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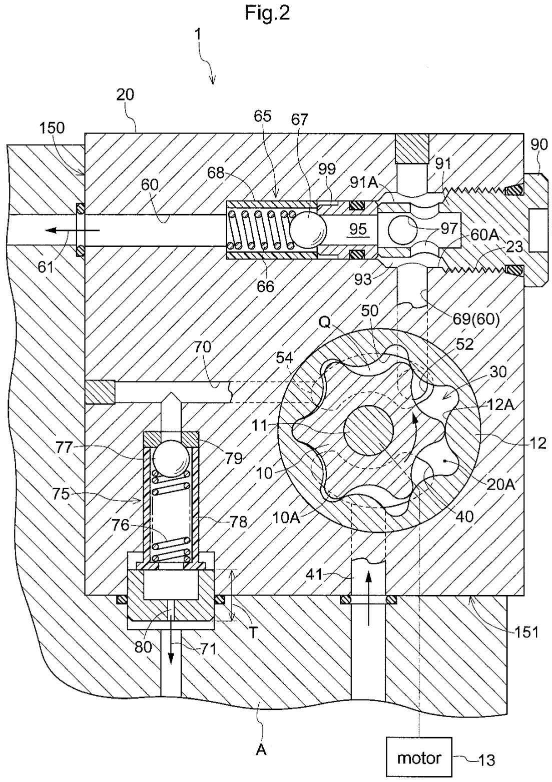
(54) **Electric oil pump**

(57) An electric oil pump (1) includes a rotor (10) driven to rotate by a motor (13) and a pump body (20) having a pump chamber (30) accommodating the rotor (10), an intake port (40) for introducing oil into the pump chamber (30) according to rotation of the rotor (10), a discharge port (50) for discharging oil from the pump chamber (30) according to rotation of the rotor (10), a first discharge passage (60) communicated to a first communication hole (52) provided in the discharge port (50) and circulating oil discharged from the discharge port (50), the first discharge passage (60) having a smaller cross sectional area than the discharge port (50), and a second discharge passage (70) communicated to a second communication hole (54) provided in the discharge port (50) separately from the first communication hole (52) and circulating oil discharged from the discharge port (50), the second discharge passage (70) having a smaller cross sectional area than the discharge port (50).

Fig.2



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Description

Technical Field

[0001] This disclosure relates to an electric oil pump for discharging oil.

Background Discussion

[0002] Conventionally, an electric oil pump has been used for controlling a hydraulically driven device driven according to oil pressure or for supplying lubricant oil to lubricate a mechanical device, etc. Further, in some arrangements provided with a main oil pump (mechanical), an auxiliary pump (electric) is used as an oil pressure source for use in an idling stop and an EV run. In case such an electric oil pump is used in a vehicle, from the viewpoints of space saving, weight reduction and cost reduction, it is conceivable to configure a single electric oil pump to provide supplying of lubricant oil even if oil pressure supply is needed for a plurality of portions (e.g. Patent Document 1: JPH07-243385).

[0003] In a variable displacement type pump disclosed in Patent Document 1, oil discharged from its discharge-side opening is circulated temporarily to a pump discharge-side pressure chamber formed outside a pump body. The downstream side of this pump discharge-side pressure chamber is communicated to a pump discharge-side passage provided in the pump body. Therefore, oil discharged from the discharge-side opening of the variable displacement pump is temporarily circulated to the outside from the pump body and then returned to the pump body. Further, the oil returned to the pump discharge-side passage is distributed to a passage for supplying to a power steering device through a metering orifice and a passage for supplying to a tank through a spool-type switching valve.

Summary

[0004] With the technique disclosed in Patent Document 1, oil discharged from a discharge-side opening is circulated to a pump discharge-side pressure chamber provided outside a pump body. For this reason, although a single electric oil pump is used for supplying oil from the viewpoints of space saving, weight reduction and cost reduction, there inevitably occurs enlargement of the outer size due to the presence of the multiple oil passages. Thus, degree of freedom in disposing is small and the layout is limited. Also, the mass is increased.

[0005] In view of the above-described problem, a need thus exists for an electric oil pump which is capable of realizing space saving and weight reduction.

[0006] According to a characterizing feature of an electric oil pump relating to this disclosure, the pump comprises:

a rotor driven to rotate by a motor; and

a pump body having:

a pump chamber accommodating the rotor;
an intake port for introducing oil into the pump chamber according to rotation of the rotor;
a discharge port for discharging oil from the pump chamber according to rotation of the rotor;
a first discharge passage communicated to a first communication hole provided in the discharge port and circulating oil discharged from the discharge port, the first discharge passage having a smaller cross sectional area than the discharge port; and
a second discharge passage communicated to a second communication hole provided in the discharge port separately from the first communication hole and circulating oil discharged from the discharge port, the second discharge passage having a smaller cross sectional area than the discharge port.

[0007] With the above-described characterizing feature, since the first discharge passage and the second discharge passage are provided from the discharge port separately from each other inside the pump body, there is no need to provide, outside the pump body, pipes to connecting portions to external pipes connected respectively to the first discharge passage and the second discharge passage. Therefore, a compact arrangement is made possible, so that an electric oil pump achieving space saving and weight reduction can be realized. Moreover, since the first discharge passage and the second discharge passage are provided from the discharge port separately from each other inside the pump body, there will occur no interference with some device or the like present around the electric oil pump. Therefore, the degree of freedom in the disposing position of the electric oil pump and the degree of freedom in the layouts of the first discharge passage and the second discharge passage can be improved. Further, with the above-described arrangement, there is no branching of the first discharge passage and the second discharge passage inside the pump body, so that the first discharge passage and the second discharge passage respectively can be disposed according to directions of their oil supplying destinations in the electric oil pump. Therefore, there can be realized a configuration with the shortest possible paths according to the directions of the oil supplying destinations of the first discharge passage and the second discharge passage. Hence, the manufacture thereof can be made easier, thus manufacture cost reduction is made possible.

