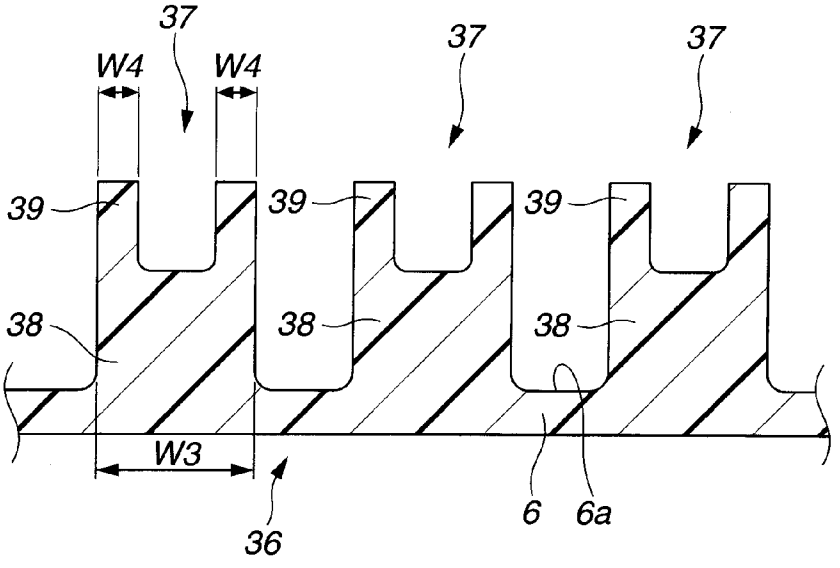


FIG.12

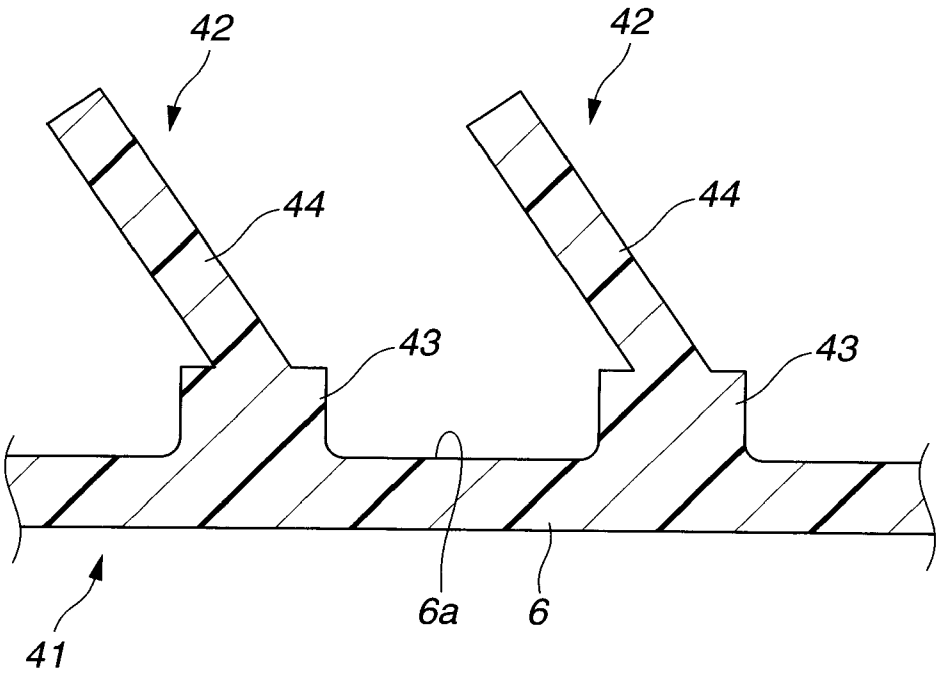


FIG.13

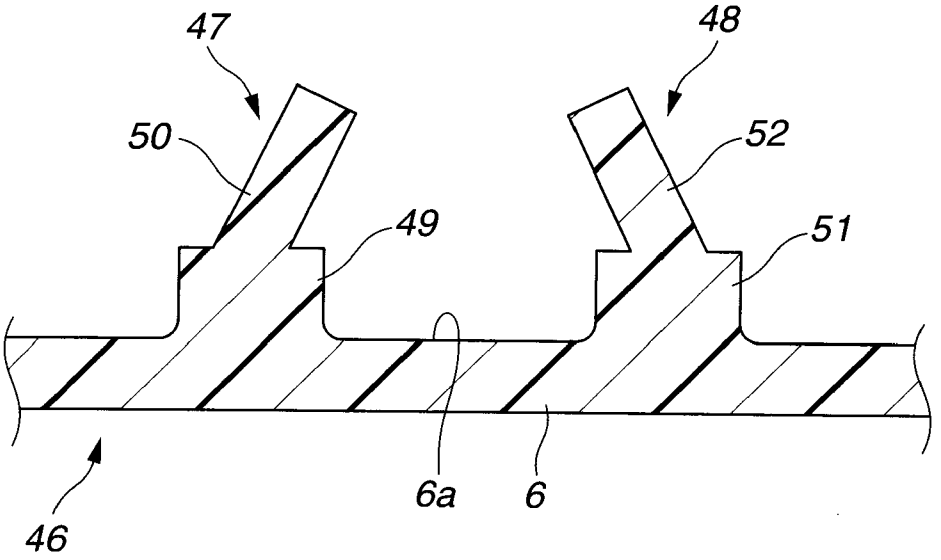
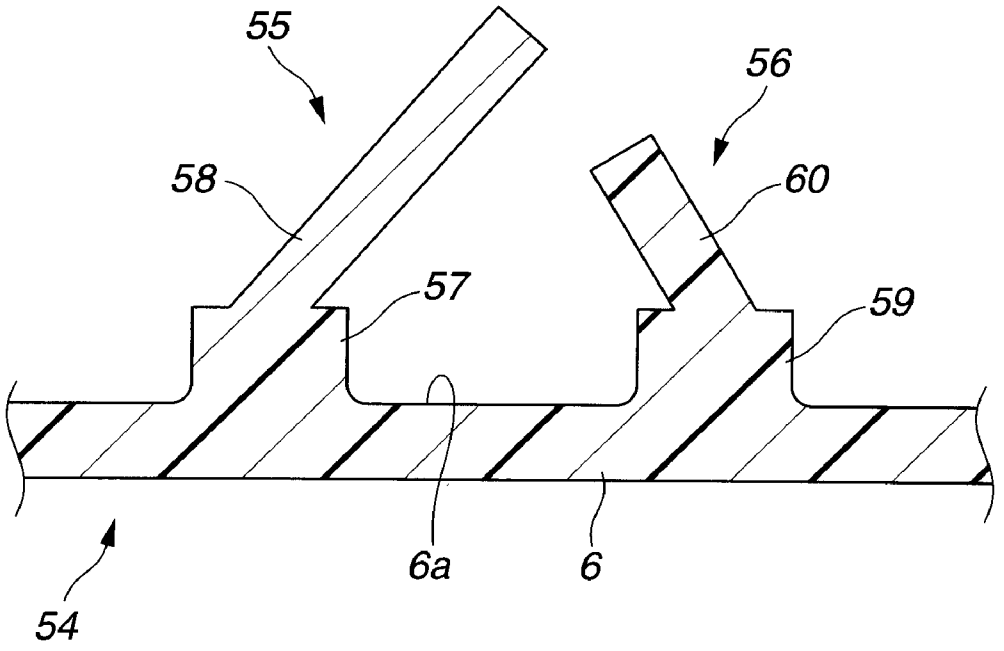


FIG.14



OIL PAN

BACKGROUND OF THE INVENTION

[0001] This invention relates to an oil pan which is made from a resin, which is mounted on a lower portion of an engine or a transmission mounted on a vehicle, and which stores a lubricating oil.

[0002] A conventional oil pan is made from a metal to ensure a strength and a rigidity. Accordingly, the oil pan increases a weight of an engine. Therefore, the oil pan adversely affects an engine output or fuel economy.

[0003] Japanese Patent Application Publication No. 2008-121643 discloses an oil pan made from a resin, and devised to decrease a weight of an engine.

SUMMARY OF THE INVENTION

[0004] The resin material has a strength which is inferior to a strength of the metal material. In particular, the oil pan is disposed in a lowest portion of the engine or a transmission case. Therefore, it is not possible to avoid a stone thrown up from a road surface while the vehicle is moving, from hitting against the oil pan. Moreover, it is difficult to ensure the sufficient strength by the resin material with respect to the stone thrown up from the road surface.

[0005] For preventing the stone thrown up from the road surface while the vehicle is moving from hitting against the oil pan, there may be provided another cover member, or the engine may be disposed on an upper portion of the vehicle body to keep the oil pan away from the road surface.

[0006] However, in a case in which another member such as the cover is provided, the cost is increased. Moreover, in a case in which the engine is disposed on the upper portion of the vehicle body, the center of gravity of the vehicle may become unstable, or it is necessary to largely vary the layout of the engine.

[0007] Moreover, it is considered that a thickness of the oil pan is merely increased for increasing the strength. However, in this case, the weight may be increased, and the cost may be increased.

[0008] It is, therefore, an object of the present invention to provide an oil pan devised to solve the above-mentioned problems, and to ensure a strength of the oil pan without varying a layout of an engine, or providing another member.

