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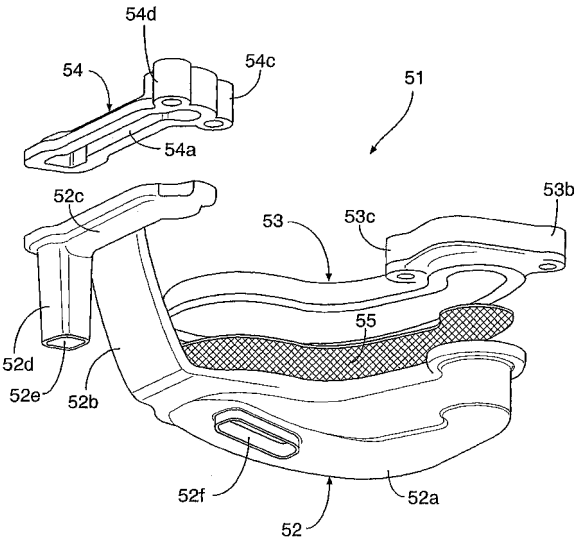
(54) **Oil strainer structure of engine and oil return structure of engine**

(57) An oil strainer 51 includes: a lower member 52 having an oil suction hole 52f opening in oil stored in an oil pan; an upper member 53 having an oil discharge hole 53a leading to an oil pump; and a strainer element 55. The lower member 52 and the upper member 53 are joined to each other with the strainer element 55 held between joint surfaces of the upper and lower members 52 and 53. Thus, it is possible to form the oil strainer 51 into a flat shape so as to be compactly arranged in a narrow space, and also maximize an area of the strainer element 55 to prevent clogging. Further, the lower member 52 and the upper member 53, which are die-molded articles, are highly flexible in their shapes, whereby the oil suction hole 52f and the oil discharge hole 53a can be arranged in the most suitable positions, and the cross-sectional area of oil flow can be sufficiently secured.

FIG.7



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Description

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

[0001] The present invention generally relates to an oil strainer structure of an engine, which includes an oil strainer for filtering oil in an oil pan, the oil strainer being arranged between a balancer housing and the oil pan of the engine and supported by the balancer housing.

[0002] Also, the present invention generally relates to an oil return structure of an engine, which includes an oil return member for returning oil separated from blowby gas to an oil pan, the oil return member being arranged between a balancer housing and the oil pan of the engine.

DESCRIPTION OF THE RELATED ART

[0003] Japanese Patent Application Laid-open No. 2001-74105 discloses an oil strainer structure of an engine in which a balancer housing is supported on a lower surface of a lower block which holds a crankshaft of the engine between itself and the cylinder block; and an oil strainer for filtering oil that is suctioned from the oil pan into the oil pump is integrally housed in the lower surface of a lower housing part of the balancer housing.

[0004] Because blowby gas leaked out of a combustion chamber into a crankcase contains oil, it is necessary to separate the oil from the blowby gas in a gas-liquid separating chamber formed in a cylinder head, return the blowby gas to an intake system, and return the oil to the oil pan.

[0005] In addressing this problem, Japanese Patent Application Laid-open No. 2003-201815 discloses an oil return structure of an engine in which a balancer housing is supported on a lower surface of a lower block joined to a lower end of a cylinder block, and an oil return passage is formed inside the cylinder block, the lower block and the balancer housing so as to return the oil from the gas-liquid separating chamber formed in the cylinder head to the oil pan.

[0006] However, in the oil strainer structure disclosed in Japanese Patent Application Laid-open No. 2001-74105, the oil strainer is integrally housed in the lower housing part of the balancer housing; and thus, the position of the oil strainer is limited to a space between the two balancer shafts, which causes the problems in that it is difficult to arrange the oil suction hole at an appropriate position, and it is difficult to secure a sufficient area of a strainer element of the oil strainer and a sufficient cross-sectional area of oil flow.

[0007] When the oil strainer and the oil return passage are integrally formed with the balancer housing, a significant limitation is imposed on flexibility in positioning of the oil suction hole of the oil strainer and positioning of the oil outlet hole of the oil return passage. Then, it is conceivable to provide the oil strainer and the oil return member (a member where an oil return passage is formed) separately from the balancer housing. In this case, however, the number of components increases in both the oil strainer and the oil return member. Thus, it is desired to minimize the increase in the number of components.

[0008] Also, when waves are formed on the liquid surface of the oil in the oil pan due to acceleration, deceleration or turn of the vehicle, air is mixed in the oil suctioned through the oil strainer, leading to a possibility that the oil pump does not normally operates. Thus, in the conventional structural arrangements, a baffle plate is provided inside the oil pan to suppress the formation of waves on the liquid surface of the oil, but this increases the number of components. Thus, it is desired to suppress the wave formation on the liquid surface of the oil without providing a dedicated baffle plate.

[0009] Further, in the oil return structure disclosed in Japanese Patent Application Laid-open No. 2003-201815, the oil outlet hole of the oil return passage directly opens in the lower surface of the balancer housing, and is located so as to be adjacent to the oil suction hole of the oil strainer formed integrally with the balancer housing. Therefore, a negative pressure is generated by suction of the oil pump in the vicinity of the oil suction hole of the oil strainer, and the negative pressure affects the oil outlet hole of the oil return passage, which may adversely affect the separation of the oil from the blowby gas in the gas-liquid separating chamber.

[0010] In order to eliminate this drawback, it is desirable that the oil outlet hole of the oil return passage is positioned away from the oil suction hole of the oil strainer, but it is difficult to freely select the position of the oil outlet hole because the oil outlet hole opens directly in the lower surface of the balancer housing.

SUMMARY OF THE INVENTION

[0011] The present invention has been made under the above-described circumstances, and a first object of the invention is to enable a high-performance oil strainer to be arranged in a narrow space between a balancer housing and an oil pan.

[0012] A second object of the invention is to minimize the number of components of the oil strainer and an oil return member, both of which are provided under the balancer housing.

[0013] A third object of the invention is to cause the oil strainer provided under the balancer housing to function as a baffle plate.

[0014] A fourth object of the invention is to enhance the degree of flexible arrangement of an oil return member for returning oil separated from blowby gas to a space between the balancer housing and the oil pan.

[0015] In order to achieve the first object, according to a first feature of the present invention, there is provided an oil strainer structure of an engine, which includes an oil strainer for filtering oil in an oil pan, the oil strainer

being arranged between a balancer housing and the oil pan of the engine and supported by the balancer housing, the oil strainer including: a lower member which is a die-molded article having an oil suction hole opening in the oil stored in the oil pan; an upper member which is a die-molded article having an oil discharge hole leading to the oil pump; and a strainer element, the lower member and the upper member being joined to each other with an outer peripheral portion of the strainer element held between joint surfaces of the upper and lower members.

[0016] With this structural arrangement, the oil strainer is formed by joining together the die-molded lower member having the oil suction hole opening in the oil stored in the oil pan and the die-molded upper member having the oil discharge hole leading to the oil pump. When the two members are joined together, the outer peripheral portion of the strainer element is held between the joint surfaces of the two members. The oil strainer is supported by the balancer housing. Thus, it is possible to form the oil strainer into a flat shape so as to be compactly arranged in a narrow space between the lower surface of the balancer housing and the bottom surface of the oil pan, and to also maximize an area of the strainer element to prevent clogging. Further, the lower member and the upper member, which are die-molded articles, are highly flexible in their shapes, whereby the oil suction hole and the oil discharge hole can be arranged in the most suitable positions, and the cross-sectional area of oil flow can be sufficiently secured.

[0017] According to a second feature of the present invention, in addition to the first feature, the oil strainer has a cross-sectional area decreasing from the oil suction hole to the oil discharge hole.

[0018] With this structural arrangement, the cross-sectional area of the oil strainer decreases from the oil suction hole to the oil discharge hole. Accordingly, the flow rate of the oil suctioned from the oil pan that flows through the oil strainer can be gradually increased, thereby minimizing resistance generated by the suction of oil into the oil pump.

[0019] In order to achieve the second object, according to a third feature of the present invention, there is provided an oil strainer structure of an engine, comprising: an oil strainer for filtering oil in an oil pan, the oil strainer including two members joined to each other and being supported on a lower surface of a balancer housing of the engine, wherein an oil return member for returning oil separated from blowby gas is formed by two members joined to each other, and wherein one of the two members forming the oil return member is commonly used as one of the two members forming the oil strainer.

[0020] With this structural arrangement, one of the two members joined together to form the oil strainer for filtering the oil in the oil pan is also used as one of the two members joined together to form the oil return member for returning the oil separated from the blowby gas to the oil pan. Therefore, the number of members is reduced to 3 instead of 4 in the case where no member is shared by the oil strainer and the oil return member, thereby reducing the number of components of the oil strainer and the oil return member as well as the cost.

