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## (54) Engine device

(57) An engine device having an engine body provided with a crankshaft and balancer shafts adapted to rotate in association with the crankshaft, with the engine body covered with an engine cover, whereby engine auxiliary is integrally incorporated in the engine cover.

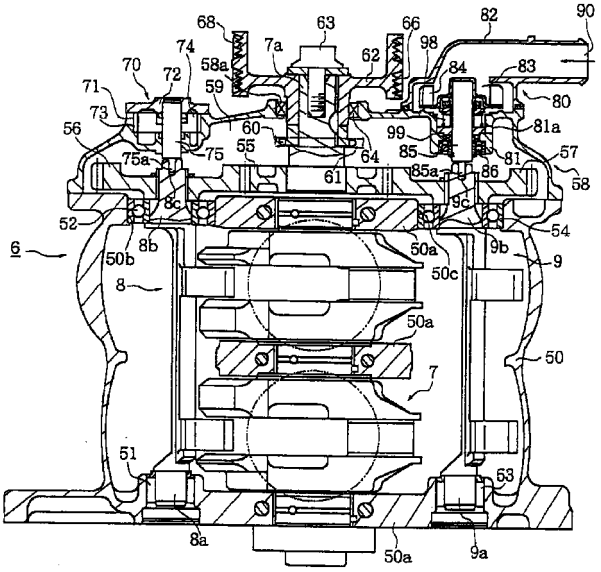


FIGURE 2

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## Description

**[0001]** This invention relates to an engine device having an engine body provided with a crankshaft and balancer shafts adapted to rotate in association with the crankshaft, with the engine body covered with an engine cover, wherein engine auxiliary is integrally incorporated in the engine cover.

**[0002]** An engine device has a structure in which engine auxiliaries, such as an oil pump or water pump are arranged as an unit at the front side of the engine unit and those auxiliaries are driven through timing chains or belt for engine auxiliaries

**[0003]** In such structure, the engine auxiliaries, such as an oil pump and water pump are incorporated in an engine body as an unit, resulting in increased number of components, complexity of assembly, increased cost or the like. It also tends to increase the number of locations to be sealed, resulting in the occurrence of leakage of oil or water. In addition, waste power is consumed in the bearings to support the load from tension force of timing chains or belts for engine auxiliaries.

**[0004]** The object of the present invention maid in view of the situation described above is to provide an engine device such that the number of components of the auxiliaries to be incorporated is reduced, as well as the number of locations to be sealed, the load applied on the bearings is lower due to the employment of the central-shaft-diercetly-driven-system and the bearings are allowed to be reduced in volume.

**[0005]** To solve the problem described set forth and to accomplish the object, the present invention is provided as follows.

**[0006]** The invention claimed in Claim 1 is that an engine device having an engine body provided with a crankshaft and balancer shafts adapted to rotate in association with the crankshaft, with the engine body covered with an engine cover, characterized in that engine auxiliary is integrally incorporated in the engine cover.

**[0007]** According to the invention claimed in Claim 1, integral incorporation of the auxiliary into the engine cover allows the reduction in the number of auxiliary components to be assembled, as well as the number of locations to be sealed.

**[0008]** The invention claimed in Claim 2 is an engine device claimed in Claim 1, characterized in that the engine auxiliary is coupled to the balancer shafts so that both the engine auxiliary and the balancer shafts are allowed to rotate together.

**[0009]** According to the invention claimed in Claim 2, since the engine auxiliary is coupled to the balancer shafts so that both the engine auxiliary and the balancer shafts are allowed to rotate together and the central-shaft-directly-driven-system is employed, it is allowed to reduce the load applied on the bearings and to reduce in volume of the bearings.

**[0010]** The invention claimed in Claim 3 is an engine device of claim 1 or 2 characterized in that the balancer shafts are rotatably supported on the engine body, the end of the crankshaft is sealed after the insertion into the engine cover, with the engine auxiliary rotatably supported, and the engine auxiliary and the balancer shafts are coupled to rotate together.

**[0011]** According to the invention claimed in Claim 3, since the balancer shafts are rotatably supported on the engine body, the auxiliary is rotatably supported on the engine cover, the engine auxiliary and the balancer shafts are coupled to rotate together, and the central-shaft-directly-driven-system is employed, it is allowed to reduce the load applied on the bearings and to reduce in volume of the bearings. Further, the positioning of the crankshaft relative to the auxiliary shaft is easily and accurately carried out as the end of the crankshaft is projected out of the engine cover and then sealed.

