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(54) ENGINE AND VEHICLE

(57) The center of gravity of the weight (42) is disposed in a first region (A1) as seen from the axial direction of the cam shaft (26). The first region (A1) is located in the first vertical (Y1) direction from the horizontal axis and in the first horizontal direction (x1) from the vertical axis. A circumferential direction end portion of a first weight (47) portion is located in the first horizontal direction (x1) from the vertical axis. A circumferential direction end portion (481) of a second weight portion (48) is located in the second horizontal direction (x2) from the vertical axis. The first weight portion (47) is longer than the second weight portion (48) in the circumferential direction of the cam shaft (26). The decompression pin (44) is connected to the first weight portion (47).

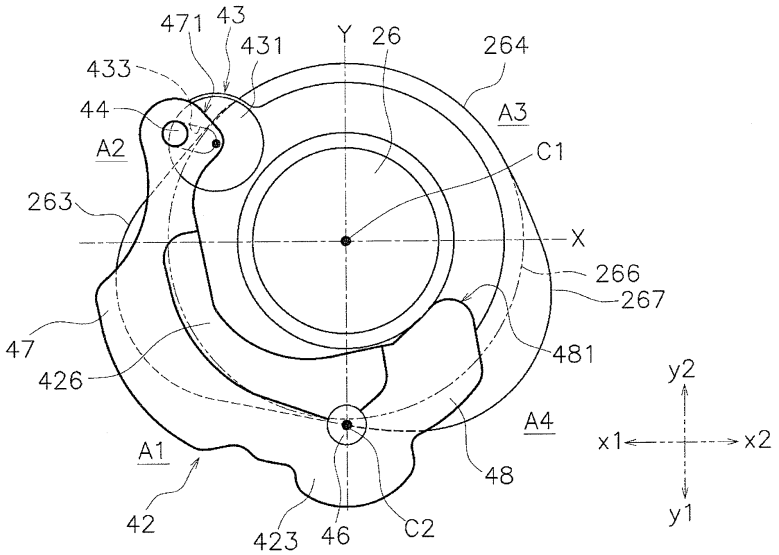


FIG. 8

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Description

[0001] The present invention relates to an engine equipped with a decompression mechanism, and to a vehicle.

[0002] When starting an engine, the engine needs to be rotated with an external force until the start is completed. For example, the engine may be rotated using a starter motor or using a kick starter. Conversely, resistance to the rotation increases because the air inside the cylinder is compressed during the compression stroke of the engine. In order to reduce this resistance, a decompression mechanism is known that reduces the pressure inside the cylinder during the compression stroke while the engine is being rotated using the external force.

[0003] For example, the decompression mechanism disclosed in Japanese Laid-Open Patent Publication No. 2008-128171 includes a decompression cam that alternates between an active state and a release state due to the rotation of a weight. This decompression mechanism is supported by a sprocket on a cam chain. As a result, there is a problem that the cam shaft that includes the decompression mechanism needs to be longer in the axial direction.

[0004] The engine disclosed in Japanese Laid-Open Patent Publication No. 2008-64083 includes a decompression mechanism that is disposed at a location between both end portions of a cam shaft. The decompression mechanism includes a weight and a decompression cam, and the weight is supported by a supporting shaft in a rotatable manner around the cam shaft. The decompression cam and the weight are connected by a pin and the pin allows the decompression cam to rotate due to the weight rotating around the support shaft.

[0005] The weight in the decompression mechanism in Japanese Laid-Open Patent Publication No. 2008-64083 is held in a closed state due to the action of a return spring when the cam shaft is not rotating. The decompression cam enters a state that allows an action on an exhaust valve while the weight is in the closed state. Therefore, the pressure inside the cylinder is reduced due to the decompression cam acting on the exhaust valve and opening the exhaust valve when starting the engine.

[0006] When the cam shaft rotates, the weight rotates around the support shaft due to centrifugal force. When the rotation speed of the cam shaft meets or exceeds a set rotation speed, the centrifugal force exceeds the spring force of the return spring and the weight enters an open state. The decompression cam does not act upon the exhaust valve while the weight is in the open state.

[0007] The decompression mechanism described in Japanese Laid-Open Patent Publication No. 2008-64083 is able to effectively use the space between both ends of the cam shaft. As a result, the cam shaft that includes the decompression mechanism can be made more compact in the axial direction in comparison to a case in which the decompression mechanism is disposed outside of the cam shaft. However, according to a study by the inventors of the present application, it can be seen that the decompression mechanism does not work during starting and the improvement in startability is insufficient in the engine as in the prior art as described in Japanese Laid-Open Patent Publication No. 2008-64083.

[0008] An object of the present invention is to provide an engine that is able to improve the startability of the decompression mechanism, and a vehicle.

[0009] This object is solved by an engine according to claim 1 and a vehicle according to claim 9. Advantageous further developments of the invention are specified in the dependent claims and described in the specification.

[0010] The inventors of the present application studied the cause of the decompression not working during starting in the engine according to the prior art. As a result, it can be seen that the weight may already be in an open state when starting the engine. That is, it can be seen that the weight rotates while in the open state when the cam shaft is not rotating.

[0011] According to studies by the inventors of the present application, it is thought that the aforementioned state arises due to weakness of the spring force of the return spring. The cause of the weakness of the spring force is attributed to the weight being reduced due to the disposition of the decompression mechanism between both ends of the cam shaft. That is, because the decompression mechanism is disposed between both ends of the cam shaft in the decompression mechanism described in Japanese Laid-Open Patent Publication No. 2008-64083, the limitation of the disposition is greater than that of the decompression mechanism described in Japanese Laid-Open Patent Publication No. 2008-128171. As a result, there is a need to make the weight in the decompression mechanism as described in Japanese Laid-Open Patent Publication No. 2008-64083 smaller than the weight as described in Japanese Laid-Open Patent Publication No. 2008-128171.

[0012] If the weight is reduced in size, the mass of the weight is reduced. The magnitude of the centrifugal force acting on the weight becomes smaller in correspondence to the reduction in the mass of the weight if the rotation speed is the same. As a result, the centrifugal force acting on the weight at the set rotation speed for initiating the open state of the weight is correspondingly reduced. Therefore, there is a need to reduce the spring force.

[0013] However, the location of the weight changes in accordance with the phase of the cam shaft rotation. The cam shaft may stop when the opening direction of the weight and the gravitational force direction are in correspondence. In this case, the inventors of the present application came to the conclusion that the moment due to gravitational force acting on the weight becomes greater than the spring force and consequently the weight enters the open state.

[0014] While it may be thought that increasing the spring force would prevent the above phenomenon from occurring, the set rotation speed for opening the weight

would rise if the spring force is increased. A rise in the set rotation speed would lead to the occurrence of noise which is not desirable.

[0015] An engine according to the present invention comprises a cylinder head, an exhaust valve, a valve mechanism, a cam shaft, a bearing, and a decompression mechanism. The exhaust valve is housed inside the cylinder head. The valve mechanism opens and closes the exhaust valve. The cam shaft drives the valve mechanism by coming into contact with the valve mechanism. The bearing supports the cam shaft in a rotatable manner on the cylinder head. The decompression mechanism is disposed between both ends of the cam shaft in the axial direction. The decompression mechanism includes a weight, a return spring, a decompression cam, and a decompression pin. The weight is supported on the cam shaft in a rotatable manner between a closed state and an open state. The return spring urges the weight to return from the open state to the closed state. The decompression cam is provided so as to come into contact with the valve mechanism when the weight is in the closed state, and so as not to come into contact with the valve mechanism when the weight is in the open state. The decompression pin connects the weight and the decompression cam.

[0016] A straight line that passes through the center of rotation of the cam shaft and the center of rotation of the weight is assumed to be a vertical axis as seen from the axial direction of the cam shaft. A straight line that is orthogonal to the vertical axis and that passes through the center of rotation of the cam shaft is assumed to be a horizontal axis. A direction from the center of rotation of the cam shaft toward the center of rotation of the weight and parallel to the vertical axis is assumed to be a first vertical direction. One direction among the directions parallel to the horizontal axis is assumed to be a first horizontal direction. The direction opposite the first horizontal direction is assumed to be a second horizontal direction.

[0017] The center of gravity of the weight is disposed in a first region as seen from the axial direction of the cam shaft. The first region is located in the first vertical direction from the horizontal axis and in the first horizontal direction from the vertical axis. The weight includes a first weight portion and a second weight portion. The first weight portion extends from the center of rotation of the weight in the circumferential direction of the cam shaft. A circumferential direction end portion of the first weight portion is located in the first horizontal direction from the vertical axis. The second weight portion extends from the center of rotation of the weight in the circumferential direction of the cam shaft. A circumferential direction end portion of the second weight portion is located in the second horizontal direction from the vertical axis. The first weight portion is longer than the second weight portion in the circumferential direction of the cam shaft. The decompression pin is connected to the first weight portion.

