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(54) ENGINE AND STRADDLED VEHICLE

(57) An end surface at one end of a crankshaft faces a cover member. An axial flow path is formed inside of the crankshaft. The axial flow path has an end opening at the end surface of the crankshaft. A pin flow path is formed inside of a pin member. A cover flow path is formed inside of the cover member. Oil stored in an oil pan is led to an oil gallery. The oil from the oil gallery is led to the pin flow path. The oil from the pin flow path is led to the cover flow path. The oil from the cover flow path is led to the end opening of the crankshaft.

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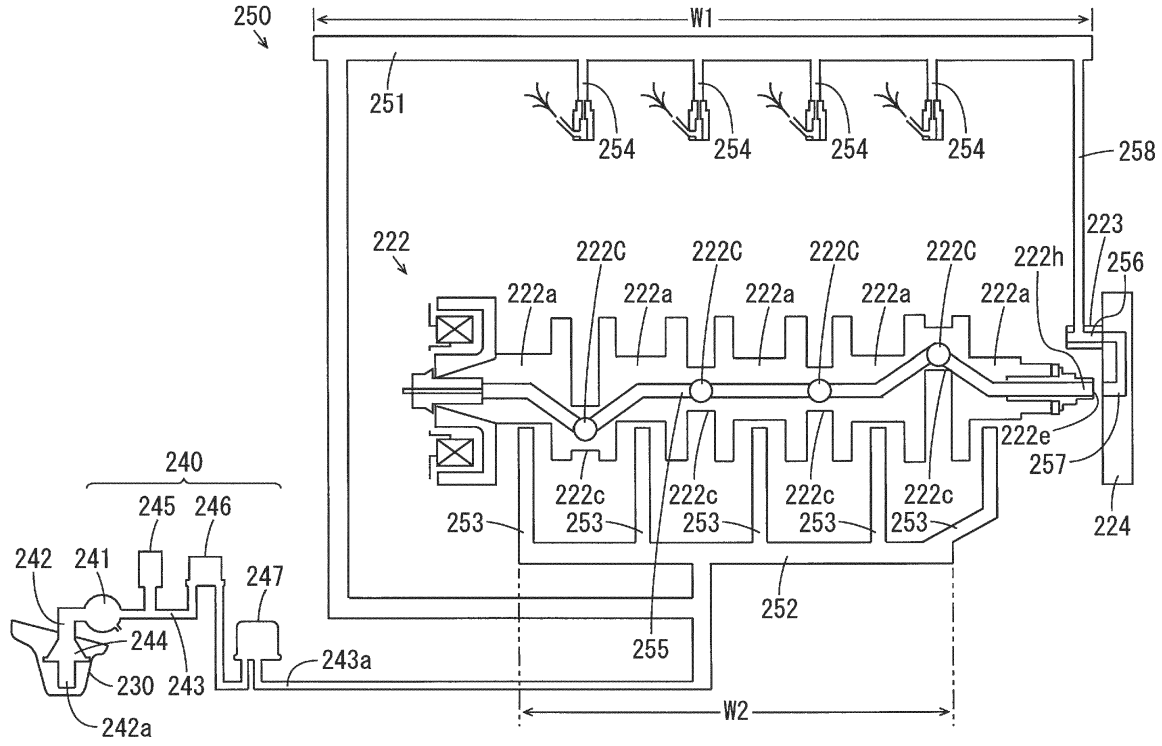

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Description

[0001] The present invention relates to an engine and a straddled vehicle.

[0002] In an engine of a vehicle such as a motorcycle, a crank journal of a crankshaft is rotatably supported at a crankcase by a bearing. Further, a crank pin of the crankshaft is coupled to a large end of a connecting rod via a bearing. Oil stored in an oil pan is supplied to the crankshaft for lubrication of these bearings (see JP 2009-204001 A, for example).

[0003] In JP 2009-204001 A, a center lubricating oil feeding crankshaft is described. In the center lubricating oil feeding crankshaft has a supply hydraulic path inside. An oil introduction hole is formed in an outer peripheral surface in the vicinity of one end of the crankshaft. The oil introduced from the oil introduction hole to the inside of the crankshaft is supplied to a crank journal and a crank pin through the supply hydraulic path. A journal distribution hydraulic path for supplying the oil from the supply hydraulic path to the bearing is formed inside of the crank journal. A pin distribution hydraulic path for supplying the oil from the supply hydraulic path to the bearing is formed in the crank pin.

[0004] When the oil is introduced from an outer peripheral surface of the crankshaft to the inside of the crankshaft as in the center lubricating oil feeding crankshaft described in JP 2009-204001 A, a centrifugal force generated by the rotation of the crankshaft is exerted on the oil introduced to the oil introduction hole of the crankshaft. Therefore, it is necessary to supply the oil at a high pressure. In contrast, when the oil is introduced from an end surface of the crankshaft to the inside of the crankshaft, it is not necessary to supply the oil at a high pressure. However, when an engine is configured to introduce the oil from the end surface of the crankshaft to the inside of the crankshaft, the number of components and the cost increase.

[0005] An object of the present invention is to provide an engine capable of supplying oil from an end surface of a crankshaft to the inside of the crankshaft without increases in number of components and cost, and a straddled-vehicle including the engine.

[0006] An engine according to one aspect of the present invention includes a crankcase having a sidewall portion at which an opening is formed, a crankshaft supported by the crankcase, an oil pan that is arranged below the crankcase and stores oil, a chain member that is coupled to one end of the crankshaft and transmits rotational force of the crankshaft to a valve mechanism, a pin member that is fixed to the crankcase and supplies tension to the chain member, a cover member attached to the sidewall portion of the crankcase to close the opening, and a first flow path through which the oil stored in the oil pan is led (an oil gallery 251 of Fig. 6, for example), wherein an end surface at the one end of the crankshaft faces the cover member, an axial flow path having an end opening at the end surface is formed inside of the crankshaft, a pin flow path through which the oil from the first flow path is led is formed inside of the pin member, and a cover flow path that leads the oil from the pin flow path to the end opening of the crankshaft is formed inside of the cover member.

[0007] In this engine, the chain member is coupled to the one end of the crankshaft supported by the crankcase, and the pin member is fixed to the crankcase. Tension is applied to the chain member by a damper held by the pin member, and the rotational force of the crankshaft is transmitted to the valve mechanism by the chain member. The cover member is attached to the sidewall portion of the crankcase to close the opening. The end surface at the one end of the crankshaft faces the cover member.

[0008] The axial flow path is formed inside of the crankshaft. The axial flow path has the end opening at the end surface of the crankshaft. The pin flow path is formed inside of the pin member. The cover flow path is formed inside of the cover member. The oil stored in the oil pan is led to the first flow path. The oil from the first flow path is led to the pin flow path. The oil from the pin flow path is led to the cover flow path. The oil from the cover flow path is led to the end opening of the crankshaft.

[0009] This configuration causes the pin flow path inside of the pin member and the cover flow path of the cover member to be used as a path for supplying the oil from the end opening at the end surface of the crankshaft to the axial flow path inside of the crankshaft. Therefore, it is not necessary to provide another component in order to supply the oil. Further, the pin flow path can be formed at the pin member, and the cover flow path can be formed at the cover member, by simple processing. As a result, it is possible to supply the oil from the end surface of the crankshaft to the inside of the crankshaft without increasing the number of components and the cost.

[0010] The crankshaft may have a crank journal and a crank pin, the engine may further include a connecting rod coupled to the crank pin, and a first bearing provided between the crank pin and the connecting rod (a bearing 226 of Fig. 6, for example), wherein the axial flow path may be formed to extend inside of the crank journal and inside of the crank pin, and the crank pin may have a first oil supply hole that supplies the oil from the axial flow path to the first bearing.

[0011] In this case, the oil from the axial flow path of the crankshaft is supplied to the first bearing through the first oil supply hole of the crank pin. Thus, the lubrication of the first bearing can be performed with a simple configuration.

[0012] The engine may further include a second bearing provided between the crank journal and the crankcase (a bearing 225 of Fig. 6, for example), a second flow path through which the oil stored in the oil pan is led (an oil gallery 252 of Fig. 6, for example), and a third flow path that supplies the oil from the second flow path to the second bearing (a bearing flow path 253 of Fig. 6, for example).

[0013] In this case, the oil stored in the oil pan is led

to the second flow path. The oil from the second flow path is supplied to the second bearing through the third flow path. The path of the oil supplied to the first bearing and the path of the oil supplied to the second bearing are different from each other. Therefore, the pressure of the oil supplied to the first bearing and the pressure of the oil supplied to the second bearing can be separately adjusted. Therefore, the lubrication of the first and second bearings can be performed by the oil having respectively suitable pressures.