**[0012]** The invention claimed in 4 is an engine device of any one of Claims 1 to 3 claim characterized in that the engine auxiliary is an oil pump and/or a water pump

**[0013]** According to the invention claimed in Claim 4, it is allowed to reduce the number of components of the oil pump and/or water pump and to reduce the load applied on the bearings and to reduce in volume of the bearings due to the employment of the central-shaft-directly-driven-system.

**[0014]** Other preferred embodiments of the present invention are laid down in further dependent claims.

**[0015]** In the following, the present invention is explained in greater detail with respect to several embodiments thereof in conjunction with the accompanying drawings, wherein:

Fig. 1 is a side view of the front side part of the vehicle equipped with the engine device;

Fig. 2 is a cross-sectional view of the engine device;

Fig 3 is a side view of the engine device;

Fig. 4 is a side view illustrated with the engine cover being removed.

Fig. 5 is a cross-sectional view of a water pump part according to another embodiment.

**[0016]** Embodiments of the engine device of the present invention will now be described with reference to the accompanying drawings wherein Fig 1 is a side view of the front side part of the vehicle equipped with the engine device; Fig. 2 is a cross-sectional view of the engine device; Fig. 3 is a side view of the engine device; Fig. 4 is a side view illustrated with the engine cover being removed; Fig. 5 is a cross-sectional view of a water pump part according to another embodiment.

**[0017]** In the front and side part of a vehicle 1, an

engine room 3 is disposed in front of the front wheels 2, an engine 4 is equipped within the engine room 3, and a radiator 5 is located in the front side of the engine 4. This engine 4 is 2-cylinder, 4-stroke engine and disposes an oil pan 700 at the bottom of an engine body 6. A crankshaft 7 is disposed within the engine body 6 along the vehicle's width direction, and balancer shafts 8, 9 are disposed in the front and rear side of the crankshaft along the width direction.

**[0018]** In a cylinder head 10 configuring the engine body 6 are formed branch exhaust passages 11, 12 and branch intake passages 13, 14 for each cylinder. The branch exhaust passages 11, 12 are opened and closed by the corresponding exhaust valve 15 disposed in respectively, and the branch intake passages 13, 14 are opened and closed by the corresponding intake valve 16 disposed in respectively. The exhaust valve 15 and the intake valve 16 are driven by cams 19, 20 disposed on camshafts 17, 18.

**[0019]** The branch exhaust passages 11, 12 are collected, and to this collected exhaust passage 21 is connected an exhaust pipe 22. The exhaust pipe 22 connected to each cylinder is collected, and the collected exhaust pipe 23 passes from the front-side of the engine body 6 through the underneath and extends rearward. In addition, to the exhaust pipe 23 is provided a catalyst 24.

**[0020]** The branch intake passages 13, 14 are collected, and in this collected intake passage 25 is provided a throttle body 26 to the cylinder head 10. The throttle body 26 has an intake passage 28 connecting to the intake passage 25 of each cylinder, and furthermore, an intake manifold 30 is connected to the throttle body 26.

**[0021]** On the cylinder head 10, an injector 35 is disposed. To the throttle body 26 is provided a throttle valve 40 controlling the flow rate of the respective intake passage 28. This throttle valve 40 is controlled in accordance with information of the engine speed and the throttle openings.

**[0022]** In a cylinder block 50 configuring the engine body 6, the crankshaft 7 is rotatably supported on bearings 50a. A balancer shaft 8 is arranged that one end portion 8a is rotatably supported through a needle bearing 51 and another end portion 8b is rotatably supported through a ball bearing 52. A balancer shaft 9 is also arranged in the same manner that one end portion 9a is rotatably supported through a needle bearing 53 and another end portion 9b is rotatably supported through a ball bearing 54. Each of the balancers 8, 9 is inserted from the end portion 8a, 9a of the opening 50b, 50c of the cylinder block 50 and assembled the ball bearing 52, 54 to the opening 50b, 50c.

**[0023]** A gear 55 is mounted on the crankshaft 7, while gears 56 and 57 are mounted on the balancer shaft 8 and 9, respectively. The gears 56 and 57 respectively engage the gear 55. As the crankshaft 7 rotates, the balancer shafts 8 and 9 are interlocked to rotate together through gears 55, 56 and 57.

**[0024]** One side of the cylinder block 50 is covered with the engine cover 58, 50 that the engine cover 58 forms a cam chain chamber 59. A cam gear 60 is disposed on the crankshaft 7, and a cam chain 61 is fitted over between the cam gear 60 and a gear disposed on the camshafts 17, 18 (not shown). The camshafts 17, 18 are interlocked to rotate by rotating of the crankshaft 7 through the cam chain 61, and the exhaust valve 15 and the intake valve 16 are opened and closed with the predetermined timing.