[0008] Preferably, the first discharge passage and the second discharge passage extend to joining faces to the oil supplying destinations in the pump body.

[0009] With the above-described arrangement, oil discharged from the discharge port is circulated through the first discharge passage and the second discharge passage respectively, so that direct oil pressure supply to a plurality of positions is made possible.

[0010] Still preferably, a first check valve opened/closed according to a pressure of oil discharged from the discharge port is provided in the first discharge passage, and a second check valve opened/closed according to a pressure of oil discharged from the discharge port is provided in the second discharge passage.

[0011] With the above-described arrangement, even when a pressure downstream the first discharge passage and the second discharge passage becomes higher than pressures of the first discharge passage and the second discharge passage, it is still possible to prevent inflow of the oil from this downstream side into the electric oil pump. Accordingly, no inflow of oil from the outside will occur even during stop of operation of the electric oil pump, so that the electric oil pump can be effectively protected. Further, as a check valve is provided in each one of the discharge passages, an entire hydraulic system having the electric oil pump can be formed compact. Therefore, the degree of freedom in layout or the like can be further improved.

[0012] Still preferably, the second discharge passage includes, downstream the second check valve, an orifice for distributing an amount of flow to the first discharge passage and an amount of flow to the second discharge passage.

[0013] With the above-described arrangement, since an orifice can be provided inside the pump body, the entire hydraulic system having the electric oil pump can be formed compact. Therefore, the degree of freedom in layout or the like can be further improved.

[0014] Still preferably, the first check valve is fixed by a fixing screw which advances through an opening hole formed in the pump body into the first discharge passage;

a tubular outer oil passage is formed between an outer circumferential face of a shank of the fixing screw and an inner circumferential face of the first discharge passage; and

an inner oil passage is formed on a radially inner side of the shank to communicate to the outer oil passage through a communication portion formed in the shank.

[0015] With the above-described arrangement, it is possible to use a fixing screw for fixing the first check valve as an oil passage. Thus, the electric oil pump can be formed compact. Therefore, the degree of freedom in layout or the like can be further improved.

Brief Description of Drawings

[0016] The foregoing and additional features and characteristics of this disclosure will become more apparent from the following detailed description considered with the reference to the accompanying drawings, wherein:

Fig. 1A is a view schematically showing a configuration of a hydraulic system having an electric oil pump,

Fig. 1B is a view schematically showing a power source for EV run,

Fig. 2 is a view schematically showing the electric oil pump,

Fig. 3 is a view schematically showing a second check valve relating to a further embodiment, and

Fig. 4 is a view schematically showing a second check valve relating to a further embodiment.

Detailed Description

[0017] An electric oil pump disclosed here is configured to be capable of supplying oil pressure to a hydraulically driven device driven hydraulically and capable also of supplying lubricant oil to mechanical components. Next, the electric oil pump 1 relating to the present embodiment will be described. In this embodiment, there will be described an exemplary case in which the electric oil pump 1 is provided in an automatic speed changer mounted in e.g. a hybrid vehicle. Fig. 1A is a view schematically showing a configuration of a hydraulic system 100 incorporating the electric oil pump 1 provided in a vehicle. Fig. 1B is a view schematically showing a drive motor M as a power source for EV run.

[0018] As shown in Fig. 1A, the hydraulic system 100 includes the electric oil pump 1, an engine 2, a gear unit 3, a mechanical oil pump 4, an oil pan 5, a forward traveling clutch 6, a hydraulic circuit 8, and a check valve 9. The engine 2 constitutes a power source of the vehicle and outputs a rotational power with combustion of a fuel such as gasoline. The rotational power of the engine 2 is transmitted to an automatic speed changer A. As shown in Fig. 1B, the drive motor M is a power source for EV run and outputs a rotational power with electric power stored in e.g. a battery. The rotational power of the drive motor M is transmitted to wheels 7.

[0019] The gear unit 3 has multiple gear positions providing different gear ratios and is configured such that the gear position is automatically changed according to a traveling state (e.g. according to a traveling speed of the vehicle or an amount of stepping on an accelerator, etc.). The rotational power of the engine 2 is transmitted to a gear position via a torque converter and the forward traveling clutch 6 and the gear position is changed as well. The output from the gear unit 3 is transmitted via an output shaft 3A to some of the wheels 7 which are mounted on the front portion of the vehicle.

[0020] The mechanical oil pump 4 is driven to rotate by the rotational power of the engine 2, thereby to supply oil stored in the oil pan 5 as lubricant oil via a discharge passage 4A to the gear unit 3 and also to provide an engaging oil pressure via a discharge passage 4B to the forward traveling clutch 6 (clutch engaged at the time of start of the vehicle). With this arrangement, during an operation of the engine 2, oil can be supplied to the gear unit 3 and the forward traveling clutch 6.

[0021] On the other hand, the vehicle mounting the present hydraulic system 100 can effect an EV run. For this reason, when the vehicle makes a stop at a traffic light or required power can be supplied by the drive motor M, the operation of the engine 2 is stopped and the mechanical pump 4 too is stopped. Therefore, the supply of oil to the gear unit 3 and the forward traveling clutch 6 will be stopped also. As a result, with stop of supply of oil pressure to the forward clutch 6, the forward traveling clutch 6 will be rendered into a completely disengaged state. When traveling of the vehicle is to be resumed under this condition, the engine 2 will restart its operation, thereby to rotate the oil pump 4, in which case an oil pressure needs to be fed to the forward traveling clutch 6. In such a case like this, as the forward traveling clutch 6 is now under the completely disengaged state, a certain period will be required until establishment of engagement of this forward traveling clutch 6. Further, if the engagement is tried hasteningly, this may cause a significant shock at the time of engagement.