[0009] According to one aspect of the present invention, An oil pan made from a resin material, the oil pan comprises: a bottom wall having an outer wall surface; and side walls surrounding the bottom wall, and defining, with the bottom wall, a space for storing a lubricating oil; the bottom wall including a plurality of ribs protruding from the outer wall surface, each of the ribs having; a base end portion protruding from the outer wall surface of the bottom wall, and having a tip end surface, and a tip end portion protruding from the tip end surface of the base end portion, the tip end portion being connected with the base end portion at a connection portion, the connection portion at which the base end portion and the tip end portion are connected with each other, which has a width that is equal to or smaller than a width of a portion at a base end position of the base end portion, and equal to or smaller than a width of a portion at a tip end position of the tip end portion.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] FIG. **1** is a perspective view showing an oil pan according to a first embodiment of the present invention.

[0011] FIG. **2** is a perspective view showing the oil pan of FIG. **1**.

[0012] FIG. **3** is a sectional view taken along a section line A-A of FIG. **1**.

[0013] FIG. **4** is a sectional enlarged view which enlarges a B part of FIG. **3**, and which shows a main part of the oil pan of FIG. **1**.

[0014] FIG. **5** is a schematic illustrative view showing a main part of an oil pan of a comparative example.

[0015] FIG. **6** is a schematic illustrative view showing the main part of the oil pan of the comparative example.

[0016] FIG. **7** is a schematic illustrative view showing a main part of the oil pan according to the first embodiment of the present invention.

[0017] FIG. **8** is a schematic illustrative view showing a main part of the oil pan according to the first embodiment of the present invention.

[0018] FIG. **9** is a schematic illustrative view showing a main part of an oil pan according to a second embodiment of the present invention.

[0019] FIG. **10** is a schematic illustrative view showing a main part of an oil pan according to a third embodiment of the present invention.

[0020] FIG. **11** is a schematic illustrative view showing a main part of an oil pan according to a fourth embodiment of the present invention.

[0021] FIG. **12** is a schematic illustrative view showing a main part of an oil pan according to a fifth embodiment of the present invention.

[0022] FIG. **13** is a schematic illustrative view showing a main part of an oil pan according to a sixth embodiment of the present invention.

[0023] FIG. **14** is a schematic illustrative view showing a main part of an oil pan according to a seventh embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0024] Hereinafter, an oil pan according to a first embodiment is illustrated in detail with reference to drawings. FIGS. **1** and **2** are schematic views showing an oil pan **1** according to the first embodiment of the present invention. FIG. **1** is a perspective view showing the oil pan **1** as viewed from an upper side. FIG. **2** is a perspective view showing the oil pan **1** as viewed from a lower side.

[0025] The oil pan **1** is made from a resin material. For example, the oil pan **1** is mounted on a lower surface of a cylinder block (not shown) of an internal combustion engine of a vehicle. The oil pan **1** stores a lubricating oil (lubricant) supplied to various parts of the internal combustion engine.

[0026] The oil pan **1** is shaped like an elongated plate (pan or dish). The oil pan **1** includes an oil pan upper member **2** which is mounted on a lower surface of the cylinder block (not shown), and which has a flange **5** formed on a peripheral portion on a lower side of the oil pan upper member **2**; and an oil pan lower member **3** mounted on the flange **5** of the oil pan upper member **2**.

[0027] The oil pan upper member **2** includes four side walls **4**, and the flange **5** formed on lower surfaces of the four side walls **4**.

[0028] The oil pan lower member **3** includes a bottom wall **6** forming a bottom of the oil pan **1**; four side walls **7** surrounding the bottom wall **6**; and a flange **8** formed on upper surfaces of the four side walls **7**, and mounted on the flange **5** on the lower surface of the oil pan upper member **2**.

[0029] As shown in FIGS. **2** and **3**, the oil pan lower member **3** includes a plurality of ribs **9** which are formed at regular intervals on an outer wall surface **6***a* of the bottom wall **6**, and which protrude from the outer wall surface **6***a*.

[0030] As shown in FIG. **4**, each of the ribs **9** includes a base end portion **10** protruding from the outer wall surface **6***a* of the bottom wall **6** to a tip end surface **10***a;* and a tip end portion **11** protruding from the tip end surface **10***a* of the base end portion **10**, and having a width narrower (smaller) than a width of the base end portion **10**. The base end portion **10** has a rectangular section having a width W**1**. The tip end portion **11** has a rectangular section having a width W**2**. That is, each of the ribs **9** has a T-shaped cross section. Each of the ribs **9** is formed so that the width W**1** of the base end portion **10** is greater than the width W**2** of the tip end portion **11**.