**[0025]** An end portion 7a of the crankshaft 7 is protruded from an opening 58a of the engine cover 58, and a driving pulley 62 is mounted on the protruding end portion 7a with a locking bolt 63. Between a shaft 62a of the driving pulley 62 and the opening 58a is sealed with sealing member 64. A driving belt 66 is fitted over between the driving pulley 62 and a air compressor 65 disposed on the front side of the engine, and a driving belt 68 is fitted over between the driving pulley 62 and an alternator 67 disposed on the rear side of the engine.

**[0026]** An oil pump 70 and a water pump 80 are integrally incorporated in the engine cover 58. That is to say, the oil pump 70 is integrally formed so that the pump housing 71 is one part of the engine cover 58, and to assemble the pump housing 71 with a cover housing 72 forms a pump chamber 73. A pump shaft 75 with blades 74 is rotatably supported between the pump housing 71 and the cover housing 72. An engaging protrusion 75a is formed on a tip of the pump shaft 75. An engaging recess 8c is formed on a tip of the balancer shaft 8 positioned opposite to the pump shaft 75. The engaging protrusion 75a of the pump shaft 75 is engaged with the engaging recess 8c of the balancer shaft 8, and the balancer shaft 8 and the pump shaft 75 are coupled integrally and rotatably. Oil is supplied to each part of the engine 4 by rotating of the pump shaft 75.

**[0027]** However, it is also possible to only arrange the water pump 80 integrally with the engine cover 58.

**[0028]** The water pump 80 is also formed integrally so that the pump housing 81 is one part of the engine cover 58, and to assemble the pump housing 81 with a cover housing 82 forms a pump chamber 83. In the pump housing 81, a pump shaft 85 with blades 84 is rotatably supported through the ball bearing 86.

**[0029]** An engaging protrusion 85a is formed on a tip of the pump shaft 85. An engaging recess 9c is formed on a tip of the balancer shaft 9 positioned opposite to the pump shaft 85. The engaging protrusion 85a of the pump shaft 85 is engaged with the engaging recess 9c of the balancer shaft 9, and the balancer shaft 9 and the pump shaft 85 are coupled integrally and rotatably.

**[0030]** The pump housing 81 is protruded into the cam chain chamber 59, and it is configured to be in a small size by that the pump shaft 85 is sealed in this pump housing 81 with a mechanical sealing member 98

and an oil-sealing member 99. The mechanical sealing member 98 and the oil-sealing member 99 shut out the cooling water and oil, and a weep hole 81 a is formed between the mechanical sealing member 98 and the oil-sealing member 99.

**[0031]** In the cover housing 82, a cooling water intake passage 90 is provided, and the cooling water from the radiator 5 is supplied to the pump chamber 83 through the cooling water intake passage 90. By driving of the water pump 80, the cooling water is supplied from a cooling water discharging passage 91 formed in the cover housing 82 and the engine cover 58 to each part of the engine.

**[0032]** In the embodiment shown in Fig. 5, a cooling water passage 101 is formed in the cover housing 100 and is communicated with a thermostat 88 disposed in the engine cover 58. Cooling water supplied from the radiator 5 is passed through the thermostat 88 via connection pipe 89 and thereafter supplied to the pump chamber 83 through the cooling water passage 101.

**[0033]** If the thermostat 88 is disposed at the cooling water inlet side in the engine cover 58 as in this embodiment, the thermostat housing 88a as part of the engine cover is formed together with the engine cover, resulting in the reduction of the number of components and the prevention of occurrence of vibration and water leakage which may be produced in case of the thermostat housing and the engine cover being separately formed.

**[0034]** In this invention, since the balancer shafts 8, 9 are rotatably supported on the engine body 6, the auxiliary such as the oil pump 70, water pump 80 or the like is rotatably supported on the engine cover 58, the engine auxiliary and the balancer shafts 8, 9 are coupled to rotate together, and the central-shaft-directly-driven-system is employed, it is allowed to reduce the load applied on the bearings and to reduce in volume of the bearings.

**[0035]** In this invention, since the balancer shafts 8, 9 are rotatably supported on the engine body 6, the auxiliary such as the oil pump 70 and water pump 80 is rotatably supported on the engine cover 58, the engine auxiliary and the balancer shafts 8, 9 are coupled to rotate together, and the central-shaft-directly-driven-system is employed, it is allowed to reduce the load applied on the bearings and to reduce in volume of the bearings. Further, the positioning of the crankshaft relative to the auxiliary shafts is easily and accurately carried out as the end of the crankshaft is projected out of the engine cover and then sealed.