[0022] Then, the electric oil pump 1 disclosed here is configured as follows. Namely, for the purpose of shortening the period required for establishment of engagement of the forward traveling clutch 6 and preventing the engagement shock occurring at the time of release of idling stop from becoming too large, during stop of the engine 4 at the time of idling stop, oil is supplied supplementarily to the forward traveling clutch 6 so as to maintain this clutch 6 under the engaged state and also oil as lubricant oil is supplied to the gear unit 3 at the time of EV run. Next, the electric oil pump 1 will be explained with reference to the drawings.

[0023] Fig. 2 is a view schematically showing the electric oil pump 1. Here, the electric oil pump 1 relating to the present embodiment is configured as a trochoid pump which per se is known. Therefore, the following description will be provided on the assumption of the electric oil pump 1 being a trochoid pump. As shown in Fig. 2, the electric oil pump 1 relating to the present embodiment includes a rotor 10 and a pump body 20.

[0024] The rotor 10 is driven to rotate by the motor 13. The motor 13 is rotated with electric energy supplied from the battery during idling stop of the engine 2, and a resultant rotational power of the motor 13 is inputted to a rotor shaft 11 mounted at the radially center portion of the rotor 10. In association with rotation of this rotor shaft 11, the rotor 10 is driven to rotate. The rotor 10 includes a plurality of outer teeth 10A in its outer circumferential face and is rotated about the axis of the rotor shaft 11. The outer teeth 10A of the rotor 10 have a tooth profile according to a trochoid curve or a cycloid curve.

[0025] On the radially outer side of the rotor 10, an outer rotor 12 is provided. The outer rotor 12 has an annular shape having a plurality of inner teeth 12A to mesh with the outer teeth 10A of the rotor 10 and the outer rotor 12 is rotated about a rotational axis offset from the rotational axis of the rotor 10. The inner teeth 12A of the outer rotor 12 are provided in a number one more than the number of the outer teeth 10A of the rotor 10 and these inner teeth 12A have a tooth profile to come into contact with the outer teeth 10A of the rotor 10 when the outer rotor 12 is rotated. Therefore, the outer rotor 12 defines a predetermined space on the radially inner side thereof and in this space, the rotor 10 is accommodated. In the instant embodiment, this space corresponds to "a pump chamber 30" disclosed here. And, this pump chamber 30 is formed in the pump body 20. Further, as the rotor 10 is accommodated in the pump chamber 30, a predetermined gap Q is formed between the outer teeth 10A and the inner teeth 12A.

[0026] Further, the pump body 20 forms an intake port 40 and a discharge port 50. The intake port 40 is an opening formed in a wall portion 20A of the pump body 20. Specifically, the intake port 40 is provided in a wall portion 20A of the inner wall of the pump body 20, which wall portion 20A is in opposition to an axial end face of the outer rotor 12, and along the radial direction of the outer rotor 12. From this intake port 40, oil is introduced into the pump chamber 30 in association with rotation of the rotor 10. As described above, the outer teeth 10A and the inner teeth 12A define therebetween the predetermined gap Q, and the oil is introduced into this gap Q with rotation of the rotor 10.

[0027] The intake port 40 is communicated to an intake passage 41 which circulates oil from the oil pan 5. And, this intake passage 41 too is formed in the pump body 20.

[0028] Like the intake port 40, the discharge port 50 too is constituted of an opening defined in the wall portion 20A of the pump body 20. Specifically, the discharge port 50 is provided in the wall portion 20A of the inner wall of the pump body 20, which wall portion is in opposition to the axial end face of the outer rotor 12, and along the radial direction of the outer rotor 12. In the instant embodiment, the discharge port 50 is provided in the wall portion 20a on the side where the intake port 40 is provided. That is, the intake port 40 and the discharge port 50 are provided in the wall portion 20A oriented in the same direction. Further, the opening constituting the discharge port 50 is spaced from the opening constituting the intake port 40 and along the radial direction of the outer rotor 12. From this discharge port 50, oil is discharged from the pump chamber 30 in association with rotation of the rotor 10. That is, from the discharge port 50, oil introduced through the intake port 40 is discharged from the predetermined gap Q formed between the outer teeth 10A and the inner teeth 12A.

[0029] A first discharge passage 60 circulates oil discharged from the discharge port 50. Here, the discharge port 50 forms a first communication hole 52 constituted of an opening hole. The first discharge passage 60 is communicated via this first communication hole 52 to the discharge port 50. And, this first discharge passage 60 is formed in the pump body 20. The oil circulated through the first discharge passage 60 is supplied to the forward traveling clutch 6 described above. More particularly, the oil is circulated to the forward traveling clutch 6 via a discharge passage 61 and a discharge passage 4B (see Fig. 1A) which are formed outside the pump body 20. And, this first discharge passage 60 has a smaller cross sectional area than the discharge port 50.

[0030] A second discharge passage 70 circulates oil discharged from the discharge port 50. Further, the discharge port 50 defines a second communication hole 54 constituted of an opening hole. The second discharge passage 70 is communicated via this second communication hole 54 to the discharge port 50. This second discharge passage 70 too is formed in the pump body 20. Oil circulated through the second discharge passage 70 is supplied as lubricant oil to the gear unit 3 described above. More specifically, the oil is circulated to the gear unit 3 via a discharge passage 71 and the discharge passage 4A (see Fig. 1A) which are provided outside the pump body 20. This second discharge passage 70 has a smaller cross sectional area than the discharge port 50.

[0031] In the instant embodiment, in the discharge port 50, the first communication hole 52 and the second communication hole 54 are provided separately. Being provided separately means that the first communication hole 52 and the second communication hole 54 are not used together. Therefore, the first discharge passage 60 and the second discharge passage 70 are branched on the downstream side of the discharge port 50. Rather, these passages 60, 70 are branched directly from the discharge port 50.

