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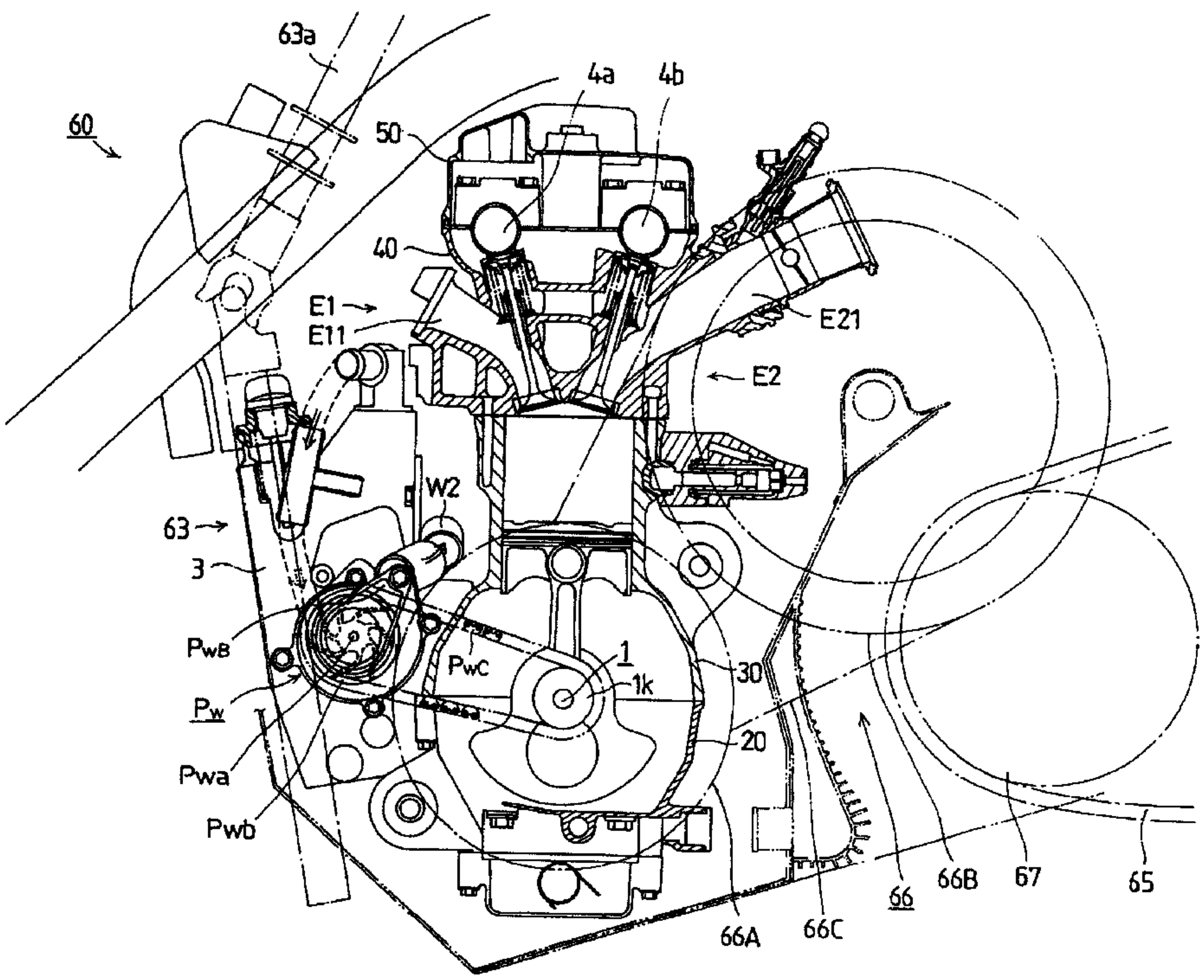


(57) Abrégé/Abstract:
A limited space in a snowmobile is to be utilized effectively by selecting a suitable auxiliary devices layout structure in an internal combustion engine mounted on a snowmobile. An oil tank 3 for dry sump, a water pump Pw and a starter motor are disposed intensively in a front portion E1 in a vehicle advancing direction of an internal combustion engine E which is mounted on a snowmobile 60 at a position close to the front side of a body of the snowmobile. A steering shaft 63a is also disposed so as to pass through the front portion E1 of the internal combustion engine E. According to this layout structure it is possible to effectively utilize a limited space in the snowmobile and a rider riding on a rear portion E2 side of the engine E can approach the engine.

ABSTRACT OF THE DISCLOSURE

A limited space in a snowmobile is to be utilized effectively by selecting a suitable auxiliary devices layout structure in an internal combustion engine mounted on a snowmobile. An oil tank 3 for dry sump, a water pump Pw and a starter motor are disposed intensively in a front portion E1 in a vehicle advancing direction of an internal combustion engine E which is mounted on a snowmobile 60 at a position close to the front side of a body of the snowmobile. A steering shaft 63a is also disposed so as to pass through the front portion E1 of the internal combustion engine E. According to this layout structure it is possible to effectively utilize a limited space in the snowmobile and a rider riding on a rear portion E2 side of the engine E can approach the engine.

SNOWMOBILE

FIELD OF THE INVENTION

The present invention relates to a snowmobile and more particularly to an improved technique for a snowmobile in which the layout of various auxiliary devices in an internal combustion engine mounted on the snowmobile is improved.

BACKGROUND OF THE INVENTION

Heretofore a snowmobile has been known in which is mounted an internal combustion engine with auxiliary devices arranged compactly due to a limited space factor.

As one concrete example of such a snowmobile there is known a small-sized snowmobile. This small-sized snowmobile has a shaft layout structure such that a crank shaft, as well as a traveling power output shaft and a pump drive shaft (auxiliary device shaft), are arranged so as to be parallel with one another in the vehicular transverse direction, and in order for the shafts to form a triangular shape when seen sideways of the vehicle body, the pump drive shaft is disposed below the power output shaft and the crank shaft is disposed at a position intermediate between the power output shaft and the pump drive shaft and on a rear side. According to this shaft layout structure, auxiliary devices to be arranged around the internal combustion engine are arranged compactly on both front and rear sides of the engine. The internal combustion engine of such a structure is installed within a limited space in the vehicle body to ensure an advantage in the mounting space (see, for example, Japanese Patent Laid-Open No. 2002-266653 (pp. 4-5, Fig. 2)

According to a snowmobile 060 of the invention disclosed in the above Japanese Patent Laid-Open No. 2002-266653 (pp. 4-5, Fig. 2), which is illustrated in Figs. 13 and 14, there is used a power output shaft 02, the power output shaft 02 being connected through the engagement of gears to a crank shaft 01 of an internal combustion engine 0E mounted on the snowmobile 060, and rotation of the power output shaft 02 is transmitted to an endless track belt 065 through a V belt type automatic transmission 066, whereby the snowmobile is driven for travel.

In the internal combustion engine 0E mounted on the snowmobile 060, the crank shaft 01, the power output shaft 02 for driving the snowmobile 060, and a pump drive shaft 03 as an auxiliary device shaft, are arranged so as to be parallel with one another in the transverse direction of the snowmobile 060 and so as to mutually form a triangle in side view of the vehicle body.

More particularly, a pump drive shaft 03 for activating a cooling pump and an oil pump is disposed below the power output shaft 02, and the crank shaft 01 is disposed at a position intermediate between and behind the power output shaft 02 and the pump drive shaft 03. As a result, various auxiliary devices to be arranged around the engine OE are disposed compactly especially on both front and rear sides of the engine OE.

The compact layout structure of various auxiliary devices around the engine OE in the invention disclosed in the above Japanese Patent Laid-Open No. 2002-266653 (pp. 4-5, Fig. 2) leads to the reduction in size of the internal combustion engine OE and such a small-sized internal combustion engine OE in the small-sized snowmobile 060 not only facilitates the installation thereof but also provides an advantageous structure in point of space.

Thus, according to the invention disclosed in the above Japanese Patent Laid-Open No. 2002-266653 (pp. 4-5, Fig. 2) there is provided an improved structure for effective utilization of such an extremely limited body space as in the small-sized snowmobile. However, the provision of a further improved structure for effective utilization of a body space in the snowmobile and for facilitating installation of an internal combustion engine onto the snowmobile body is demanded. Particularly, it is required to provide an improved structure of a small-sized snowmobile for effective utilization of a mounting space for an internal combustion engine and various auxiliary devices associated with the engine which occupy a large relative importance related to space.

SUMMARY OF THE INVENTION

The present invention is concerned with an improved structure of a snowmobile taking note of an auxiliary devices layout structure in an internal combustion engine mounted on the snowmobile for solving the above-mentioned problems and from the standpoint of effectively utilizing a limited space in the snowmobile. According to the present invention there is provided, in a snowmobile including an internal combustion engine mounted on a front side of a body of the snowmobile, a rider seat provided behind the internal combustion engine, and a crank shaft of the internal combustion engine, wherein the rotation of the crank shaft is transmitted to an endless track belt through a transmission mechanism, whereby the endless track belt is driven to drive the snowmobile, the improvement characterized in that auxiliary devices are disposed intensively in a front portion of the internal combustion engine mounted on the snowmobile.

The present invention is also characterized in that the auxiliary devices disposed intensively in a front portion of the internal combustion engine are a cooling water pump, an oil tank for dry sump, and a starter motor. The present invention is further characterized in that the cooling water pump and the starter motor both disposed in the front portion of the internal combustion engine are received respectively within cutout spaces defined by the oil tank for dry sump.

According to the present invention in a snowmobile including an internal combustion engine mounted on a front side of a body of the snowmobile, a rider seat provided behind the internal combustion engine, and a crank shaft of the internal combustion engine, wherein the rotation of the crank shaft is transmitted to an endless track belt through a transmission mechanism: auxiliary devices are disposed intensively in a front portion of the internal combustion engine mounted on the snowmobile. Thus, since auxiliary devices are mounted intensively in the front portion of the engine and are not disposed in the rear portion of the engine, i.e., on the rider seat side, it becomes possible for the rider to so much approach the engine and there is attained effective utilization of a limited mounting space in the body of the snowmobile.

Moreover, since auxiliary devices are disposed intensively in the front portion of the internal combustion engine, the engine itself is small-sized and made compact and it becomes easy to ensure an effective space around the engine, so that the mounting of the internal combustion engine onto the vehicle body becomes easier and the engine mounting work efficiency is improved, whereby it is possible to reduce the cost.

An aspect of the invention in combination with the invention defined above is characterized in that the auxiliary devices disposed intensively in the front portion of the internal combustion engine are a cooling water pump, an oil tank for dry sump, and a starter motor. Consequently, it is possible to put the surroundings of the engine in order and it becomes so much easier to ensure an effective space around the engine. Moreover, since the engine can be constructed in a small and compact form, the mounting of the engine to the vehicle body becomes easier and the engine mounting work efficiency is improved, whereby the cost can be reduced.

A further aspect of the invention in combination with the invention defined above, is characterized in that the cooling water pump and the starter motor both disposed in the front portion of the internal combustion engine are received respectively within cutout spaces formed by the oil tank for dry sump. Consequently, what is called a dead space diminishes to attain effective utilization of space and the surroundings of the engine are put in order compactly, whereby it becomes easier to ensure an effective space. Besides, since the engine can be made compact, mounting of the engine onto the vehicle body can be done easily with a space margin and the engine mounting work efficiency is improved, whereby it is possible to attain the reduction of cost.

BRIEF DESCRIPTION OF THE DRAWINGS

Preferred embodiments of the invention are shown in the drawings, wherein:

Fig. 1 is a side view of a snowmobile according to the present invention with an exterior cover, etc. removed for showing a main structural portion thereof;

Fig. 2 is a top view of a snowmobile according to the present invention with an exterior cover, etc. removed for showing a main structural portion thereof;

Fig. 3 is an enlarged side view of a vicinity of an internal combustion engine mounting portion in the snowmobile;

Fig. 4 is a longitudinal sectional view of a main structural portion of an internal combustion engine mounted on the snowmobile;

Fig. 5 shows a structural portion of an automatic transmission in a drive mechanism for the snowmobile;

Fig. 6 shows an appearance structure of the internal combustion engine on a front side in a vehicle advancing direction mounted on the snowmobile;

Fig. 7 is a side view showing the main structural portion of the internal combustion engine mounted on the snowmobile;

Fig. 8 is a top view of a certain portion of the internal combustion engine mounted on the snowmobile;

Fig. 9 is an enlarged sectional view of a main structural portion showing lubricating oil supply paths in the internal combustion engine mounted on the snowmobile;

Fig. 10 is a schematic explanatory diagram showing a lubricating oil supply system in the internal combustion engine mounted on the snowmobile;

Fig. 11 is a diagram of a main structural portion showing cooling water supply paths in the internal combustion engine mounted on the snowmobile;

Fig. 12 shows a part of a main cooling water supply structure in the internal combustion engine mounted on the snowmobile;

Fig. 13 is a perspective view showing a conventional internal combustion engine mounted on a snowmobile; and

Fig. 14 shows a snowmobile on which the internal combustion engine shown in Fig. 13 is mounted.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

In an internal combustion engine mounted on a snowmobile, auxiliary devices such as an oil tank for dry sump, a cooling water pump and a starter motor are disposed intensively in a front portion of the engine which faces the front side of the vehicle.