[0031] That is, each of the ribs **9** is formed so that a width of a connection portion at which the base end portion **10** and the tip end portion **11** are connected (continuous) with each other is equal to or smaller than a width of a portion at a base end position of the base end portion **10**, and equal to or smaller than a width of a portion at the tip end position of the tip end portion **11**.

[0032] Each of the ribs **9** includes a first corner portion **12** at which the base end portion **10** and the outer wall surface **6***a* of the bottom wall **6** are connected (continuous) with each other, and which is formed by the side wall surface **10***b* of the base end portion **10** and the outer wall surface **6***a* of the bottom wall **6**; and a second corner portion **13** at which the base end portion **10** and the tip end portion **11** are connected (continuous) with each other, and which is formed by the tip end surface **10***a* of the base end portion **10** and a side wall surface **11***a* of the tip end portion **11**. The first corner portion **12** has a curved surface having a predetermined radius of curvature (curvature radius) R**1**. The second corner portion **13** has a curved surface having a predetermined radius of curvature (curvature radius) R**2**. Each of the ribs **9** is formed so that the radius of curvature R**1** is greater than the radius of curvature R**2**.

[0033] The portion at which the base end portion **10** and the outer wall surface **6***a* of the bottom wall **6** are connected (continuous) with each other is the first corner portion **12** which is the curved surface. The width of the first corner portion **12** becomes greater than the width of the base end portion **10** as the first corner portion **12** is positioned closer to the bottom wall **6**. In this specification, the width of the portion at which the base end portion **10** and the outer wall surface **6***a* of the bottom wall **6** are connected with each other is defined as (by) a width that the curved surface of the first corner portion **12** is not considered, that is, a width that the curved surface is not set at the portion at which the base end portion **10** and the outer wall surface **6***a* are connected with each other. That is, in this first embodiment, the width W**1** of the base end portion **10** is the width of the portion at which the base end portion **10** and the outer wall surface **6***a* of the bottom wall **6** are connected with each other since the base end portion **10** has the rectangular section. Similarly, in this specification, the width of the portion at which the base end portion **10** and the tip end portion **11** are connected with each other is defined as (by) a width that the curved surface of the second corner portion **13** is not considered, that is, a width that a curved surface is not set at the portion at which the base end portion **10** and the tip end portion **11** are connected with each other. That is, in this first embodiment, the width W**2** of the tip end portion **11** is the width of the portion at which the base end portion **10** and the tip end portion **11** are connected with each other since the tip end portion **11** is rectangular section.

[0034] Each of the ribs **9** is formed so that a length L**2** of the tip end portion **11** is greater than a length L**1** of the base end portion **10**. For example, a ratio of the length L**1** of the base end portion **10** to the length L**2** of the tip end portion **11** is set to 2:3.

[0035] In this first embodiment, the plurality of ribs **9** are formed at the predetermined regular intervals. In particular, the plurality of ribs **9** are formed at the predetermined regular intervals such that a stone (that is, 6-size crushed stone (No. 6-sized crushed stone) having a size of about ϕ5-ϕ13 (particle size of 5-13 mm) is caught in (stuck with) a gap between the tip end portions **11** and **11** of the ribs **9** and **9** adjacent to each other (cf. FIG. **7** described later).

[0036] The oil pan **1** is mounted on the vehicle so that the bottom wall **6** confronts a road surface. The ribs **9** of the oil pan **1** are formed so that longitudinal directions of the ribs **9** (a direction perpendicular to a plane of a paper of FIGS. **3** and **4**) are perpendicular to a traveling direction of the vehicle. That is, in this embodiment, the oil pan **1** is mounted on the vehicle so that the longitudinal direction of the oil pan **1** is parallel with the forward and rearward directions of the vehicle. Accordingly, the ribs **9** of the oil pan **1** are formed in a direction perpendicular to the longitudinal direction of the oil pan **1**.

[0037] FIGS. **5** and **6** are schematic views showing a main part of an oil pan **15** of a comparative example. The following explanation is directed only to points different from the first embodiment, and repetitive explanation is omitted as to similar component parts to which the same reference numerals are given.

[0038] The oil pan **15** of the comparative example has a structure substantially identical to the oil pan **1** according to the above-described first embodiment. However, each of ribs **16** of the oil pan **15** does not have the T-shaped section. Each of the ribs **16** has a rectangular section. Each of the ribs **16** has a height (length) identical to the height (length) of each rib **9** of the first embodiment. Each of the ribs **16** has a width identical to the width W**1** of the base end portion **10** of each rib **9**.

[0039] In this comparative example, when the stone **17** is thrown up while the vehicle is moving, the stone **17** hits against (on) the ribs **16** protruding from the bottom wall **6**, prior to hitting against the bottom wall **6** of the oil pan **15**. In this comparative example, each of the ribs **16** has the simple rectangular section. Accordingly, when the stone **17** thrown up from the road surface hits against the ribs **16** while the vehicle is running, the large stress is acted to the base end portions of the ribs **16**.