[0032] By forming the first communication hole 52 and the second communication hole 54 separately inside the pump body, it is possible to form the first discharge passage 60 and the second discharge passage 70 as shortest possible passages in correspondence with the disposing positions of the discharge passage 61 and the discharge passage 71. Therefore, the manufacture of the pump body 20 can be facilitated, so that manufacture cost can be reduced.

[0033] Further, the first discharge passage 60 and the second discharge passage 70 are formed to extend to joining faces of the pump body 20 to destinations of oil supply. Here, the "destinations of oil supply" are the forward traveling clutch 6 and the gear unit 3. And, the "joining faces" correspond to joining faces 150, 151 relative to the forward traveling clutch 6 and the gear unit 3. Therefore, the first discharge passage 60 and the second discharge passage 70 are formed to extend to the joining faces 150, 151 included in the pump body 20.

[0034] Here, as described hereinbefore, this electric oil pump 1 is used for supplying oil to the gear unit 3 and the forward traveling clutch 6 when the mechanical pump 4 is stopped. For this reason, during an operation of the mechanical pump 4, a sufficient amount of oil is supplied from the mechanical pump 4 to the gear unit 3 and the forward traveling clutch 6, so that operation of the electric oil pump 1 will be stopped. As shown in Fig. 1Aand Fig. 2, the first discharge passage 60 of the electric oil pump 1 is provided to communicate via the discharge passage 61 to the discharge passage 4C of the mechanical pump 4 and the second discharge passage 70 of the electric oil pump 1 is provided to communicate via the discharge passage 71 to the discharge passage 4A provided on the downstream side of the hydraulic circuit 8. Therefore, in order to prevent oil discharged from the mechanical pump 4 from entering the electric oil pump 1 during stop of operation of this pump 1, the first discharge passage 60 incorporates a first check valve 65 and the second discharge passage 70 incorporates a second check valve 75.

[0035] The first check valve 65 is opened/closed according to a pressure of oil discharged from the discharge port 50. The first check valve 65 includes a spring 66, a steel ball 67 and a cage 68. The cage 68 is provided as a tubular member having a groove portion or an opening extending along the axial direction and the cage 68 is disposed to surround the spring 66 and the steel ball 67. When the pressure of oil discharged from the discharge port 50 is greater than an urging force of the spring 66, a gap is formed between the steel ball 67 and a tubular member 99, which constitutes a valve-opened state of the first check valve 65. On the other hand, when the pressure of oil discharged from the discharge port 50 is smaller than the urging force of the spring 66, no gap is formed between the steel ball 67 and the tubular member 99, which constitutes a valve-closed state of the first check valve 65. With this, inflow of oil discharged from the mechanical pump 4 during stop of operation of the electric oil pump 1 can be prevented.

[0036] In the instant embodiment, the first check valve 65 incorporated in the first discharge passage 60 is fixed by a leading end portion of a fixing screw 90 which advances into the first discharge passage 60 through an opening hole 23 defined in the pump body 20. Preferably, the axis of the opening hole 23 is disposed orthogonal to at least a portion of the first discharge passage 60 (a portion of the first discharge passage 60 upstream the opening hole 23, which will be referred to "a first discharge passage upstream portion 69" hereinafter). Still preferably, the axis is disposed be orthogonal at the vicinity of the shank 91 of the fixing screw 90 advanced into the opening hole 23. Further, in the instant embodiment, the first check valve 65 is fixed by the fixing screw 90 via a tubular member 99 formed of a tubular iron member.

[0037] In the instant embodiment, the first discharge passage 60 (the first discharge passage upstream portion 69) merges with the opening hole 23 orthogonally. Also, the fixing screw 90 supports and fixes the first check valve 65 via the tubular member 99. In the opening hole 23, an outer oil passage 93 and an inner oil passage 95 are formed for allowing oil introduced into the opening hole 23 from the first discharge passage 60 (the first discharge passage upstream portion 69) to circulate toward the first check valve 65.

[0038] The outer oil passage 93 is provided in a tubular form between an outer circumferential face 91A of the shank 91 of the fixing screw 90 and an inner circumferential face 60A of the first discharge passage 60. The outer circumferential face 91A of the shank 91 of the fixing screw 90 refers to the surface of the advancing portion of the fixing screw 90 advancing into the opening hole 23. The inner circumferential face 60A of the first discharge passage 60 refers to the inner circumferential face of the first discharge passage 60 merged with the opening hole 23. The outside diameter of the shank 91 of the fixing screw 90 is formed smaller than the inside diameter of the first discharge passage 60 into which the fixing screw 90 advances. Therefore, at least a tubular gap is present between the outer circumferential face 91A and the inner circumferential face 60A. This tubular gap corresponds to the outer oil passage 93. Oil discharged from the discharge port 50 first enters this outer oil passage 93.

[0039] The inner oil passage 95 is communicated to the outer oil passage 93 via a communication portion 97 formed in the shank 91 on its radially inner side. The communication portion 97 refers to a portion which establishes communication between the inner oil passage 95 and the outer oil passage 93. In the instant embodiment, the communication portion corresponds to a through hole extending radially through the shank 91. In particular, in this embodiment, as shown in Fig. 2, there are formed communication portions 97 opposed to each other along the radial direction. And, such communication portions 97 are formed at positions axially different from each other. With this, the oil introduced into the outer oil passage 93 flows into the inner oil passage 95 and can then flow into the first check valve 65. With this, since the fixing screw 90 for fixing the first check valve 65 can be used as an oil passage, the electric oil pump 1 can be formed compact, in comparison with a case providing an oil passage separately.