[0014] The first flow path may be arranged above the crankshaft, and the second flow path may be arranged below the crankshaft.

[0015] In this case, it is not necessary for the second flow path arranged below the crankshaft to lead the oil to the cover member, so that the length of the second flow path can be shortened in a direction in which the crankshaft extends. Therefore, when the engine is provided in the straddled vehicle, a lower portion of the straddled vehicle is prevented from projecting in the left-and-right direction. Thus, the bank angle of the straddled vehicle is prevented from being limited.

[0016] The engine may further include a second bearing provided between the crank journal and the crankcase, wherein the crank journal may have a second oil supply hole that supplies the oil from the axial flow path to the second bearing.

[0017] In this case, the oil from the axial flow path of the crankshaft is supplied to the second bearing through the second oil supply hole of the crank journal. Thus, the lubrication of the second bearing can be performed with a simple configuration.

[0018] The engine may further include a piston connected to the connecting rod, and a fourth flow path that supplies the oil from the first flow path to the piston in a direction in parallel with a reciprocating direction of the piston (a piston flow path 254 of Fig. 7, for example).

[0019] In this case, the oil from the first flow path is supplied to the piston through the fourth flow path. Thus, the piston can be cooled. Further, the oil is supplied in a direction in parallel with a reciprocating direction of the piston, so that the oil can be reliably supplied to the piston when the piston reciprocates. Therefore, the cooling efficiency of the piston can be improved.

[0020] The crankcase may include a lower casing that supports the crankshaft from below and an upper casing that supports the crankshaft from above.

[0021] In this case, the crankshaft is supported by the lower casing and the crankshaft in the top-and-bottom direction. Therefore, the first flow path can be easily assembled into the crankcase together with the crankshaft.

[0022] A straddled vehicle according to another aspect of the present invention includes a vehicle main body, the above-mentioned engine provided in the vehicle main body, and a drive wheel rotated by a torque generated by the engine.

[0023] In this straddled vehicle, the engine according to one aspect of the present invention is provided in the vehicle main body. The drive wheel is rotated by the torque generated by the engine.

[0024] In the engine, the chain member is coupled to the one end of the crankshaft supported by the crankcase, and the pin member is fixed to the crankcase. The rotational force of the crankshaft is transmitted to the valve mechanism by the chain member. The cover member is attached to the sidewall portion of the crankcase to close the opening. The end surface at the one end of the crankshaft faces the cover member.

[0025] The axial flow path is formed inside of the crankshaft. The axial flow path has the end opening at the end surface of the crankshaft. The pin flow path is formed inside of the pin member. The cover flow path is formed inside of the cover member. The oil stored in the oil pan is led to the first flow path. The oil from the first flow path is led to the pin flow path. The oil from the pin flow path is led to the end opening of the crankshaft.

[0026] This configuration causes the pin flow path inside of the pin member and the cover flow path of the cover member to be used as the path for supplying the oil from the end opening at the end surface of the crankshaft to the axial flow path inside of the crankshaft. Therefore, it is not necessary to provide another component in order to supply the oil. Further, the pin flow path can be formed at the pin member, and the cover flow path can be formed at the cover member, by simple processing. As a result, it is possible to supply the oil to the inside of the crankshaft from the end surface of the crankshaft without increasing the number of members and the cost.

Fig. 1 is a side view of one side of a motorcycle according to one embodiment of the present invention;
Fig. 2 is a left side view of an engine;
Fig. 3 is a perspective view of a crankcase as viewed from the right front;
Fig. 4 is a perspective view of the crankcase as viewed from the right behind;
Fig. 5 is a right side view of the crankcase;
Fig. 6 is a schematic cross sectional view showing a configuration of a crankshaft and its periphery;
Fig. 7 is a schematic diagram showing part of an oil supply flow path; and
Fig. 8 is a schematic cross sectional view showing the configuration of the crankshaft and its periphery in another embodiment.

[0027] A straddled vehicle according to one embodiment of the present invention will be described below with reference to drawings. In the following description, a motorcycle will be described as one example of the straddled vehicle.

[0028] Fig. 1 is a side view of one side of the motorcycle according to one embodiment of the present invention. In Fig. 1, the motorcycle 100 standing up to be perpendicular to the road surface is shown. In Figs. 1, a front-and-rear direction L, a top-and-bottom direction H and a left-and-right direction W of the motorcycle 100 are indi-

cated by arrows. In the following description, a direction in which the arrow is directed in the front-and-rear direction L is referred to as forward, and its opposite direction is referred to as rearward. Further, a direction in which the arrow is directed in the top-and-bottom direction H is referred to as upward, and its opposite direction is referred to as downward. Further, a direction in which the arrow is directed in the left-and-right direction W is referred to as leftward, and its opposite direction is referred to as rightward.

[0029] As shown in Fig. 1, the motorcycle 100 includes a vehicle body frame 10. The vehicle body frame 10 includes a pair of main frames 11, a rear frame 12 and a head pipe 13. The pair of main frames 11 obliquely extends rearward and downward from the head pipe 13. The rear ends of the pair of main frames 11 are curved downward. The rear frame 12 extends rearward from upper portions at the rear ends of the pair of main frames 11.

[0030] A front fork device 20 is attached to the head pipe 13 to be rotatable in the left-and-right direction. The front fork device 20 includes a steering shaft (a stem shaft) 21, a pair of fork pipes 22, a handle member 23 and a front wheel 24.

[0031] The steering shaft 21 is inserted into the head pipe 13 to extend downward and forward. The pair of fork pipes 22 is arranged at the left and the right of the steering shaft 21, respectively. The pair of fork pipes 22 is connected to the steering shaft 21 by a plurality of connection members (an under bracket and an upper bracket that are not shown).

[0032] The front wheel 24 is rotatably supported between lower portions of the pair of fork pipes 22. A handle member 23 includes a pair of handles. The handle member 23 is connected to the pair of fork pipes 22. The front fork device 20 is rotated with respect to the head pipe 13 when the handle member 23 is operated.

[0033] A cowl 1 is provided to cover the head pipe 13 from the front and to cover the pair of fork pipes 22 from both sides. The cowl 1 is attached to the pair of main frames 11.

[0034] A multi-cylinder engine 200 is provided below the pair of main frames 11. The engine 200 includes a cylinder unit 210, a crank unit 220 and an oil pan 230. The crank unit 220 is located below the cylinder unit 210, and the oil pan 230 is located below the crank unit 220. The cylinder unit 210 is supported by the pair of main frames 11.

[0035] An exhaust device 30 that leads an exhaust gas to the outside is connected to the cylinder unit 210. The exhaust device 30 includes a plurality of exhaust pipes 31 and a muffler (a silencer) 32. The exhaust pipes 31 are provided to pass the side of the oil pan 230 from the cylinder unit 210 to extend rearward.

[0036] The rear ends of the exhaust pipes 31 are connected to the muffler 32. The muffler 32 is provided to extend to the side of a rear wheel 5, described below. A three-way catalyst is provided in the muffler 32. An exhaust gas generated by the combustion of the fuel-air mixture in the cylinder unit 210 is sent to the muffler 32 through the exhaust pipes 31 to be exhausted into the atmosphere through the muffler 32.

[0037] A fuel tank 2 is supported by the pair of main frames 11 above the engine 200. A seat 3 is supported by the rear frame 12 behind the fuel tank 2. A swing arm 4 is provided to extend rearward from the lower end of the main frame 11. The rear wheel 5 is rotatably held at the rear end of the swing arm 4. The rear wheel 5 is rotated by the rotational force of the engine 200.

[0038] Fig. 2 is a left side view of the engine 200. As described above, the engine 200 includes the cylinder unit 210, the crank unit 220 and the oil pan 230. As shown in Fig. 2, a plurality of connecting rods 201 are provided inside of the cylinder unit 210 and the crank unit 220.

[0039] The cylinder unit 210 includes a cylinder head 211 and a cylinder body 212. Outer walls of the cylinder head 211 and the cylinder body 212 are referred to as a cylinder casing 210C.

[0040] In the cylinder head 211, a combustion chamber V is formed. Further, an ignition device 213, a plurality of intake valves 214, a plurality of exhaust valves 215, a valve mechanism 216 and the like are stored in the cylinder head 211. Further, a plurality of exhaust ports 217 and a plurality of intake ports (not shown) are formed in the cylinder head 211.