[0021] According to a fourth feature of the present invention, in addition to the third feature, the commonly used member is a lower member; and the lower member and a first upper member that is joined to the balancer housing constitute the oil strainer, and the lower member and a second upper member that is joined to the balancer housing constitute the oil return member.

[0022] With this structural arrangement, the first upper member and the second upper member, which are joined to the balancer housing, are separate members. Therefore, the first and second upper members become high-precision parts to facilitate their being joined together, thereby suppressing leakage of the oil through the joint portion.

[0023] In order to achieve the third object, according to a fifth feature of the present invention, there is provided an oil strainer structure of an engine, having: an oil strainer for filtering oil in an oil pan, the oil strainer being supported on a lower surface of a balancer housing of the engine, wherein the oil strainer is supported so as to bridge between opposite ends of the balancer housing.

[0024] With this structural arrangement, the oil strainer for filtering the oil in the oil pan is supported on the lower surface of the balancer housing so that the oil strainer bridges between the opposite ends of the balancer housing. Therefore, the oil strainer can prevent the liquid surface of the oil stored in the oil pan from moving with acceleration, deceleration or turn of the vehicle, that is, the oil strainer can function as a baffle plate. Thus, it is possible to eliminate or downsize the conventional baffle plate, thereby contributing to reduction in the number of components and the cost.

[0025] According to a sixth feature of the present invention, in addition to the fifth feature, the structure further comprises a rib which is projectingly provided on an upper or lower surface of the oil strainer.

[0026] With this structure, the rib is projectingly provided on the upper or lower surface of the oil strainer. Therefore, the rib can enhance the rigidity of the oil strainer, and further enhance the function of the baffle plate excreted by the oil strainer.

[0027] According to a seventh feature of the present invention, in addition to the fifth or sixth feature, the structure further comprises an oil return member for returning oil separated from blowby gas to the oil pan, the oil return member being integrally formed at a joint portion where an end of the oil strainer is joined to the balancer housing.

[0028] With this structural arrangement, the oil return member is formed integrally at the joint portion where the end of the oil strainer is joined to the balancer housing. Therefore, it is possible to reduce the number of components as compared with the case where the oil return member and the balancer housing are separately provided.

[0029] In order to achieve the fourth object, according

to an eighth feature of the present invention, there is provided an oil return structure of an engine, having: an oil return member for returning oil separated from blowby gas to an oil pan, the oil return member being arranged between a balancer housing and the oil pan of the engine, the oil return member including: an upper member which is a die-molded article having an oil inlet hole leading to an oil return passage in the balancer housing; and a lower member which is a die-molded article having an oil outlet hole opening in the oil in the oil pan, the upper and lower members being joined to each other.

[0030] With this structural arrangement, the oil return member is formed by joining together the upper member having the oil inlet hole leading to the oil return passage of the balancer housing and the lower member having the oil outlet hole opening in the oil in the oil pan. Therefore, it is possible to enhance the flexibility in determining the position of the oil outlet hole. Accordingly, the oil outlet hole can be arranged in a position where the oil outlet hole is less susceptible to the influence of the negative pressure generated by suction of the oil at the inlet hole of the oil strainer arranged inside the oil pan, thereby reliably performing gas-liquid separation between the blowby gas and the oil. Further, the lower member and the upper member, which are die-molded articles, are highly flexible in their shapes, whereby the oil outlet hole can be reliably arranged below the liquid surface of the of oil in the oil pan to prevent the pressure fluctuation in the crankcase from affecting the gas-liquid separation.

[0031] The above and other objects, features and advantages of the invention will become apparent from preferred embodiments taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0032]

Figs. 1 to 9 show a first embodiment of the invention, wherein

Fig. 1 is a front view of an engine;

Fig. 2 is a cross-sectional view taken along line 2-2 of Fig. 1;

Fig. 3 is a view in direction of arrow 3-3 of Fig. 2;

Fig. 4 is a view in direction of arrow 4-4 of Fig. 2;

Fig. 5 is a cross-sectional view taken along line 5-5 of Fig. 3;

Fig. 6 is a cross-section taken along line 6-6 of Fig. 3;

Fig. 7 is an exploded perspective view of an oil strainer viewed from obliquely below;

Fig. 8 is an exploded perspective view of the oil strainer viewed from obliquely above; and

Fig. 9 is a perspective view of a balancer device equipped with the oil strainer.

Fig. 10 is a view corresponding to Fig. 8 according to a second embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0033] A first embodiment of the present invention will be described with reference to Figs. 1 to 9.

[0034] Figs. 1 and 2 show the following structural arrangement. A lower block 12 is fixed to a lower surface of a cylinder block 11 of a diesel engine E of an automobile. An oil pan 13 is fixed to the lower surface of the lower block 12. Provided on a lower surface of the lower block 12 is a balancer device 14 which reduces secondary vibration of the engine E, and which is housed in the oil pan 13. A crankshaft 15 is rotatably supported between the cylinder block 11 and the lower block 12. A drive sprocket 16 is provided at an end of the crankshaft 15. A driven sprocket 17 is provided at an end of a drive balancer-shaft 29 of the balancer device 14. An endless chain 18 is wound around the drive and driven sprockets 16 and 17.

[0035] Figs. 3 to 6 show the following structural arrangement. The balancer device 14 has a balancer housing 19 including an upper housing part 20 and a lower housing part 21. The upper and lower housing parts 20 and 21 are joined together by a plurality of bolts 22. A right-side housing part 23 is joined to the balancer housing 19 on an end face on the right side of the vehicle. A left-side housing part 25 is joined to the balancer housing 19 on an end face on the left side of the vehicle. The balancer housing 19 is fixed to the lower surface of the lower block 12 with two bolts 27 and 27 penetrating the upper and lower housing parts 20 and 21, and with another two bolts 28 and 28 penetrating the right-side housing part 23.

[0036] The balancer housing 19 supports the drive balancer-shaft 29 and a driven balancer-shaft 30 which are parallel to each other. Provided on the drive balancer-shaft 29 are the driven sprocket 17, a drive gear 31, a first balancer-weight 32 and a second balancer-weight 33, sequentially from one end to the other end of the drive balancer-shaft 29. Provided on the driven balancer-shaft 30 are a driven gear 34, a first balancer-weight 35 and a second balancer-weight 36, sequentially from one end to the other end of the driven balancer-shaft 30. The endless chain 18 is wound around the drive sprocket 16 provided on the crankshaft 15 and the driven sprocket 17 provided on the drive balancer-shaft 29. The drive gear 31 provided on the drive balancer-shaft 29 meshes with the driven gear 34 provided on the driven balancer-shaft 30.

[0037] Accordingly, when the engine E operates, the rotation of the crankshaft 15 is transmitted to the drive balancer-shaft 29 via the drive sprocket 16, the endless chain 18 and the driven sprocket 17; and the rotation of the drive balancer-shaft 29 is transmitted to the driven balancer-shaft 30 via the drive gear 31 and the driven gear 34. In this structural arrangement, the number of teeth of the drive sprocket 16 on the crankshaft 15 is set at twice the number of the teeth of the driven sprocket 17 on the drive balancer-shaft 29, while the drive and

driven gears 31 and 34 have the same number of teeth. Consequently, the drive and driven balancer-shafts 29 and 30 rotate in directions opposite to each other, at the same rotational speed that is twice the rotational speed of the crankshaft 15, so that the first and second balancer weights 32, 33: 35, 36 provided on the drive balancer-shaft 29 and the driven balancer-shaft 30 reduce the secondary vibration in the engine E.

[0038] Fig. 6 clearly shows the following structure. An oil pump 37, which is a trochoidal pump, has a circular-shaped pump chamber 23a which opens in the joint surface of the right-side housing part 23 with respect to the upper and the lower housing parts 20 and 21. An outer rotor 38 and an inner rotor 39 are housed inside the pump chamber 23a such that they mesh with each other. A suction port 40 facing the pump chamber 23a communicates with a suction passage 41 which opens in the lower surface of the lower housing part 21. A discharge port 42 facing the pump chamber 23a communicates with a discharge passage 43 (see Fig. 3), which opens in the upper surface of the right-side housing part 23; that is, in the joint surface between the right-side housing part 23; and the lower block 12.

[0039] Next, an oil strainer 51 for filtering the oil suctioned from the oil pan 13 into the oil pump 37 will be described with reference to Figs. 4 to 9.

[0040] Figs. 7 and 8 show the following structure. The oil strainer 51 is constituted by total four members: a lower member 52, a first upper member 53 and a second upper member 54, all of which are injection-molded from a synthetic resin into a die; and a strainer element 55 made of a synthetic resin mesh.