An embodiment of the present invention will be described hereinunder with reference to Figs. 1 to 12. Fig. 1 is a side view showing the whole of a snowmobile 60 and Fig. 2 is a top view showing the whole of the snowmobile 60. As can be seen from both figures, an internal combustion engine E is mounted on a body of the snowmobile 60 at a position close to the front side of the body. Left and right front suspensions 61a, 61b are disposed in the front portion of the vehicle body and steering skis 62a and 62b are connected to the front suspensions 61a and 61b.

The steering skis 62a and 62b are connected through a steering shaft 63a and members of a steering system 63 such as arm pivots and link rods to a handle 63b located nearly centrally of the vehicle body. The members of the steering system 63 are disposed so as to pass through the front portion of the internal combustion engine E. A rider seat 64 is disposed on the vehicle body at a position behind the handle 63b.

Further provided is a V belt type automatic transmission 66 having a driving pulley 66A and a driven pulley 66B, the driving pulley 66A and the driven pulley 66B constituting a drive section for transmitting a drive force of the internal combustion engine mounted at a position close to the front side of the vehicle body to an endless track belt 65. In accordance with a transmission method to be described later a rotational drive force shifted by the automatic transmission 66 is transmitted to a driving wheel 67, whereby the endless track belt 65 is driven to drive the snowmobile 60. The numeral 68 in Fig. 1 denotes a radiator disposed under the seat 64.

As is apparent from Figs. 1, 2, or 3, intake pipes E21 and exhaust pipes E11 of the engine E are shown in these figures. The intake pipes E21 extend backward of the vehicle body from the rear portion of the engine E and are then bent upward, with an air cleaner E22 being disposed on the upwardly bent portion. As can be seen from Fig. 2, four exhaust pipes E11 are gathered in two sets each consisting of two pipes from the front portion of the engine E toward the front side of the vehicle body, then are gathered into one pipe, then the pipe is bent in U shape on the front side of the vehicle body, and again extends backward of the vehicle body to form a backward bent portion, with a muffler E12 being disposed on the backward bent portion.

In Fig. 3, the structure of the portion where the internal combustion engine E is mounted is shown on a larger scale. A frame as a part of the vehicle body, the V belt type automatic transmission 66 as a part of the drive section, and a part of the steering system 63 such as the steering shaft 63a, are also shown in the same figure. The internal combustion engine E is mounted on the vehicle body in a state such that a cylinder portion E0 thereof is somewhat inclined backward (see Fig. 1). In the same figure, the left side of the engine E is a front portion E1 of the engine which faces the front side of the body of the snowmobile 60. The front portion E1 of the engine E constitutes an exhaust side and therefore the exhaust pipes E11 extend from the front portion E1.

The internal combustion engine E, whose principal portion is shown in a longitudinal section view of Fig. 4, has a body structure including a crank case 20, a cylinder block 30, a cylinder head 40, and a cylinder head cover 50. Within the crank case 20, a crank shaft 1 is supported rotatably through bearings, large end portions 1c of connecting rods 1b are pivotably supported respectively by four crank pins 1a of the crank shaft 1, and pistons 1f are secured respectively to small end portions 1d of the connecting rods 1b through pistons 1e. As is seen from this description, the internal combustion engine E in this embodiment is an in-line four-cylinder four-cycle engine.

The crank shaft 1 is supported by five journal portions 1g of the crank case 20 and is further supported at a position close to a right end 1h by a ball bearing 1i taking into account the presence of the V belt type automatic transmission 66. The driving pulley 66A of the V belt type automatic transmission 66 is mounted on a right extending shaft portion 1j of the crank shaft 1 extending outside the shaft bearing portion constituted by the ball bearing 1i.

More specifically, the V belt type automatic transmission 66 which transmits the shifted rotational drive force to the driving wheel 67 for travel of the vehicle is constructed such that, as shown in Figs. 1 and 3, a rotational drive force of the driving pulley 66A is transmitted at a desired reduction gear (transmission gear) ratio to the driven pulley 66B side through a V belt 66C and is then transmitted from the driven pulley 66B to a sprocket (not shown) coaxial with the driving wheel 67 through a sprocket (not shown) coaxial with the pulley 66B. The transmission of the drive force between both sprockets is performed through a chain (not shown) or the like which is stretched between the two.

The rotational drive force thus transmitted to the sprocket coaxial with the driving pulley 67 causes the driving wheel 67 to rotate, whereby the endless track belt 65 for travel of the snowmobile 60 is rotated along a slide rail 65a while being guided by the slide rail.

A brief description will now be given about the V belt type automatic transmission 66 with reference to Fig. 5. When the engine E is rotating at a low speed or is OFF, the driving pulley 66A is held under the action of a spring (not shown) disposed on the driven pulley 66B side so that a V groove 66a thereof becomes wider, that is, a substantial effective diameter of the pulley 66A becomes smaller, and a V groove 66b of the driven pulley 66B becomes narrower, that is, a substantial effective diameter of the pulley 66B becomes larger.

A movable pulley piece 66A2 of the driving pulley 66A is provided with a weight member not shown in Fig. 5. The weight member functions to change the reduction gear (transmission gear) ratio in the V belt type automatic transmission 66 and the weight member moves radially of the pulley piece 66A2 under the action of a centrifugal force proportional to the rotation of the engine E (crank shaft 1), so that the pulley piece 66A2 moves in a direction in which the width of the V groove 66a is changed. In this way the reduction gear ratio is changed and a shift is made automatically in a continuously variable manner.

According to this structure, when the engine E (crank shaft 1)rotates at a high speed, the weight member (not shown) moves radially outwards of the movable pulley piece 66A2 against the spring force (the spring of the driven pulley 66B) and the movable pulley piece 66A2 is moved in a direction in which the width of the V groove 66a of the driving pulley 66A is narrowed. Consequently, the position of contact of the V belt 66C with the V groove 66a on which it is entrained is shifted radially outwards and thus a substantial effective diameter of the driving pulley 66A is made large.

On the other hand, in the driven pulley 66B, as the position of contact of the V belt 66C on the driving pulley 66A side shifts radially outwards, a pulley piece 66B1 is moved against the spring force (not shown) conversely in a direction in which the width of the V groove 66b becomes larger, whereby a substantially effective diameter of the driven pulley 66B is made small and so is the reduction gear ratio. The endless track belt 65 is driven at this reduction gear ratio and the snowmobile 60 runs at a high speed.

When the engine E (crank shaft 1) rotates at a low speed, the weight member is positioned radially inside of the movable pulley piece 66A2 and the movable pulley piece 66A2 is moved in a direction in which the V groove 66a is widened, so that a substantially effective diameter of the driving pulley 66A is made small. On the other hand, in the driven pulley, the V groove 66b is conversely narrowed, a substantial effective diameter of the driven pulley 66B is made large and so is the reduction gear ratio. The endless track belt 65 is driven at this reduction gear ratio and the snowmobile 60 runs at a low speed. Such a V belt type automatic transmission 66 itself is already known.

Referring again to Fig. 4, as can be seen from the same figure, a sprocket 1k of a small diameter is disposed at a position adjacent to the support portion of ball bearing 1i close to the right end 1h of the crank shaft 1, and a chain Pwc is stretched between the sprocket 1k and a sprocket Pwb mounted on a pump shaft Pwa a cooling water pump Pw which will be described later (see Figs. 3 and 12). With the chain Pwc, the cooling water pump Pw is activated in interlock with rotation of the crank shaft 1.

On the other hand, a rotor 2a of a generator 2 is mounted near a left end 1m of the crank shaft 1 and a bolt B is implanted into the left end 1m of the shaft 1 to form an extending shaft portion 1n. An oil pump shaft 1q coaxial with the extending shaft portion 1n and extending while being connected with the end portion 1m through a joint 1p is connected to the extending shaft portion 1n. Two oil pumps Pf and Ps are mounted side by side on the oil pump shaft 1q.

One oil pump Pf is a feed pump for the supply of lubricating oil, while the other oil pump Ps is a scavenging pump for return of oil staying in a bottom 21 of the crank case 20 to an oil tank 3 for dry sump. As to the supply and delivery of lubricating oil by both pumps Pf and Ps, a description will be given later and therefore an explanation thereof will here be omitted.

A sprocket 1r of a small diameter is mounted on the crank shaft 1 at a position close to the left end 1m of the crank shaft. The sprocket 1r is for actuating two cam shafts 4a and 4b in a valve operating system 4. A cam chain 4e is stretched between sprockets 4c, 4d mounted on the cam shafts 4a, 4b and the sprocket 1r, whereby the rotation of the crank shaft 1 is transmitted to the two cam shafts 4a and 4b at a number of revolutions of 1/2.

A gear 1s of a relatively large diameter is mounted on the crank shaft 1 through a one-way clutch 1t at a position adjacent to the sprocket 1r. The gear 1s, which is for a starter motor 5 (see Fig. 5), is connected interlockedly through the engagement of intermediate gears 5b and 5c to a gear 5a which is integral with a motor shaft 5A of the starter motor 5 (see Fig. 5).

The cylinder block 30 is connected to an upper portion of the crank case 20 and four cylinder bores 31 are formed side by side through the cylinder block 30. Pistons 1f are adapted to slide respectively through the interiors of the four cylinder bores 31. The cylinder head 40 is connected to an upper portion of the cylinder block 30.

In the cylinder head 40, four combustion chambers 42 are formed by four concave portions 41 and upper portions of the four cylinder bores 31. In each combustion chamber 42 there are provided intake and exhaust ports 43, 44, intake and exhaust valves 45, 46 for opening and closing the intake and exhaust ports 43, 44, and a spark plug 47.

Within the cylinder head 40 there are formed intake and exhaust passages 48,49 communicating with the intake and exhaust ports 43, 44 which are provided in the combustion chambers 42. In an upper portion of the cylinder head 40 there are provided a valve operating mechanism for actuating the intake and exhaust valves 45, 46, i.e., cams 4f, 4g and cam shafts (two) 4a, 4b, a drive mechanism for the valve operating mechanism, and tappets 4h. Further, a cylinder head cover 50 is attached to the upper portion of the cylinder head 40.

As shown in Figs. 3 and 7, in the front portion E1 of the internal combustion engine E at a position corresponding to wall portions of the crank case 20 and the cylinder block 30 in the engine E, i.e., in the front portion E1 of the wall portions orthogonal to the vehicle advancing direction of the engine E when mounted on the vehicle, the oil tank 3 for dry sump having a length corresponding to approximately the entire width of the front portion E1 is disposed. As shown in Fig. 6, in a front view of the tank 3 as seen from the front portion E1 of the engine E, a right lower portion of the tank 3 is cut out in a rectangular shape to form a space E1a in the engine E front portion E1, while a left upper portion of the tank is cut out in a rectangular shape to form a space E1b in the engine E front portion E1.

The cooling pump Pw is positioned in the space E1a formed by the right lower cutout portion of the oil tank 3 for dry sump. The pump Pw is received within the space E1a and thereby mounted in the front portion E1 of the engine E in such a manner that a cooling water suction port PwA1 thereof is located at a lower position and a discharge port PwB thereof is located at an upper position. The starter motor 5 is positioned within the space E1b formed by the left upper cutout portion. The starter motor 5 is received within the space E1b and thereby mounted in the engine front portion E1 in such a manner that the motor shaft 5A of the starter motor 5 projects leftwards in the figure, i.e., in a transversely outward direction of the engine E.

In the above front view of the oil tank 3 for dry sump, a concave groove 3b having a generally arcuate section is formed in a nearly transversely central portion 3a of the tank 3, the concave groove 3b being used for the steering shaft 63a (see Fig. 7) which passes vertically through the tank 3 and which is connected to the steering handle 63b of the snowmobile 60. The concave groove 3b has a steering post 3A which faces somewhat obliquely in the vertical direction to match the extending direction of the steering shaft 63a so as to receive the steering shaft therein.