[0018] The circumferential direction end portion of the first weight portion is located in the first horizontal direction from the vertical axis in the engine according to the present invention. That is, the first weight portion extends so as not to cross the vertical axis in the second horizontal direction. Therefore, the center of gravity of the weight can be provided further away from the center of rotation of the cam shaft in comparison to when the first weight portion extends from a region located in the first horizontal direction from the vertical axis to a location in which the first weight portion crosses the vertical axis in the second horizontal direction. Therefore, the centrifugal force acting on the weight increases if the rotation speed of the cam shaft is the same. As a result, the spring force can be increased whereby the opening of the weight due to gravitational force can be suppressed without raising the set rotation speed.

[0019] A moment due to the gravitational force acting on the weight can be reduced because the center of gravity of the weight can be provided nearer the center of rotation of the weight. As a result, the opening of the weight due to the gravitational force can be suppressed.

[0020] Moreover, the decompression pin is connected to the first weight portion which is longer than the second weight portion. As a result, the distance between the decompression pin and the center of rotation of the weight can be increased in comparison to when the decompression pin is connected to the second weight portion. As a result, the movement amount of the decompression pin relative to the rotation angle of the weight is increased. In other words, the rotation angle of the weight which allows the weight to switch from the closed state to the open state can be reduced. As a result, displacement of the locations of the center of gravity of the weight when the weight is in the closed state and when the weight is in the open state can be reduced. By reducing the rotation angle of the weight, interference with members around the weight can be avoided more easily. As a result, the shape of the weight has a higher degree of freedom.

[0021] The distance between the center of gravity of the weight and the center of rotation of the cam shaft when the weight is in the open state is greater than the distance between the center of gravity of the weight and the center of rotation of the cam shaft when the weight is in the closed state. As a result, it becomes more difficult for the weight to return to the closed state as the displacement of the locations of the center of gravity of the weight increases when the weight is in the closed state and in the open state increases.

[0022] However, the weight is able to return to the closed state more easily because the aforementioned displacement of the locations of the center of gravity of the weight when the weight is in the closed state and in the open state can be reduced in the engine according to the present embodiment.

[0023] The startability of the engine can be improved because the open state of the weight when starting the engine can be avoided more easily as described above in the engine according to present embodiment.

[0024] The first weight portion preferably includes a

first portion and a second portion. The first portion is disposed in a first region as seen from the axial direction of the cam shaft. The second portion is disposed in a second region as seen from the axial direction of the cam shaft. The second region is located in a second vertical direction from the horizontal axis and in the first horizontal direction from the vertical axis. The second vertical direction is the direction opposite the first vertical direction. The circumferential direction end portion of the first weight portion is disposed in the second region as seen from the axial direction of the cam shaft. In this case, the center of gravity of the weight can be provided further away from the center of rotation of the cam shaft in comparison to when the first weight portion extends from a region located in the first horizontal direction from the vertical axis to a location in which the first weight portion crosses the vertical axis in the second horizontal direction. The decompression pin is more easily provided away from the center of rotation of the weight in comparison to when the end portion of the first weight portion is disposed in the first region.

[0025] The decompression pin is preferably disposed in the second region as seen from the axial direction of the cam shaft. In this case, the end portion of the first weight portion can be disposed in the second region as seen from the axial direction of the cam shaft.

[0026] As seen from the axial direction of the cam shaft, the distance between the center of rotation of the weight and the decompression pin is preferably not less than the distance between the center of rotation of the weight and the center of rotation of the cam shaft. In this case, the distance between the decompression pin and the center of rotation of the weight can be increased.

[0027] The cam shaft preferably includes an exhaust cam that comes into contact with the decompression mechanism. The exhaust cam includes a cam lobe that protrudes to the outside of a base circle. The center of rotation of the weight is located further toward the inside in a cam shaft radial direction than the base circle of the exhaust cam. In this case, the center of rotation of the weight and the center of gravity of the weight can be brought nearer to each other.

[0028] The center of rotation of the weight may be located further toward the outside in a cam shaft radial direction than the external peripheral surface of the cam lobe. In this case, the distance between the decompression pin and the center of rotation of the weight can be increased.

[0029] The weight preferably does not include a portion that is disposed in a third region as seen from the axial direction of the cam shaft. The third region is located in a second vertical direction from the horizontal axis and in a second horizontal direction from the vertical axis. In this case, the center of gravity of the weight can be provided further away from the center of rotation of the cam shaft. Moreover, the center of rotation of the weight and the center of gravity of the weight can be brought nearer to each other.

[0030] An end portion of the second weight portion is preferably provided in a fourth region as seen from the axial direction of the cam shaft. The fourth region is located in the first vertical direction from the horizontal axis and in the second horizontal direction from the vertical axis. In this case, the center of rotation of the weight and the center of gravity of the weight can be brought nearer to each other.

[0031] A vehicle according to the present invention includes the above engine.

[0032] According to the present invention, an engine that allows for an improvement in the startability of the decompression mechanism, and a vehicle can be provided.

FIG. 1 is a side view of a vehicle.
FIG. 2 is a partial cross-sectional view of an engine.
FIG. 3 is a cross-sectional view of a cylinder head on a plane perpendicular to a cam shaft.
FIG. 4 is an enlarged cross-sectional view of a cam shaft assembly.
FIG. 5 is a perspective view of a cam shaft assembly.
FIG. 6 is an exploded view of the cam shaft assembly.
FIG. 7 illustrates a weight in a closed state.
FIG. 8 illustrates a weight in an open state.
FIG. 9 depicts enlargements of an exhaust cam.
FIG. 10 is side view of the cam shaft assembly.
FIG. 11 illustrates the cam shaft assembly as seen from the axial direction of the cam shaft.
FIG. 12 illustrates the weight as seen from the axial direction of the cam shaft.
FIG. 13 is a perspective view of the weight.
FIG. 14 is side view of the cam shaft assembly as seen from the direction of arrow XIV in FIG. 10.
FIG. 15 illustrates a flange, the weight, and a return spring as seen from the axial direction of the cam shaft.
FIG. 16 illustrates a cylinder head while a head cover is removed.
FIG. 17 illustrates a weight according to a first modified example.
FIG. 18 illustrates a weight according to a second modified example.
FIG. 19 illustrates a weight according to a third modified example.
FIG. 20 illustrates a weight according to a fourth modified example.

[0033] The following is an explanation of a vehicle 1 according to the embodiments with reference to the drawings. FIG. 1 is a side view of the vehicle 1. The vehicle 1 is a scooter-type motorcycle. The vehicle 1 includes a vehicle body 2, a front wheel 3, a rear wheel 4, a handle 5, and a seat 6. The vehicle body 2 includes a flat foot board 2a. The vehicle body 2 supports the front wheel 3 and the rear wheel 4. The handle 5 and the seat 6 are attached to the vehicle body 2. The flat foot board 2a is

disposed in front of and under the seat 6.

[0034] The vehicle 1 includes an engine 7 according to the embodiment. FIG. 2 is a partial cross-sectional view of the engine 7. As illustrated in FIG. 2, the engine 7 includes a crankshaft 11, a crankcase 12, a cylinder body 13, a cylinder head 14, and a head cover 19. The cylinder body 13 is connected to the crankcase 12. The cylinder body 13 may be integrated with the crankcase 12 or may be a separate body. The cylinder body 13 houses a piston 15. The piston 15 is coupled to the crankshaft 11 via a connecting rod 16. The crankshaft 11 is connected to a transmission 8.

[0035] The cylinder head 14 is connected to the cylinder body 13. The cylinder head 14 includes a combustion chamber 17. A spark plug 18 is attached to the cylinder head 14. A distal end portion of the spark plug 18 is disposed so as to face the combustion chamber 17. The head cover 19 is attached to the cylinder head 14.

[0036] The engine 7 includes a valve mechanism 25 and a cam shaft 26. The valve mechanism 25 and the cam shaft 26 are housed in the cylinder head 14. The cam shaft 26 drives the valve mechanism 25 by coming into contact with the valve mechanism 25.

[0037] The cam shaft 26 is supported on the cylinder head 14. The cylinder head 14 includes a first supporting wall 141 and a second supporting wall 142. The first supporting wall 141 and the second supporting wall 142 are disposed so as to be aligned in the axial direction of the cam shaft 26 (referred to below as "cam shaft direction"). The first supporting wall 141 supports the cam shaft 26. The first supporting wall 141 supports the cam shaft 26 via a first bearing 27. The second supporting wall 142 supports the cam shaft 26. The second supporting wall 142 supports the cam shaft 26 via a second bearing 28. The first bearing 27 and the second bearing 28 are supported in the cylinder head 14 in a manner that allows the cam shaft 26 to rotate. The outer diameter of the first bearing 27 is larger than the outer diameter of the second bearing 28. The first supporting wall 141 may support the cam shaft 26 without the first bearing 27. The second supporting wall 142 may support the cam shaft 26 without the second bearing 28.