[0040] Therefore, in the oil pan **15** of this comparative example, when the ribs **16** are bent and broken by the impact of the stone **17** thrown up from the road surface, the ribs **16** are bent and broken at the base end positions of the ribs **16**, as shown in FIG. **6**. Consequently, a thickness of the bottom wall **6** of the oil pan **15** may become equal to or smaller than a desired thickness, and a strength of the bottom wall **6** of the oil pan **1** may become equal to or smaller than a desired strength.

[0041] On the other hand, in the oil pan **9** according to the first embodiment, the stone **17** thrown up from the road surface while the vehicle is moving hits against the ribs **9** protruding from the bottom wall **6**, prior to hitting against the bottom wall **6** of the oil pan **1**. In the first embodiment, each

of the ribs **9** has the T-shaped section. Accordingly, when the stone **17** thrown up from the road surface while the vehicle is moving hits against the ribs **9**, the stone **17** hits against the tip end portions **11** of the ribs **9**, as shown in FIG. **7**. Therefore, the larger stress is acted to a portion near the second corner portion **13** at which the base end portion **10** and the tip end portion **11** are connected with each other, relative to a portion near the first corner portion **12** which is a base end portion of the rib **9**.

[0042] That is, each of the ribs **9** has the T-shaped section. The width of the connection portion at which the base end portion **10** and the tip end portion **11** are connected (continuous) with each other is equal to or smaller than the width of the portion at the base end position of the base end portion **10**, and equal to or smaller than the width of the tip end position of the tip end portion **11**. In this first embodiment, a predetermined position between the base end and the tip end of the rib **9**, that is, the connection portion at which the base end portion **10** and the tip end portion **11** are connected with each other has a relatively low strength (is a weak portion). Accordingly, in the first embodiment, even when the ribs **9** are bent and broken by the impact of the stone **17** thrown up from the road surface, the rib **9** is not bent and broken at the base end position of the base end portion **10**, and the rib **9** is bent and broken at the portion at which the base end portion **10** and the tip end portion **11** are connected with each other, as shown in FIG. **8**.

[0043] In this way, in the oil pan **1** according to the first embodiment, even when the rib **9** is bent and broken by the impact of the stone thrown up from the road surface, the tip end portion **11** of the rib **9** is bent and broken to remain the base end portion **10**. Accordingly, it is possible to prevent from directly breaking the bottom wall **6** of the oil pan **1** by bending and breaking the rib **9**, as shown in FIG. **8**. Therefore, it is possible to suppress the thickness of the bottom wall **6** of the oil pan **1** from becoming equal to or smaller than the desired thickness, and to suppress the strength of the bottom wall **6** of the oil pan **1** from becoming equal to or smaller than the desired strength.

[0044] That is, it is possible to decrease the used amount (usage) of the resin for forming the oil pan **1** by optimizing the shapes of the ribs **9** formed on the bottom wall **6** of the oil pan **1** made from the resin. Moreover, it is possible to secure the desired strength of the oil pan **1**, to decrease the weight of the oil pan **1**, and to decrease the cost. Furthermore, it is possible to avoid providing another component such as a cover, and largely varying layout of the vehicle for securing the strength of the oil pan **1**.

[0045] Moreover, in this first embodiment, the tip end portion **11** has the length longer than the length of the base end portion **10**. With this, it is possible to relatively increase a distance from the portion against which the thrown-up stone hits, to the connection portion at which the base end portion **10** and the tip end portion **11** are connected with each other. Consequently, when the thrown-up stone hits against the rib **9**, it is possible to relatively increase the moment acted to the connection portion at which the base end portion **10** and the tip end portion **11** are connected with each other. That is, it is possible to surely bend and break the rib **9** at the connection portion at which the base end portion **10** and the tip end portion **11** are connected with each other by increasing the length of the tip end portion **11** relative to the length of the base end portion **10**.

[0046] Moreover, each of the ribs **9** is formed so that the radius of the curvature R**1** of the first corner portion **12** is greater than the radius of the curvature R**2** of the second corner portion **13**. With this, when the stone thrown up from the road surface hits against the rib **9**, it is possible to relatively decrease the stress acted to the portion near the first corner portion **12** at the base end position of the base end portion **10**.

[0047] In this first embodiment, the ribs **9** are formed in liner shapes on the bottom wall **6** of the oil pan **1**. However, the ribs **9** may be formed in a grid shape (in a reticular pattern) on the bottom wall **6** of the oil pan **1**.