[0041] The ignition device 213 ignites a fuel-air mixture filled in the combustion chamber V. The plurality of intake valves 214 are provided to be capable of respectively opening and closing a plurality of intake holes of the combustion chamber V. The plurality of exhaust valves 215 are provided to be capable of respectively opening and closing the plurality of exhaust holes of the combustion chamber V. The valve mechanism 216 includes an intake cam, an exhaust cam and a camshaft. The plurality of intake valves 214 and the plurality of exhaust valves 215 are opened and closed by the valve mechanism 216.

[0042] A plurality of pistons 218 are respectively stored insides of a plurality of cylinders of the cylinder body 212. Small ends 201 b of the plurality of connecting rods 201 are respectively coupled to pins of the plurality of pistons 218. A plurality of bearings (not shown) are respectively attached between the plurality of pistons 218 and the small ends 201 b of the plurality of connecting rods 201.

[0043] The crank unit 220 includes a crankcase 221, a crankshaft 222, a starter motor (not shown), a generator (not shown), a transmission (not shown) and the like. The crankcase 221 is arranged below the cylinder casing 210C. The crankcase 221 in the present embodiment is an upper-lower divided type crankcase. The crankcase 221 is constituted by a lower casing 221 a and an upper casing 221b. The crankcase 221 stores the crankshaft 222, the starter motor, the generator, the transmission and the like.

[0044] The oil pan 230 is arranged below the crankcase 221. Oil is stored in the oil pan 230. An oil pump unit 240 is arranged in the crankcase 221. An oil suction port 242a of the oil pump unit 240 is located near a bottom

portion of the oil pan 230.

[0045] The oil pump unit 240 sucks the oil stored in the oil pan 230 by the oil suction port 242a and supplies the oil to various constituent members (a plurality of bearings 225, 226 of Fig. 6, described below, for example) from an oil discharge port. Thus, lubrication, cooling, corrosion inhibiting and the like for the various constituent members are performed. The oil supplied to the various constituent members is returned to the oil pan 230. Details of an oil supply flow path will be described below.

[0046] Fig. 3 is a perspective view of the crankcase 221 as viewed from the right front. Fig. 4 is a perspective view of the crankcase 221 as viewed from the right behind. Fig. 5 is a right side view of the crankcase 221. In Figs. 3 to 5, the front-and-rear direction L, the top-and-bottom direction H and the left-and-right direction W are shown with the crankcase 221 being provided in the motorcycle 100.

[0047] As shown in Figs. 3 to 5, an opening 221C is formed at a right sidewall portion 221R of the crankcase 221. A peripheral wall portion 221c and a bottom portion 221d are formed inward of the opening 221C. An opening 221D having a diameter smaller than the opening 221C is formed at the bottom portion 221d of the opening 221C. The openings 221C, 221D are located at the right sidewall portion 221R in the vicinity of a boundary between the lower casing 221 a and the upper casing 221b.

[0048] As shown in Figs. 3 and 5, an insertion hole 221 E reaching the inward of the opening 221C is formed in a right upper portion of the upper casing 221 b. As indicated by a one-dot and dash line in Fig. 3, a lower portion of a chain member 202 is inserted into the insertion hole 221 E. In this case, as shown in Fig. 5, the lower portion of the chain member 202 is located inward of the opening 221C of the crankcase 221. The lower portion of the chain member 202 is coupled to one end of the crankshaft 222 of Fig. 2. An upper portion of the chain member 202 is coupled to the valve mechanism 216.

[0049] As shown in Fig. 3, a pin attachment portion 221 F is formed in the bottom portion 221d of the opening 221C. A pin member 223 is attached to the pin attachment portion 221F. In the present embodiment, the pin member 223 is a hollow pin. The pin member 223 holds a damper for applying tension to the chain member 202. The crankshaft 222 is rotated, so that the rotational force is transmitted to the valve mechanism 216 by the chain member 202.

[0050] A cover member 224 is attached to the right sidewall portion 221R of the crankcase 221 to close the opening 221C. An end surface 222e at one end of the crankshaft 222 (see Fig. 6, described below) faces the cover member 224.

[0051] Fig. 6 is a schematic cross sectional view showing a configuration of the crankshaft 222 and its periphery. As shown in Fig. 6, the crankshaft 222 is constituted by a plurality of crank journals 222a, a plurality of crank webs 222b and a plurality of crank pins 222c. The plurality of crank journals 222a are supported by the lower casing 221a and the upper casing 221 b of Fig. 2. The plurality of bearings 225 are respectively attached between the plurality of crank journals 222a, and each of the lower casing 221 a and the upper casing 221 b.

[0052] Each crank web 222b includes a crank arm and a balance weight. The plurality of crank webs 222b are connected to the plurality of crank journals 222a. The plurality of crank pins 222c are attached between the adjacent crank webs 222b. Large ends 201 a of the plurality of connecting rods 201 are respectively coupled to the plurality of crank pins 222c. The plurality of bearings 226 are respectively attached between the plurality of crank pins 222c and the large ends 201 a of the plurality of connecting rods 201.

[0053] Reciprocating motion of the plurality of pistons 218 is converted into rotational motion by the crankshaft 222. As described above, the rotational motion of the crankshaft 222 is transmitted to the valve mechanism 216 of Fig. 5 via the chain member 202. Further, the rotational motion of the crankshaft 222 is transmitted to the rear wheel 5 of Fig. 1 via the transmission (not shown).

[0054] In the engine 200, the oil supply flow path for supplying the oil stored in the oil pan 230 (see Fig. 2) to the various constituent members is provided. Fig. 7 is a schematic diagram showing part of the oil supply flow path. In Fig. 7, the oil pan 230 and the oil pump unit 240 are shown together with part of the oil supply flow path 250.

[0055] As shown in Fig. 7, the oil pump unit 240 includes a pump main body 241, an upstream pipe 242, a downstream pipe 243, a strainer 244, a relief valve 245, an oil cooler 246 and an oil cleaner 247. The pump main body 241 is arranged in the crankcase 221 of Fig. 2. A downstream end of the upstream pipe 242 is connected to an oil flow-in port of the pump main body 241, and an upstream end of the downstream pipe 243 is connected to an oil flow-out port of the pump main body 241.

[0056] The oil suction port 242a is formed at an upstream end of the upstream pipe 242, and an oil discharge port 243a is formed at a downstream end of the downstream pipe 243. As described above, the oil suction port 242a is arranged near the bottom portion of the oil pan 230. The pump main body 241 sucks the oil stored in the oil pan 230 by the oil suction port 242a of the upstream pipe 242 and discharges the oil from the oil discharge port 243a of the downstream pipe 243 to the oil supply flow path 250.

[0057] The strainer 244 is inserted into the upstream pipe 242 in the oil pan 230. The strainer 244 removes relatively large impurities from the oil sucked by the oil suction port 242a.

[0058] The relief valve 245, the oil cooler 246 and the oil cleaner 247 are inserted into the downstream pipe 243. The oil cooler 246 cools the oil in the downstream pipe 243. The oil cooler 246 may be realized by an air-cooling type or may be realized by a system using a cooling medium such as a water-cooling type. The oil cleaner 247 removes relatively small impurities from the oil in the

downstream pipe 243.

[0059] The oil supply flow path 250 includes two oil galleries 251, 252, a plurality of bearing flow paths 253, a plurality of piston flow paths 254, an axial flow path 255, a pin flow path 256, a cover flow path 257 and a coupling flow path 258. The oil supply flow path 250 will be described below with reference to Figs. 3 to 7. In Fig. 4, the oil galleries 251, 252, the axial flow path 255, the pin flow path 256 and the cover flow path 257 are indicated by dotted lines, and the plurality of bearing flow paths 253 and the plurality of piston flow paths 254 are not shown.

[0060] As shown in Figs. 4, 6 and 7, the oil gallery 251 is provided in the upper casing 221 b to extend in parallel with the crankshaft 222. The oil discharged from the oil discharge port 243a of the oil pump unit 240 of Fig. 7 is led to the oil gallery 251.

[0061] As shown in Figs. 4, 6 and 7, the pin flow path 256 is formed inside of the pin member 223. The one end of the oil gallery 251 and the pin flow path 256 are coupled to each other by the coupling flow path 258. The oil in the oil gallery 251 is led to the pin flow path 256 through the coupling flow path 258.

[0062] The cover flow path 257 is formed inside of the cover member 224. The pin flow path 256 in the pin member 223 and the cover flow path 257 in the cover member 224 communicate with each other. The oil from the pin flow path 256 is led to the cover flow path 257.