As can be seen from the above description and from Fig. 6, in the front portion E1 of the engine E, the cooling water pump Pw and the starter motor 5 are disposed in a well-balanced state at right and left positions so as to sandwich the concave groove 3b which extends vertically through the tank 3 at the tank central portion 3a for the steering post 3A. A characteristic structure to be emphasized is that the oil tank 3 for dry sump, cooling water pump Pw and starter motor 5 are disposed intensively in the front portion E1 of the engine E. With this arrangement, the rider who rides on a rear portion E2 of the engine E can approach the engine.

In a side portion (the left side face in Fig. 4) parallel to the vehicle advancing direction of the engine E, as shown in Figs. 4, 7 and 11, an oil cooler 11 and an oil filter 12 are disposed in the portion corresponding to the wall portions of cylinder block 30 and the cylinder head 40 and at positions approximately above the oil pumps Pf, Ps and the generator 2 on the left end 1m of the crank shaft 1. The oil cooler 11 and the oil filter 12 are integral with each other as a unit 10 and in their mounted state a lower structural portion of the unit 10 is attached to an upper portion of a crank case cover 23, whereby the above layout is effected.

The lower structural portion in the mounted state of the unit 10 as an integral structure, i.e., the lower structural portion to be mounted to the upper portion of the crank case cover 23, is constructed as the oil cooler 11. The oil cooler 11 has a cylindrical heat exchanger portion though not clearly shown and a cooling water inlet pipe 11a and discharge pipe 11b for the heat exchanger are provided (see Fig. 11). An upper structural portion of the unit 10 is constructed as the oil filter 12.

In connection with the internal combustion engine E according to this embodiment, which is mainly constructed as above, an additional description will be given below about a lubricating oil supply structure which adopts a so-called dry sump method. The structure of the lubricating oil supply path is shown fragmentarily in plural drawings and is difficult to understand. In the following description, therefore, it is requested that reference be made to Fig. 10 which is a schematic diagram showing a lubricating oil supply system used in this embodiment.

As already described and as shown in Figs. 4 and 9, at the left end 1m of the crank shaft 1, two oil pumps Pf and Ps, i.e., the feed pump Pf and the scavenging pump Ps, are mounted side by side on the pump shaft 1q which is adapted to rotate coaxially and interlockedly with the crank shaft 1.

As shown in Fig. 7, a suction port PfA of the feed pump Pf is in communication through a lubricating oil suction path F1 with an opening 3c formed in a lower portion of the oil tank 3 for dry sump. Further, a discharge port PfB of the feed pump Pf is in communication through a lubricating oil supply path F2 with the unit 10 which is an integral structure of the oil cooler 11 and the oil filter 12. The lubricating oil supply path F2 provides a communication between the oil cooler 11 as the lower structural portion of the unit 10 and the discharge port PfB of the feed pump Pf. When the feed pump Pf is activated, lubricating oil present within the oil tank 3 for dry sump is fed to the unit 10.

A branch oil path F01 (see Fig. 10) is provided in the lubricating oil supply path F2 and a relief valve V1 (see Figs. 1 and 7) is disposed in the branch oil path F01. The relief valve V1 functions to regulate the lubricating oil supply pressure in the lubricating oil supply path F2 and oil flowing out from the relief valve V1 passes through a branch oil path F02 (see Fig. 10) and is again returned to the lubricating oil suction oil path F1.

As can be seen by reference to Figs. 4, 7, 8 and 9, the lubricating oil which has been fed to the unit 10, cooled by the oil cooler 11 within the unit 10 and filtered by the oil filter 12 is fed from a lubricating oil outlet of the unit 10 to the oil gallery F5 and valve operating system 4 through branch supply paths, i.e., lubricating oil supply paths F3 and F4 (see Fig. 7) for the supply of lubricating oil to the oil gallery F5 and lubricating oil supply paths F10 and F11 (see Fig. 4) for the supply of lubricating oil to the valve operating system 4.

A check valve V2 is disposed in the lubricating oil supply paths F3 and F4 which are branch supply paths to the oil gallery F5 communicating with the lubricating oil outlet of the unit 10 (see Fig. 9). The check valve V2 is disposed by utilizing a connection 24 between the crank case 20 and the case cover 23.

As shown in Fig. 4, the oil gallery F5 extends below and in parallel with the crank shaft 1 so that the length of the extension corresponds to approximately the overall length of the crank shaft 1. Plural lubricating oil supply paths F6 and F7 communicating with the journal portions 1g of the crank shaft 1 and with the crank pin portions 1a to which the connecting rods are connected, injection ports F8 for inner walls of the cylinder bores 31, and a lubricating oil supply path F9 communicating with the ball bearing 1i positioned close to the right end of the crank shaft 1, are in communication with the oil gallery F5.

Lubricating oil supply paths F10 and F11 communicating with the cam shafts 4a and 4b in the valve operating system 4 are formed as in Fig. 4. As shown in the same figure, the lubricating oil supply path F10 communicates with the lubricating oil outlet of the unit 10 and extends horizontally past the connection 24 between the crank case 20 and the crank case cover 23, and the lubricating oil supply path F11 is bent at approximately right angles from the supply path F10 and extends upward along openings 30A and 40A for the cam chain 4e which opening are formed respectively in the cylinder block 30 and the cylinder head 40 at the upper portion of the crank case 20. The lubricating oil supply paths F10 and F11 communicate through a branch supply path F12 with lubricating oil supply paths F13 and F14 formed within the cam shafts 4a and 4b. Plural apertures F15 and F16 which are open to cam surfaces are formed respectively in the lubricating oil supply paths F13 and F14 formed within the cam shafts 4a and 4b (see Fig. 8).

A suction port PsA (see Fig. 4) of the scavenging pump Ps juxtaposed to the feed pump Pf is connected to an oil path S1 which is for the suction of oil (to be described later) staying in the bottom 21 of the crank case 20. In Fig. 4, the bottom oil suction oil path S1 extends from the pump suction port PsA to an oil sump portion 22 positioned nearly centrally of the bottom 21 of the crank case 20, and an opening S0 for the suction of oil staying in the oil sump portion 22 is formed in an extending end of the suction oil path S1 which end faces the oil sump portion 22.

The bottom oil suction oil path S1 extends from the oil sump portion 22 substantially horizontally along the bottom 21 of the crank case 20 and below and in parallel with the crank shaft 1 and the oil gallery F5, then is brought into communication with the suction port PsA of the scavenging pump Ps.

As shown in Fig. 7, a discharge port PsB of the scavenging pump Ps communicates through with an upper opening 3d of the oil tank 3 for dry sump through a bottom oil return oil path S2, the oil path S2 extending substantially obliquely upwards toward an upper portion of the oil tank 3 from the pump discharge port PsB. Thus, with the bottom oil recovering oil paths S1 and S2 communicating with the scavenging pump Ps, the oil staying in the crank case bottom 21 is returned to the oil tank 3 for dry sump upon operation of the scavenging pump Ps.

Now, with reference to Figs. 4, 7, 8 and 9, an additional description will be given about the supply of lubricating oil in the internal combustion engine E having the above structure for the supply of lubricating oil. In the following description, as in the above description, it is requested that reference be made to Fig. 10 which is a schematic diagram of the lubricating oil supply system.

With rotation of the crank shaft 1 upon start-up of the internal combustion engine E, the two oil pumps Pf and Ps, i.e., the feed pump Pf and the scavenging pump Ps, are activated. When the feed pump Pf is activated, as shown in Fig. 7, the lubricating oil present within the oil tank 3 for dry sump is sucked into the pump Pf from the pump suction port PfA through the lubricating oil suction oil path F1. The pump pressure of the lubricating oil is increased within the pump Pf and then the pressurized lubricating oil is discharged from the discharge port PfB of the pump Pf.

The pressurized lubricating oil is then fed from the lubricating oil feed path F2 to the unit 10 as an integral structure of both oil cooler 11 and oil filter 12. The feed pressure in the lubricating oil feed path F2 is regulated by the relief valve V1 disposed in the branch oil path F01 (see Fig. 10) and the lubricating oil flowing out under the pressure regulating action of the valve V1 passes through the branch oil path F02 (see Fig. 10) and is again returned to the lubricating oil suction oil path F1.

The lubricating oil which has entered the unit 10 circulates through the unit 10 while being cooled by the heat exchanger portion of the oil cooler 11 and filtered by the oil filter 12. The lubricating oil thus cooled and filtered within the unit 10 is then fed to the oil gallery F5 and the cam shafts 4a, 4b in the valve operating system 4 through the branch lubricating oil supply paths F3, F4 and F10, F11 (see Fig. 4).

The lubricating oil which has been fed under pressure to the branch lubricating oil supply path F3 communicating with the oil gallery F5 pushes open the check valve V2 (see Fig. 9), then flows through the lubricating oil supply path F4 and is fed to the oil gallery F5. The lubricating oil thus fed to the oil gallery F5 flows through the oil gallery F5 which extends below and along the crank shaft 1.

The lubricating oil thus flowing through the oil gallery F5 then passes through the branch lubricating oil supply paths F6 and F7 and is fed to the journal portions 1g of the crank shaft 1 and the crank pin portions 1a to which the connecting rods 1b are connected. The lubricating oil is also fed to the inner wall portions of the cylinder bores 31 from the lubricating oil injection port F8 and is further fed through the branch lubricating oil supply path F9 to the ball bearing 1i positioned close to the right end of the crank shaft 1 (see Fig. 4).

On the other hand, the lubricating oil which has been fed under pressure to the branch lubricating oil supply paths F10 and F11 communicating with the cam shafts 4a and 4b in the valve operating system 4 first flows through the lubricating oil supply path F10 which extends horizontally through the connection 24 between the crank case 20 and the case cover 23, then turns at approximately right angles and flows into the lubricating oil supply path F11 which extends upward inside and along the wall portions of the openings 30A, 40A for the cam chain 4e in the cylinder block 30 and the cylinder head 40 and also along a water jacket 32 of the cylinder block 30 (see Fig. 4).

The lubricating oil which has flowed through the lubricating oil supply path F11 is divided through the lubricating oil supply path F12 which branches in two at an upper portion of the supply path F11, then flows through the lubricating oil supply paths F13 and F14 as hollow bores 4i and 4j formed within the two cam shafts 4a and 4b, i.e., the intake-side cam shaft 4a and the exhaust-side cam shaft 4b, then flows out from plural cam surfaces through the apertures F15 and F16 which are open to the cam surfaces, and is used for lubricating and cooling the cam surfaces of the cams 4f, 4g and the tappets 4h (see Figs. 4 and 8). The return oil which has been used for lubrication, though not clearly shown, is allowed to flow to the oil sump portion 22 of the bottom 21 of the crank case 20 through a return oil path or the like which extends through the cylinder block 30.

Though not clearly shown and explanations are omitted, lubricating oil is fed to drive shafts of auxiliary devices through other branch lubricating oil supply paths. The lubricating oil which has been used for lubricating various portions of the engine E then flows down dropwise through the interior of the engine E and is allowed to flow to the oil sump portion 22 of the bottom 21 of the crank case 20 through a lubricating oil return oil path though not clearly shown (see Fig. 4).

The lubricating oil which has been used for lubricating the above various portions of the internal combustion engine E, followed by flowing down dropwise into the oil sump portion 22 of the bottom 21 of the crank case 20 or flowing into the oil sump portion 22 through a return oil path (not shown), is sucked in from the pump suction port PsA through the bottom oil suction oil path S1 by means of the scavenging pump Ps which is driven along with the feed pump Pf. The bottom oil whose pressure has been raised within the pump Ps is returned and recovered from the upper opening 3d of the oil tank 3 for dry sump into the tank 3 through the bottom oil return oil path S2 (see Figs. 4 and 7), then is again fed to the various portions of the engine E through the foregoing lubricating oil supply paths.

Next, an additional description will be given below about the cooling structure in the internal combustion engine E. As shown in Fig. 6 and as described earlier, the cooling water pump Pw disposed in the cutout space E1a of the oil tank 3 for dry sump in the front portion E1 of the internal combustion engine E is adapted to be rotated in synchronism with rotation of the crank shaft 1 through the chain Pwc which is stretched between the sprocket 1k (see Figs. 3 and 4) positioned close to the right end 1h and the sprocket Pwb mounted on the cooling water pump shaft Pwa (see Figs. 3 and 12).