**[0036]** Also, integral incorporation of the auxiliaries such as an oil pump 70 and water pump 80 into the engine cover 58 allows the reduction in the number of auxiliary components to be assembled, as well as the number of locations to be sealed. It is also allowed to reduce the number of components of the oil pump 70 and water pump 80 to be incorporated, to reduce the load applied on the bearings and to reduce in volume of the bearings due to the employment of the central-shaft-directly-driven-system.

**[0037]** As shown and described, according to the invention disclosed in Claim 1, integral incorporation of the auxiliary into the engine cover allows the reduction in the number of auxiliary components to be assembled, as well as the number of locations to be sealed.

**[0038]** According to the invention disclosed in Claim 2, since the engine auxiliary is coupled to the balancer shafts so that both the engine auxiliary and the balancer shafts are allowed to rotate together and the central-shaft-directly-driven-system is employed, it is allowed to reduce the load applied on the bearings and to reduce in volume of the bearings.

**[0039]** According to the invention claimed in Claim 3, since the balancer shafts are rotatably supported on the engine body, the auxiliary is rotatably supported on the engine cover, the engine auxiliary and the balancer shafts are coupled to rotate together, and the central-shaft-directly-driven-system is employed, it is allowed to reduce the load applied on the bearings and to reduce in volume of the bearings. Further, the positioning of the crankshaft relative to the auxiliary shafts is easily and accurately carried out as the end of the crankshaft is projected out of the engine cover and then sealed.

**[0040]** According to the invention claimed in Claim 4, it is allowed to reduce the number of components of the oil pump and/or water pump, to reduce the load applied on the bearings and to reduce in volume of the bearings due to the employment of the central-shaft-directly-driven-system.

## Claims

1. An engine device (1) having an engine body (6) provided with a crankshaft (7) and balancer shafts (8,9) adapted to rotate in association with the crankshaft (7), with the engine body (6) covered with an engine cover (58), **characterized in that** engine auxiliary (70,80) is integrally incorporated in the engine cover (58).

2. An engine device (1) according to claim 1, **characterized in that** the engine auxiliary (70,80) is coupled to the balancer shafts (8,9) so that both the engine auxiliary (70,80) and the balancer shafts (8,9) are allowed to rotate together.

3. An engine device (1) according to claim 1 or 2, **characterized in that** the balancer shafts (8,9) are rotatably supported on the engine body (6), the end of the crankshaft (7) is sealed after the insertion into the engine cover (6), with the engine auxiliary (70,80) rotatably supported, and the engine auxiliary (70,80) and the balancer shafts (8,9) are coupled to rotate together.

4. An engine device (1) according to at least one of

the preceding claims 1 to 3, **characterized in that** the engine auxiliary is an oil pump (70) and/or a water pump (80).

**5.** An engine device (1) according to claim 4, **characterized in that** the oil pump (70) is integrally formed so that a pump housing (71) is one part of the engine cover (58), said pump housing (71) forms together with a cover housing (72) a pump chamber (73).

**6.** An engine device (1) according to claim 5, **characterized in that** an engaging protrusion (75a) of a pump shaft (75) is in engagement with an engaging recess (8c) formed on a tip of said balancer shaft (8) and the balancer shaft (8) and the pump shaft (75) are coupled integrally rotatably.

**7.** An engine device (1) according to at least one of the preceding claims 4 to 6, **characterized in that** the water pump (80) is formed integrally so that a pump housing (81) is one part of the engine cover (58), said pump housing (81) forms together with a cover housing (82) a pump chamber (83).

**8.** An engine device (1) according to claim 7, **characterized in that** an engaging protrusion (85a) of a pump shaft (85) is in engagement with an engaging recess (9c) of the balancer shaft (9) and the balancer shaft (9) and the pump shaft (85) are coupled integrally rotatably.

**9.** An engine device (1) according to at least one of the preceding claims 1 to 8, **characterized in that** in a cylinder block (50) forming the engine body (6) the crankshaft (7) is supported on bearings (50a) and that a first (8) of the balancer shafts (8,9) is at one end portion (8a) rotatably supported by a needle bearing (51), whereas the other end portion (8b) is supported by a ball bearing (52).

**10.** An engine device (1) according to at least one of the preceding claims 1 to 9, **characterized in that** a cylinder block (50) forming the engine body (6), a second (9) of the balancer shafts (8, 9) is at one end portion (9a) rotatably supported by a needle bearing (53), whereas the other end portion (9b) is rotatably supported by a ball bearing (54).