[0038] The cam shaft 26 includes a first cam shaft end portion 261 and a second cam shaft end portion 262. The first bearing 27 is disposed nearer the first cam shaft end portion 261 in the cam shaft direction than the second cam shaft end portion 262. The second bearing 28 is disposed nearer the second cam shaft end portion 262 in the cam shaft direction than the first cam shaft end portion 261.

[0039] A cam chain 29 is wound around the cam shaft 26 and the crankshaft 11. Specifically, a first sprocket 31 is attached to the cam shaft 26. The first sprocket 31 is attached to the first cam shaft end portion 261. A second sprocket 32 is attached to the crankshaft 11. The cam chain 29 is wound around the first sprocket 31 and the second sprocket 32.

[0040] The rotation of the crankshaft 11 is transmitted to the cam shaft 26 via the cam chain 29 whereby the cam shaft 26 rotates. The cam shaft 26 includes a suction cam 263 and an exhaust cam 264. The suction cam 263 and the exhaust cam 264 are disposed in a line in the cam shaft direction. The cam shaft 26 rotates whereby the suction cam 263 and the exhaust cam 264 rotate. The suction cam 263 and the exhaust cam 264 come into contact with the valve mechanism 25 and the valve mechanism 25 is driven by the rotation of the suction cam 263 and the exhaust cam 264.

[0041] FIG. 3 is a cross-sectional view of the cylinder head 14 on a plane perpendicular to the cam shaft 26. As illustrated in FIG. 3, the engine 7 includes an exhaust valve 23 and a suction valve 24. The cylinder head 14 includes a suction port 21 and an exhaust port 22 that communicate with the combustion chamber 17. The exhaust valve 23 and the suction valve 24 are housed in the cylinder head 14. The suction valve 24 opens and closes the suction port 21. The exhaust valve 23 opens and closes the exhaust port 22. The valve mechanism 25 opens and closes the suction valve 24 and the exhaust valve 23.

[0042] A suction valve spring 241 is attached to the suction valve 24. The suction valve spring 241 urges the suction valve 24 in a direction that causes the suction valve 24 to close the suction port 21. An exhaust valve spring 231 is attached to the exhaust valve 23. The exhaust valve spring 231 urges the exhaust valve 23 in a direction that causes the exhaust valve 23 to close the exhaust port 22.

[0043] The valve mechanism 25 includes an exhaust rocker shaft 33 and an exhaust rocker arm 34. The exhaust rocker shaft 33 is disposed parallel to the cam shaft 26. The exhaust rocker shaft 33 is supported on the cylinder head 14. The exhaust rocker arm 34 is supported on the exhaust rocker shaft 33 in a manner that enables swinging around the exhaust rocker shaft 33. The exhaust rocker arm 34 is provided in a manner that allows the exhaust valve 23 to operate. The exhaust rocker arm 34 includes an arm body 341, an exhaust roller 342, and an exhaust valve compressing portion 343.

[0044] The arm body 341 is supported on the exhaust rocker shaft 33 in a manner that enables swinging. One end of the arm body 341 supports the exhaust roller 342 in a rotatable manner. The other end of the arm body 341 supports the exhaust valve compressing portion 343. The exhaust roller 342 comes into contact with the exhaust cam 264 and rotates due to the rotation of the exhaust cam 264. A distal end of the exhaust valve compressing portion 343 faces a stem end 232 of the exhaust valve 23.

[0045] When the exhaust roller 342 is pushed upward due to the exhaust cam 264, the exhaust valve compressing portion 343 presses down on the stem end 232 of the exhaust valve 23 due to the swinging of the exhaust rocker arm 34. As a result, the exhaust valve 23 is pressed down and the exhaust port 22 is opened. When the exhaust roller 342 is not pushed upward by the exhaust cam 264, the exhaust valve 23 is pressed upward by the

exhaust valve spring 231 and the exhaust port 22 is closed.

[0046] The valve mechanism 25 includes a suction rocker shaft 35 and a suction rocker arm 36. The suction rocker shaft 35 is disposed parallel to the cam shaft 26. The suction rocker shaft 35 is supported on the cylinder head 14. The suction rocker arm 36 is supported on the suction rocker shaft 35 in a manner that enables swinging around the suction rocker shaft 35. The suction rocker arm 36 is provided in a manner that allows the suction valve 24 to operate. The suction rocker arm 36 includes an arm body 361, a suction roller 362, and a suction valve compressing portion 363.

[0047] The arm body 361 is supported on the suction rocker shaft 35 in a manner that enables swinging. One end of the arm body 361 supports the suction roller 362 in a rotatable manner. The other end of the arm body 361 supports the suction valve compressing portion 363. The suction roller 362 comes into contact with the suction cam 263 and rotates due to the rotation of the suction cam 263. A distal end of the suction valve compressing portion 363 faces a stem end 242 of the suction valve 24.

[0048] When the suction roller 362 is pushed upward due to the suction cam 263, the suction valve compressing portion 363 presses down on the stem end 242 of the suction valve 24 due to the swinging of the suction rocker arm 36. As a result, the suction valve 24 is pressed down and the suction port 21 is opened. When the suction roller 362 is not pushed upward by the suction cam 263, the suction valve 24 is pressed down by the suction valve spring 241 and the suction port 21 is closed.

[0049] As illustrated in FIG. 2, the engine 7 includes a decompression mechanism 40. FIG. 4 is an enlargement of an assembly (referred to as "cam shaft assembly" below) including the cam shaft 26, the decompression mechanism 40, and the first bearing 27. The decompression mechanism 40 is disposed between the first cam shaft end portion 261 and the second cam shaft end portion 262 in the cam shaft direction. The decompression mechanism 40 is disposed between the first supporting wall 141 and a second supporting wall 142 of the cylinder head 14.

[0050] FIG. 5 is a perspective view of the cam shaft assembly. FIG. 6 is an exploded view of the cam shaft assembly. As illustrated in FIGS. 5 and 6, the decompression mechanism 40 includes a flange 41, a weight 42, a decompression cam 43, a decompression pin 44, and a return spring 45.

[0051] As illustrated in FIG. 6, the flange 41 is separate from the cam shaft 26 and is fixed to the cam shaft 26. Specifically, the flange 41 includes a hole 411. The cam shaft 26 is inserted into the hole 411 of the flange 41 and the flange 41 is fixed to the cam shaft 26 by press-fitting. The flange 41 is disposed between the weight 42 and the exhaust cam 264 in the cam shaft direction.

[0052] The flange 41 includes a first convex portion 412 and a second convex portion 413. A pivot pin 46 is attached to the first convex portion 412. A hole 414 is provided in the second convex portion 413. The decompression cam 43 is inserted into the hole 414 of the second convex portion 413.

[0053] The weight 42 is disposed between the first bearing 27 and the flange 41 in the cam shaft direction. The weight 42 is supported on the cam shaft 26 in a rotatable manner between a closed state and an open state.

[0054] FIGS. 7 and 8 are cross-sectional views along line A-A in FIG. 4. FIG. 7 illustrates the weight 42 in the closed state. FIG. 8 illustrates the weight 42 in the open state.

[0055] The decompression cam 43 is supported in a rotatable manner on the flange 41. Specifically, the weight 42 is supported in a rotatable manner on the flange 41 via the pivot pin 46. The weight 42 switches between the closed state and the open state by rotating around the pivot pin 46.

[0056] The decompression cam 43 is connected to the weight 42 via the decompression pin 44. As a result, the decompression cam 43 rotates in response to the rotation of the weight 42.

[0057] Specifically as illustrated in FIGS. 4 and 6, the decompression cam 43 includes a head portion 431 and a shaft portion 432. The shaft portion 432 is inserted into the hole 414 of the flange 41. The head portion 431 is disposed between the flange 41 and the weight 42. The outer diameter of the head portion 431 is larger than the inner diameter of the hole 414 of the flange 41. The head portion 431 includes a groove portion 433. The groove portion 433 has a shape that is recessed from the end surface of the head portion 431. The groove portion 433 extends from the external peripheral surface of the head portion 431 toward the inside of the head portion 431. An end portion of the decompression pin 44 is disposed inside the groove portion 433. In the present embodiment, inside signifies the inside in the radial direction. Further, outside signifies outside in the radial direction.

[0058] The shaft portion 432 includes a cam portion 434. The exhaust cam 264 includes a recessed portion 265, and the recessed portion 265 has a shape that is recessed from the external peripheral surface of the exhaust cam 264 toward the inside of the exhaust cam 264. FIGS. 9A and 9B depict enlargements of the exhaust cam 264. FIG. 10 is side view of the cam shaft assembly.

[0059] The cam portion 434 is disposed inside the recessed portion 265 of the exhaust cam 264. A cross-section of the cam portion 434 has a shape that is circular with a portion cut out. As mentioned above, the decompression cam 43 rotates in response to the rotation of the weight 42. FIG. 9A illustrates the decompression cam 43 when the weight 42 is in the open state. FIG. 9B illustrates the decompression cam 43 when the weight 42 is in the closed state. The decompression cam 43 switches between a state of coming into contact with the exhaust roller 342 of the valve mechanism 25 and a state of not coming into contact with the exhaust roller 342, in response to the rotation of the weight 42.