As can be seen by reference to Figs. 6 and 12, there is formed a cooling water return path W1 which provides communication between the cooling water suction port PwA1 of the cooling water pump Pw and a cooling water outlet of the radiator 68 (see Fig. 1) disposed below the seat 64 of the snowmobile 60 not shown in Figs. 6 and 12. Also provided is a cooling water supply path W2 which provides communication between the cooling water discharge port PwB of the cooling water pump Pw and the cooling water inlet port E01 for the interior of the central part of the front portion E1 of the internal combustion engine E. Further provided is a cooling water supply path W3 which includes the water jacket 32 for conducting the cooling water introduced from the cooling water inlet port E01 to around the cylinder bores 31 in the engine E.(see Fig. 11)

Additionally, there is provided a cooling water path W4, with a thermostat and a reservoir tank (neither shown) interposed therein, for communication between an outlet of the cooling water supply path W3, i.e., a cooling water discharge port E02 from the engine E, and a cooling water inlet of the radiator 68. Also provided is a cooling water bypath W10 branching from the thermostat to bypass the cooling water when the cooling water temperature is low (during warming up) (see Figs. 6 and 11). The cooling water bypath W10 is in communication with a suction port PwA2 (see Fig. 6) of the cooling water pump Pw.

The cooling water inlet port E01 for the interior of the engine E is positioned nearly centrally in the vertical direction of the cylinder block 30, while the cooling water discharge port E02 for the discharge of cooling water from the interior of the engine E is located at an upper position in the vertical direction of the cylinder block 30. Thus, the cooling water inlet port E01 and the cooling water discharge port E02 are disposed in a vertical (up and down) positional relation in the cylinder block 30 (see Fig. 6).

A cooling water supply path W20 connected to the cooling water inlet pipe 11a of the oil cooler 11 is formed in the vicinity of the connection between the cooling water supply path W2 and the cooling water inlet port E01 (see Figs. 6 and 11), and a cooling water path W21 (see Fig. 11) connected to the cooling water discharge pipe 11b of the oil cooler 11 is provided. Though not shown, the cooling water path W21 is in communication with the cooling water path W4 which provides communication between the cooling water discharge port E02 and the cooling water inlet of the radiator 68.

Therefore, the cooling water pump Pw rotates in interlock with rotation of the crank shaft 1 upon start-up of the internal combustion engine E to suck in cooling water from the suction port PwA1 after being cooled by the radiator 68. The pump pressure of the cooling water thus sucked into the pump Pw is increased within the same pump and is discharged from the discharge port PwB of the pump, then passes through the cooling water supply path W2, further through the cooling water inlet port E01 for the interior of the central part of the front portion E1 of the internal combustion engine E (see Fig. 6), and flows into the cooling water supply path W3 including the water jacket 32, etc. in the engine E (see Fig. 11).

The cooling water thus flowing into the cooling water supply path W3 in the engine E is introduced into the water jacket 32 around the cylinder bores 31 which water jacket constitutes a main portion of the cooling water path W3, then passes through the jacket 32 and further through the cooling water supply paths formed within the cylinder head 40 though not shown and absorbs heat. The thus-warmed cooling water is allowed to flow out to the exterior the engine E from the outlet of the cooling water path W3 in the engine, that is, from the cooling water discharge port E02 which is for the discharge of cooling water from the interior of the engine E, then flows through the cooling water path W4 which is a connection path to the radiator 68 communicating with the discharge port E02 (see Fig. 11), and is introduced from the upper portion of the radiator 68 into the radiator through the inlet of the radiator.

The warmed cooling water thus introduced into the radiator 68 circulates through the radiator while being deprived of heat and is cooled thereby. The cooling water thus cooled is again sucked into the suction port PwA1 of the cooling water pump Pw through the cooling water return path W1 (see Fig. 6) and is circulated for cooling various portions of the engine E through the cooling water supply paths.

According to this embodiment constructed as above there are attained the following unique functions and effects.

Since auxiliary devices such as the oil tank 3 for dry sump, the cooling water pump Pw and the starter motor 5, as well as the steering shaft, are disposed intensively in the front portion E1 of the engine E which is mounted on the snowmobile 60, that is, since the auxiliary devices and the steering shaft 63a are not disposed on the rider side of the engine E, the rider can so much approach the engine E.

The steering post 3A including the concave groove 3b which is for the steering shaft 63a is provided, the steering shaft 63a passing vertically through approximately the central portion 3a of the oil tank 3 for dry sump disposed in the front portion E1 of the internal combustion engine E, and right and left cutout spaces E1a, E1b are formed in a sandwiching relation to the steering post 3A. Further, the cooling water pump Pw and the starter motor 5 are received within the spaces E1a and E1b, respectively. Therefore, the engine E is well-balanced in its weight on the right and left sides. Besides, the oil tank 3, the cooling water pump Pw and the starter motor 5 are arranged compactly without waste in point of space. Thus, the so-called dead space decreases and it is possible to not only construct the surroundings of the engine E compactly but also ensure an effective space around the engine.

Since the surroundings of the internal combustion engine E can be made compact, there arises a space margin in mounting the engine E onto the snowmobile 60, it becomes easier to install the engine E, the engine mounting work efficiency is improved, and the reduction of cost can result.

The structure of the snowmobile carrying the internal combustion engine having the characteristic layout structure of auxiliary devices in the present invention is also applicable to other vehicles within the scope including a common technical matter, e.g., a technical subject such that an advantage in point of space is to be ensured in engine installation.

Although various preferred embodiments of the present invention have been described herein in detail, it will be appreciated by those skilled in the art, that variations may be made thereto without departing from the spirit of the invention or the scope of the appended claims.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. In a snowmobile comprising an internal combustion engine mounted on a front side of a body of the snowmobile, a rider seat provided behind the internal combustion engine, and a crank shaft of the internal combustion engine, wherein the rotation of the crank shaft is transmitted to an endless track belt through a transmission mechanism whereby the endless track belt is driven to drive the snowmobile, the improvement characterized in that auxiliary devices are disposed intensively in a front portion of the internal combustion engine mounted on the snowmobile.

2. A snowmobile according to claim 1, wherein the auxiliary devices disposed intensively in the front portion of the internal combustion engine comprising a cooling water pump, an oil tank for dry sump, and a starter motor.

3. A snowmobile according to claim 2, wherein the cooling water pump and the starter motor both disposed in the front portion of the internal combustion engine are received respectively within cutout spaces formed by the oil tank for dry sump.