[0041] The lower member 52 includes: a main-body portion 52a, a support-arm portion 52b, an oil-return-passage formed portion 52c and an oil-discharge-pipe portion 52d. The main-body portion 52a has a shallow container shape with an open upper surface and curved into a comma shape. The support-arm portion 52b has a plate shape extending obliquely upward from a part of the outer periphery of the main-body portion 52a. The oil-return-passage formed portion 52c has a linear shape connecting to an upper end of the support-arm portion 52b. The oil-discharge-pipe portion 52d has a pipe shape extending downward from an end of the oil-return-passage formed portion 52c. A rectangular-shaped oil suction hole 52f opens in the main-body portion 52a on one end side (wider side). A gutter-shaped groove 52g is formed in an upper surface of the oil-return-passage formed portion 52c, and communicates with the oil-discharge-pipe portion 52d. An oil outlet hole 52e opens at a bottom end of the oil-discharge-pipe portion 52d, and is located below the liquid surface of the oil stored in the oil pan 13. Therefore, the pressure fluctuation in the crankcase does not affect the intake system via the oil-return passage 58 leading to the cylinder head.

[0042] The first upper member 53 has substantially the same shape as that of the main-body portion 52a of the lower member 52, and is formed into a shallow container shape with an open lower surface. An oil discharge hole 53a is formed in the first upper member 53 on the other end side (narrower side) so as to penetrate upward the first upper member 53.

[0043] The second upper member 54 has substantially the same shape as that of the oil-return-passage formed portion 52c of the lower member 52. A gutter-shaped groove 54a is formed in the lower surface of the second upper member 54 so as to face the gutter-shaped groove 52g of the oil-return-passage formed portion 52c. An oil inlet hole 54b is formed in the second upper member 54 at an end on a side opposite to the oil-discharge-pipe portion 52d. Mounting bosses 54c and 54d each having a bolt-hole are projectingly formed on opposite sides of the oil inlet hole 54b.

[0044] The lower surfaces of the first and second upper members 53 and 54 are respectively joined by fusing to the upper surfaces of the main-body portion 52a and the oil-return-passage formed portion 52c. In this process, the outer peripheral portion of the strainer element 55 is held and fixed between the lower surface of the first upper member 53 and the upper surface of the main-body portion 52a of the lower member 52. As a result, a dirty chamber 56 is defined between the strainer element 55 and the main-body portion 52a of the lower member 52, and a clean chamber 57 is defined between the strainer element 55 and the first upper member 53. The oil return passage 58 is formed between the groove 52g in the oil-return-passage formed portion 52c of the lower member 52 and the groove 54a of the second upper member 54. The opposite ends of the oil return passage 58 communicate with the oil inlet hole 54b and the oil-discharge-pipe portion 52d.

[0045] The oil strainer 51 comprises the lower member 52, the first upper member 53 and the second upper member 54, all of which are synthetic resin die-molded articles, and thus has a high flexibility in designing the shape. Accordingly, the compact high-performance oil strainer 51 can be arranged in the narrow space between the balancer housing 19 and the oil pan 13. More particularly, in the oil suction route to the oil pump 37, the oil suction hole 52f and the oil discharge hole 53a can be arranged in the most suitable positions, and the cross-sectional area of oil flow can be sufficiently secured. Also, in the oil returning route for returning the oil separated from the blowby gas, the oil outlet hole 52e can be arranged in a position sufficiently away from the oil suction hole 52f, and can be kept below the liquid surface of the oil.

[0046] As clearly shown in Fig. 4, the oil strainer 51 structured as described above is fastened to the lower housing part 21 of the balancer housing 19 with three bolts 59 penetrating from below the bolt-holes of the three mounting bosses 53b, 53c and 53d of the first upper member 53, and is fastened to the upper housing part 20 of the balancer housing 19 with two bolts 60 and 60 penetrating from above the bolt-holes of the two mounting bosses 54c and 54d of the second upper member

54. In this structural arrangement, the two mounting bosses 54c and 54d of the second upper member 54 are fixed to the end portion of the upper housing part 20 on the drive balancer-shaft 29 side; the mounting bosses 53b and 53c of the first upper member 53 are fixed to the lower housing part 21 on the driven balancer-shaft 30 side; and the remaining mounting boss 53d of the first upper member 53 is fixed to the lower housing part 21 between the drive balancer-shaft 29 and the driven balancer-shaft 30. Consequently, the oil strainer 51 is supported at a position so as to cover the lower surface of the lower housing part 21.

[0047] In the above-described mounted state, the oil discharge hole 53a of the first upper member 53 communicates, through the suction passage 41 opening in the lower surface of the lower housing part 21, with the suction port 40 of the oil pump 37 (see Fig. 6). Also, the oil inlet hole 54b of the second upper member 54 communicates, through an oil return passage 20a opening in the lower surface of the upper housing part 20, with the oil return passage 23b which opens in the joint surface of the right-side housing part 23 with respect to the lower block 12 (see Fig. 9). The oil return passage 23b of the right-side housing part 23 communicates, through another oil return passage (not illustrated) penetrating the lower block 12 and the cylinder block 11, with a labyrinth-type gas-liquid separating chamber (not illustrated) formed in the cylinder head.

[0048] Next, the operation of the first embodiment of the present invention will be described.

[0049] When the engine E operates, the rotation of the crankshaft 15 is transmitted to the drive balancer-shaft 29 via the endless chain 18, and the rotation of the drive balancer-shaft 29 is transmitted to the driven balancer-shaft 30 via the drive and driven gears 31 and 34. Thus, the oil pump 37 connected to the driven balancer-shaft 30 starts to operate.

[0050] As a result, the oil stored in the oil pan 13 is suctioned into the oil strainer 51 through the oil suction hole 52f formed in the lower member 52 of the oil strainer 51; passes from the dirty chamber 56 through the strainer element 55 while being filtered thereby; passes from the clean chamber 57 through the oil discharge hole 53a of the first upper member 53; and further passes through the suction passage 41 of the lower housing part 21 of the balancer housing 19 (see Figs. 3 and 6) and the suction port 40 of the right-side housing part 23, and is suctioned into the oil pump 37.

[0051] The oil discharged to the discharge port 42 of the oil pump 37 is supplied from the discharge passage 43 of the right-side housing part 23 (see Fig. 3) to the lower block 12, and then branches therefrom into plural routes and used to lubricate a journal portion of the crankshaft 15 and a valve operating mechanism.

[0052] The main-body portion 52a of the lower member 52 and the second upper member 54 dividing the interior of the oil strainer 51 into the dirty chamber 56 and the clean chamber 57, has a vertically flat shape, and the outer peripheral portion of the strainer element 55 having a large area is held between the lower member 52 and the second upper member 54. Therefore, it is possible to minimize the increase in the flow resistance of the oil, and to prevent the clogging of the strainer element 55.

[0053] As clearly shown in Figs. 7 and 8, the oil strainer 51 is made thinner on the oil suction hole 52f side and thicker on the oil discharge hole 53a side in order to avoid any interference with the bottom surface of the oil pan 13. However, the oil strainer 51 is made wider on the oil suction hole 52f side and narrower on the oil discharge hole 53a side, thereby preventing the sudden change in the cross-sectional area of oil flow to minimize the increase in the flow resistance of the oil. Particularly because the cross-sectional area of the passage of the oil strainer 51 gradually decreases from the oil suction hole 52f side to the oil discharge hole 53a side, the flow rate of the oil flowing from the oil suction hole 52f to the oil discharge hole 53a slowly increases, thereby reducing the flow resistance against the oil flowing into the oil pump 37.

[0054] The blowby gas that leaks out of the combustion chamber of the engine E is supplied to the cylinder head while containing the oil; and is subjected to the gas-liquid separation in the gas-liquid separating chamber provided in the cylinder head to separate therefrom the oil. Consequently, the gas is returned to the intake system and the oil is returned to the oil pan 13. The oil separated from the blowby gas flows down through an oil return passage (not shown) formed in the cylinder block 11 and the lower block 12; passes through the oil return passage 23b (see Figs. 3 and 9) in the right-side housing part 23 of the balancer housing 19 joined to the lower block 12 and through the oil return passage 20a (see Figs. 3 and 9) in the upper housing part 20; and flows into the oil inlet hole 54b of the second upper member 54 of the oil strainer 51 (see Figs.8 and 9).

[0055] The oil that flows flowed into the oil inlet hole 54b of the second upper member 54, passes through the oil return passage 58 formed between the oil-return-passage formed portion 52c of the lower member 52and the second upper member 54, further through the oil-discharge-pipe portion 52b of the lower member 52, and returns to the undersurface of the oil stored in the oil pan 13 through the oil outlet hole 52e located below the liquid surface of the oil in the oil pan 13.

[0056] As described above, the oil return passage 58 and the oil-discharge-pipe portion 52d for returning the oil separated from the blowby gas to the oil pan 13, are formed integrally with the oil strainer 51. Consequently, the number of components and the number of assembling steps are reduced as compared with the case where the oil return passage 58 and the oil-discharge-pipe section 52d are formed separately from the oil strainer 51.