[0063] As shown in Figs. 6 and 7, the axial flow path 255 is formed to pass through the insides of the crank journals 222a, the insides of the crank webs 222b and the insides of the crank pins 222c of the crankshaft 222. The axial flow path 255 has an end opening 222h at the end surface 222e at the one end of the crankshaft 222. As shown in Figs. 4 and 5, the opening 221 D of the right sidewall portion 221 R of the crankcase 221 overlaps with the end opening 222h of the axial flow path 255.

[0064] The cover flow path 257 in the cover member 224 and the axial flow path 255 in the crankshaft 222 communicate with each other. The oil from the cover flow path 257 is led to the axial flow path 255 through the end opening 222h of the end surface 222e of the crankshaft 222.

[0065] As shown in Fig. 6, an oil supply hole 222C that supplies the oil from the axial flow path 255 to the corresponding bearing 226 is formed in each crank pin 222c. The oil from the axial flow path 255 of the crankshaft 222 is supplied to the corresponding bearing 226 through the oil supply hole 222C of each crank pin 222c. Thus, lubrication of the bearing 226 is performed.

[0066] As shown in Fig. 7, the plurality of piston flow paths 254 are connected to the oil gallery 251. The plurality of piston flow paths 254 are provided to respectively correspond to the plurality of pistons 218. Each piston flow path 254 supplies the oil from the oil gallery 251 to the corresponding piston 218. In this case, the oil is supplied in a direction in parallel with a reciprocating direction of the piston 218. Thus, each piston 218 is cooled. Further, the oil is reliably supplied to each piston 218 when each piston 218 reciprocates. Therefore, cooling efficiency of each piston 218 can be improved.

[0067] As shown in Figs. 4, 6 and 7, the oil gallery 252 is provided in the lower casing 221a to extend in parallel with the crankshaft 222. The oil discharged from the oil discharge port 243a of the oil pump unit 240 of Fig. 7 is led to the oil gallery 252.

[0068] As shown in Figs. 6 and 7, a plurality of bearing flow paths 253 are connected to the oil gallery 252. The plurality of bearing flow paths 253 are provided to respectively correspond to the plurality of bearings 225. Each bearing flow path 253 supplies the oil from the oil gallery 252 to the corresponding bearing 225. Thus, the lubrication of the bearing 225 is performed.

[0069] It is not necessary for the oil gallery 252 to lead the oil to the cover member 224. Thus, as shown in Fig. 7, in a direction in which the crankshaft 222 extends, a length W2 of the oil gallery 252 can be shorter than a length W1 of the oil gallery 251. The oil gallery 251 is arranged above the crankshaft 222, and the oil gallery 252 is arranged below the crankshaft 222.

[0070] This arrangement causes the width of a lower portion of the lower casing 221 a of the crankcase 221 to be smaller than the width of the upper casing 221b in the left-and-right direction of the motorcycle 100. Thus, a lower portion of the motorcycle 100 is prevented from projecting in the left-and-right direction. As a result, the bank angle of the motorcycle 100 is prevented from being limited.

[0071] In the present embodiment, the oil stored in the oil pan 230 is led to the end opening 222h of the crankshaft 222 through the oil gallery 251, the pin flow path 256 and the cover flow path 257. In this case, as the path for supplying the oil to the axial flow path 255 inside of the crankshaft 222 from the end opening 222h of the end surface 222e of the crankshaft 222, the pin flow path 256 inside of the pin member 223 and the cover flow path 257 inside of the cover member 224 are used. Therefore, it is not necessary to provide another component in order to supply the oil. Further, the pin flow path 256 can be formed at the pin member 223, and the cover flow path 257 can be formed at the cover member 224, by simple processing. As a result, it is possible to supply the oil from the end surface 222e of the crankshaft 222 to the inside of the crankshaft 222 without increasing the number of components and the cost.

[0072] Further, the oil from the axial flow path 255 of the crankshaft 222 is supplied to the corresponding bearing 226 through the oil supply hole 222C of each crank pin 222. Further, the oil from the oil gallery 252 is supplied to the corresponding bearing 225 through each bearing flow path 253. In this manner, the path of the oil supplied to each bearing 226 and the path of the oil supplied to each bearing 225 are different from each other. Therefore, the pressure of the oil supplied to each bearing 226 and the pressure of the oil supplied to each bearing 225 can be separately adjusted. Therefore, the lubrication of

each bearing 225, 226 can be performed by the oil having respectively suitable pressures.

[0073] Further, the crankcase 221 is the upper-lower divided type crankcase, and the crankshaft 222 is supported in the top-and-bottom direction by the lower casing 221 a and the upper casing 221 b. Therefore, the oil gallery 251 can be easily assembled into the crankcase 221 together with the crankshaft 222. Further, the crankshaft 222 used in the multi-cylinder engine 200 can be easily stored.

[0074] Fig. 8 is a schematic cross sectional view showing the configuration of the crankshaft 222 and its periphery in another embodiment. As shown in Fig. 8, an oil supply hole 222A is formed in each crank journal 222a in the other embodiment. The oil from the axial flow path 255 of the crankshaft 222 is supplied to the corresponding bearing 225 through the oil supply hole 222A of each crank journal 222a. Thus, the lubrication of the bearing 225 is performed. In this configuration, the plurality of oil supply holes 222A are used and the plurality of bearing flow paths 253 are not used in order to supply the oil to the plurality of bearings 225. Therefore, the plurality of bearing flow paths 253 are not provided in the oil supply flow path 250.

[0075] While the engine 200 according to the above-mentioned embodiment is a multi-cylinder engine, the engine according to the present invention is not limited to this. The engine 200 may be a single-cylinder engine.

[0076] While the above-mentioned embodiment is an example in which the present invention is applied to the motorcycle, the invention is not limited to this. The present invention may be applied to another straddled vehicle such as a tricycle, an ATV (All Terrain Vehicle) or the like.

[0077] Correspondences between Constituent Elements in Claims and Parts in Preferred Embodiments

[0078] In the following paragraphs, non-limiting examples of correspondences between various elements recited in the claims below and those described above with respect to various preferred embodiments of the present invention are explained.

[0079] In the above-mentioned embodiment, the opening 221C is an example of an opening, a right sidewall portion 221 R is an example of a sidewall portion, the crankcase 221 is an example of a crankcase, the crankshaft 222 is an example of a crankshaft, the oil pan 230 is an example of an oil pan, the valve mechanism 216 is an example of a valve mechanism, the chain member 202 is an example of a chain member, the pin member 223 is an example of a pin member, and the cover member 224 is an example of a cover member.

[0080] The oil galleries 251, 252 are respectively examples of first and second flow paths, the end surface 222e is an example of an end surface, the end opening 222h is an example of an end opening, the axial flow path 255 is an example of an axial flow path, the pin flow path 256 is an example of a pin flow path, the cover flow path 257 is an example of a cover flow path, the engine 200 is an example of an engine, the crank journal 222a is an example of a crank journal, and the crank pin 222c is an example of a crank pin.

[0081] The connecting rod 201 is an example of a connecting rod, the bearings 226, 225 are respectively examples of first and second bearings, the oil supply holes 222C, 222A are respectively examples of first and second oil supply holes, the bearing flow path 253 is an example of a third flow path, the piston 218 is an example of a piston, the piston flow path 254 is an example of a fourth flow path, the lower casing 221a is an example of a lower casing, the upper casing 221 b is an example of an upper casing, the vehicle body frame 10 is an example of a vehicle main body, the rear wheel 5 is an example of a drive wheel, and the motorcycle 100 is an example of a straddled vehicle.

[0082] As each of constituent elements recited in the claims, various other elements having configurations or functions described in the claims can be also used.

[0083] The present invention can be effectively utilized for straddled vehicles including engines.

Claims

1. An engine (200) comprising:

a crankcase (221) having a sidewall portion (221R) at which an opening (221C) is formed;
a crankshaft (222) supported by the crankcase (221);
an oil pan (230) that is arranged below the crankcase (221) and stores oil;
a chain member (202) that is coupled to one end of the crankshaft (222) and transmits rotational force of the crankshaft (222) to a valve mechanism (216);
a pin member (223) that is fixed to the crankcase (221) and supplies tension to the chain member (202);
a cover member (224) attached to the sidewall portion (221 R) of the crankcase to close the opening (221 C); and
a first flow path (251) through which the oil stored in the oil pan (230) is led, wherein
an end surface (222e) at the one end of the crankshaft (222) faces the cover member (224),
an axial flow path (255) having an end opening (222h) at the end surface (222e) is formed inside of the crankshaft (222),
a pin flow path (256) through which the oil from the first flow path (251) is led is formed inside of the pin member (223), and
a cover flow path (257) that leads the oil from the pin flow path (256) to the end opening (222h) of the crankshaft (222) is formed inside of the cover member (224).