Name of Document DRAWINGS

FIG. 1

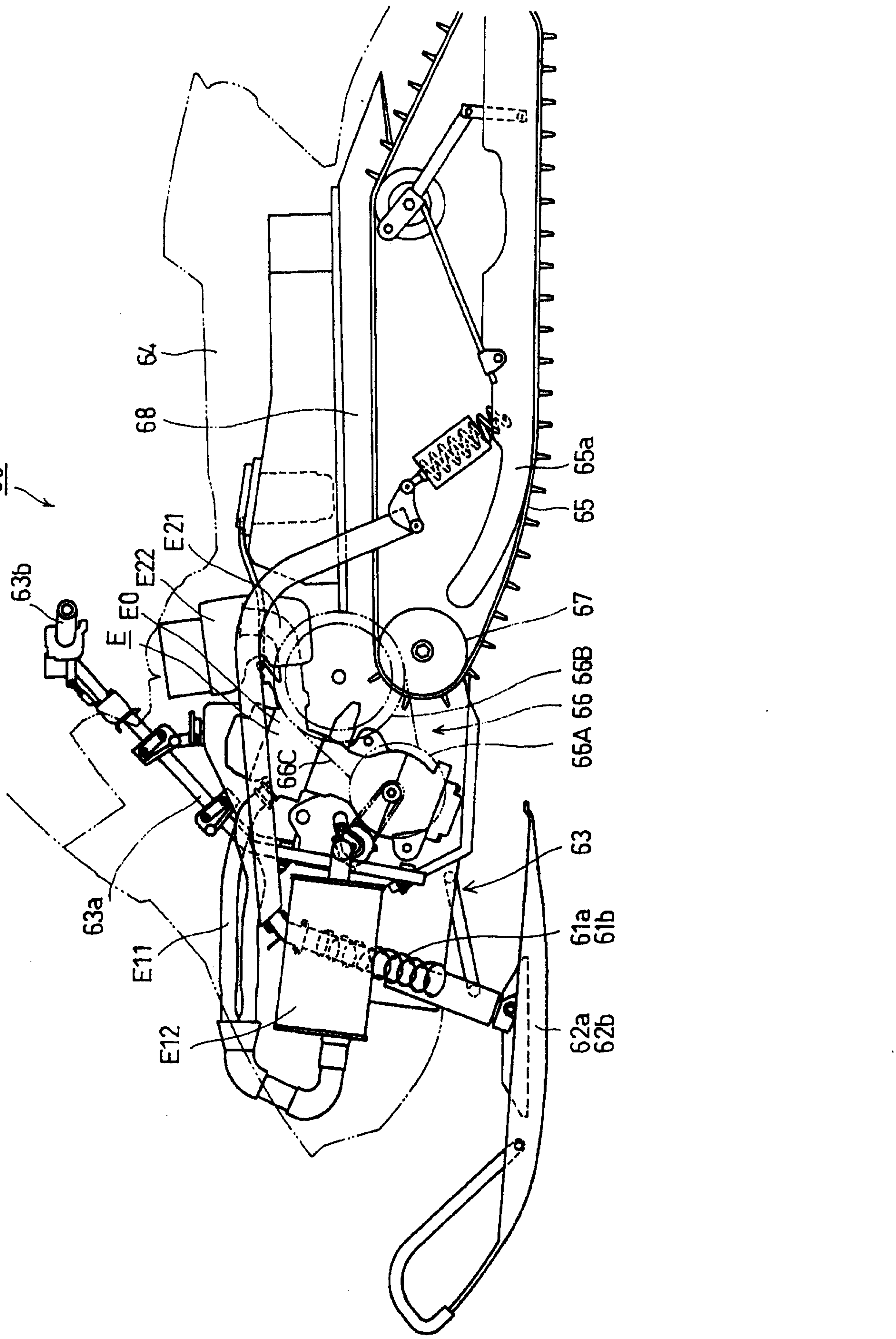


FIG. 2

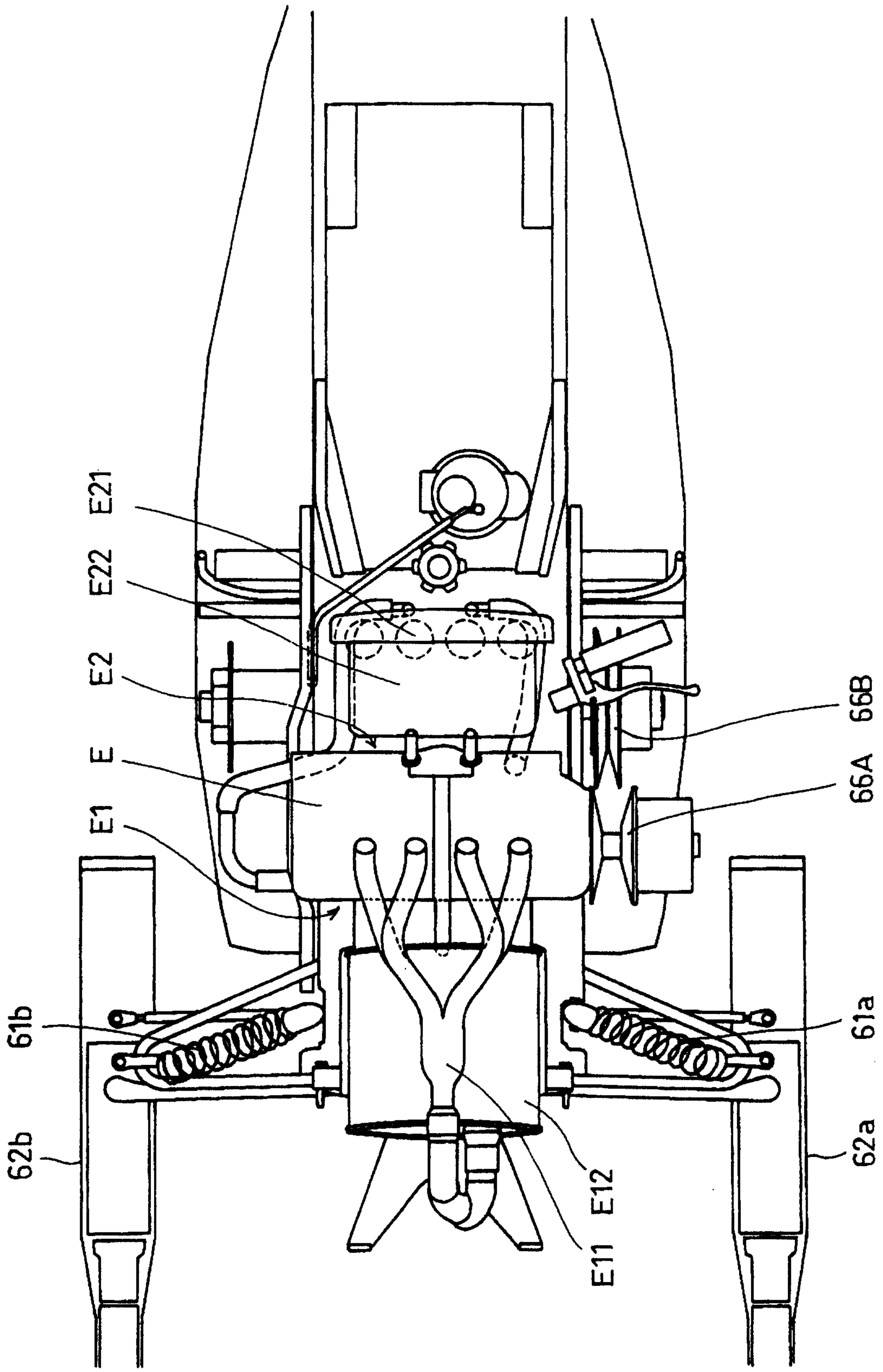
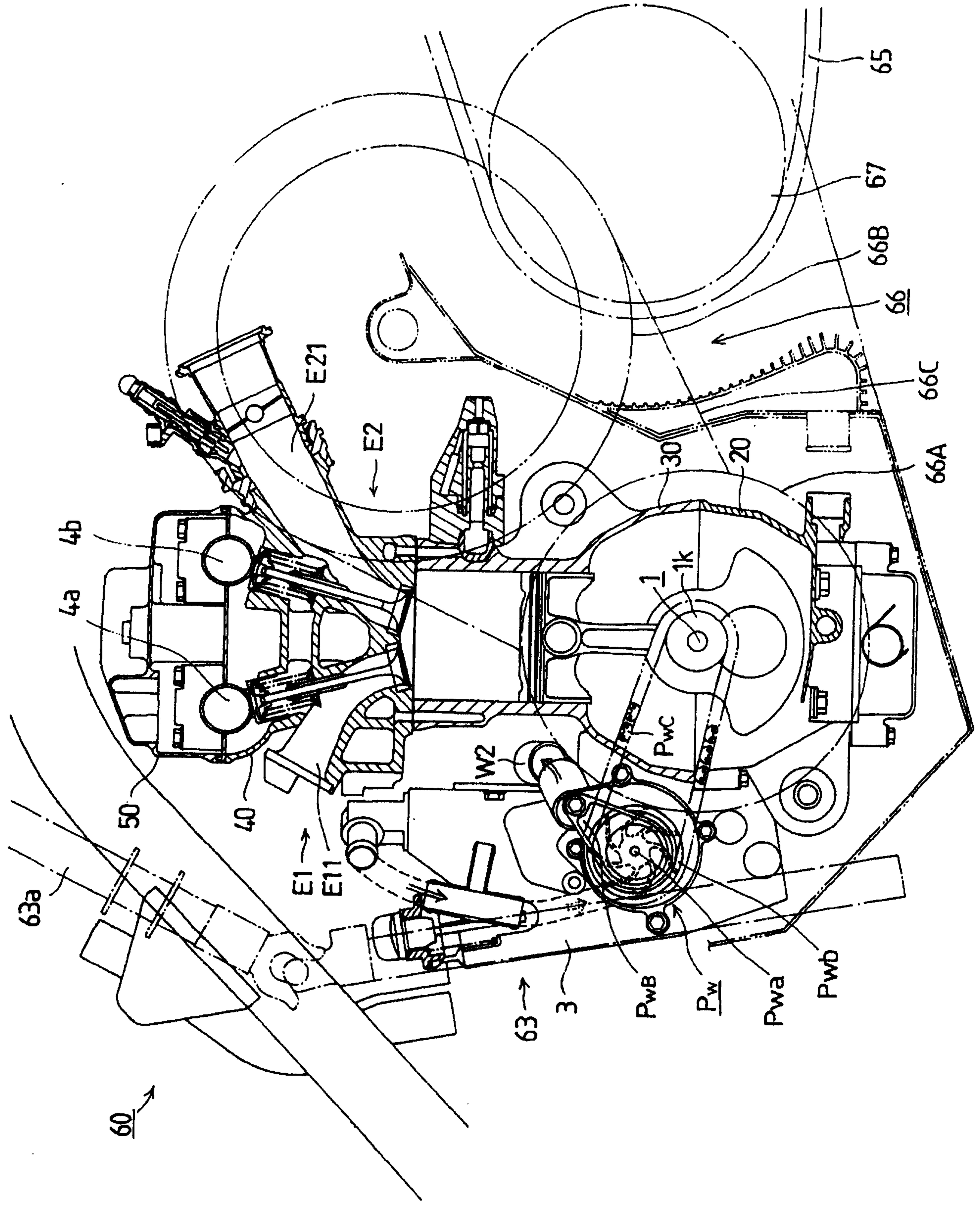


FIG. 3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PwB
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Pwb
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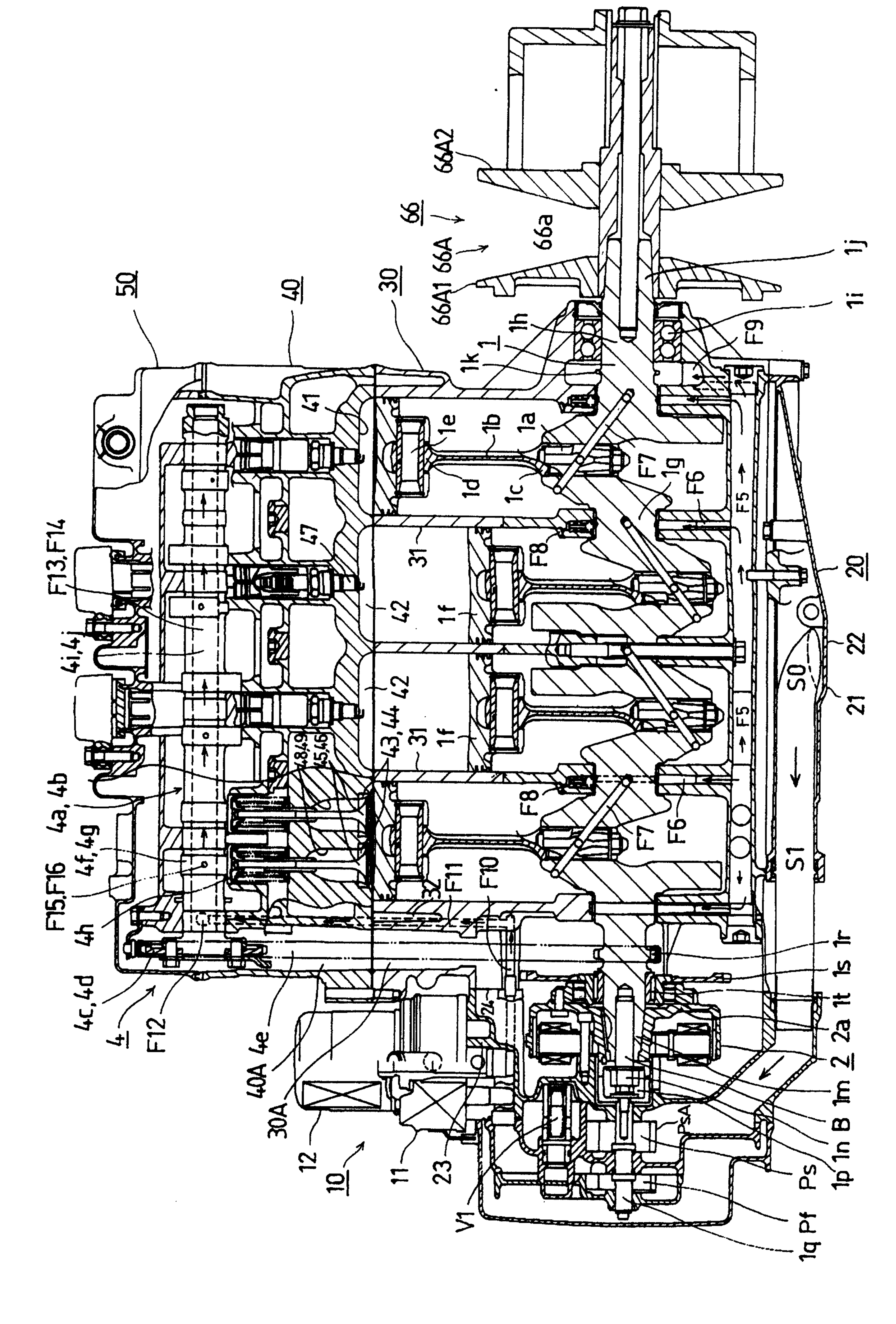
FIG. 4



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F5
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F8
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1f
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F15,F16
4f,4g
4h
4c,4d
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F12
F11
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11
10
23
V1

FIG. 5

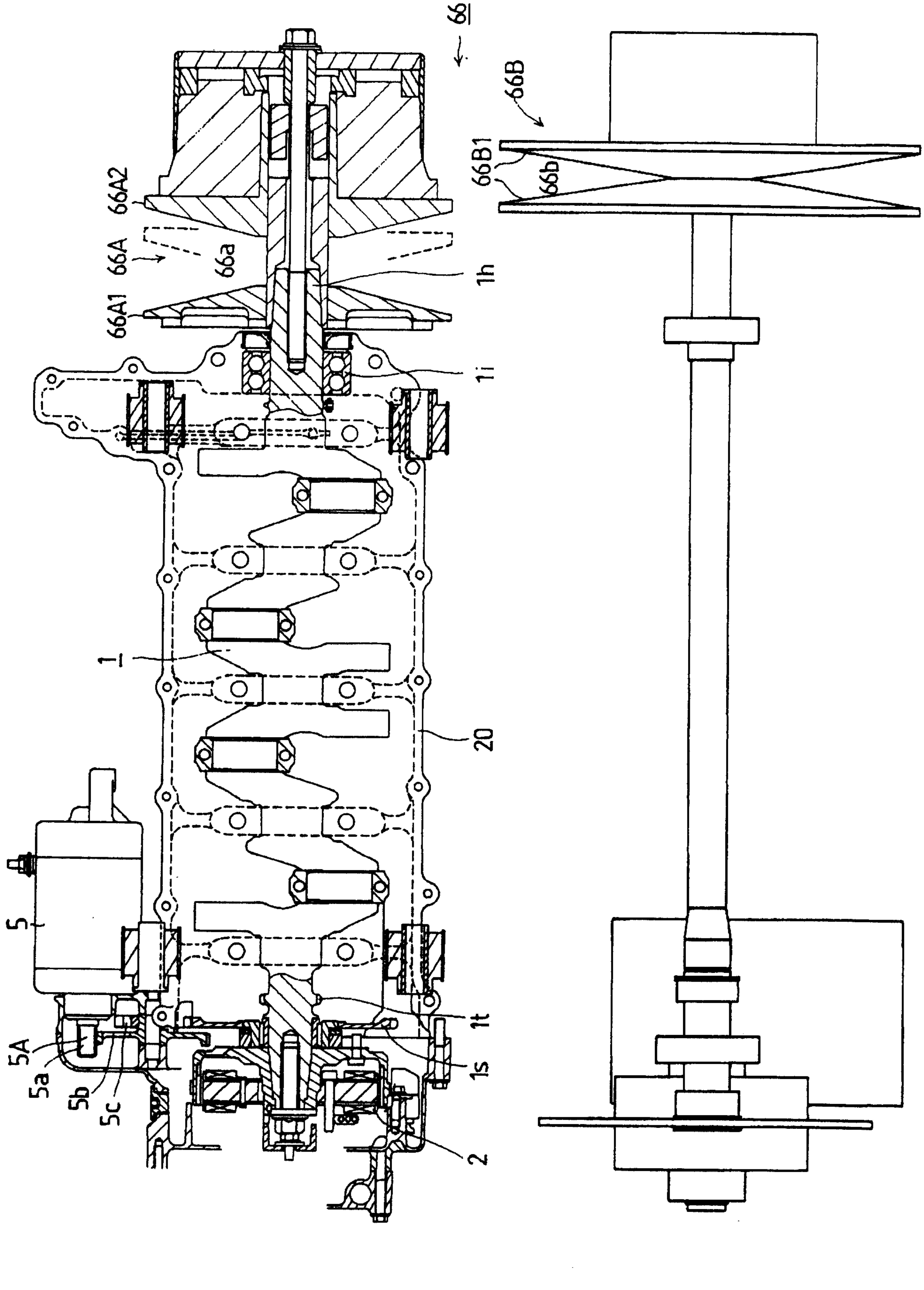
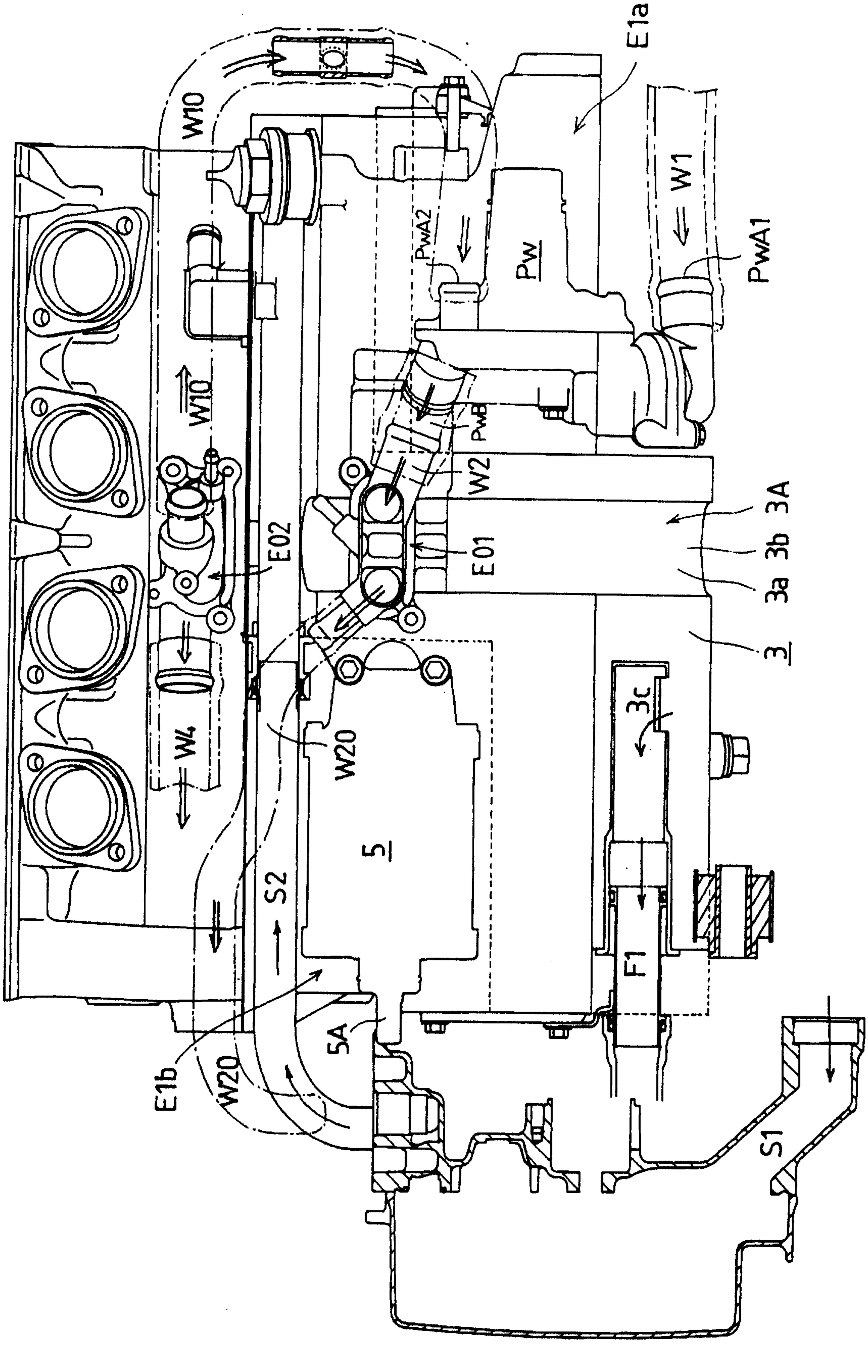