[0057] As described above, the lower member 52 forming a part of the oil strainer 51 for filtering the oil in the oil pan 13 is also used for forming a part of the oil return member for returning the oil separated from the blowby

gas to the oil pan 13. Consequently, the number of members is reduced to 3, instead of 4, in the case where no member is commonly used, thereby reducing the number of components of the oil strainer 51 and the oil return member to reduce the cost.

[0058] In addition, because the first and second upper members 53 and 54 which are joined to the balancer housing 19 are separate members, they can be high-precision parts, thereby facilitating joining them to the balancer housing 19 to suppress the leakage of oil out of the joint portion. Assuming that the first and second upper members 53 and 54 are integrated into a single member, the single member becomes large in dimensions, and also the oil discharge hole 53a and the oil inlet hole 54b are required to be formed in the single member which requires a severe dimensional accuracy in aligning the oil discharge hole 53a and the oil inlet hole 54b respectively with the suction passage 41 and the oil return passage 20a of the balancer housing 19. Therefore, this structural arrangement results in an increased processing cost.

[0059] Depending on the positional relationship between the oil suction hole 52f and the oil outlet hole 52e in the oil strainer 51, the negative pressure generated by suction of the oil pump 37 and acting on the oil suction hole 52f may affect the oil outlet hole 52e, leading to a possibility that the negative pressure adversely affects the separation of the oil from the blowby gas in the gas-liquid separation chamber leading to the oil outlet hole 52e. However, according to the present embodiment, the positional relationship between the oil suction hole 52f and the oil outlet hole 52e can be flexibly established by using the oil return passage 58 formed between the oil-return-passage formed portion 52c of the lower member 52 and the second upper member 54 so as to avoid the influence of the negative pressure generated by suction of the oil pump 37.

[0060] Further, the oil-discharge-pipe portion 52d is formed in the lower member 52 so as to project downward, and the oil outlet hole 52e opens at the bottom end of the oil-discharge-pipe portion 52d. Consequently, the pressure fluctuation in the crankcase is prevented from adversely affecting the gas-liquid separation.

[0061] Furthermore, the oil strainer 51 is supported so as to provide a bridge between the opposite end of the balancer housing 19, and partitions the space between the lower surface of the balancer housing 19 and the bottom surface of the oil pan 13. Consequently, the oil strainer 51 functions as a baffle plate for suppressing the fluctuation of the liquid surface of the oil due to acceleration, deceleration or turn of the vehicle, thereby reliably preventing cavitation in the oil pump 37 due to air mixed into the oil. Therefore, it is possible to eliminate the need to provide a dedicated baffle plate, and downsize the conventional baffle plate, thereby reducing the number of components and the cost. Particularly because the support-arm portion 52b connecting together the main-body portion 52a and the oil-return-passage formed portion 52c of the lower member 52 is formed into a plate shape, the support-arm portion 52b can effectively suppress the movement of the oil to enhance the function of the oil strainer as a baffle plate.

[0062] Next, a second embodiment of the present invention will be described with reference to Fig. 10.

[0063] In the second embodiment, a rib 53e is integrally formed on an upper surface of a first upper member 53 of an oil strainer 51 so as to project upward toward a lower surface of a lower housing part 21 of a balancer housing 19. The direction in which the rib 53e extends is substantially orthogonal to the direction in which a support-arm portion 52b of a lower member 52 extends.

[0064] Because the rib 53e is integrally formed on the first upper member 53 as described above, it is possible to enhance rigidity of the oil strainer 51, and also effectively suppress formation of waves on the liquid surface of the oil by causing the rib 53e to function as a baffle plate. Particularly because the rib 53b extends in the direction orthogonal to the direction in which the support-arm portion 52b extends, it is possible to suppress the waves regardless of the direction in which the oil moves.

[0065] The embodiments of the present invention have been described above, but various changes in design may be made without departing from the subject matter of the present invention.

[0066] For example, in the embodiments, the oil return passage 58 and the oil-discharge-pipe portion 52d for returning the oil separated from the blowby gas to the oil pan 13 are formed integrally with the oil strainer 51, but they may be formed separately from the oil strainer 51.

[0067] Also, in the above embodiments, the lower member 52, the first upper member 53 and the second upper member 54 are die-molded synthetic resin articles, but they can be die-molded metal articles (pressed products or die-cast products) or any other articles made not by die-molding.

[0068] An oil strainer 51 includes: a lower member 52 having an oil suction hole 52f opening in oil stored in an oil pan; an upper member 53 having an oil discharge hole 53a leading to an oil pump; and a strainer element 55. The lower member 52 and the upper member 53 are joined to each other with the strainer element 55 held between joint surfaces of the upper and lower members 52 and 53. Thus, it is possible to form the oil strainer 51 into a flat shape so as to be compactly arranged in a narrow space, and also maximize an area of the strainer element 55 to prevent clogging. Further, the lower member 52 and the upper member 53, which are die-molded articles, are highly flexible in their shapes, whereby the oil suction hole 52f and the oil discharge hole 53a can be arranged in the most suitable positions, and the cross-sectional area of oil flow can be sufficiently secured.

Claims

1. An oil strainer structure of an engine, comprising:

an oil strainer for filtering oil in an oil pan, the oil strainer including two members joined to each other and being supported on a lower surface of a balancer housing of the engine,
wherein an oil return member for returning oil separated from blowby gas is formed by two members joined to each other, and
wherein one of the two members forming the oil return member is commonly used as one of the two members forming the oil strainer.

2. The oil strainer structure of an engine according to claim 1,
wherein the commonly used member is a lower member; and the lower member and a first upper member that is joined to the balancer housing constitute the oil strainer, and the lower member and a second upper member that is joined to the balancer housing constitute the oil return member.

3. An oil strainer structure of an engine, comprising
an oil strainer for filtering oil in an oil pan, the oil strainer being supported on a lower surface of a balancer housing of the engine,
wherein the oil strainer is supported so as to provide a bridge between opposite ends of the balancer housing.

4. The oil strainer structure of an engine according to claim 3, further comprising a rib which is projectingly provided on an upper or lower surface of the oil strainer.

5. The oil strainer structure of an engine according to claim 3 or 4, further comprising an oil return member for returning oil separated from blowby gas to the oil pan, the oil return member being integrally formed at a joint portion where an end of the oil strainer is joined to the balancer housing.

6. An oil return structure of an engine, comprising:

an oil return member for returning oil separated from blowby gas to an oil pan, the oil return member being arranged between a balancer housing and the oil pan of the engine, the oil return member including:

an upper member which is a die-molded article having an oil inlet hole leading to an oil return passage in the balancer housing; and
a lower member which is a die-molded article having an oil outlet hole opening in the oil in the oil pan,
the upper and lower members being joined to each other.