[0040] The second check valve 75 is opened/closed according to a pressure of oil discharged from the discharge port 50. The second check valve 75 relating to the instant embodiment includes a spring 76, a steel ball 77, a cage 78 and a bush 79. The cage 78 is provided as a tubular member having a groove portion or an opening extending along the axial direction and the cage 78 is disposed to surround the spring 76 and the steel ball 77. The bush 79 is formed of iron. When the pressure of oil discharged from the discharge port 50 is greater than an urging force of the spring 76, a gap is formed between the steel ball 77 and the bush 79, which constitutes a valve-opened state of the second check valve 75. On the other hand, when the pressure of oil discharged from the discharge port 50 is smaller than the urging force of the spring 76, no gap is formed between the steel ball 77 and the bush 79, which constitutes a valve-closed state of the second check valve 75. With this, inflow of oil discharged from the mechanical pump 4 into the electric oil pump 1 during stop of operation of the electric oil pump 1 can be prevented.

[0041] In the instant embodiment, the second discharge passage 70 incorporates, on the downstream side of the second check valve 75, an orifice 80 for distributing an amount of oil to the first discharge passage 60 and an amount of oil to the second discharge passage 70. Here, oil circulating through the second discharge passage 70 is used as lubricant oil. Therefore, the aperture area of the orifice 80 will be set according to an amount of oil required by the gear unit 3 to which this lubricant oil is to be supplied and an oil pressure required by the forward traveling clutch 6. This arrangement eliminates need for providing the orifice 80 outside the pump body 20, so that the hydraulic system 100 having the electric oil pump 1 can be formed compact.

[0042] Further, this orifice 80 is provided in the form of a unit having a predetermined thickness T in its oil flowing direction. And, this unit will be pressed in from the outer side of the pump body 20 toward the second check valve 75. In such case, preferably, the unit will be pressed in so that e.g. a portion of the predetermined thickness T of the unit projects from the pump body 20. With this pressing-in, the projecting remaining portion (e.g. a half portion of the thickness T) can be used for positioning when the pump body 20 is assembled.

[0043] As described above, according to this disclosure, since the first discharge passage 60 and the second discharge passage 70 can be provided inside the pump body 20, the piping to the discharge passage 61 and the discharge passage 71 to which the first discharge passage 60 and the second discharge passage 70 are connected respectively can be formed compact. Therefore, it is possible to realize an electric oil pump 1 achieving space saving and weight reduction. Further, since such first discharge passage 60 and the second discharge passage 70 are provided inside the pump body 20, there will occur no interference with any devices present around the electric oil pump 1. Therefore, the degree of freedom in the disposing position of the electric oil pump 1 and the degree of freedom in the layouts of the first discharge passage 60 and the second discharge passage 70 can be improved.

[Other Embodiments]

[0044] In the foregoing embodiment, it was explained that the electric oil pump 1 is a trochoid pump. However, the application of this disclosure is not limited thereto. It is possible as a matter of course to configure the pump as any other pump than a trochoid pump, as long as such other pump too is driven to rotate by electric energy.

[0045] In the foregoing embodiment, it was explained that the first discharge passage 60 incorporates the first check valve 65 and the second discharge passage 70 incorporates the second check valve 75. However, the application of this disclosure is not limited thereto. It is possible as a matter of course to configure the first discharge passage 60 without the first check valve 65 and to configure the second discharge passage 70 without the second check valve 75. In such case, preferably, the respective check valves may be provided outside the pump body 20. Further, it is also possible as a matter of course to provide a check valve in only one of the first discharge passage 60 and the second discharge passage 70 and to provide the other check valve outside the pump body 20.

[0046] In the foregoing embodiment, it was explained that the orifice 80 is pressed into the pump body 20. However, the application of this disclosure is not limited thereto. As shown in Fig. 3 for instance, it is also possible to employ an arrangement of fastening it with a screw. In such case, preferably, in order to prevent e.g. deformation of the cage 78 formed as a resin member due to excessive fastening of the screw, the unit of the orifice 80 is provided with a flange portion 80a having a seat face which comes into contact with the pump body 20. With this, it becomes possible to prevent deformation, etc. of the cage 78.

[0047] In the foregoing embodiment, it was explained that the second discharge passage 70 has the orifice 80 on the downstream side of the second check valve 75. However, the application of the present invention is not limited thereto. It is also possible as a matter of course not to provide the orifice 80 on the downstream side of the second check valve 75.

[0048] Further, as shown in Fig. 4, it is also possible to provide the orifice 80 on the side of the bush 79. In this case too, the oil amount can be adjusted appropriately. And, if a fit-in portion 78a is formed in the cage 78 for allowing snap-fitting of the cage 78 to the pump body 20, the number of components can be restricted.

[0049] In the foregoing embodiment, it was explained that the first check valve 65 is fixed by the fixing screw 90. However, the application of this disclosure is not limited thereto. For instance, it is also possible as a matter of course to configure the first check valve 65 in a different form.

[0050] Further, it was explained that the outer oil passage 93 and the inner oil passage 95 are formed in the vicinity of the fixing screw 90. However, the application of this disclosure is not limited thereto. For instance, it is also possible to configure such that by merging the first discharge passage 60 in the vicinity of the tubular member 99, both the outer oil passage 93 and the inner oil passage 95 are omitted. Further, it is also possible to provide only one of the outer oil passage 93 and the inner oil passage 95.

[0051] Further, in the foregoing embodiment, it was explained that the axis of the opening hole 23 is set preferably orthogonal to at least a portion of the first discharge passage 60. However, the application of this disclosure is not limited thereto. It is also possible as a matter of course to provide the axis of the opening hole 23 not orthogonal relative to the first discharge passage 60.

[0052] Further, in the foregoing embodiment, it was explained that the first check valve 65 is fixed by the fixing screw 90 via the tubular member 99. However, the application of this disclosure is not limited thereto. It is also possible as a matter of course to fix the first check valve 65 by the fixing screw 90, without using the tubular member 99.