FIG. 6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W20
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S2
F1
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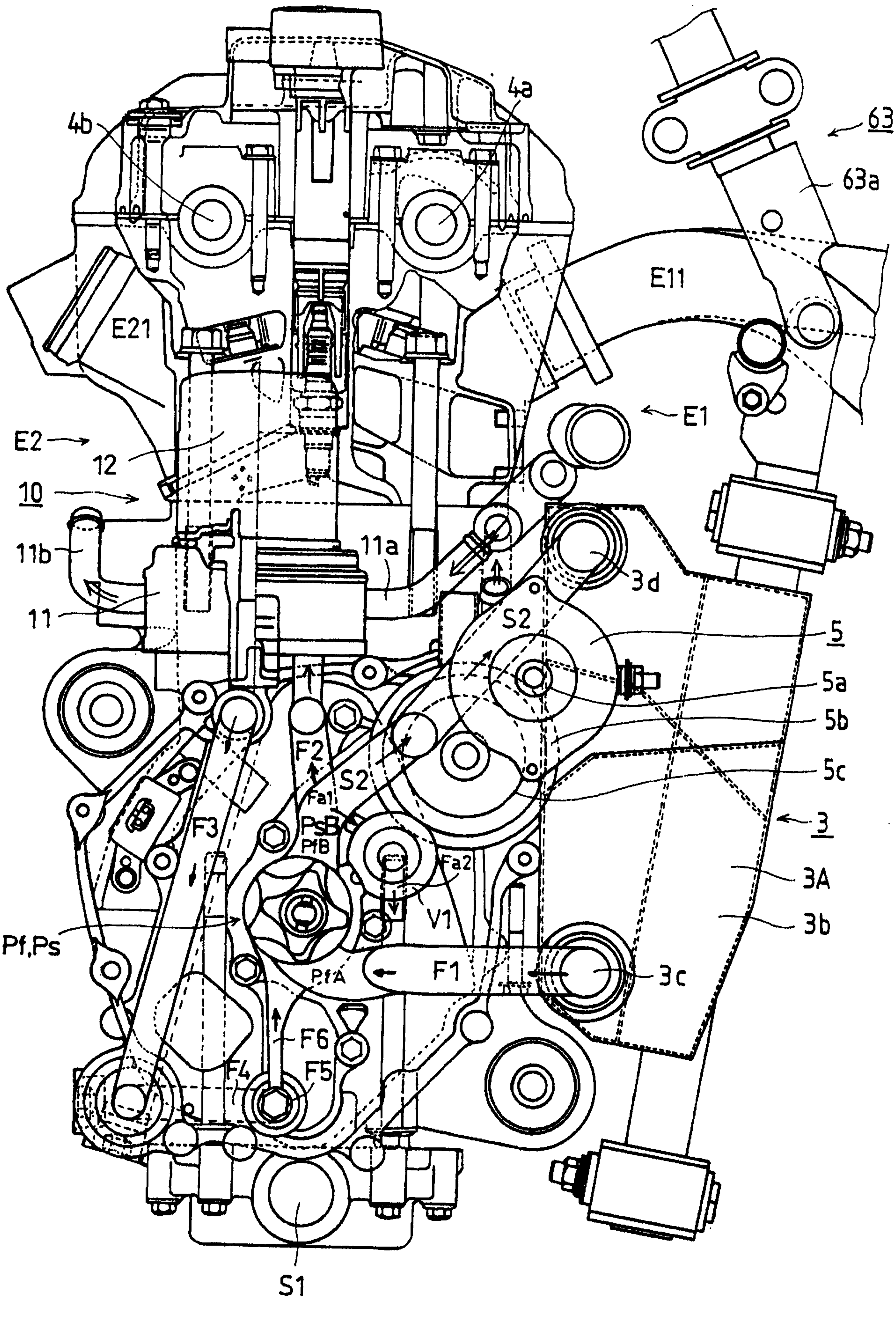
S1

FIG. 7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S2
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F5
S1