FIG.1

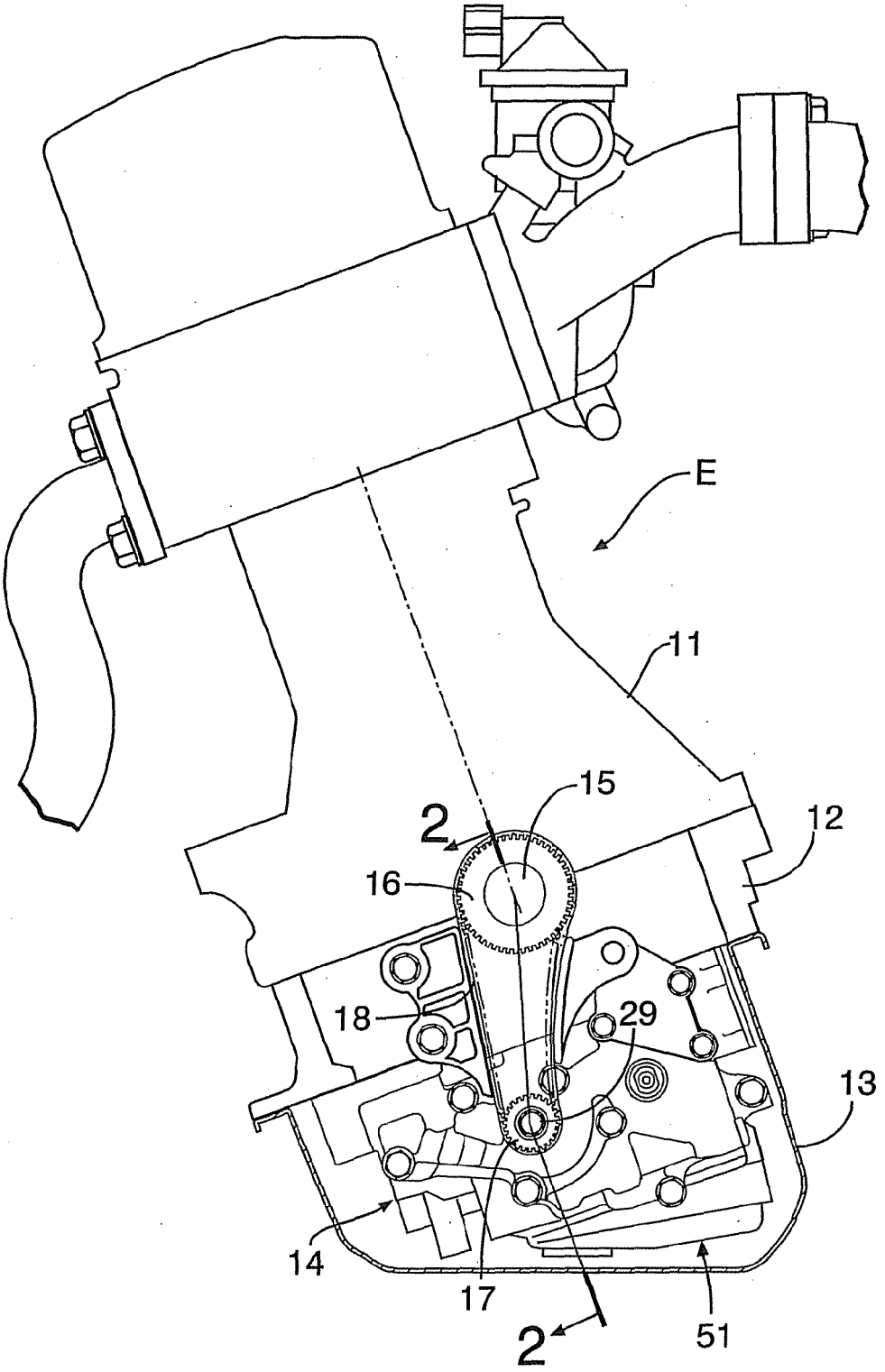

FIG.2

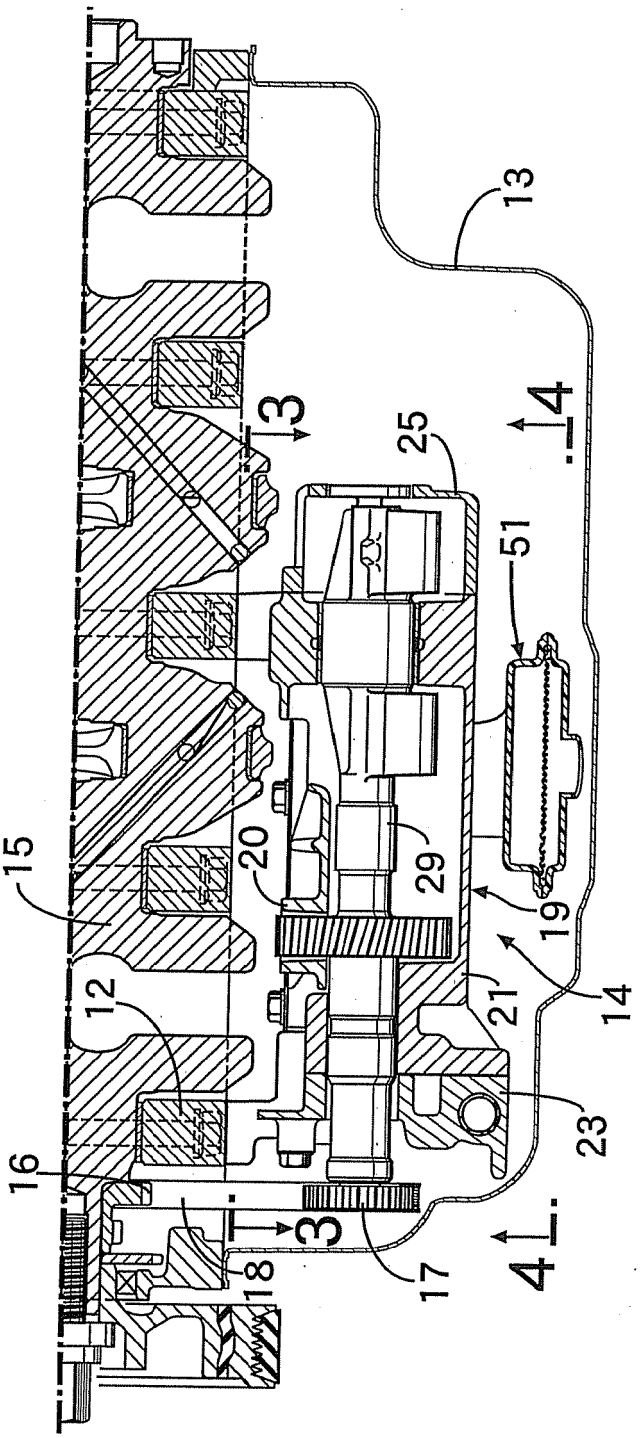

FIG.3

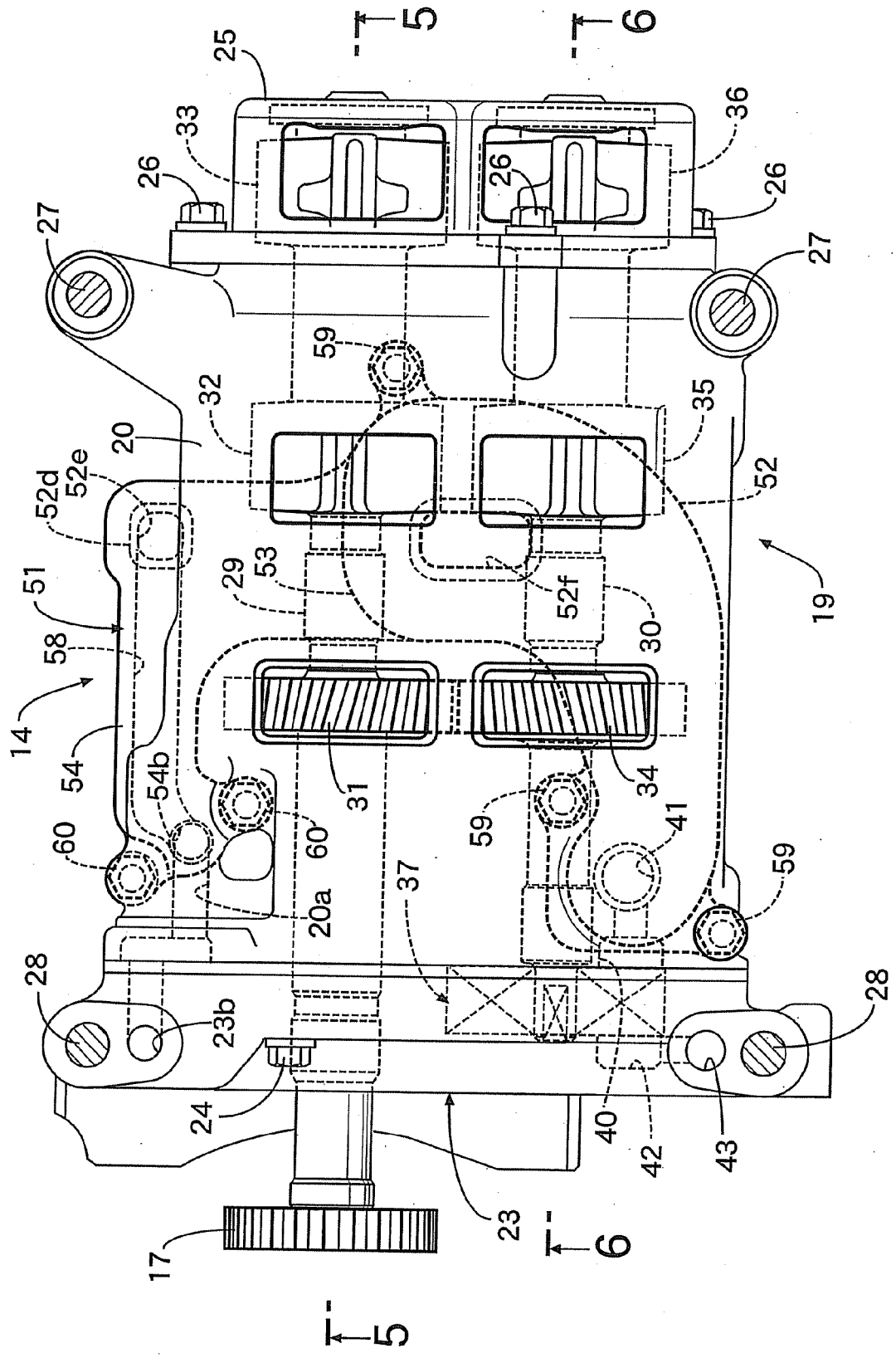
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FIG.4