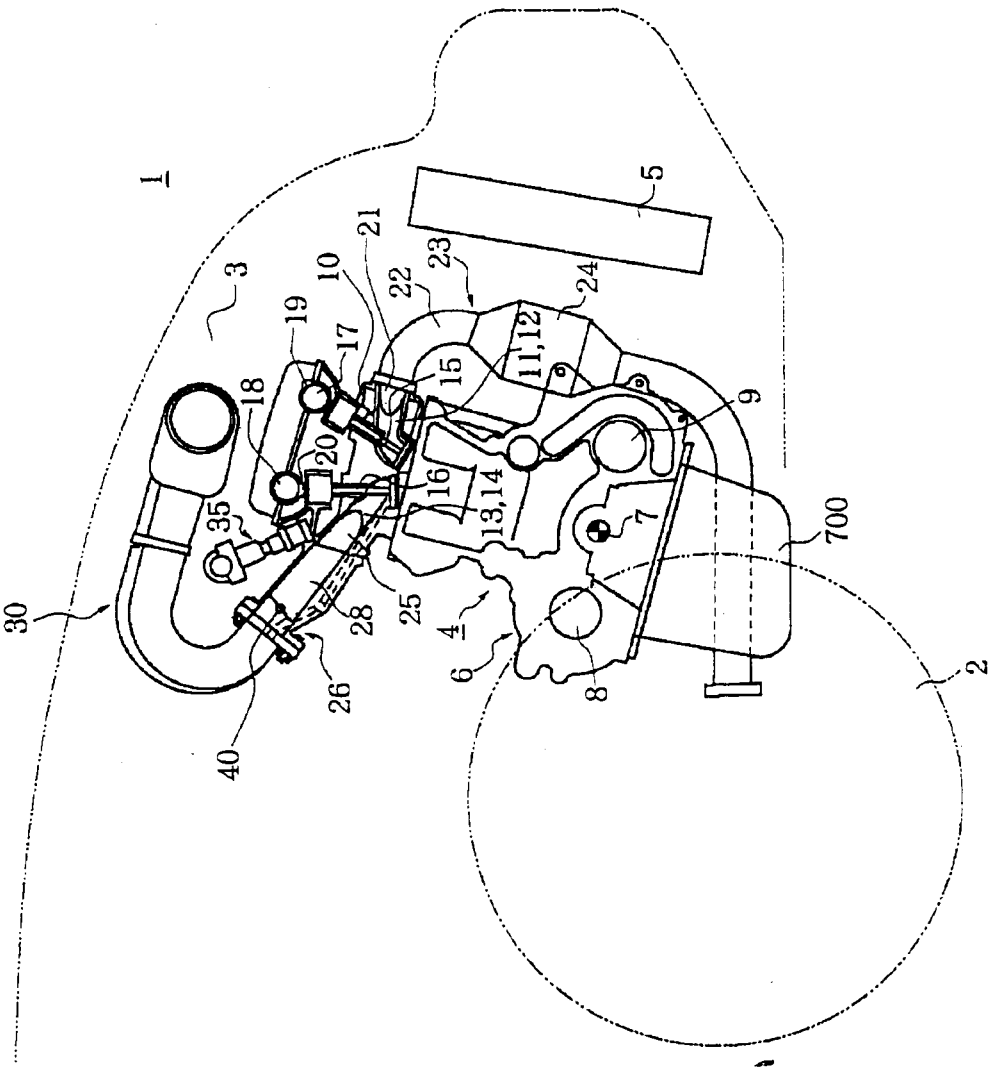
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FIGURE 1