[0053] Further, in the foregoing embodiment, it was explained that the communication portion 97 is a portion which establishes communication between the inner oil passage 95 and the outer oil passage 93 and that this portion corresponds to a through hole which radially extends through the shank 91 of the fixing screw 90. However, the application of this disclosure is not limited thereto. Namely, it is also possible as a matter of course to configure the communication portion 97 not as a through hole, but as a groove portion.

[0054] Further, in the foregoing embodiment, it was explained that the communication portions 97 are formed in opposition to each other along the radial direction and at positions axially different from each other. However, the application of this disclosure is not limited thereto. The fixing screw 90 may be provided with only one communication portion 97. Further alternatively, it is also possible as a matter of course to provide the communication portions at respective positions thereof in agreement with each other along the axial direction of the fixing screw 90.

[0055] In the foregoing embodiment, it was explained that the first check valve 65 is fixed by the fixing screw 90 and the orifice 80 is provided on the downstream side of the second check valve 75. However, the application of this disclosure is not limited thereto. It is also possible as a matter of course to configure such that the orifice 80 is provided on the downstream side of the first check valve 65 and the second check valve 75 is fixed by the fixing screw 90.

[0056] This disclosure may be implemented in an electric oil pump for discharging oil. And, as the destination of oil supply, aside from the gear unit, a power steering unit, a shock absorber unit, etc. may be used as such.

[0057] The principles, preferred embodiments and mode of operation of the present invention have been described in the foregoing specification. However, the invention which is intended to be protected is not to be construed as limited to the particular embodiments disclosed. Further the embodiments described herein are to be regarded as illustrative rather than restrictive. Variations and changes may be made by others, and equivalents employed, without departing from the spirit of the present invention. Accordingly, it is expressly intended that all such variations, changes and equivalents which fall within the spirit and scope the present invention as defined in the claims, be embraced thereby.

[0058] It is explicitly stated that all features disclosed in the description and/or the claims are intended to be disclosed separately and independently from each other for the purpose of original disclosure as well as for the purpose of restricting the claimed invention independent of the composition of the features in the embodiments and/or the claims. It is explicitly stated that all value ranges or indications of groups of entities disclose every possible intermediate value or intermediate entity for the purpose of original disclosure as well as for the purpose of restricting the claimed invention, in particular as limits of value ranges.

[Reference Signs List]

[0059]

1: electric oil pump
10: rotor
13: motor
20: pump body
23: opening hole
30: pump chamber
40: intake port
50: discharge port
52: first communication hole
54: second communication hole
60: first discharge passage
60A: inner circumferential face
65: first check valve
70: second discharge passage
75: second check valve
80: orifice
91: fixing screw
91: shank
91A: outer circumferential face
93: outer oil passage
95: inner oil passage
97: communication portion

Claims

1. An electric oil pump comprising:

a rotor (10) driven to rotate by a motor (13); and
a pump body (20) having:

a pump chamber (30) accommodating the rotor (10);
an intake port (40) for introducing oil into the pump chamber (30) according to rotation of the rotor (10);
a discharge port (50) for discharging oil from the pump chamber (30) according to rotation of the rotor (10);
a first discharge passage (60) communicated to a first communication hole (52) provided in the discharge port (50) and circulating oil discharged from the discharge port (50), the first discharge passage (60) having a smaller cross sectional area than the discharge port (50); and
a second discharge passage (70) communicated to a second communication hole (54) provided in the discharge port (50) separately from the first communication hole (52) and circulating oil discharged from the discharge port (50), the second discharge passage (70) having a smaller cross sectional area than the discharge port (50).

2. The electric oil pump according to claim 1, wherein the first discharge passage (60) and the second discharge passage (70) extend to joining faces (150, 151) to the oil supplying destinations (6, 3) in the pump body (20).

3. The electric oil pump according to claim 1 or 2, wherein a first check valve (65) opened/closed according to a pressure of oil discharged from the discharge port (50) is provided in the first discharge passage (60), and a second check valve (75) opened/closed according to a pressure of oil discharged from the discharge port (50) is provided in the second discharge passage (70).

4. The electric oil pump according to claim 3, wherein the second discharge passage (70) includes, downstream the second check valve (75), an orifice (80) for distributing an amount of flow to the first discharge passage (60) and an amount of flow to the second discharge passage (70).

5. The electric oil pump according to claim 3 or 4, wherein
the first check valve (65) is fixed by a fixing screw (90) which advances through an opening hole (23) formed in the pump body (20) into the first discharge passage (60);
a tubular outer oil passage (93) is formed between an outer circumferential face (91A) of a shank (91) of the fixing screw (90) and an inner circumferential face (60A) of the first discharge passage (60); and
an inner oil passage (95) is formed on a radially inner side of the shank (91) to communicate to the outer oil passage (93) through a communication portion (97) formed in the shank (91).