[0060] Specifically as illustrated in FIG. 9(A), the entire cam portion 434 of the decompression cam 43 is disposed inside the recessed portion 265 when the weight 42 is in the open state. That is, the cam portion 434 is in a state of not protruding to the outside from the external peripheral surface of the exhaust cam 264 when the weight 42 is in the open state. As a result, the decompression cam 43 does not come into contact with the exhaust roller 342 when the weight 42 is in the open state.

[0061] When the weight 42 is in the closed state as illustrated in FIG. 9B, a portion of the cam portion 434 of the decompression cam 43 is disposed outside of the recessed portion 265. That is, a portion of the cam portion 434 is in a state of protruding to the outside from the external peripheral surface of the exhaust cam 264 when the weight 42 is in the closed state. As a result, the decompression cam 43 comes into contact with the exhaust roller 342 when the weight 42 is in the closed state.

[0062] The return spring 45 urges the weight 42 to return to the closed state from the open state. In the present embodiment, the return spring 45 is a coil spring. However, the return spring 45 may be another type of spring. As illustrated in FIG. 6, the return spring 45 includes a first spring end portion 451 and a second spring end portion 452. The first spring end portion 451 extends in the cam shaft direction. The second spring end portion 452 extends in a direction that is orthogonal to the cam shaft direction. The second spring end portion 452 extends in the circumferential direction of the return spring 45. The first spring end portion 451 is locked to the flange 41. The second spring end portion 452 is locked to the weight 42.

[0063] The following is a detailed description of the structure of the weight 42. As illustrated in FIG. 7, a straight line that passes through the center of rotation C1 of the cam shaft 26 and the center of rotation C2 of the weight 42 is assumed to be a vertical axis Y as seen from the axial direction of the cam shaft. A straight line that is orthogonal to the vertical axis Y and passes through the center of rotation C1 of the cam shaft 26 is assumed to be a horizontal axis X. The direction parallel to the vertical axis Y that extends from the center of rotation C1 of the cam shaft 26 toward the center of rotation C2 of the weight 42 is assumed to be a first vertical direction y1. The direction opposite the first vertical direction y1 is assumed to be a second vertical direction y2. One direction among the directions parallel to the horizontal axis X is assumed to be a first horizontal direction x1. The direction opposite the first horizontal direction x1 is assumed to be a second horizontal direction x2.

[0064] A region located in the first vertical direction y1 from the horizontal axis X and in the first horizontal direction x1 from the vertical axis Y is assumed to be a first region A1. A region located in the second vertical direction y2 from the horizontal axis X and in the first horizontal direction x1 from the vertical axis Y is assumed to be a second region A2. A region located in the second vertical direction y2 from the horizontal axis X and in the second horizontal direction x2 from the vertical axis Y as seen from the cam shaft direction is assumed to be a third region A3. A region located in the first vertical direction y1 from the horizontal axis X and in the second horizontal direction x2 from the vertical axis Y is assumed to be a fourth region A4.

[0065] FIG. 7 illustrates the weight 42 as seen from the first cam shaft end portion 261 side in the cam shaft direction. Therefore, the aforementioned directions x1, x2, y1, and y2 and the regions A1 to A4 are defined when seen from the first cam shaft end portion 261 side in the cam shaft direction, but the aforementioned directions x1, x2, y1, and y2 and the regions A1 to A4 may also be defined when seen from the second cam shaft end portion 262 side in the cam shaft direction.

[0066] As illustrated in FIG. 7, the weight 42 has a shape that extends along the circumferential direction of the cam shaft 26. The weight 42 is disposed around the cam shaft 26 in the first region A1, the second region A2, and the fourth region A4. The weight 42 has a shape that straddles a plurality of regions among the first to fourth regions A1 to A4 in the circumferential direction of the cam shaft 26. The weight 42 does not include a portion that is disposed in the third region A3 as seen from the cam shaft direction.

[0067] Specifically, the weight 42 includes a first weight portion 47 and a second weight portion 48. The first weight portion 47 extends from the center of rotation C2 of the weight 42 in the circumferential direction of the cam shaft 26 and in the first horizontal direction x1. An end portion 471 in the circumferential direction of the first weight portion 47 is located in the first horizontal direction x1 from the vertical axis Y. That is, the entire first weight portion 47 is located in the first horizontal direction x1 from the vertical axis Y. The end portion 471 of the first weight portion 47 is disposed in the second region A2 as seen from the cam shaft direction.

[0068] The second weight portion 48 extends from the center of rotation C2 of the weight 42 in the circumferential direction of the cam shaft 26 and in the second horizontal direction x2. An end portion 481 in the circumferential direction of the second weight portion 48 is located in the second horizontal direction x2 from the vertical axis Y. That is, the entire second weight portion 48 is located in the second horizontal direction x2 from the vertical axis Y. The end portion 481 of the second weight portion 48 is disposed in the fourth region A4 as seen from the cam shaft direction.

[0069] The first weight portion 47 is longer than the second weight portion 48 in the circumferential direction of the cam shaft 26. That is, an angle from the center of rotation C2 of the weight 42 to the end portion 471 of the first weight portion 47 around the center of rotation C1 of the cam shaft 26 is greater than an angle from the center of rotation C2 of the weight 42 to the end portion 481 of the second weight portion 48.

[0070] The first weight portion 47 includes a first portion 421 and a second portion 422. The first portion 421 is

disposed in the first region A1 as seen from the cam shaft direction. The second portion 422 is disposed in the second region A2 as seen from the cam shaft direction. The second weight portion 48 is disposed in the fourth region A4.

[0071] The weight 42 includes a pivot pin support portion 423. The pivot pin support portion 423 is disposed across the first portion 421 and the second portion 422. The pivot pin 46 is attached to the pivot pin support portion 423.

[0072] The exhaust cam 264 includes a cam lobe 267 that protrudes further to the outside than a base circle 266. A portion of the pivot pin 46 does not overlap the cam lobe 267 as seen from the cam shaft direction. That is, a portion of the pivot pin 46 is located outside of the external peripheral surface of the exhaust cam 264 as seen from the cam shaft direction. The pivot pin 46 further includes a portion located inside of the base circle 266 as seen from the cam shaft direction.

[0073] The decompression pin 44 is connected to the first weight portion 47. Specifically, the decompression pin 44 is connected to the second portion 422. The decompression pin 44 is disposed in the second region A2 as seen from the cam shaft direction. A distance between the center of rotation C2 of the weight 42 and the decompression pin 44 as seen from the cam shaft direction is equal to or greater than a distance between the center of rotation C2 of the weight 42 and the center of rotation C1 of the cam shaft 26.

[0074] FIG. 11 illustrates the cam shaft assembly as seen from the cam shaft direction. As illustrated in FIG. 11, the contour of the flange 41 as seen from the cam shaft direction includes a portion larger than the contour of the first bearing 27. Specifically, the first convex portion 412 protrudes to the outside of the external peripheral surface of the first bearing 27.

[0075] The first portion 421 of the weight 42 in the closed state includes a first protruding portion 424. The first protruding portion 424 protrudes to the outside of the external peripheral surface of the first bearing 27 as seen from the cam shaft direction. The external peripheral surface of the second portion 422 is located on the inside of the external peripheral surface of the first bearing 27as seen from the cam shaft direction. The external peripheral surface of the second weight portion 48 is located on the inside of the external peripheral surface of the first bearing 27 as seen from the cam shaft direction.

[0076] The pivot pin support portion 423 includes a protruding portion 425 that protrudes to the outside of the external peripheral surface of the first bearing 27 as seen from the cam shaft direction. The maximum value of the protrusion length of the protruding portion 425 is greater than the maximum value of the protrusion length of the first protruding portion 424. That is, the protruding portion 425 protrudes more than the first protruding portion 424 in the radial direction of the first bearing 27. The protrusion length signifies the length of protrusion from the external peripheral surface of the first bearing 27 in the radial direction of the first bearing 27.

[0077] As illustrated in FIG. 11, the first bearing 27 includes an inner ring 271 and an outer ring 272. The inner ring 271 is in contact with the cam shaft 26. The outer ring 272 is in contact with the first supporting wall 141 of the cylinder head 14. As illustrated in FIG. 7, the weight 42 includes an inner ring contact portion 426. The inner ring contact portion 426 is disposed in line with the inner ring 271 in the cam shaft direction. The inner ring contact portion 426 protrudes toward the inner ring 271 from the surface of the weight 42 adjacent to the first bearing 27.

[0078] As illustrated in FIG. 11, the inner ring contact portion 426 is located further to the inside than the inner peripheral surface of the outer ring 272. The inner ring contact portion 426 is located further to the inside than the inner peripheral surface of the outer ring 272 regardless of whether the weight 42 is in the closed state or the open state. At least a portion of the inner ring contact portion 426 is disposed nearer the center of rotation C2 of the weight 42 than the center of rotation C1 of the cam shaft 26 as seen from the cam shaft direction. The inner ring contact portion 426 is located between the center of rotation C2 of the weight 42 and the cam shaft 26 as seen from the cam shaft direction. As illustrated in FIG. 4, the other portions of the weight 42 do not come into contact with the outer ring 272 in a state in which the inner ring contact portion 426 is in contact with the inner ring 271.