FIG. 8

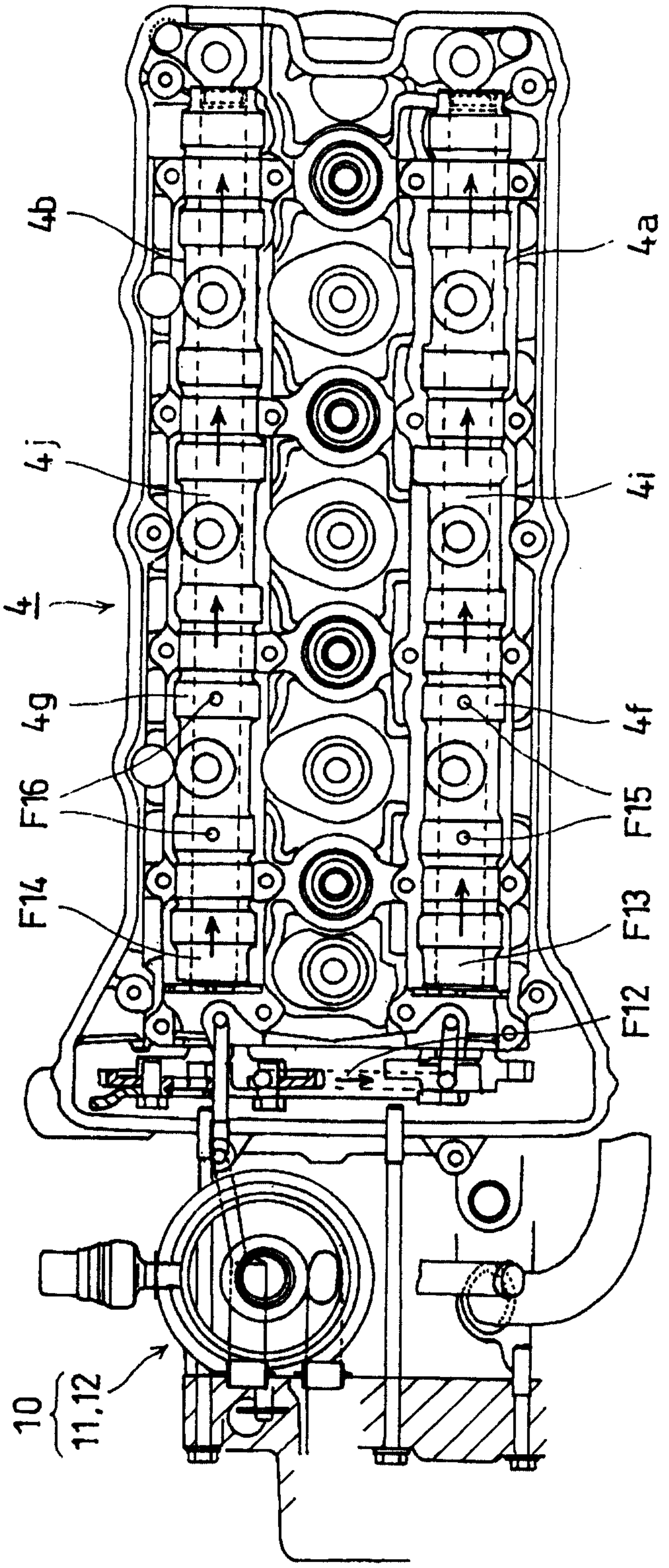


FIG. 9

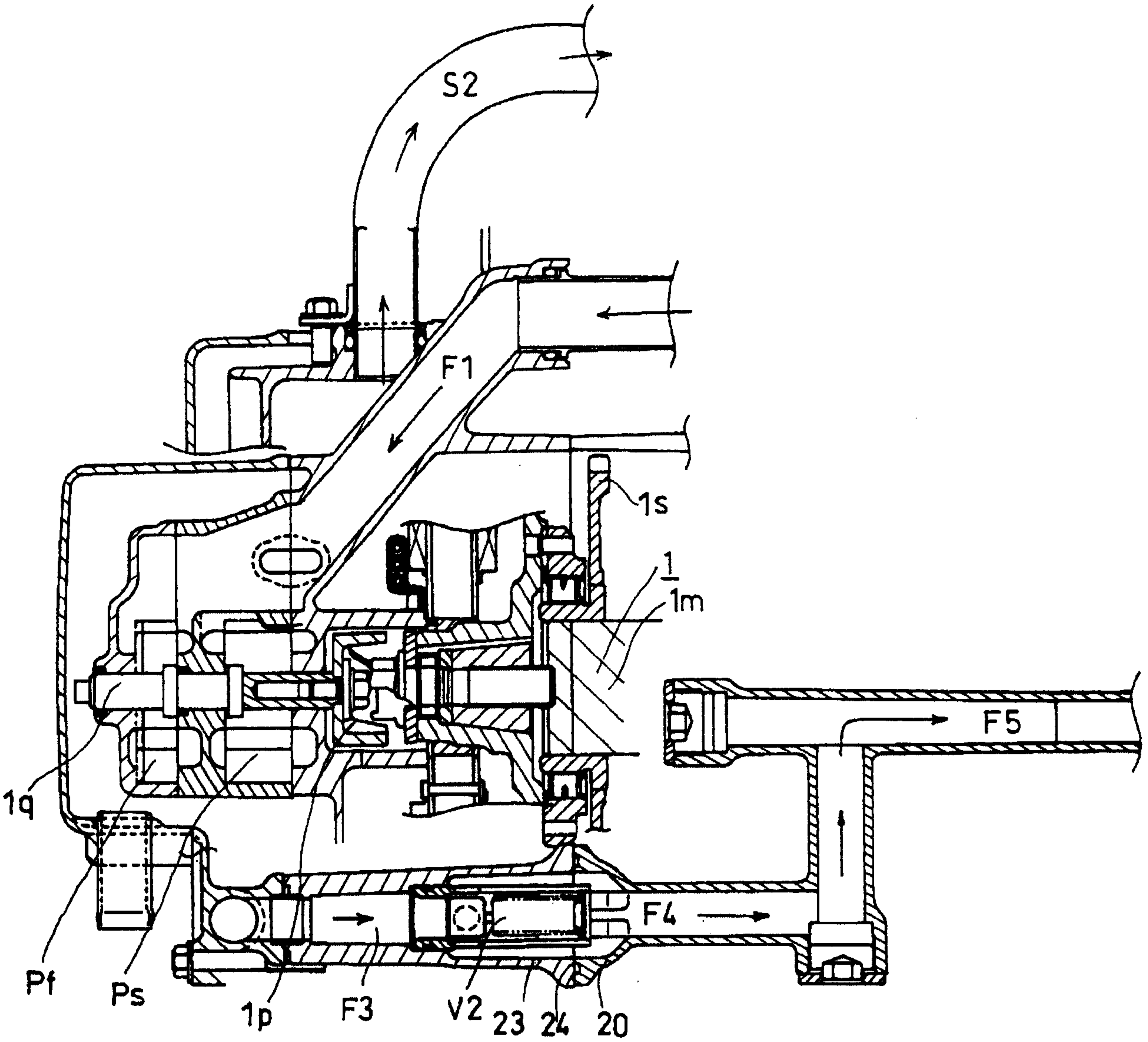
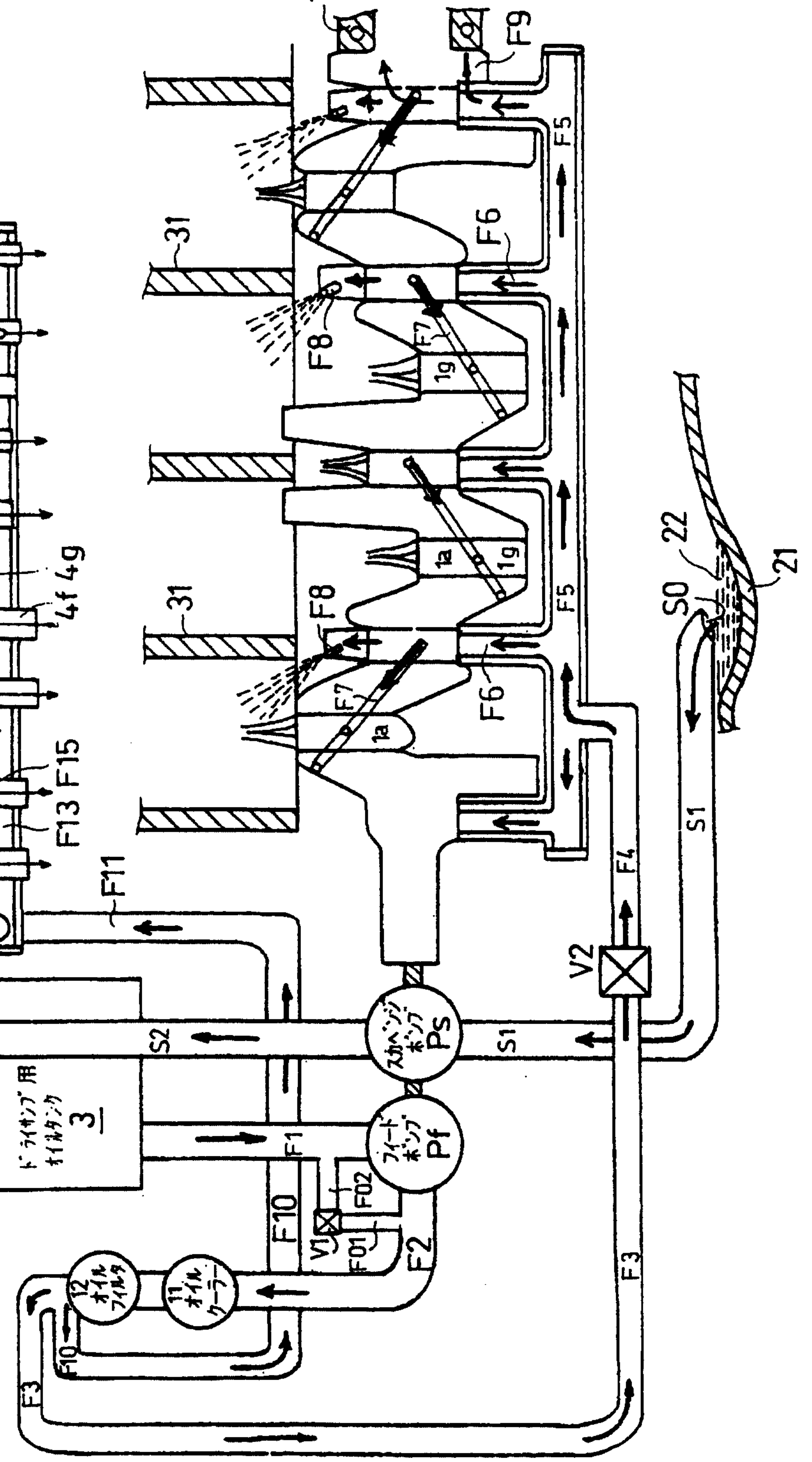


FIG. 10



3: Oil tank for dry sump
11: Oil cooler
12: Oil filter
Pf: Feed pump
Ps: Scavenging pump