Fig.1A

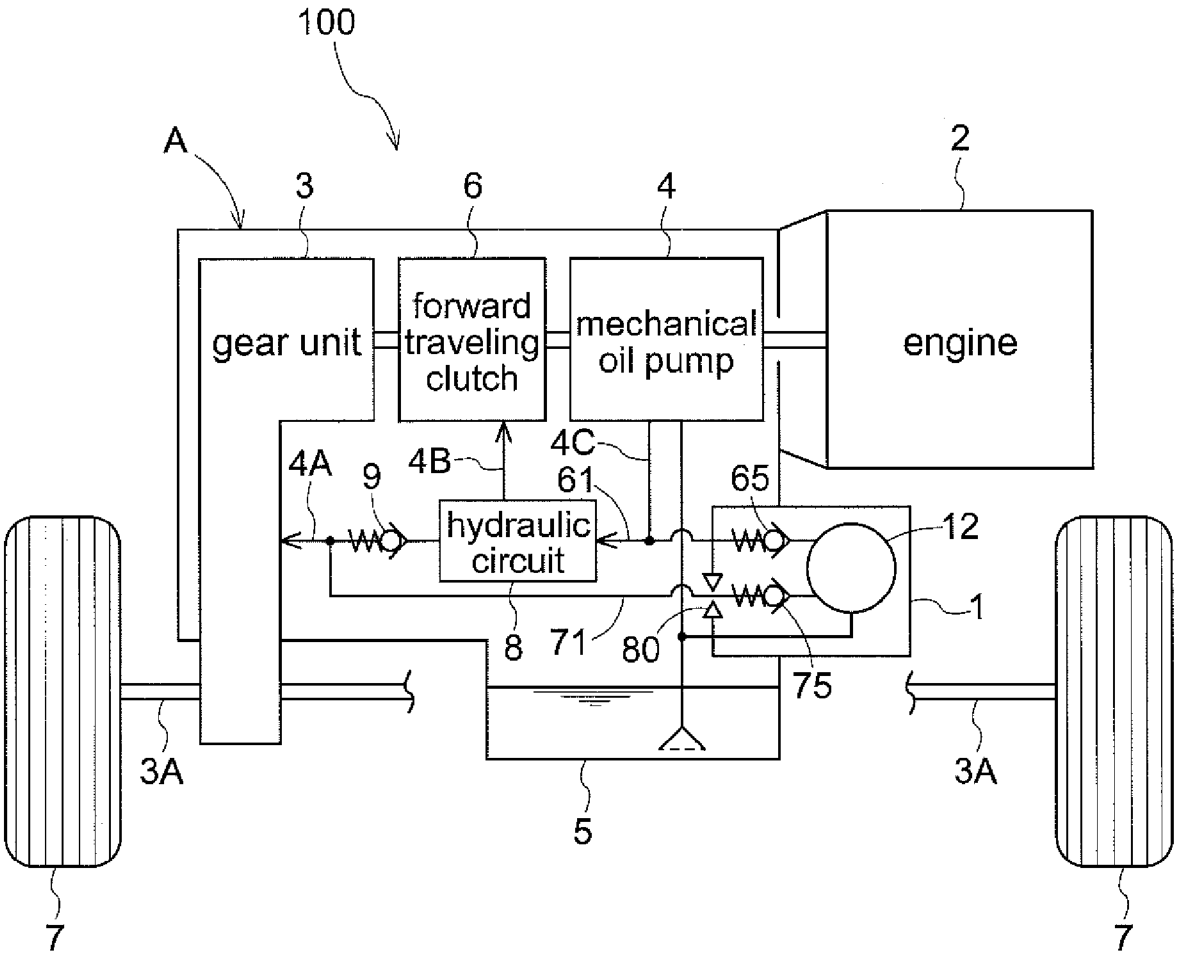

100
A
3
6
4
2
gear unit
forward traveling clutch
mechanical oil pump
engine
4A
9
4B
4C
61
65
hydraulic circuit
12
1
8
71
80
75
3A
5
3A
7
7