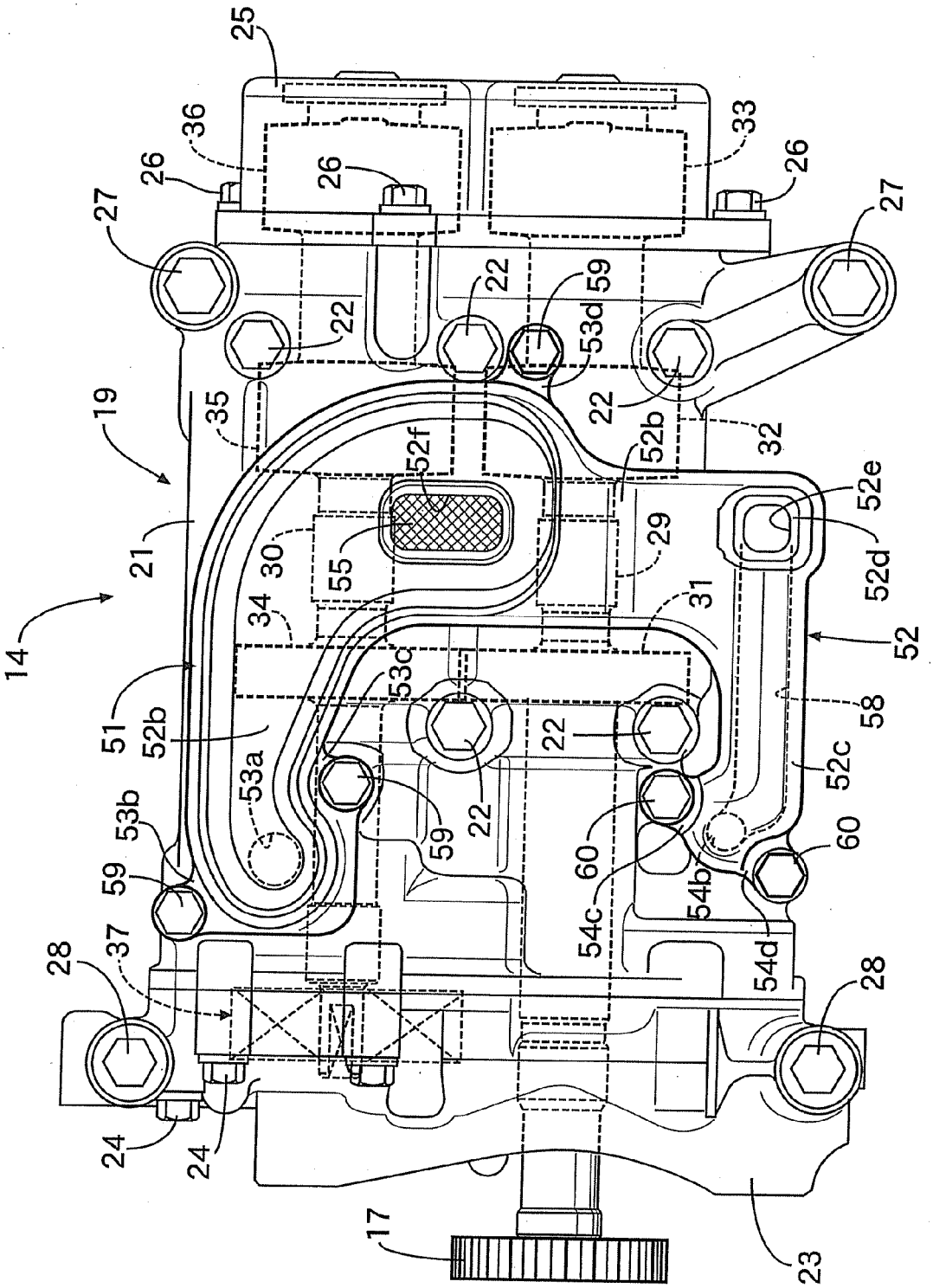
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FIG.5