2. The engine (200) according to claim 1, wherein
the crankshaft (222) has a crank journal (222a) and a crank pin (222c),
the engine (200) further comprising:

a connecting rod (201) coupled to the crank pin (222c); and
a first bearing (226) provided between the crank pin (222c) and the connecting rod (201), wherein the axial flow path (255) is formed to extend inside of the crank journal (222a) and inside of the crank pin (222c), and
the crank pin (222c) has a first oil supply hole (222C) that supplies the oil from the axial flow path (255) to the first bearing (226).

3. The engine (200) according to claim 2, further comprising:

a second bearing (225) provided between the crank journal (222a) and the crankcase (221);
a second flow (252) path through which the oil stored in the oil pan is led; and
a third flow path (253) that supplies the oil from the second flow path (252) to the second bearing (225).

4. The engine (200) according to claim 3, wherein
the first flow path (251) is arranged above the crankshaft (222), and
the second flow path (252) is arranged below the crankshaft (222).

5. The engine (200) according to claim 2, further comprising a second bearing (225) provided between the crank journal (222a) and the crankcase (221), wherein
the crank journal (222a) has a second oil supply hole (222A) that supplies the oil from the axial flow path (255) to the second bearing (225).

6. The engine (200) according to any one of claims 2 to 5, further comprising:

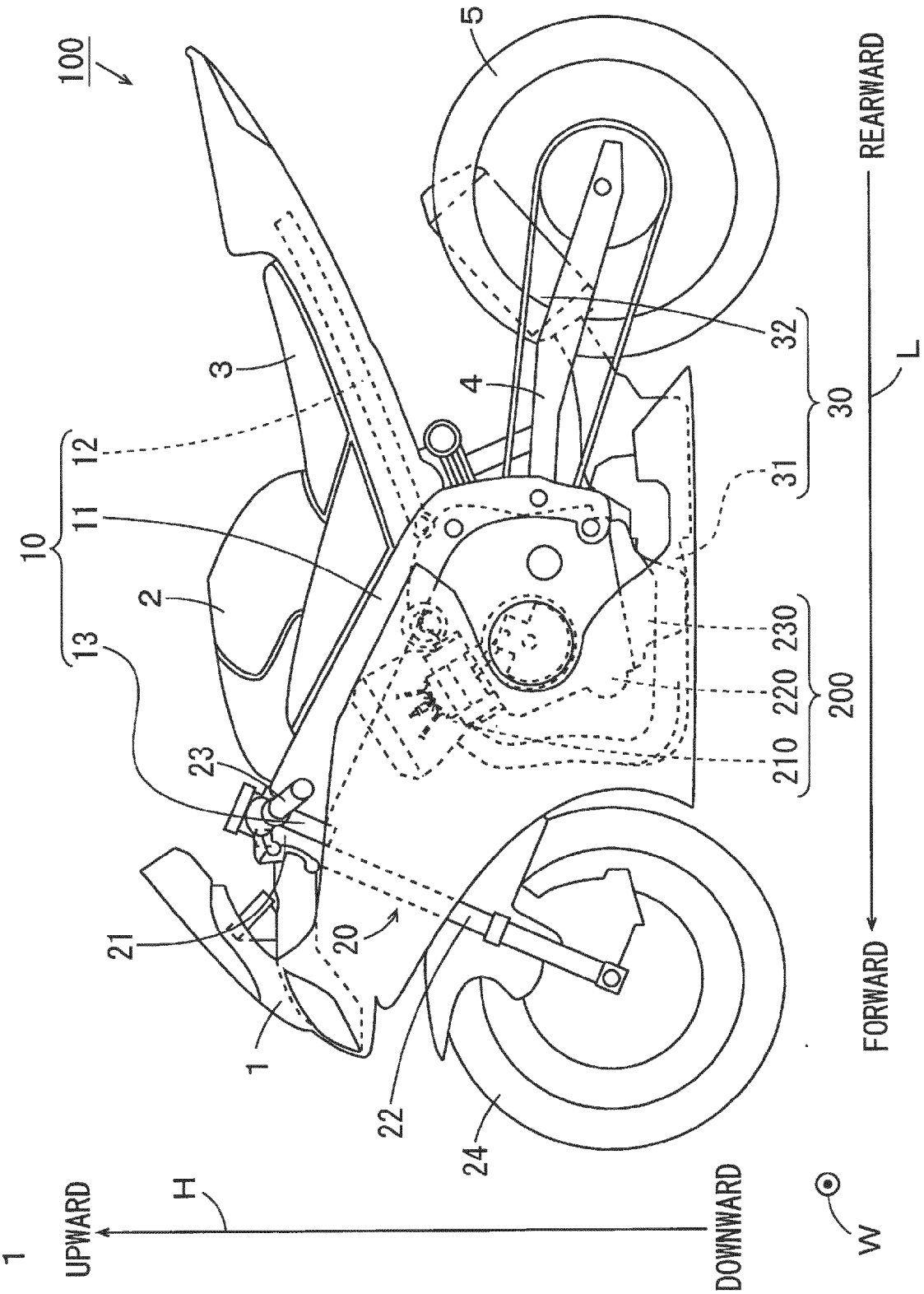
a piston (218) connected to the connecting rod (201); and
a fourth flow path (254) that supplies the oil from the first flow path (251) to the piston (218) in a direction in parallel with a reciprocating direction of the piston (218).

7. The engine (200) according to any one of claims 1 to 6, wherein
the crankcase (221) includes a lower casing (221 a) that supports the crankshaft (222) from below and an upper casing (221b) that supports the crankshaft (222) from above.

8. A straddled vehicle (100) comprising:

a vehicle main body (10);
the engine (200) according to any one of claims 1 to 7 provided in the vehicle main body (10); and
a drive wheel (5) rotated by a torque generated by the engine.

FIG. 1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3
4
32
30
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REARWARD
10
12
11
2
31
13
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220
200
210
23
21
20
1
22
24
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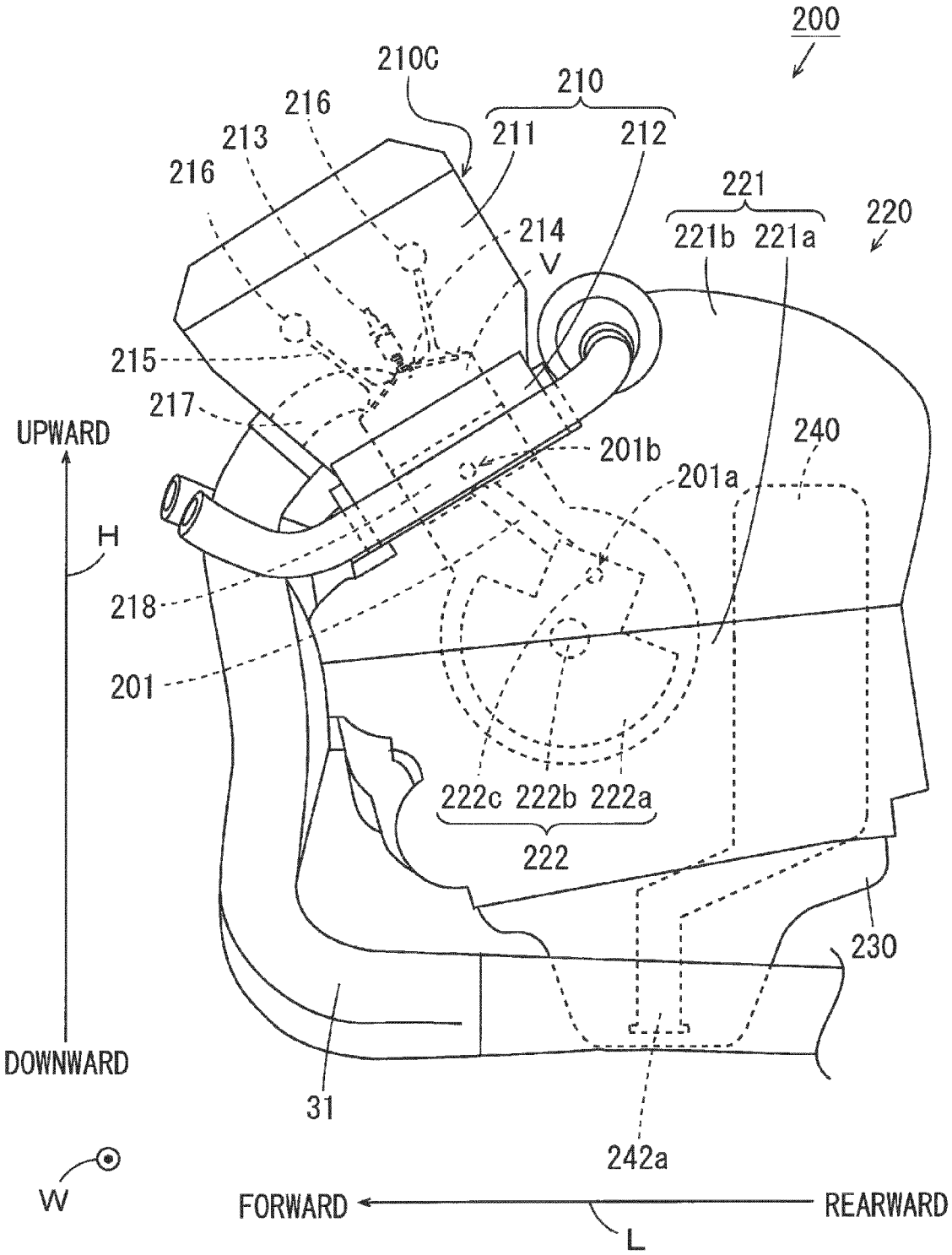
UPWARD
H
DOWNWARD
W