Fig.1B

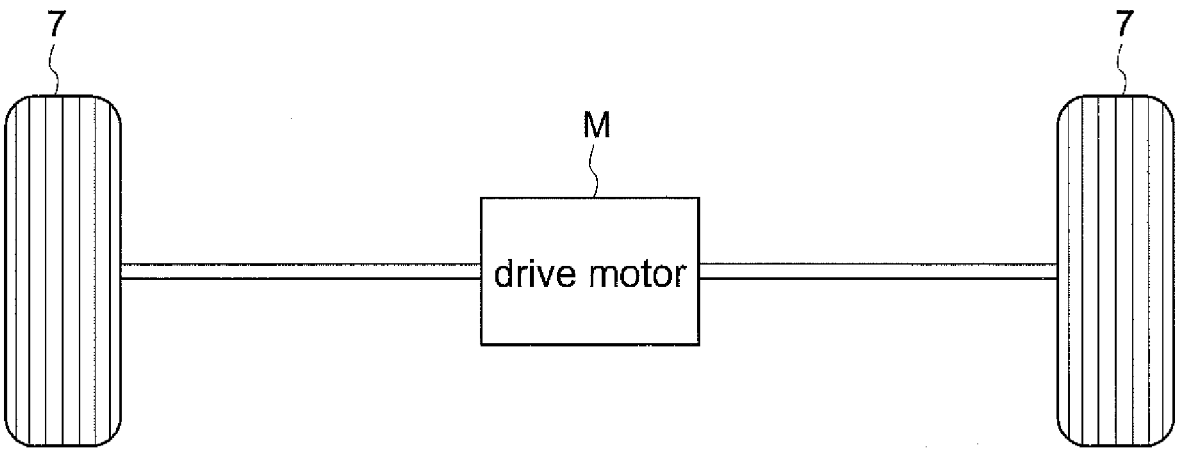

7
7
M
drive motor

Fig.2

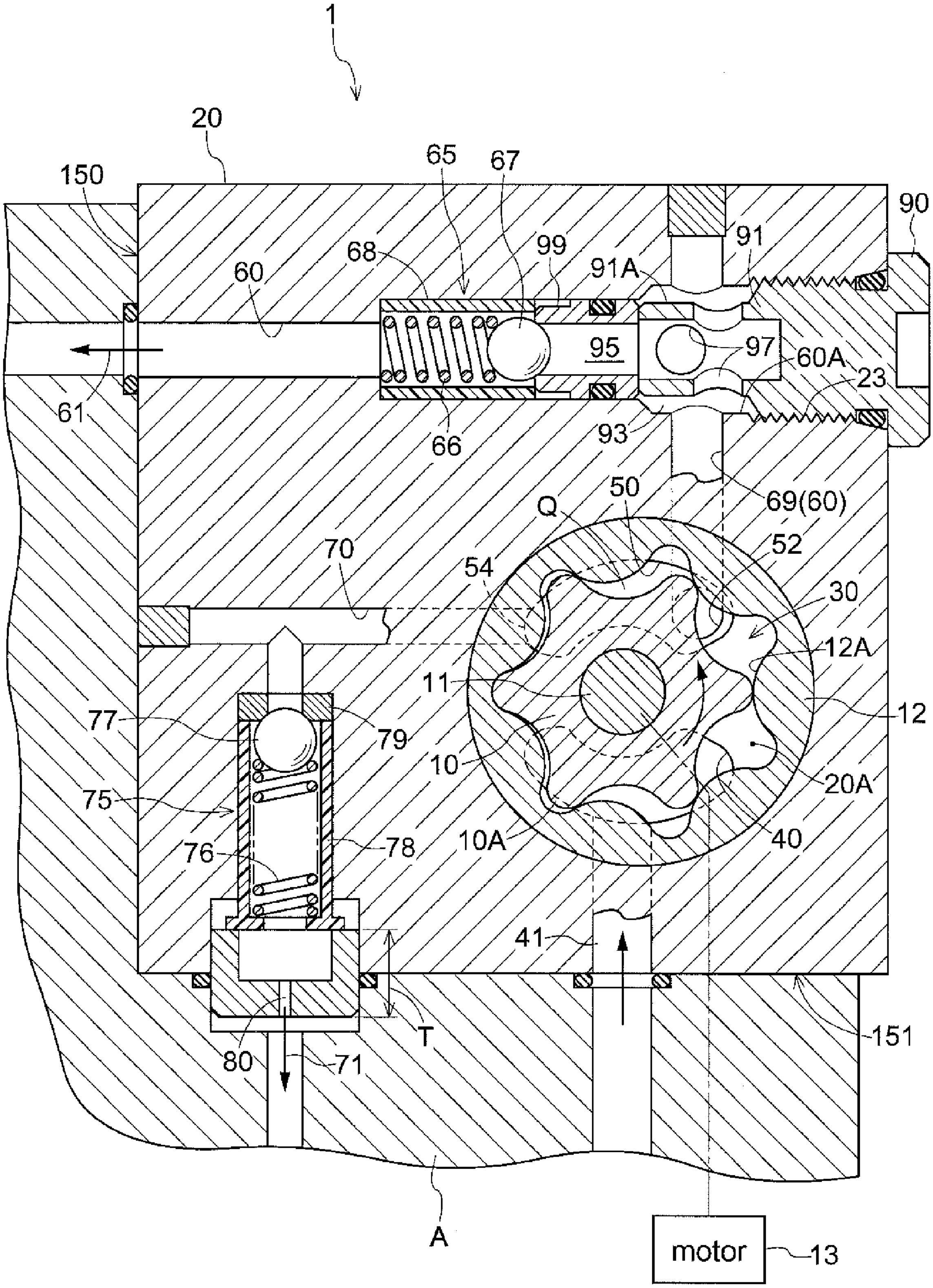

1
20
150
65
67
68
99
91A
91
90
60
95
97
60A
23
61
66
93
69(60)
Q
50
52
70
54
30
12A
11
12
77
79
10
20A
75
76
78
10A
40
41
T
80
71
151
A
motor
13

Fig.3

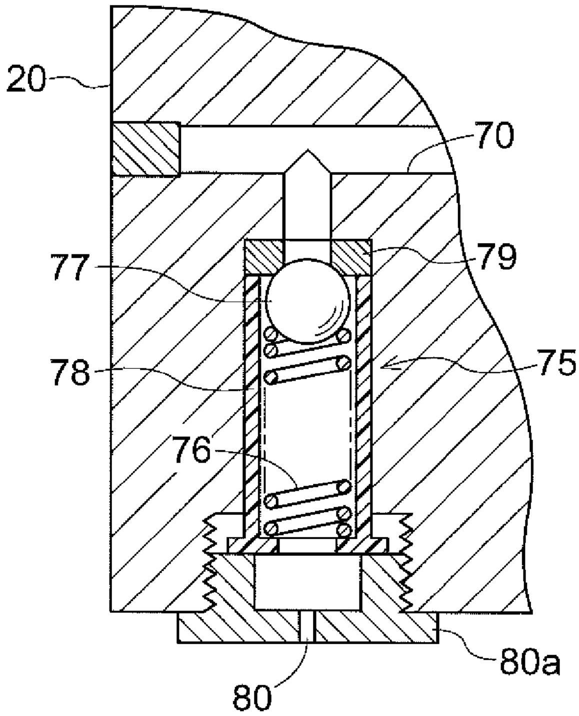
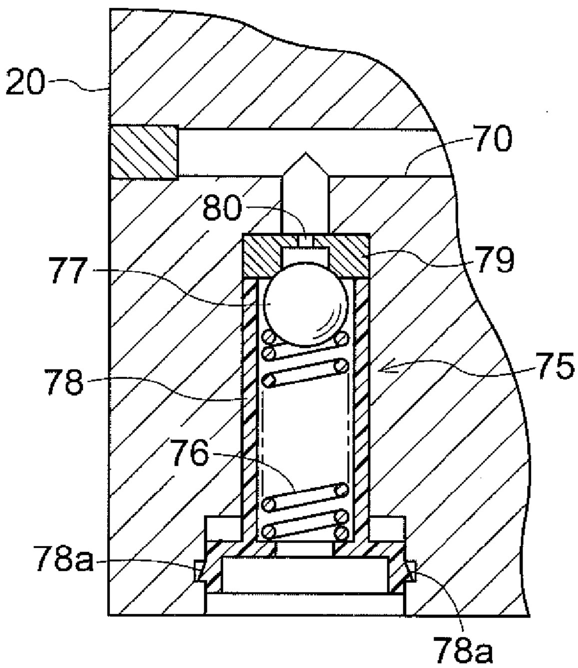


Fig.4



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Application Number
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