FIG. 11

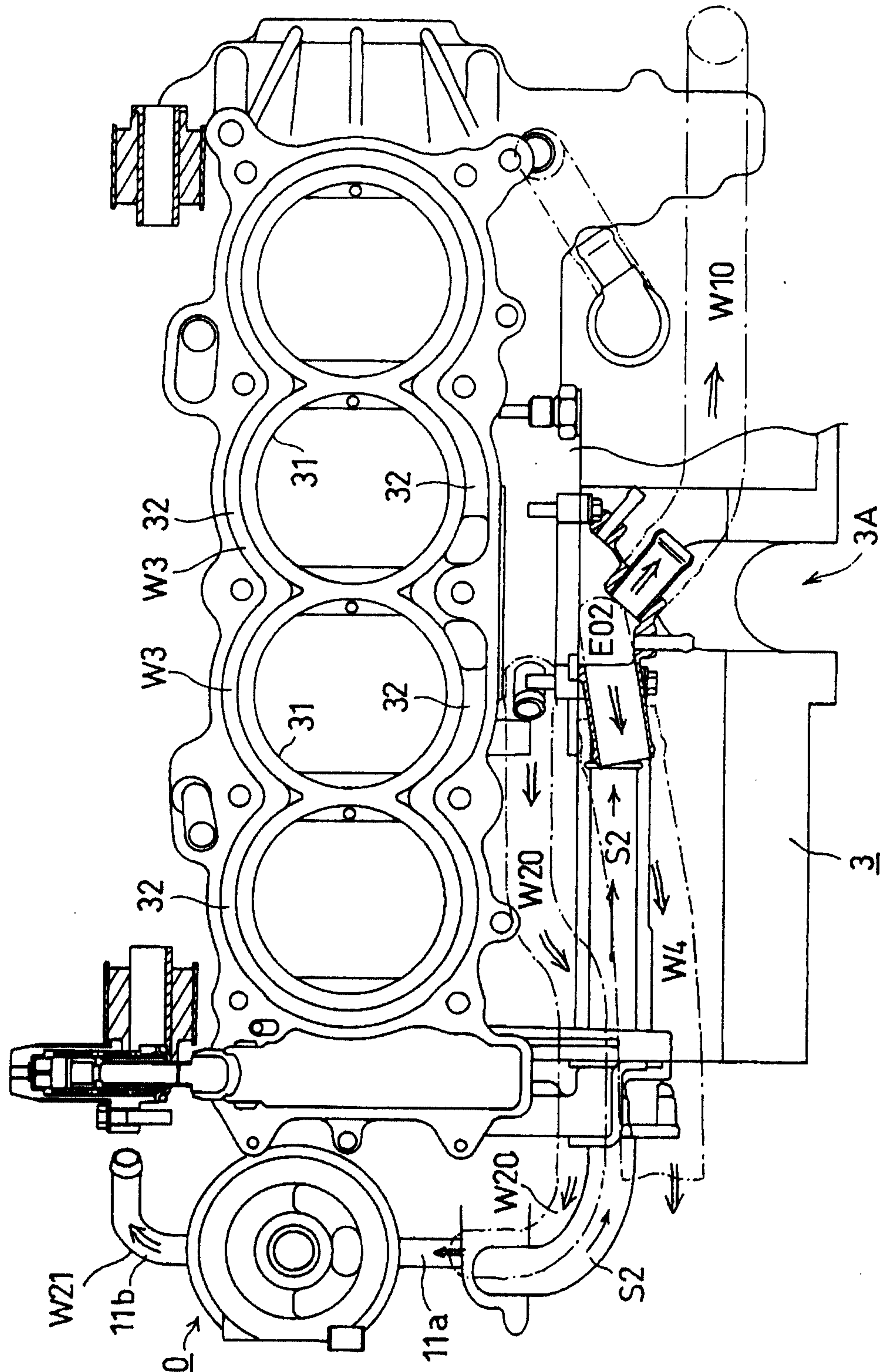


FIG. 12

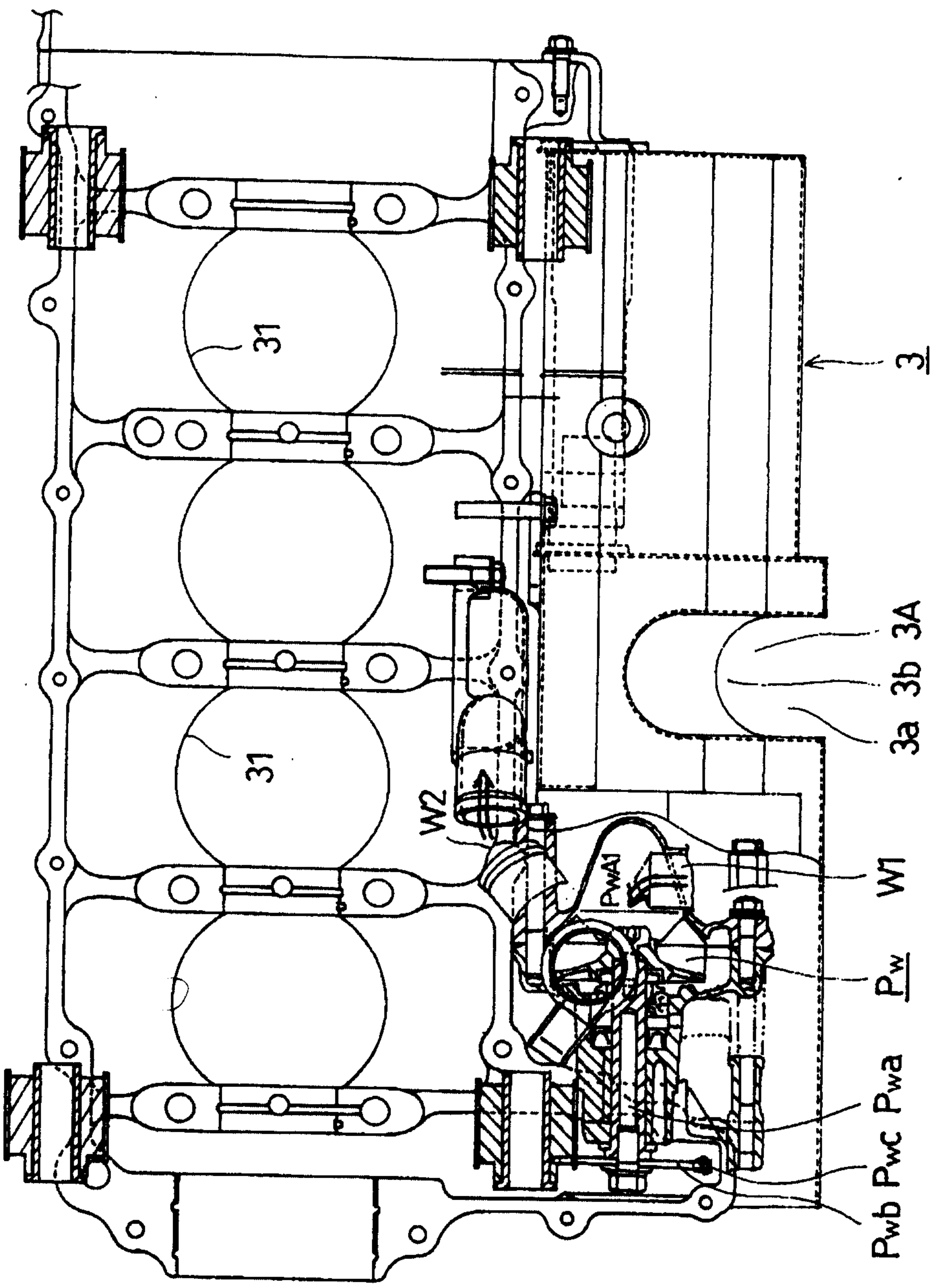


FIG. 13

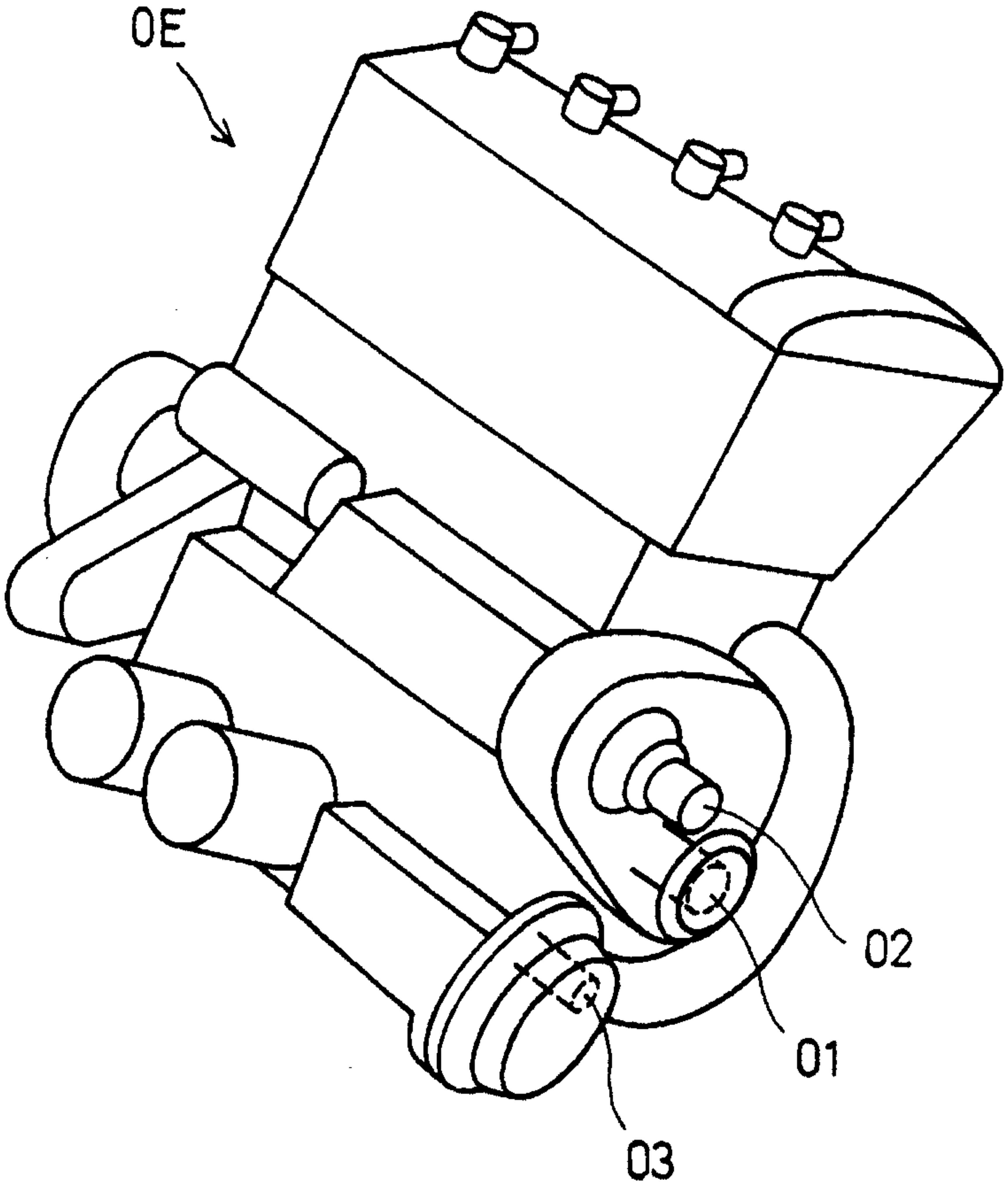
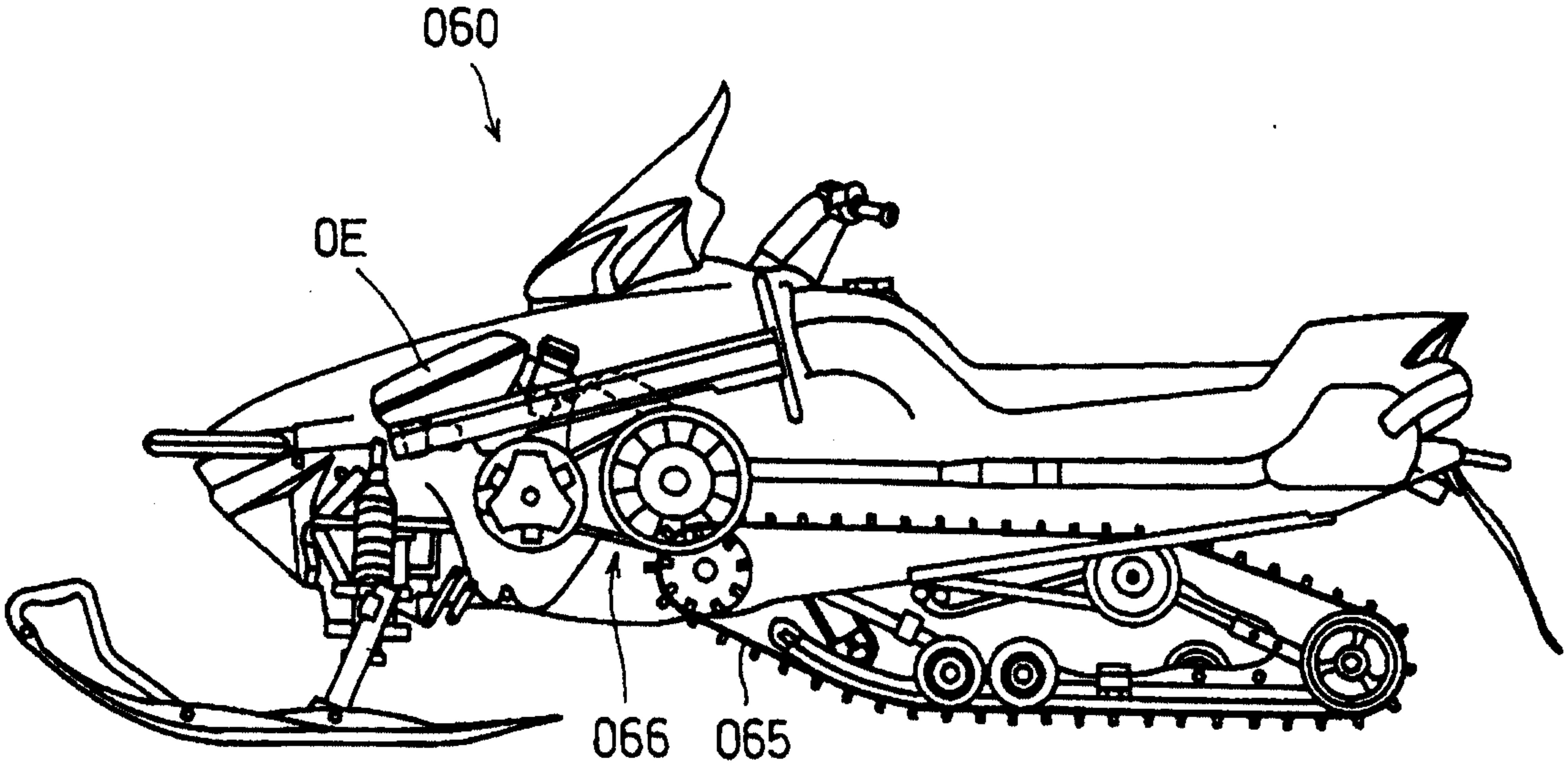
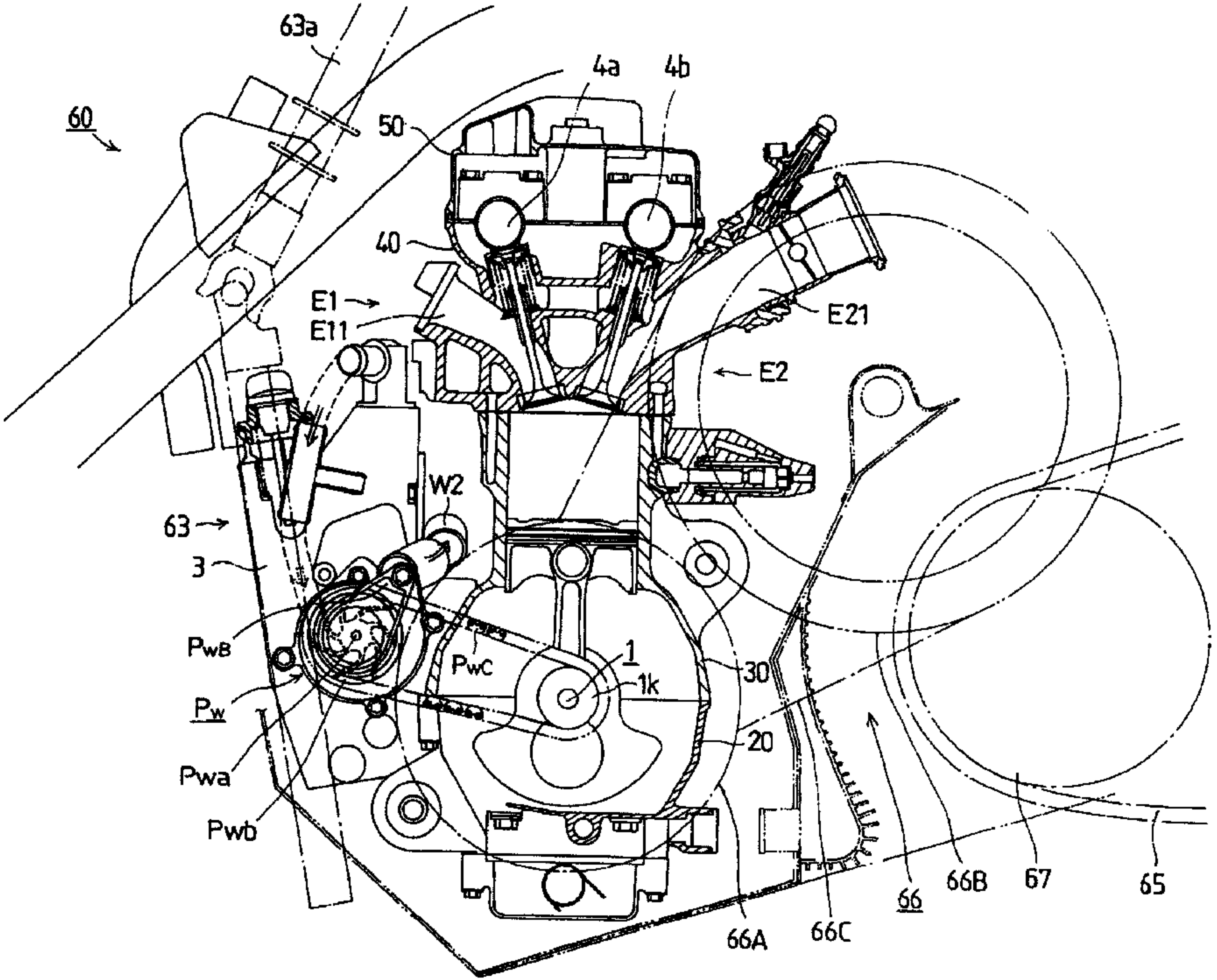


FIG. 14





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