[0079] Specifically, the inner ring contact portion 426 is disposed across the fourth region A4, the first region A1, and the second region A2 when the weight 42 is in the closed state. The inner ring contact portion 426 includes a first contact portion 426a, a second contact portion 426b, and a third contact portion 426c. The first contact portion 426a is disposed in the first region A1 when the weight 42 is in the closed state. The second contact portion 426b is disposed in the second region A2 when the weight 42 is in the closed state. The third contact portion 426c is disposed in the fourth region A4 when the weight 42 is in the closed state. The surface area of the first contact portion 426a is larger than the surface area of the second contact portion 426b as seen from the cam shaft direction. The surface area of the first contact portion 426a is larger than the surface area of the third contact portion 426c as seen from the cam shaft direction.

[0080] G1 in FIG. 12 indicates the location of the center of gravity of the weight 42. G2 indicates the location of the center of gravity of the weight 42 when there is no first protruding portion 424. Hatching is provided for the first protruding portion 424 in FIG. 12. The phrase "when there is no first protruding portion 424" signifies a state in which the hatched portions in FIG. 12 are removed. The chain double-dashed line in FIG. 12 indicates the external peripheral surface of the first bearing 27. As illustrated in FIG. 12, the center of gravity G1 of the weight 42 is disposed in the first region A1 as seen from the cam shaft direction. The distance between the center of gravity G1 of the weight 42 and the center of rotation C1 of the cam shaft 26 is greater than the distance between

the center of gravity G1 of the weight 42 and the center of rotation C2 of the weight 42. The first protruding portion 424 includes a near portion 424a and a distant portion 424b that are, as seen from the cam shaft direction, respectively nearer to and further away from the center of rotation C2 of the weight 42 in the circumferential direction of the first bearing 27 than the location of the center of gravity G2 of the weight 42 if there were no first protruding portion 424. The amount of protrusion outward from the external peripheral surface of the first bearing 27 is greater in the near portion 424a than in the distant portion 424b.

[0081] As seen from the cam shaft direction, a portion of the inner ring contact portion 426 nearer the center of rotation C2 of the weight 42 than the center of gravity G1 of the weight 42 is larger than a portion of the inner ring contact portion 426 further away from the center of rotation C2 of the weight 42 than the center of gravity G1 of the weight 42. For example, the maximum width of the first contact portion 426a in the radial direction of the cam shaft 26 is greater than the maximum width of the second contact portion 426b in the radial direction of the cam shaft 26.

[0082] FIG. 13 is a perspective view illustrating the surface on the second cam shaft end portion 262 side of the weight 42. FIG. 14 is side view of the cam shaft assembly as seen from the direction of arrow XIV in FIG. 10. As illustrated in FIG. 13, the maximum thickness of the first portion 421 in the cam shaft direction is greater than the maximum thickness of the second portion 422 in the cam shaft direction. The maximum thickness of the second weight portion 48 in the cam shaft direction is greater than the maximum thickness of the second portion 422 in the cam shaft direction.

[0083] As illustrated in FIG. 13, the first portion 421 includes an inner diameter portion 421a and an outer diameter portion 421b. The inner diameter portion 421a is located on the inside of the outer diameter portion 421b. The thickness of the outer diameter portion 421b in the cam shaft direction is greater than the thickness of the inner diameter portion 421a in the cam shaft direction. The outer diameter portion 421b includes the aforementioned first protruding portion 424. Therefore, the maximum thickness of the first protruding portion 424 in the cam shaft direction is greater than the maximum thickness of the second portion 422 in the cam shaft direction. The maximum thickness of the first protruding portion 424 in the cam shaft direction is greater than the maximum thickness of the second weight portion 48 in the cam shaft direction. The thickness of the first protruding portion 424 in the cam shaft direction is greater than the thickness of the pivot pin support portion 423 in the cam shaft direction.

[0084] As illustrated in FIG. 10, a portion of the weight 42 overlaps the flange 41 as seen from the radial direction of the cam shaft 26. Specifically, the outer diameter portion 421b of the first portion 421 overlaps the flange 41 as seen from the radial direction of the cam shaft 26. The surface of the second weight portion 48 and the surface of the inner diameter portion 421a on the second cam shaft end portion 262 side face the surface of the flange 41 on the first cam shaft end portion 261 side. The aforementioned head portion 431 of the decompression cam 43 is disposed between the second portion 422 and the flange 41.

[0085] As illustrated in FIG. 13, the pivot pin support portion 423 includes a housing portion 423a and a boss portion 423b. The boss portion 423b protrudes from the housing portion 423a in the cam shaft direction. The thickness of the housing portion 423a in the cam shaft direction is less than the thicknesses of the first portion 421 and the second weight portion 48 in the cam shaft direction. Therefore, the housing portion 423a has a shape that is recessed in the cam shaft direction from the surface of the weight 42.

[0086] FIG. 15 is a view of the flange 41, the weight 42, and the return spring 45 as seen from the second cam shaft end portion 262 side. As illustrated in FIG. 15, the housing portion 423a houses the return spring 45. The boss portion 423b is inserted into the aforementioned return spring 45. A hole 423c is provided in the boss portion 423b. The pivot pin 46 is inserted into the hole 423c of the boss portion 423b.

[0087] As illustrated in FIGS. 13 and 15, the weight 42 includes a second locking portion 42b. The second locking portion 42b locks the second spring end portion 452 of the return spring 45. The second locking portion 42b is included in the first portion 421. Specifically, the second locking portion 42b is a stepped portion shaped with regard to the pivot pin support portion 423 in the first portion 421.

[0088] As illustrated in FIGS. 14 and 15, the flange 41 includes a first locking section 42a. The first locking section 42a locks the first spring end portion 451 of the return spring 45. Specifically, the first locking section 42a is a portion of the first convex portion 412. The first locking section 42a is formed integrally with the flange 41. For example, the flange 41 is formed integrally to include the first locking section 42a using a manufacturing method such as sintering, forging, or casting.

[0089] FIG. 16 illustrates the cylinder head 14 in a state in which the head cover 19 is removed. As illustrated in FIG. 16, the cylinder head 14 includes a first bearing support hole 143. The first bearing support hole 143 supports the first bearing 27. The first bearing support hole 143 is provided in the first supporting wall 141. The first bearing support hole 143 includes a first recessed portion 144, a second recessed portion 145, and a third recessed portion 146. The first recessed portion 144, the second recessed portion 145, and the third recessed portion 146 are located on the side opposite the crankshaft 11 from the center of the first bearing support hole 143. The first recessed portion 144 has a shape that allows the passage of the first protruding portion 424 and the suction cam 263. The second recessed portion 145 has a shape that allows the passage of the exhaust cam 264. The

third recessed portion 146 has a shape that allows the passage of the pivot pin support portion 423. A portion of the first recessed portion 144 may be located on the opposite side of the crankshaft 11 from the center of the first bearing support hole 143, and the other portion of the first recessed portion 144 may be located on the same side as the crankshaft 11 from the center of the first bearing support hole 143. Alternatively, a portion of the second recessed portion 145 may be located on the opposite side of the crankshaft 11 from the center of the first bearing support hole 143, and the other portion of the second recessed portion 145 may be located on the same side as the crankshaft 11 from the center of the first bearing support hole 143.

[0090] The circumferential direction end portion 471 of the first weight portion 47 is located in the first horizontal direction x1 from the vertical axis in the engine according to the present embodiment. That is, the first weight portion 47 extends so that the first weight portion 47 does not cross the vertical axis Y in the second horizontal direction x2. Therefore, the center of gravity G1 of the weight 42 can be provided further away from the center of rotation C1 of the cam shaft 26 in comparison to when the first weight portion 47 extends from a region located in the first horizontal direction x1 from the vertical axis Y to a location in which the first weight portion 47 crosses the vertical axis Y in the second horizontal direction x2. Therefore, the centrifugal force acting on the weight 42 increases if the rotation speed of the cam shaft 26 is the same. As a result, opening of the weight 42 due to gravitational force can be suppressed without raising the set rotation speed because the spring force of the return spring 45 can be increased.

[0091] Because the center of gravity G1 of the weight 42 can be provided nearer the center of rotation C2 of the weight 42, the moment due to the gravitational force acting on the weight 42 can be reduced. The opening of the weight 42 due to the gravitational force can be suppressed.