FIG. 2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V
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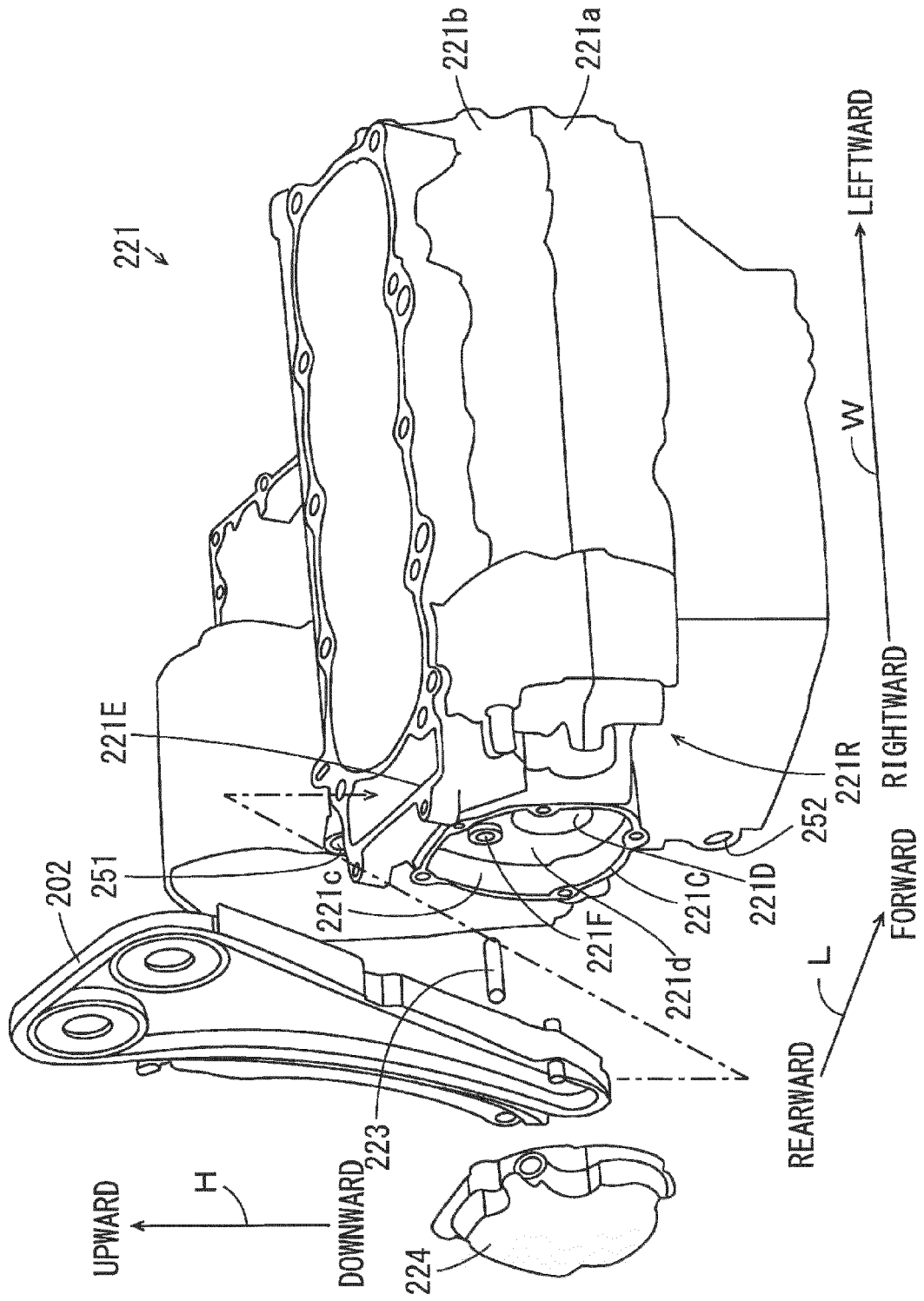
242a
W
FORWARD
REARWARD
L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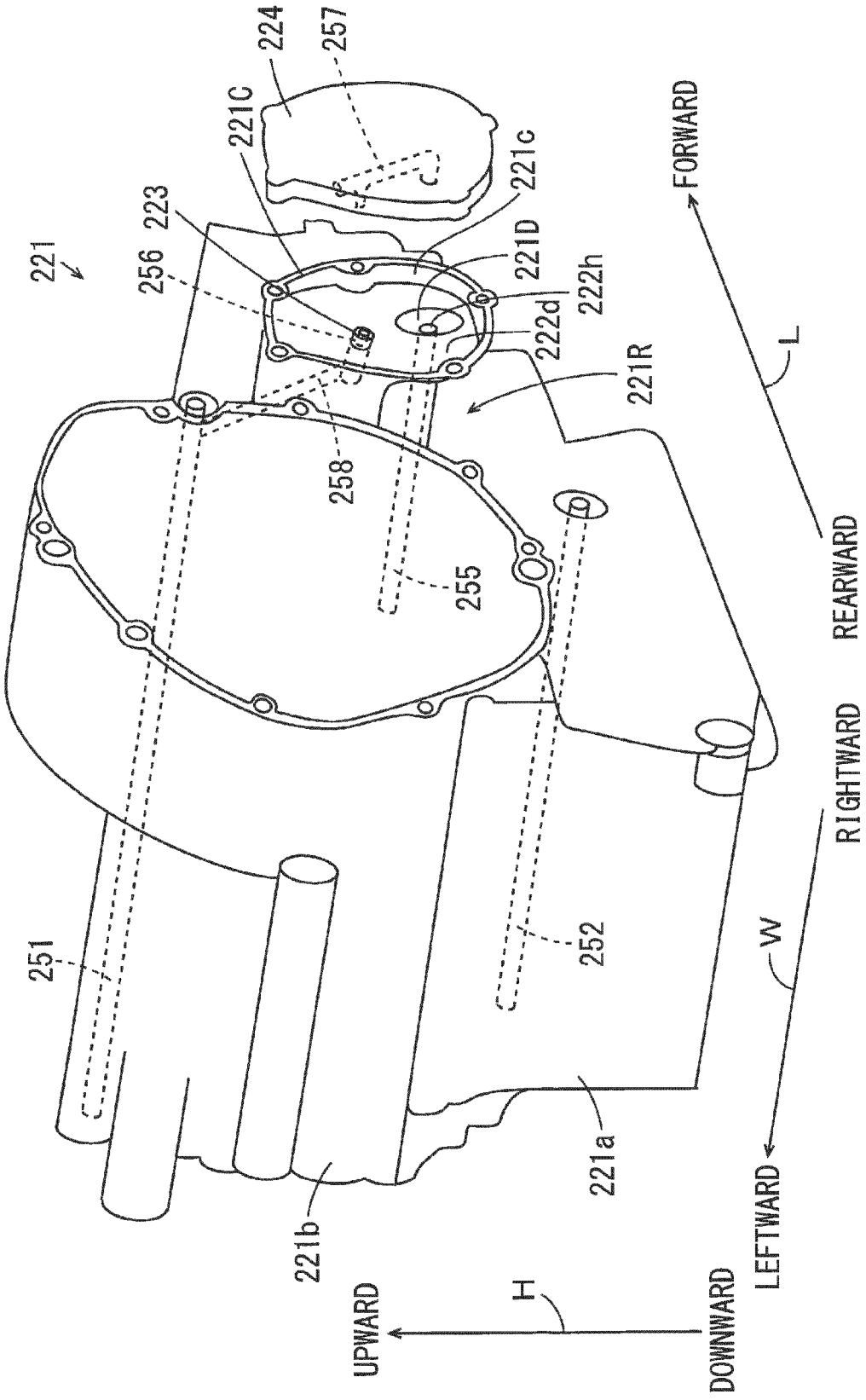
RIGHTWARD
221E
221R
252
202
251
221c
221C
221D
221F
221d
L
FORWARD
REARWARD
223
H
UPWARD
DOWNWARD
224