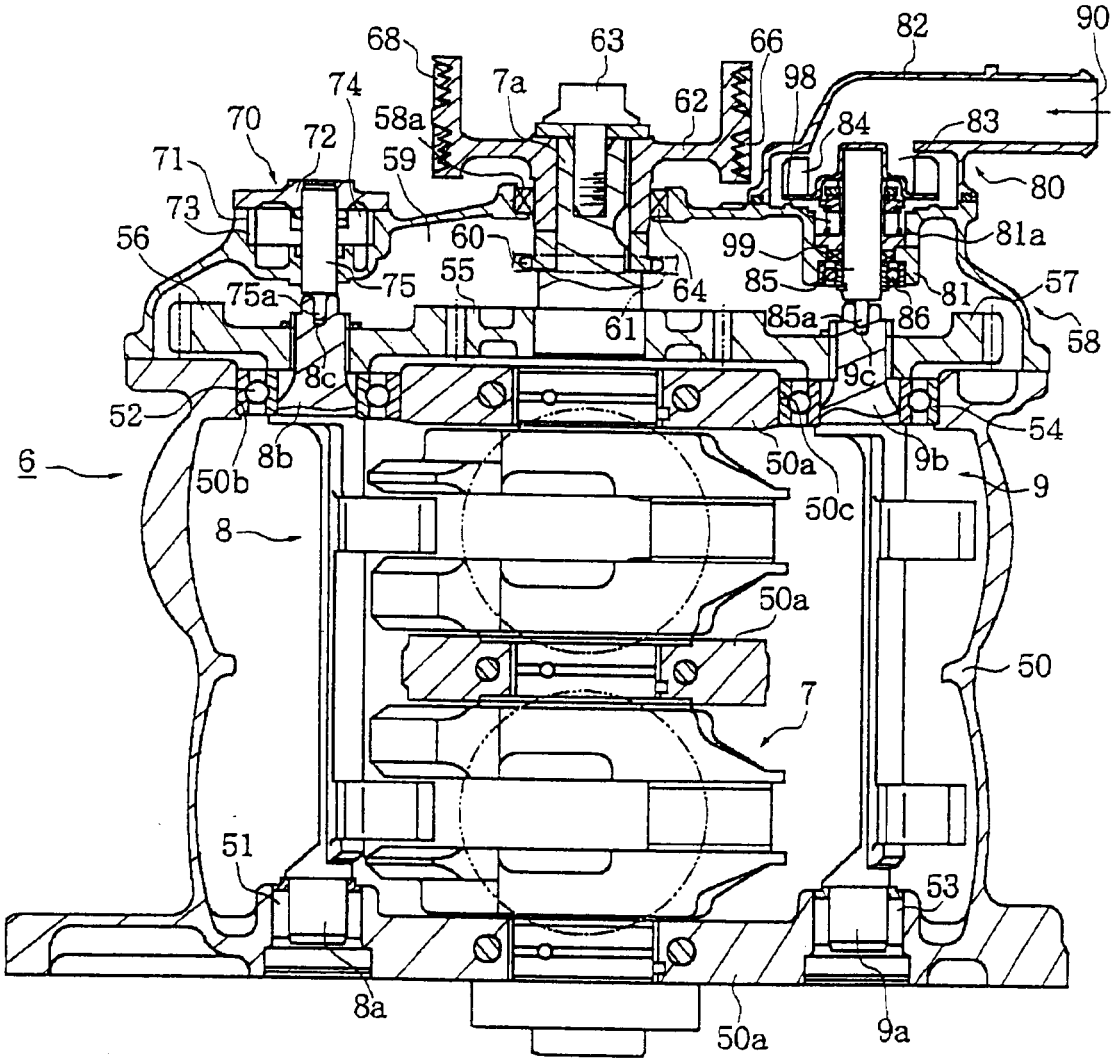
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FIGURE 2