[0092] Moreover, the decompression pin 44 is connected to the first weight portion 47 that is longer than the second weight portion 48. As a result, the distance between the decompression pin 44 and the center of rotation C2 of the weight 42 can be increased in comparison to when the decompression pin 44 is connected to the second weight portion 48. As a result, the movement amount of the decompression pin 44 relative to the rotation angle of the weight 42 is increased. In other words, the rotation angle of the weight 42 which allows the weight 42 to switch from the closed state to the open state can be reduced. As a result, displacement of the locations of the center of gravity G1 of the weight 42 when the weight 42 is in the closed state and when the weight 42 is in the open state can be reduced. By reducing the rotation angle of the weight 42, interference with members around the weight 42 can be avoided more easily. As a result, the shape of the weight 42 has a higher degree of freedom.

[0093] The distance between the center of gravity G1 of the weight 42 and the center of rotation C1 of the cam shaft 26 when the weight 42 is in the open state is greater than the distance between the center of gravity G1 of the weight 42 and the center of rotation C1 of the cam shaft 26 when the weight 42 is in the closed state. As a result, it becomes more difficult for the weight 42 to return to the closed state as the displacement of the locations of the center of gravity G1 of the weight 42 when the weight 42 is in the closed state and when the weight 42 is in the open state increases.

[0094] However, , the weight 42 is able to return to the closed state more easily because the aforementioned displacement of the locations of the center of gravity G1 of the weight 42 when the weight 42 is in the closed state and in the open state can be reduced in the engine according to the present embodiment.

[0095] The startability of the engine 7 can be improved because the open state of the weight 42 when starting the engine can be avoided more easily as described above in the engine according to present embodiment.

[0096] The end portion 471 of the first weight portion 47 is disposed in the second region A2 as seen from the cam shaft direction. As a result, the center of gravity G1 of the weight 42 can be provided further away from the center of rotation C1 of the cam shaft 26 in comparison to when the first weight portion 47 extends from a region located in the first horizontal direction x1 from the vertical axis Y to a location in which the first weight portion 47 crosses the vertical axis Y in the second horizontal direction x2. Further, the decompression pin 44 is more easily provided away from the center of rotation C2 of the weight 42 in comparison to when the end portion 471 of the first weight portion 47 is provided in the first region A1.

[0097] The decompression pin 44 is disposed in the second region A2 as seen from the cam shaft direction. As a result, the end portion 471 of the first weight portion 47 can be provided in the second region A2 as seen from the cam shaft direction.

[0098] The distance between the center of rotation C2 of the weight 42 and the decompression pin 44 as seen from the cam shaft direction is no less than the distance between the center of rotation C2 of the weight 42 and the center of rotation C1 of the cam shaft 26. As a result, the distance between the decompression pin 44 and the center of rotation C2 of the weight 42 can be increased.

[0099] The weight 42 does not include a portion that is disposed in the third region A3 as seen from the cam shaft direction. As a result, the center of gravity G1 of the weight 42 can be provided further away from the center of rotation C1 of the cam shaft 26. Moreover, the center of rotation C2 of the weight 42 and the center of gravity G1 of the weight 42 can be brought nearer to each other.

[0100] The end portion 481 of the second weight portion 48 is disposed in the fourth region A4 as seen from the cam shaft direction. As a result, the center of rotation C2 of the weight 42 and the center of gravity G1 of the weight 42 can be brought nearer to each other.

[0101] Although an embodiment of the present invention has been described so far, the present invention is not limited to the above embodiments and various modifications may be made within the scope of the invention.

[0102] The shape of the weight 42 is not limited to the shape of the above embodiment and may be changed. FIG. 17 illustrates the weight 42 according to a first modified example. As illustrated in FIG. 17, the second portion 422 may include a second protruding portion 427. The second protruding portion 427 protrudes to the outside of the external peripheral surface of the first bearing 27 as seen from the cam shaft direction. The volume of the first protruding portion 424 is greater than the volume of the second protruding portion 427. In this case, the center of gravity G1 of the weight 42 can be provided further away from the center of rotation C1 of the cam shaft 26 in the same way as the above embodiment. The location of the center of gravity G1 of the weight 42 can be provided nearer the center of rotation C2 of the weight 42 in comparison to when the volume of the second protruding portion 427 is greater than the volume of the first protruding portion 424.

[0103] Alternatively, the length in the circumferential direction of the weight can be made shorter than that of the weight 42 of the above embodiment. For example, a circumferential direction end portion 471 of the first weight portion 47 may be disposed in the first region A1.

[0104] Alternatively, the first protruding portion 424 of the weight 42 may be omitted. That is, the first portion 421 is located on the inside of the external peripheral surface of the first bearing 27 as seen from the cam shaft direction.

[0105] FIG. 18 illustrates the weight 42 according to a second modified example. As illustrated in FIG. 18, the pivot pin support portion 423 may be located on the inside of the external peripheral surface of the first bearing 27 as seen from the cam shaft direction.

[0106] FIG. 19 illustrates the weight 42 according to a third modified example. As illustrated in FIG. 19, the pivot pin 46 may be located on the inside of the base circle 266 of the exhaust cam 264 as seen from the cam shaft direction. That is, the center of rotation C2 of the weight 42 may be located on the inside of the base circle 266 of the exhaust cam 264 as seen from the cam shaft direction.

[0107] FIG. 20 illustrates the weight 42 according to a fourth modified example. As illustrated in FIG. 20, the center of rotation C2 of the weight 42 may be located on the outside of the cam lobe 267 of the exhaust cam 264 as seen from the cam shaft direction. The entire pivot pin 46 may be located on the outside of the external peripheral surface of the exhaust cam 264.

[0108] The weight 42 in the above embodiment is supported by the cam shaft 26 via the flange 41, but the weight may also be supported directly by the cam shaft. The flange 41 is separate from the cam shaft 26 in the above embodiment and is fixed to the cam shaft 26 by press-fitting, but the flange 41 may be fixed with a fixing means other than press-fitting. Alternatively, the flange may be formed integrally with the cam shaft 26.

[0109] The inner ring contact portion of the weight 42 may be omitted. The housing portion of the weight 42 may be omitted. That is, the return spring may be disposed in a location other than on the weight 42.

[0110] While a scooter-type motorcycle is mentioned as an example of the vehicle in the above embodiment, the vehicle according to the present invention is not limited to a scooter and may be another type of motorcycle such as a sports type, an off-road type, or a moped. The motorcycle is not limited to two wheels and includes a vehicle with three wheels. Moreover, while the vehicle according to the present invention is preferably a saddle-riding vehicle such as a motorcycle, an all-terrain vehicle, or a snowmobile, the vehicle may also be a vehicle other than a saddle-riding vehicle.

Claims

1. An engine (7) comprising:

a cylinder head (14);
an exhaust valve housed inside the cylinder head (14);
a valve mechanism (25) for opening and closing the exhaust valve;
a cam shaft (26) for driving the valve mechanism (25) by coming into contact with the valve mechanism (25);
a bearing (27) supporting the cam shaft (26) in a rotatable manner on the cylinder head (14); and
a decompression mechanism (40) disposed between both ends of the cam shaft (26) in an axial direction of the cam shaft (26);
wherein the decompression mechanism (40) includes:

a weight (42) supported on the cam shaft (26) in a rotatable manner between a closed state and an open state;
a return spring (45) for urging the weight (42) to return from the open state to the closed state;
a decompression cam (43) provided so as to come into contact with the valve mechanism (25) when the weight (42) is in the closed state and so as not to come into contact with the valve mechanism (25) when the weight (42) is in the open state; and
a decompression pin (44) connecting the weight (42) and the decompression cam (43);
wherein,
when, as seen from the axial direction of the cam shaft (26), a straight line that passes

through the center of rotation (C1) of the cam shaft (26) and through the center of rotation (C2) of the weight (42) is assumed to be a vertical axis (Y), a straight line that is orthogonal to the vertical axis (Y) and that passes through the center of rotation (C1) of the cam shaft (26) is assumed to be a horizontal axis (X), a direction from the center of rotation (C1) of the cam shaft (26) toward the center of rotation (C2) of the weight (42) among directions parallel to the vertical axis (Y) is assumed to be a first vertical direction (y1), a direction parallel to the horizontal axis (X) is assumed to be a first horizontal direction (x1), and a direction opposite the first horizontal direction (x1) is assumed to be a second horizontal direction (x2),
the center of gravity (G1) of the weight (42) is disposed in a first region (A1) that is located in the first vertical direction (y1) from the horizontal axis (X) and in the first horizontal direction (x1) from the vertical axis (Y) as seen from the axial direction of the cam shaft (26);
wherein the weight (42) includes:

a first weight portion (47) that extends from the center of rotation (C2) of the weight (42) in the circumferential direction of the cam shaft (26), a circumferential direction end portion (471) of the first weight portion (47) being located in the first horizontal direction (x1) from the vertical axis (Y); and
a second weight portion (48) that extends from the center of rotation (C2) of the weight (42) in the circumferential direction of the cam shaft (26), a circumferential direction end portion (481) of the second weight portion (48)being located in the second horizontal direction (x2) from the vertical axis (Y);
wherein the first weight portion (47) is longer than the second weight portion (48) in the circumferential direction of the cam shaft (26); and
wherein the decompression pin (44) is connected to the first weight portion (47).