FIG. 3

FIG. 4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DOWNWARD
H
UPWARD
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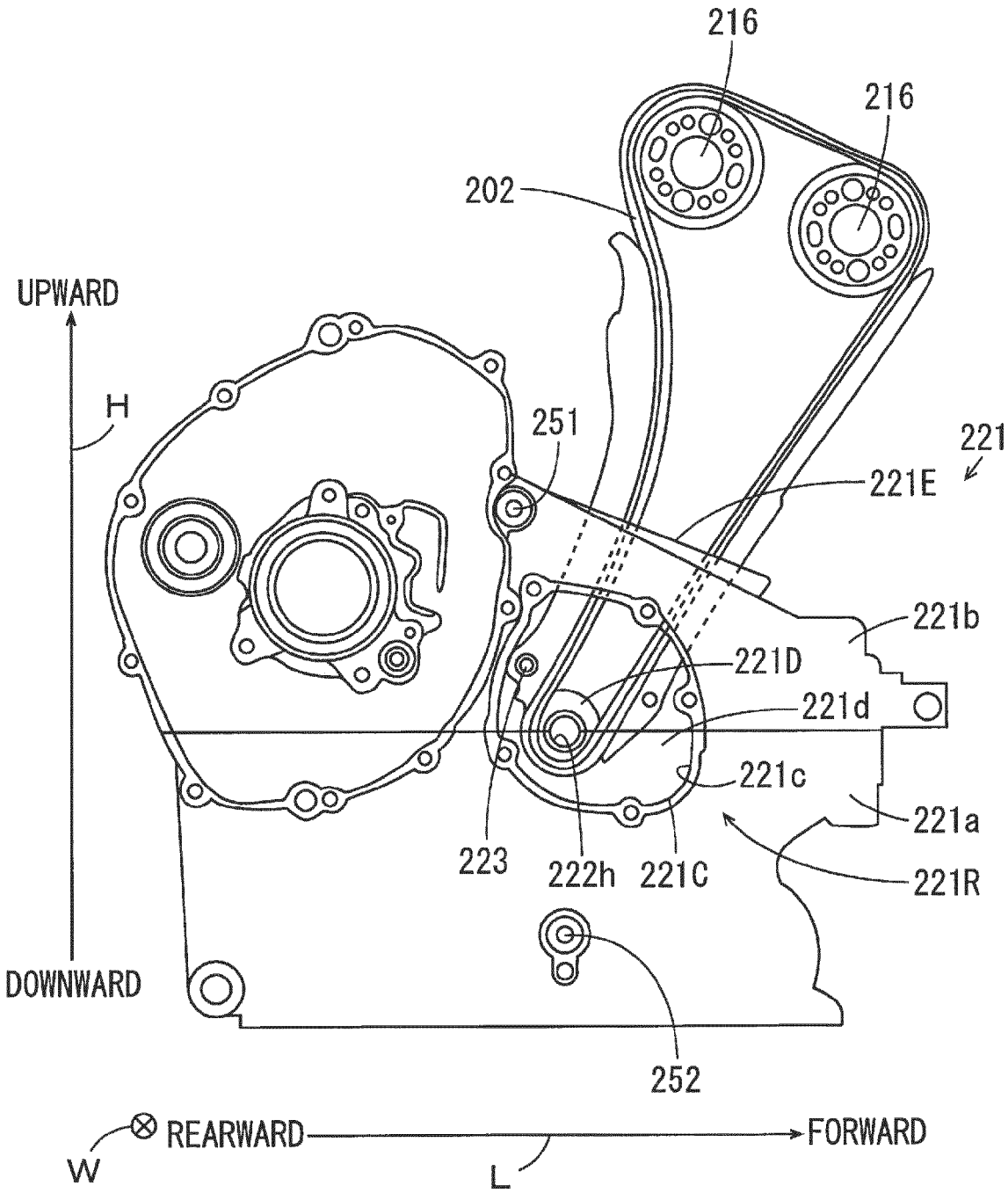
255
251
252
221a
221b

FIG. 5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DOWNWARD
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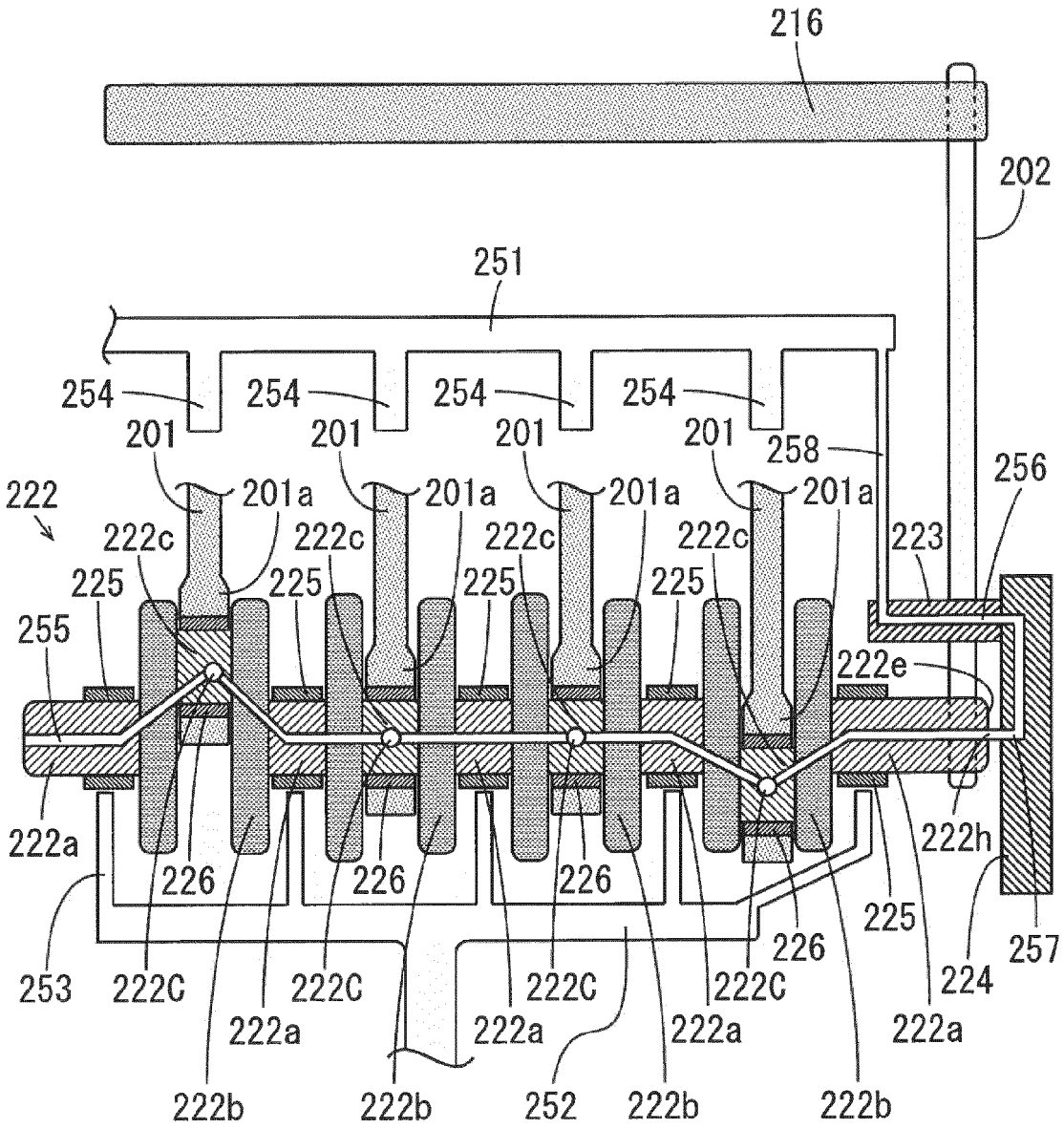
REARWARD
FORWARD
W
L