[0048] Hereinafter, other embodiments according to the present invention are illustrated. The following explanations are directed only to points different from the first embodiment, and repetitive explanation is omitted as to similar component parts to which the same reference numerals are given.

[0049] FIG. **9** is a sectional view showing a main part of an oil pan **20** according to a second embodiment of the present invention. This oil pan **20** according to the second embodiment has a structure substantially identical to the structure of the first embodiment. As shown in FIG. **9**, widths of ribs **21**, **22** and **23** protruding from the outer wall surface **6***a* of the bottom wall **6** of the oil pan **20** are not uniform (even). A distance between the ribs **21** and **22**, and a distance between the ribs **22** and **23** are not uniform (even).

[0050] In this second embodiment, the distance between the ribs **22** and **23** is greater than the distance between the ribs **21** and **22**. Moreover, a width of a base end portion **24** of the rib **22** is greater than a width of a base end portion **26** of the rib **21** and a width of a base end portion **28** of the rib **23**. A width of a tip end portion **25** of the rib **22** is greater than a width of a tip end portion **27** of the rib **21** and a tip end portion **29** of the rib **23**. Furthermore, the width of the base end portion **28** of the rib **23** is smaller than the width of the base end portion **26** of the rib **21** and the base end portion **24** of the rib **22**. The width of the tip end portion **29** of the rib **23** is smaller than the width of the tip end portion **27** of the rib **21** and the tip end portion **25** of the rib **22**.

[0051] In this second embodiment, in the ribs **21**, **22** and **23**, the width of the connection portion at which the base end portion and the tip end portion are connected (continuous) with each other is equal to or smaller than the width of the portion at the base end position of the base end portion, and equal to or smaller than the width of the portion at the tip end position of the tip end portion. Even when each of the ribs **21**, **22** and **23** is bent and broken by the impact of the stone thrown up from the road surface, each of the ribs **21**, **22** and **23** is not bent and broken at the base end position of the base end portion, and each of the ribs **21**, **22** and **23** is bent and broken at the connection portion at which the base end portion and the tip end portion are connected with each other. Therefore, the oil pan **20** according to the second embodiment makes it possible to attain the effects identical to those of the oil pan according to the first embodiment.

[0052] FIG. **10** is a sectional view showing a main part of an oil pan **31** according to a third embodiment of the present invention. This oil pan **31** according to the third embodiment has a structure substantially identical to the structure of the oil pan **1** according to the first embodiment. As shown in FIG. **10**, the oil pan **31** includes a plurality of ribs **32** protruding from the outer wall surface **6***a* of the bottom wall **6** of the oil pan **31**. Each of the ribs **32** includes a base end portion **33** having an isosceles trapezoid section, and a tip end portion **34** having an

isosceles trapezoid section. The base end portion **33** is formed so that a width on the outer wall surface **6***a*'s side is greater than a width on the tip end side (on the upper side of the base end portion **33** in FIG. **10**). The tip end portion **34** is formed so that a width on the base end portion **33**'s side is smaller than a width on the tip end side (on the upper side of the tip end portion **34** in FIG. **10**). A width of the tip end of the base end portion **33** is identical to the width of the base end of the tip end portion **34**.

[0053] In this third embodiment, a width of a connection portion at which the base end portion **33** and the tip end portion **34** are connected (continuous) with each other is equal to or smaller than a width of a portion at a base end position of the base end portion **33**, and equal to or smaller than a width of a portion at a tip end position of the tip end portion **34**. With this, even when the rib **32** is bent and broken by the impact of the stone thrown up from the road surface, the rib **32** is not bent and broken at the portion at the base end position of the base end portion **33**, and the rib **32** is bent and broken at the portion at which the base end portion **33** and the tip end portion **34** are connected with each other. Therefore, the oil pan **31** according to the third embodiment makes it possible to attain the effects identical to those of the oil pan **1** according to the first embodiment.

[0054] The shape of the rib is not limited to the shapes of the above-described embodiments. It is possible to vary the shape of the rib as long as the width of the connection portion at which the base end portion and the tip end portion are connected with each other is equal to or smaller than the width of the portion at the base end position of the base end portion, and equal to or smaller than the width of the portion at the tip end position of the tip end portion.

[0055] Moreover, the rib provided to the oil pan is not limited to the structure having one tip end portion with respect to one base end portion. For example, a rib **37** can be formed to have one base end portion **38** having a rectangular section, and two tip end portions **39** and **39** each having a rectangular section, as shown in an oil pan **36** in FIG. **11**.

[0056] FIG. **11** is a schematic view showing an oil pan **37** according to a fourth embodiment of the present invention. In this fourth embodiment, a width W**4** of each tip end portion **39** is set so that the summation of the widths W**4** of the two tip end portions **39** and **39** is smaller than a width W**3** of the base end portion **38**.