2. The engine according to claim 1, wherein:

a second vertical direction (y2) is assumed to be opposite the first vertical direction (y1),
the first weight portion (47) includes a first portion (421) and a second portion (422),
the first portion (421) is disposed in the first region (A1) as seen from the axial direction of the cam shaft (26),
the second portion (422) is disposed in a second region (A2) that is located in the second vertical direction (y2) from the horizontal axis (X) and in the first horizontal direction (x1) from the vertical axis (Y) as seen from the axial direction of the cam shaft (26), and
the circumferential direction end portion (471) of the first weight portion (47) is disposed in the second region (A2) as seen from the axial direction of the cam shaft (26).

3. An engine according to claim 1 or 2, wherein:

the decompression pin (44) is disposed in the second region (A2) as seen from the axial direction of the cam shaft (26).

4. An engine according to any one of claims 1 to 3, wherein:

a distance between the center of rotation (C2) of the weight (42) and the decompression pin (44) is not less than a distance between the center of rotation (C2) of the weight (42) and the center of rotation (C1) of the cam shaft (26) as seen from the axial direction of the cam shaft (26).

5. An engine according to any one of claims 1 to 4, wherein:

the cam shaft (26) includes an exhaust cam (264) that comes into contact with the decompression mechanism (40),
the exhaust cam (264) includes a cam lobe (267) that protrudes outward from a base circle (266), and
the center of rotation (C2) of the weight (42) is located further toward the inside in a radial direction of the cam shaft (26) than the base circle (266) of the exhaust cam (264) as seen from the axial direction of the cam shaft (26).

6. An engine according to any one of claims 1 to 4, wherein:

the cam shaft (26) includes an exhaust cam (264) that comes into contact with the decompression mechanism (40),
the exhaust cam (264) includes a cam lobe (267) that protrudes outward from a base circle (266), and
the center of rotation (C2) of the weight (42) is located further toward the outside in a radial direction of the cam shaft (26) than an external peripheral surface of the cam lobe (267) as seen

from the axial direction of the cam shaft (26).

7. The engine according to any one of claims 1 to 6, wherein
the weight (42) does not include a portion disposed in a third region (A3) that is located in the second vertical direction (y2) from the horizontal axis (X) and in the second horizontal direction (x2) from the vertical axis (Y) as seen from the axial direction of the cam shaft (26).

8. The engine according to any one of claims 1 to 7, wherein,
the circumferential direction end portion (481) of the second weight portion (48) is disposed in a fourth region (A4) that is located in the first vertical direction (y1) from the horizontal axis (X) and in the second horizontal direction (x2) from the vertical axis (Y) as seen from the axial direction of the cam shaft (26).