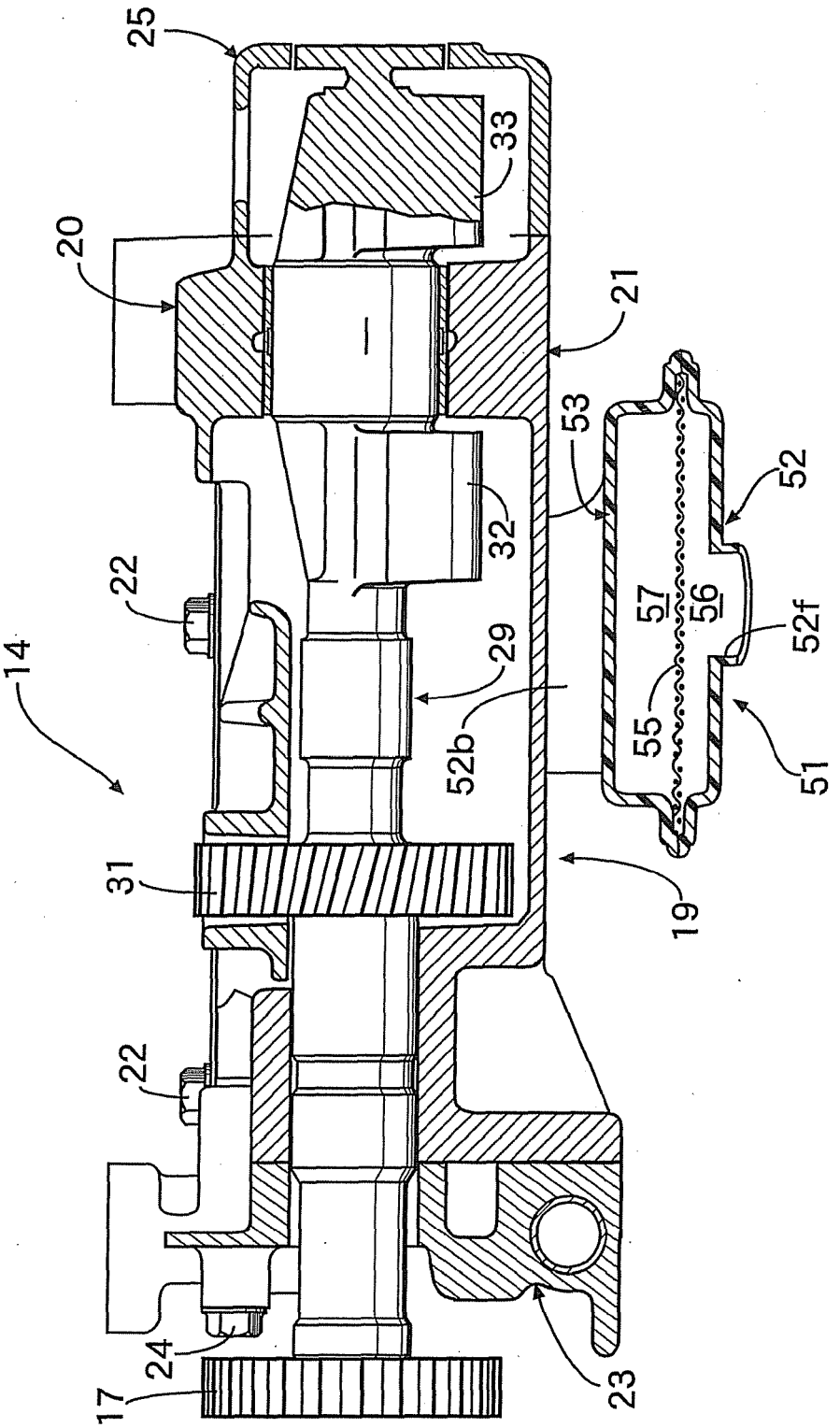

FIG.6

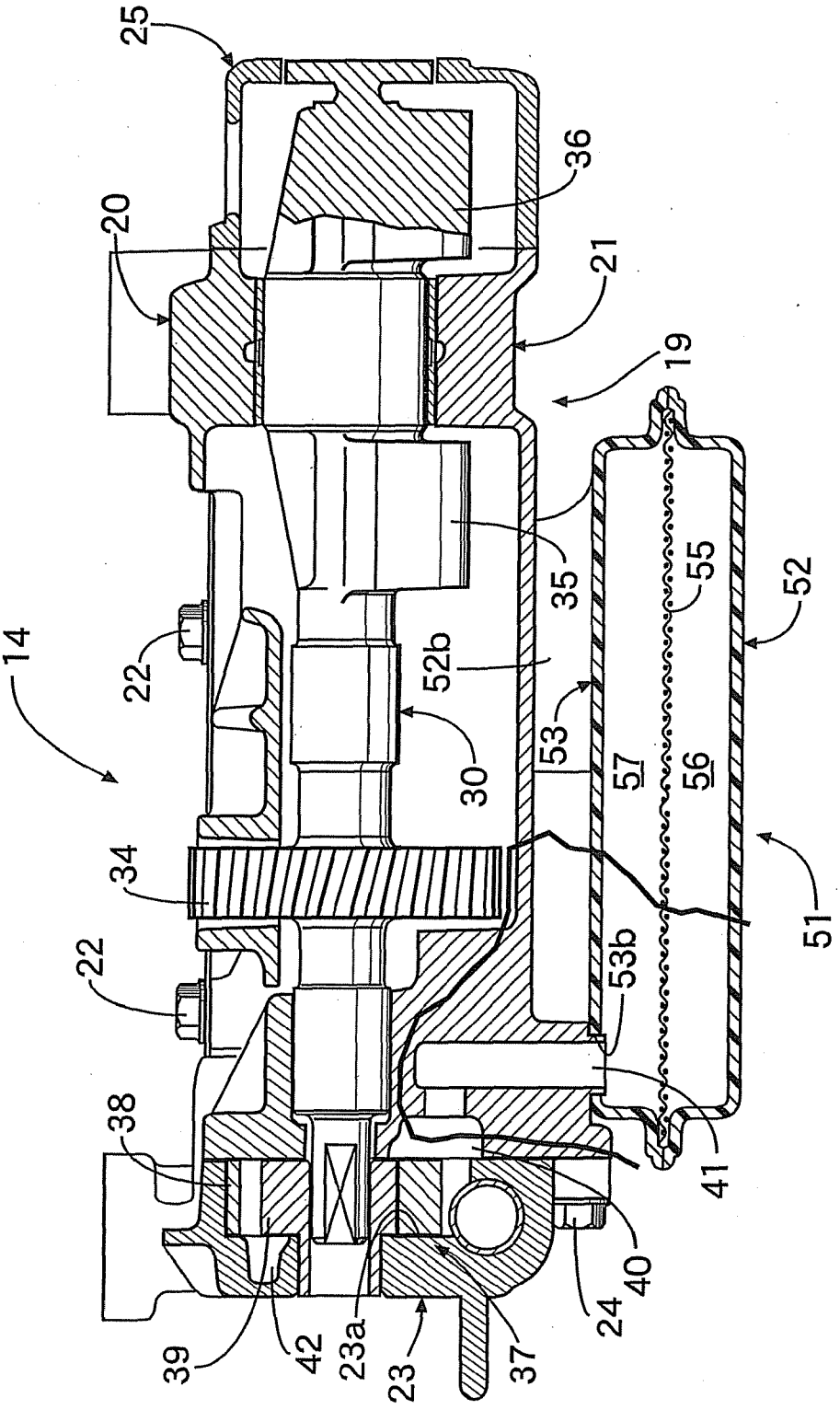
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FIG.7