[0057] In this fourth embodiment, the width (W**4**) of a connection portion at which the base end portion **38** and the tip end portion **39** are connected (continuous) with each other is equal to or smaller than the width (W**3**) of the portion at the base end position of the base end portion **38**, and equal to or smaller than the width (W**4**) of the portion at the tip end position of the tip end portion **39**. Accordingly, even when the rib **37** is bent and broken by the impact of the stone thrown up from the road surface, the rib **37** is not bent and broken at the base end position of the base end portion **38**, and the rib **37** is bent and broken at the connection portion at which the base end portion **38** and the tip end portion **39** are connected with each other. Therefore, the oil pan **36** according to the fourth embodiment makes it possible to attain the effects identical to those of the oil pan according to the first embodiment.

[0058] FIG. **12** is a sectional view showing a main part of an oil pan **41** according to a fifth embodiment of the present invention. The oil pan **41** according to the fifth embodiment has a structure substantially identical to the structure of the oil pan **1** according to the first embodiment. As shown in FIG. **12**, each of ribs **42** includes a tip end portion **44** protruding from a base end portion **43** to be inclined by a predetermined angle (for example, 45 degrees). The tip end portions **44** of the ribs **42** are inclined in the same direction (in the left direction in FIG. **12**). That is, each of the base end portions **43** is perpendicular to the outer wall surface **6***a* of the bottom wall **6**. All of the tip end portions **44** are inclined in the same direction (in the left direction in FIG. **12**) by the predetermined angle with respect to the outer wall surface **6***a* of the bottom wall **6**.

[0059] In this fifth embodiment, a distance between the base end portions **43** and **43** of the two ribs **42** and **42** adjacent to each other is identical to the distance of the base end portions **10** and **10** of the ribs **9** and **9** of the first embodiment. By inclining the tip end portions **44**, the thrown-up small stone becomes easy to hit against the tip end portions **44**, relative to the tip end portions **11** of the first embodiment. Accordingly, it is possible to further suppress the stone from hitting against the base end portion **43**.

[0060] It is desirable that the tip end portions **44** are inclined in the rearward direction of the vehicle. With this, the stone is difficult to hit against the base end portion, relative to inclining the tip end portion **44** in the forward direction of the vehicle.

[0061] Moreover, it is unnecessary that all of the tip end portions of the ribs provided on the outer wall surface **6***a* of the bottom wall **6** are inclined in the same direction. As shown in FIGS. **13** and **14**, the tip end portions of the two ribs adjacent to each other may be inclined in opposite directions.

[0062] FIG. **13** is a sectional view showing a main part of an oil pan **46** according to a sixth embodiment of the present invention. The oil pan **46** according to the sixth embodiment has a structure substantially identical to the structure of the oil pan **1** according to the first embodiment. Tip end portions **50** and **52** of two ribs **47** and **48** adjacent to each other are inclined in opposite directions. That is, the tip end portion **50** of the rib **47** protrudes from a base end portion **49** to be inclined by a predetermined angle (for example, 45 degrees) in the right direction of FIG. **13**. The tip end portion **52** of the rib **48** protrudes from a base end portion **51** to be inclined by a predetermined angle (for example, 45 degrees) in the left direction of FIG. **13**.

[0063] FIG. **14** is a sectional view showing a main part of an oil pan **54** according to a seventh embodiment of the present invention. The oil pan **54** according to the seventh embodiment has a structure substantially identical to the structure of the oil pan **1** according to the first embodiment. Tip end portions **58** and **60** of a pair of ribs **55** and **56** adjacent to each other are inclined in opposite directions. The tip end portions **58** and **60** of the pair of the ribs **55** and **56** adjacent to each other have different lengths. That is, the tip end portion **58** of the rib **55** protrudes from a base end portion **57** to be inclined by a predetermined angle (for example, 45 degrees) in the right direction of FIG. **14**. The tip end portion **60** of the rib **56** protrudes from a base end portion **59** to be inclined by a predetermined angle (for example, 45 degrees) in the left direction of FIG. **14**. The tip end portion **58** of the rib **55** has a length longer than a length of the tip end portion **60** of the rib **56**.

[0064] The oil pan according to the present invention is not limited to the oil pan mounted on the lower surface of the cylinder block of the internal combustion engine. The present invention is applicable to an oil pan which is positioned on a lower surface side of the vehicle, and which is used in a portion confronting the road surface when the oil pan is

mounted on the vehicle. For example, the present invention is applicable to an oil pan provided on a lower portion of a transmission, and arranged to store a hydraulic fluid supplied to the transmission.