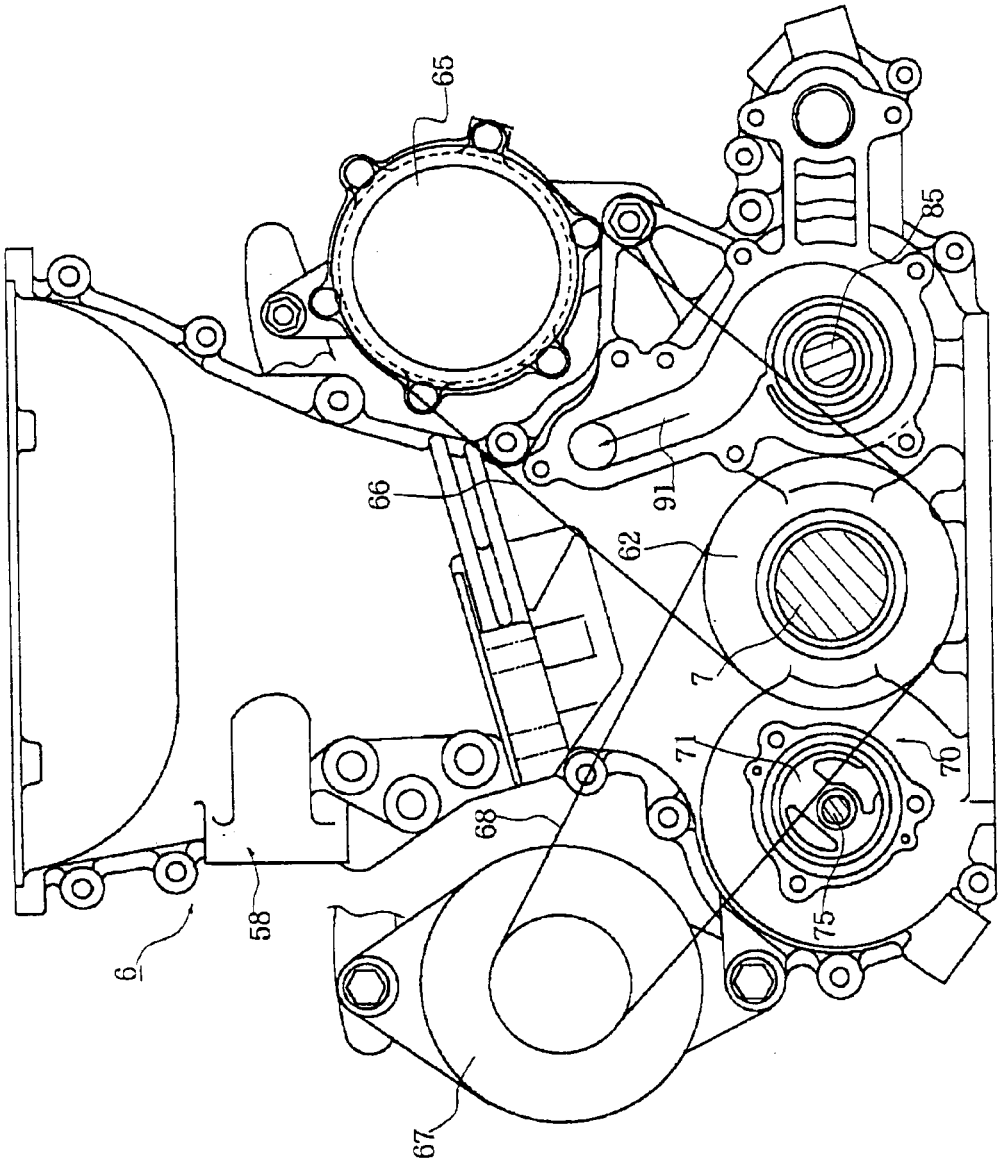


FIGURE 3

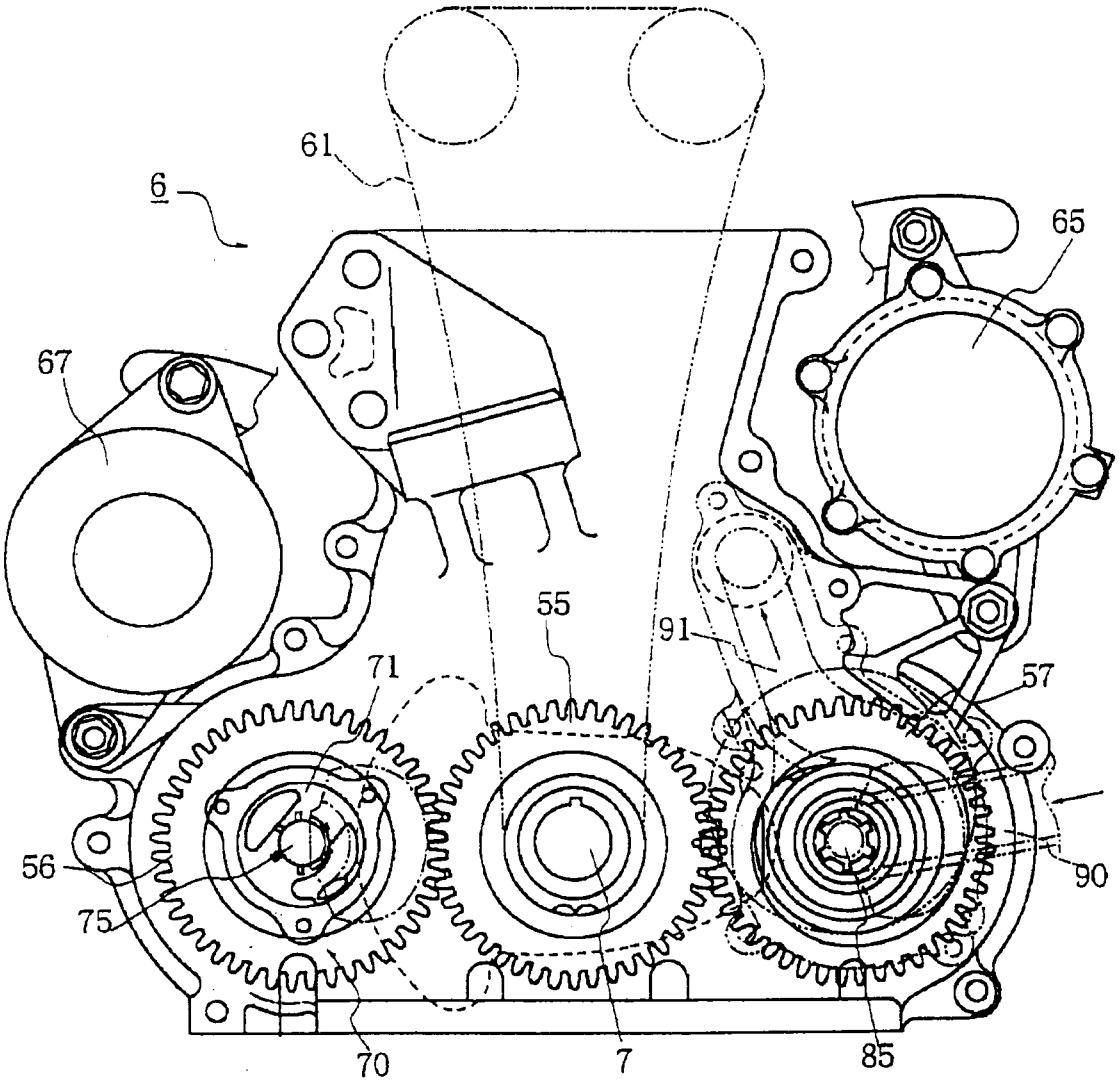


FIGURE 4