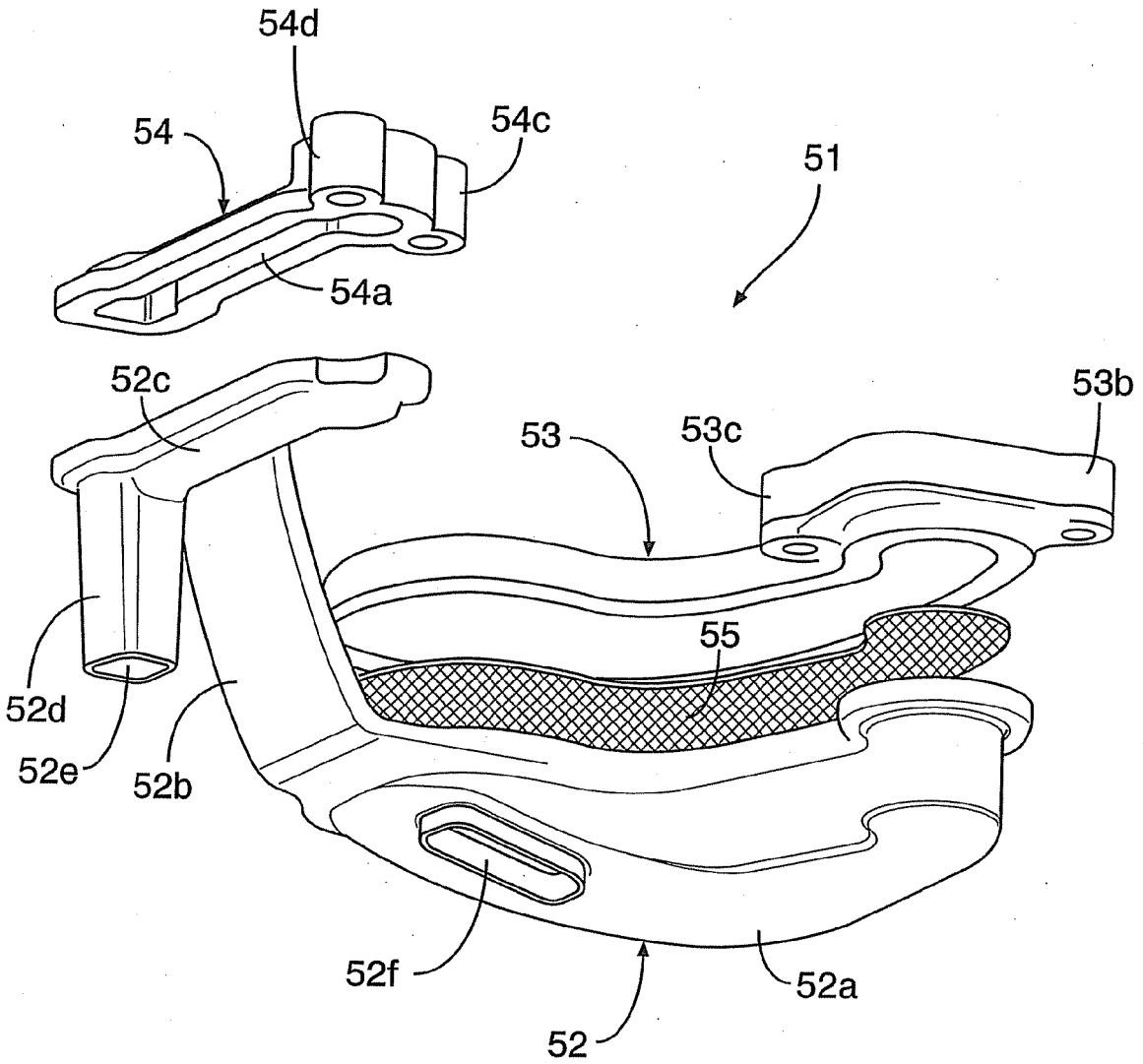

FIG.8

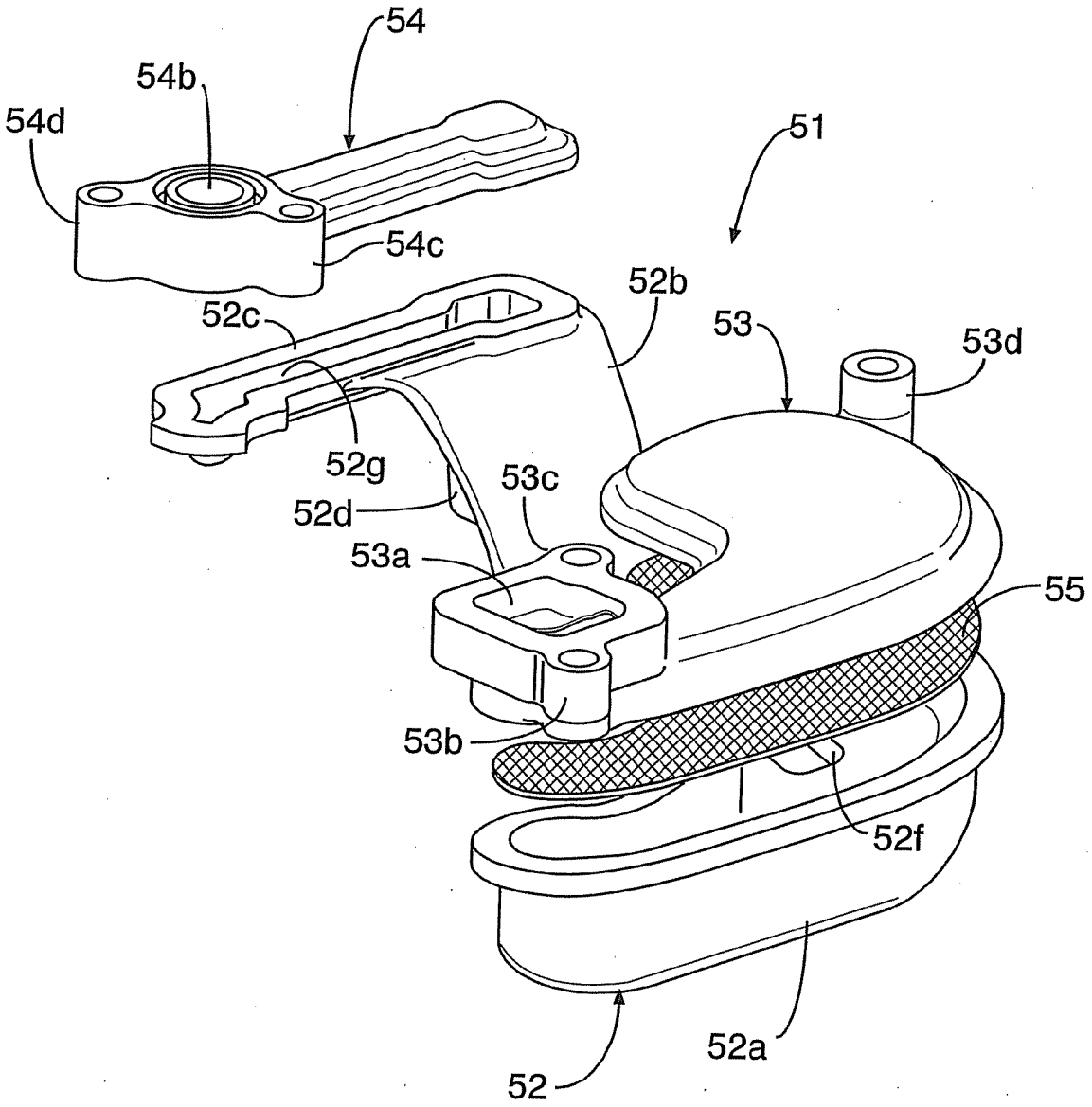

FIG.9

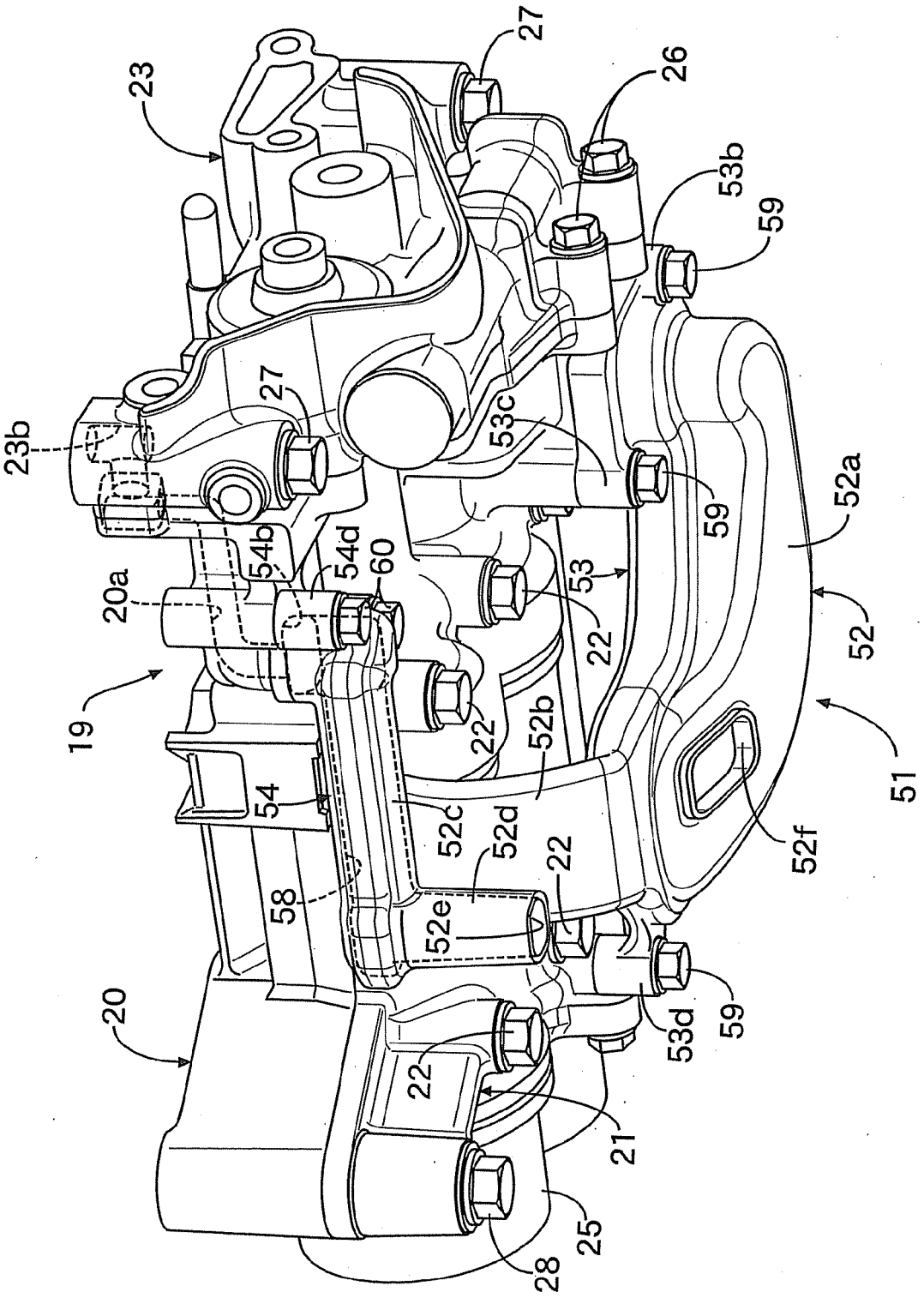
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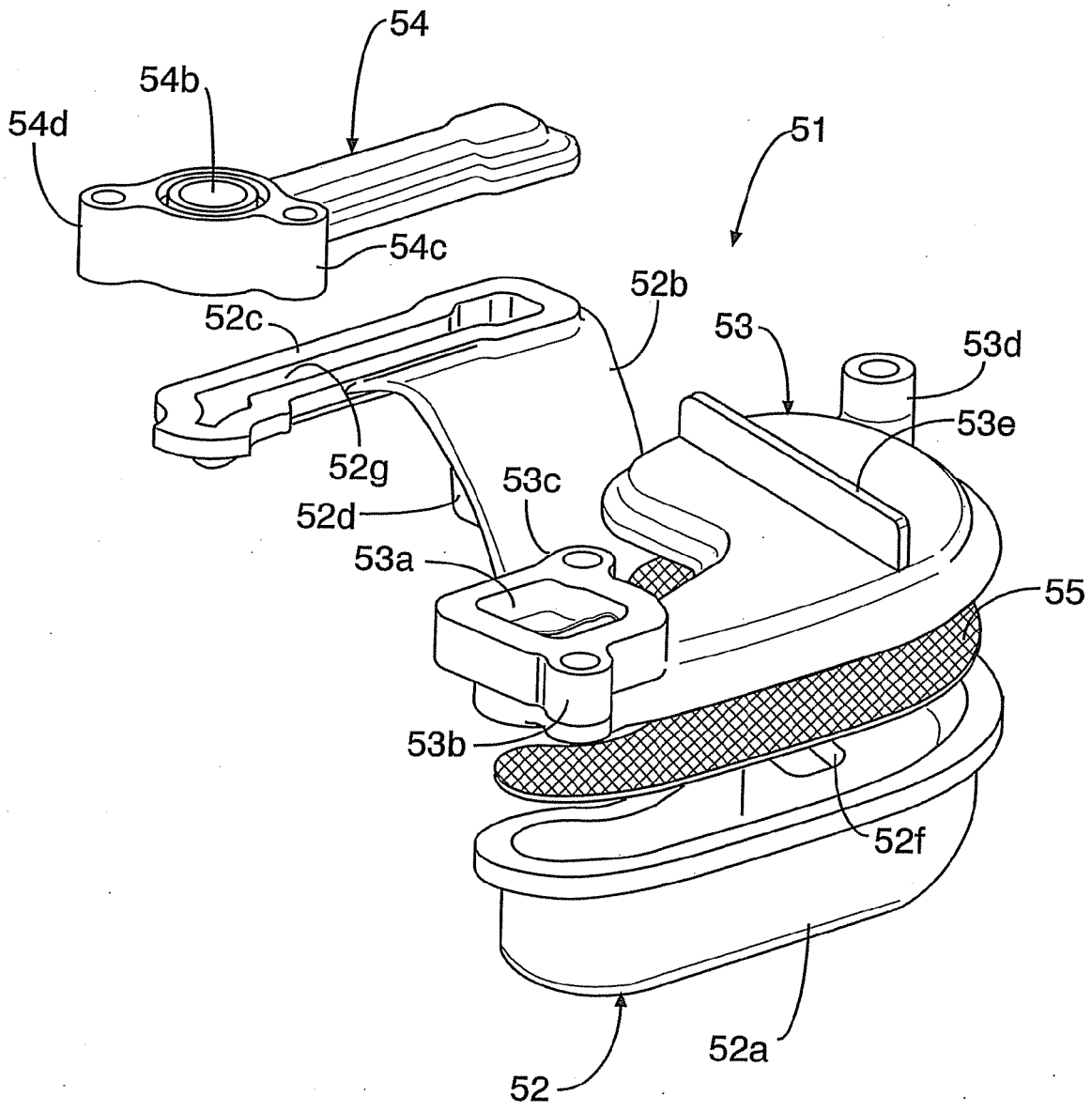
FIG.10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Patent documents cited in the description

- JP 2001074105 A **[0003] [0006]**
- JP 2003201815 A **[0005] [0009]**