FIG. 6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222e
222a
226
226
226
222h
225
253
222C
222C
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222C
226
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222a
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222a
222b
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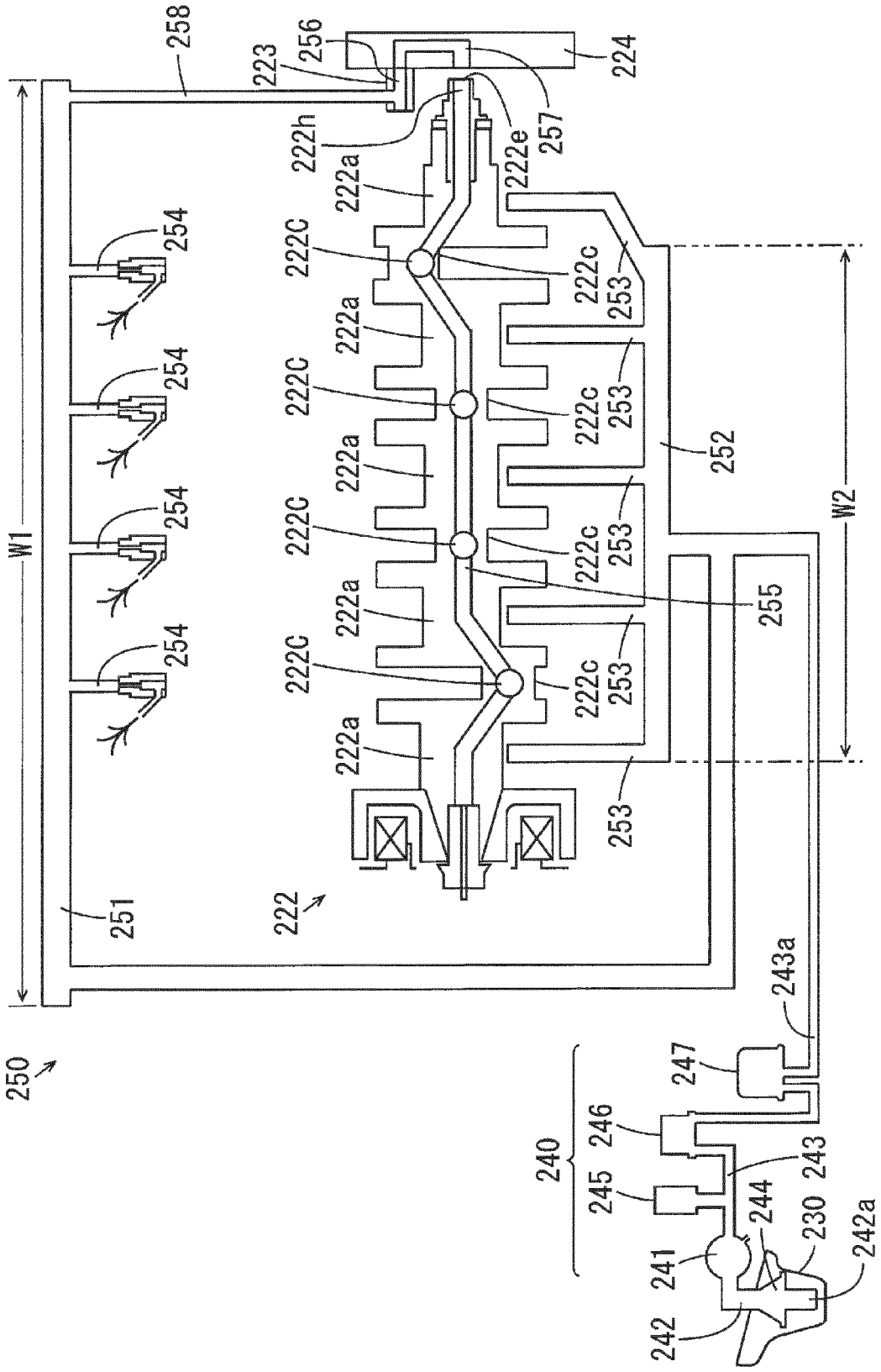
222b

FIG. 7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222C
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W2
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243a
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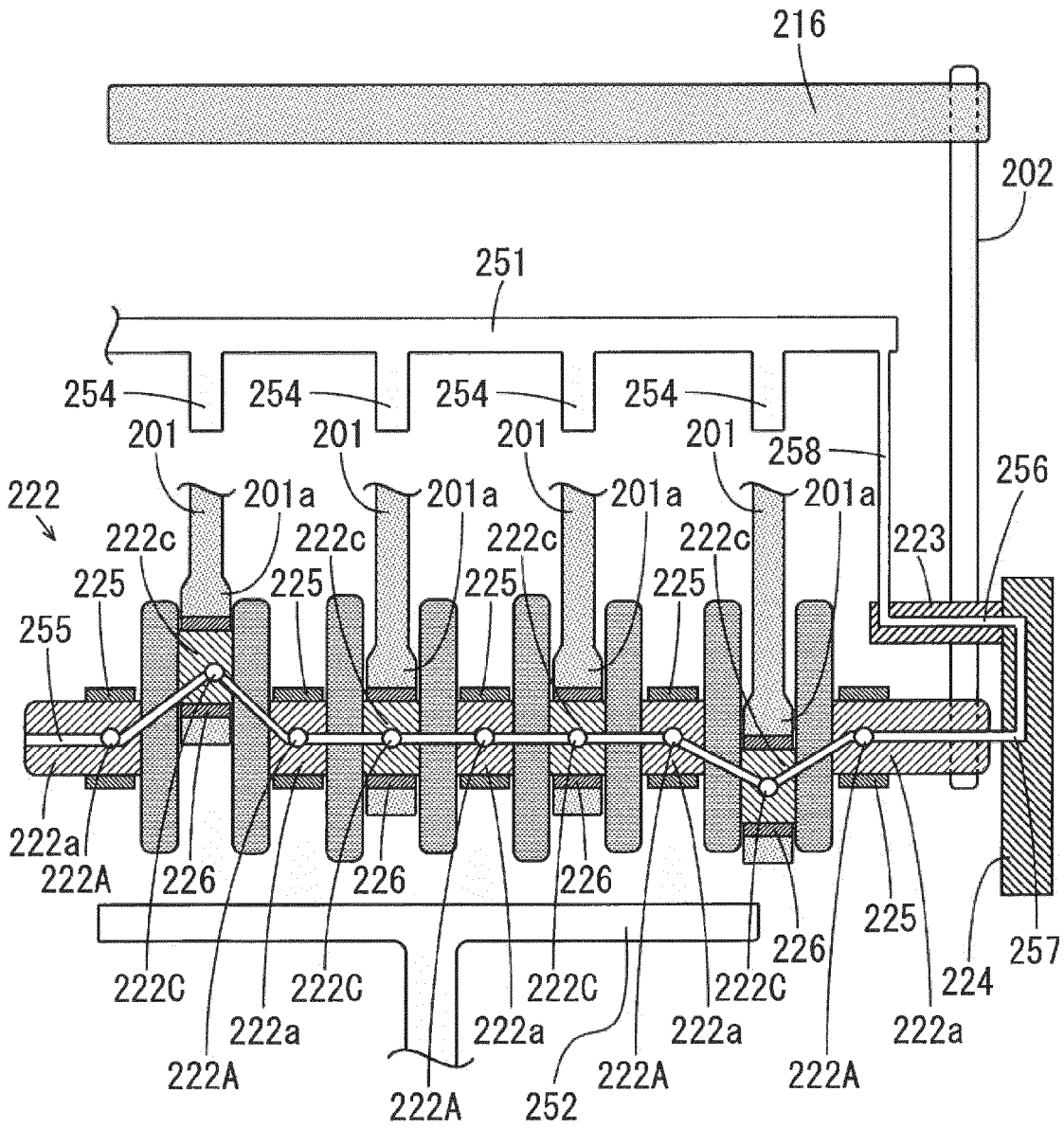
242
242a

FIG. 8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EUROPEAN SEARCH REPORT

Application Number
EP 15 19 0929

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A	DE 10 2013 217913 A1 (HONDA MOTOR CO LTD [JP]) 3 April 2014 (2014-04-03) * paragraph [0040] - paragraph [0044]; figures *	1	INV. F01M1/06 F01M11/02
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F01M
F01L

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	29 January 2016	Mouton, Jean

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29-01-2016

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