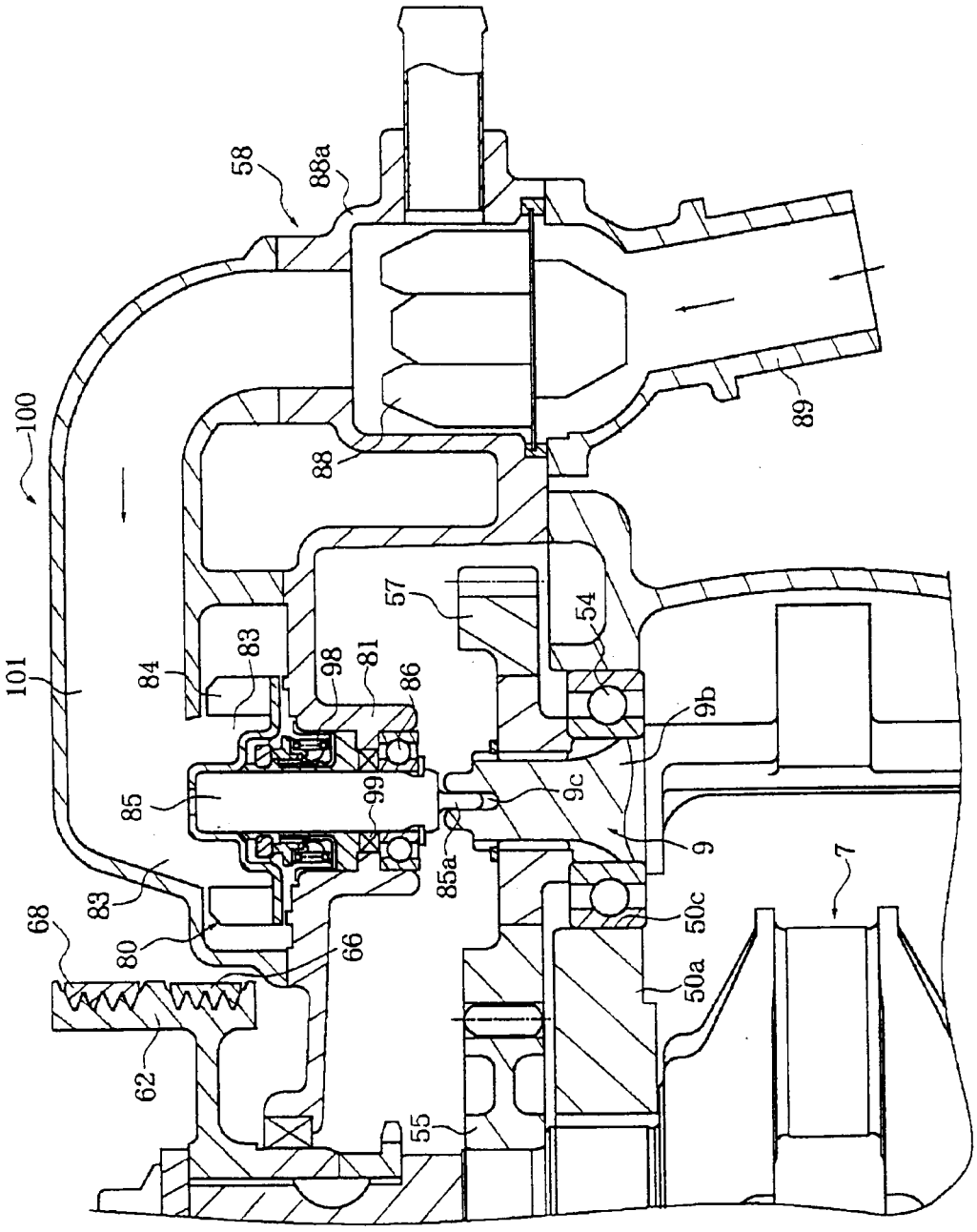
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FIGURE 5