[0065] An oil pan made from a resin material, the oil pan according to the present invention includes: a bottom wall having an outer wall surface; and side walls surrounding the bottom wall, and defining, with the bottom wall, a space for storing a lubricating oil; the bottom wall including a plurality of ribs protruding from the outer wall surface, each of the ribs having; a base end portion protruding from the outer wall surface of the bottom wall, and having a tip end surface, and a tip end portion protruding from the tip end surface of the base end portion, the tip end portion being connected with the base end portion at a connection portion, the connection portion at which the base end portion and the tip end portion are connected with each other, which has a width that is equal to or smaller than a width of a portion at a base end position of the base end portion, and equal to or smaller than a width of a portion at a tip end position of the tip end portion.

[0066] The width of the connection portion at which the base end portion and the tip end portion are connected (continuous) with each other is equal to or smaller than the width of the portion at the base end position of the base end portion, and equal to or smaller than the width of the portion at the tip end position of the tip end portion. Therefore, the connection portion which is between the base end and the tip end of the rib, and at which the base end portion and the tip end portion are connected with each other is a relatively weak portion (has a relatively low strength).

[0067] Therefore, even when the rib is bent and broken by the impact of the stone thrown up from the road surface, the rib is not bent and broken at the base end position of the base end portion, and the rib is bent and broken at the connection portion at which the base end portion and the tip end portion are connected (continuous) with each other.

[0068] In the oil pan according to the first embodiment, even when the rib is bent and broken by the impact of the stone thrown up from the road surface, the tip end portion of the rib is bent and broken to remain the base end portion. Accordingly, it is possible to prevent from directly breaking the bottom wall of the oil pan. Therefore, it is possible to suppress the thickness of the bottom wall of the oil pan from becoming equal to or smaller than the desired thickness, and to suppress the strength of the bottom wall of the oil pan from becoming equal to or smaller than the desired strength.

[0069] The entire contents of Japanese Patent Application No. 2009-275052 filed Dec. 3, 2009 are incorporated herein by reference.

[0070] Although the invention has been described above by reference to certain embodiments of the invention, the invention is not limited to the embodiments described above. Modifications and variations of the embodiments described above will occur to those skilled in the art in light of the above teachings. The scope of the invention is defined with reference to the following claims.

What is claimed is:

1. An oil pan made from a resin material, the oil pan comprising:

a bottom wall having an outer wall surface; and

side walls surrounding the bottom wall, and defining, with the bottom wall, a space for storing a lubricating oil;

the bottom wall including a plurality of ribs protruding from the outer wall surface, each of the ribs having;

a base end portion protruding from the outer wall surface of the bottom wall, and having a tip end surface, and

a tip end portion protruding from the tip end surface of the base end portion, the tip end portion being connected with the base end portion at a connection portion,

the connection portion at which the base end portion and the tip end portion are connected with each other, which has a width that is equal to or smaller than a width of a portion at a base end position of the base end portion, and equal to or smaller than a width of a portion at a tip end position of the tip end portion.

2. The oil pan as claimed in claim **1**, wherein the tip end portion of each of the ribs has a length longer than a length of the base end portion of the each of the ribs.

3. The oil pan as claimed in claim **1**, wherein each of the ribs has a T-shaped section; and a width of the base end portion of each of the ribs is greater than a width of the tip end portion of the each of the ribs.

4. The oil pan as claimed in claim **1**, wherein a distance between a pair of the ribs adjacent to each other is different from a distance between another pair of the ribs adjacent to each other; the base end portion of one of the ribs has a width different from a width of the base end portion of another of the ribs; and the tip end portion of one of the ribs has a width different from a width of the tip end portion of another of the ribs.

5. The oil pan as claimed in claim **1**, wherein the base end portion of each of the ribs has an isosceles trapezoid section; and the tip end portion of each of the ribs has an isosceles trapezoid section.

6. The oil pan as claimed in claim **1**, wherein each of the ribs includes a pair of tip end portions; the pair of the tip end portions of the each of the ribs are connected with the base end portion of the each of the ribs at connection portions; the connection portion of the each of the ribs between each of the pair of the tip end portions and the base end portion has a width which is equal to or smaller than the width of the portion at the base end position of the base end portion of the each of the ribs, and equal to or smaller than the width of the portion at the tip end position of the each of the par of the tip end portions of the each of the ribs.

7. The oil pan as claimed in claim **1**, wherein the tip end portion of each of the ribs is inclined by a predetermined angle.

8. The oil pan as claimed in claim **7**, wherein the tip end portions of the ribs protrude from the tip end surface of the base end portion to be inclined in the same direction.

9. The oil pan as claimed in claim **7**, wherein the tip end portions of the ribs adjacent to each other protrude to be inclined in opposite directions.

10. The oil pan as claimed in claim **9**, wherein the tip end portions of the ribs adjacent to each other have different lengths.

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