9. A vehicle (1) comprising the engine (7) according to any one of the claims 1 to 8.

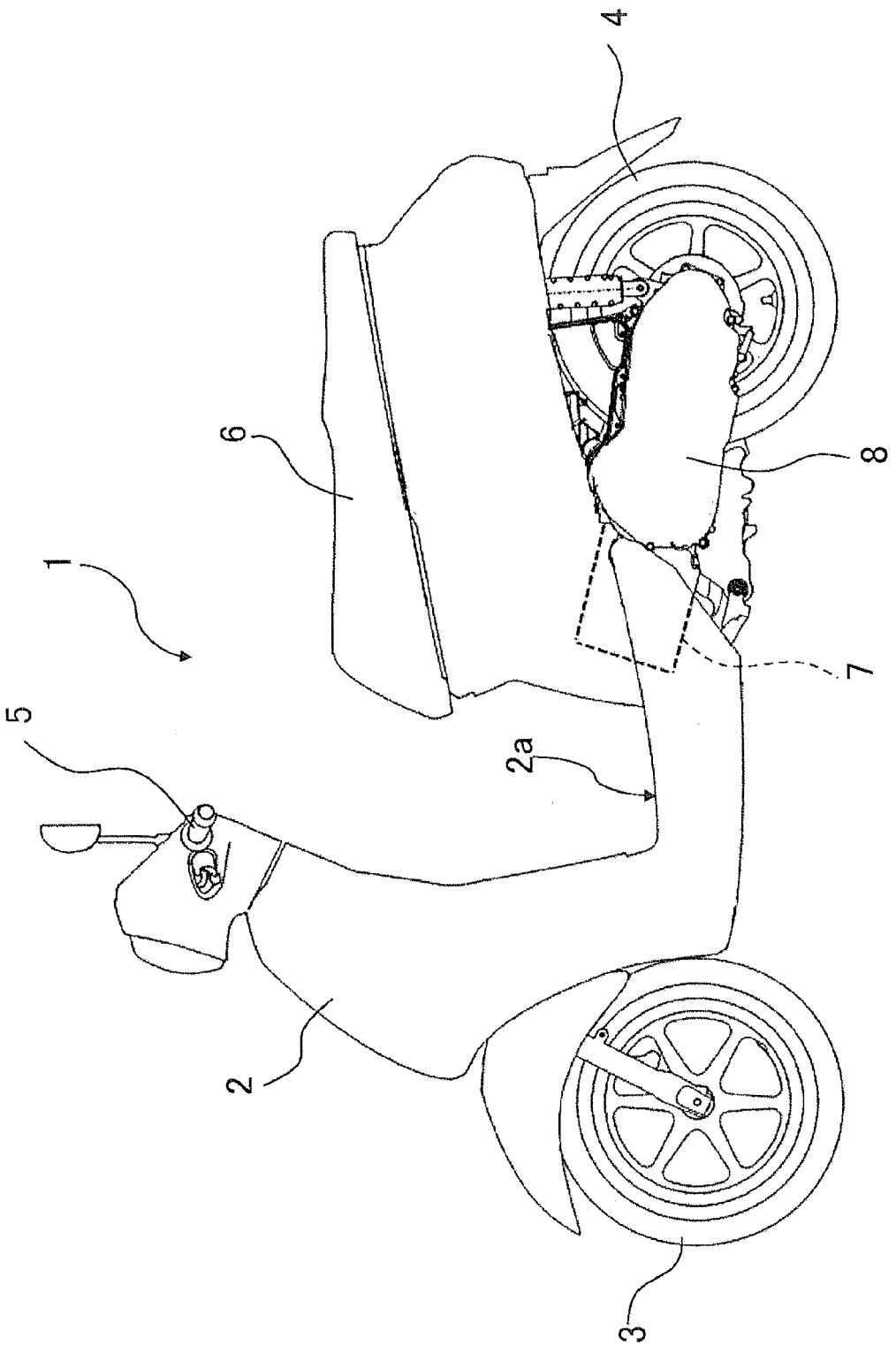


FIG. 1

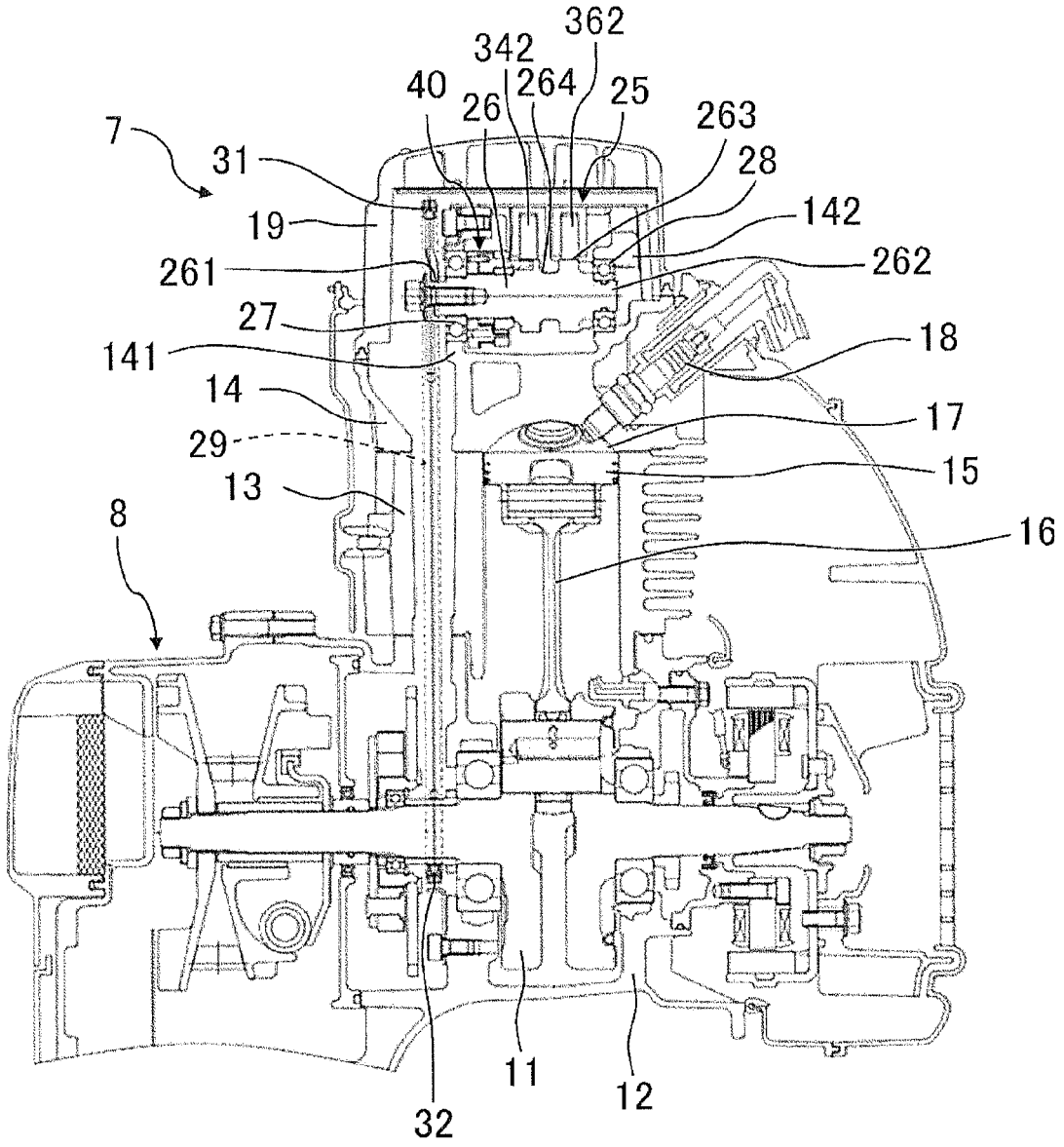

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FIG. 2

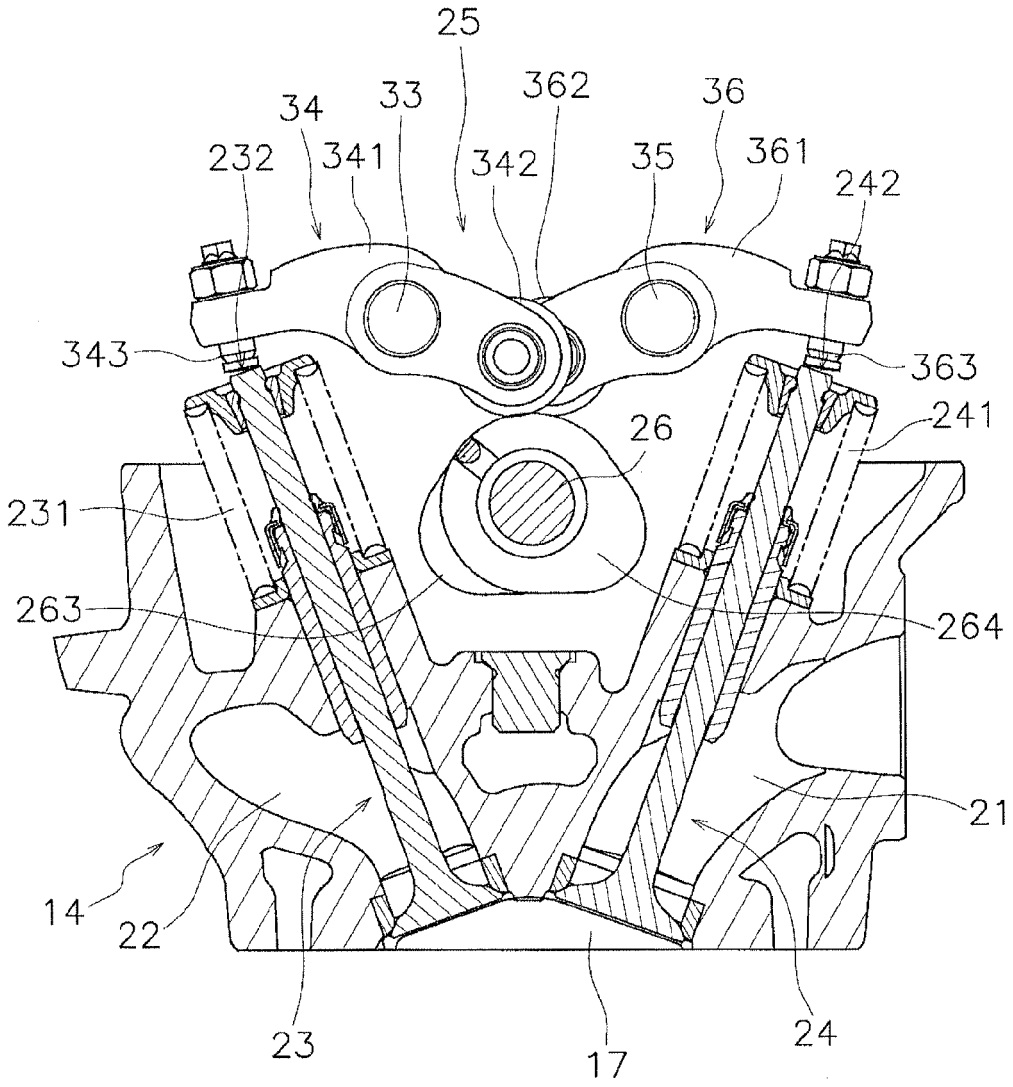

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FIG. 3

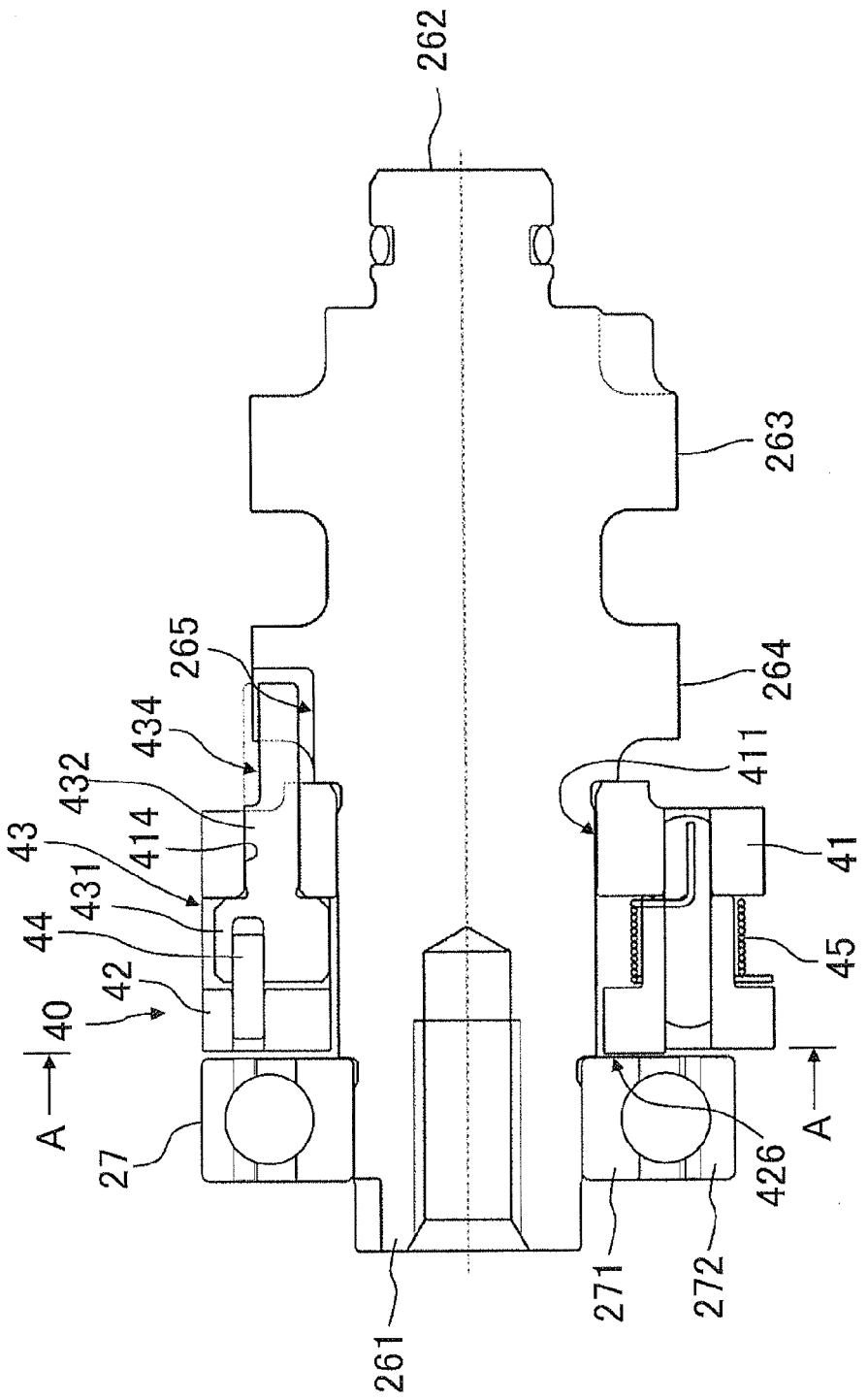

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FIG. 4

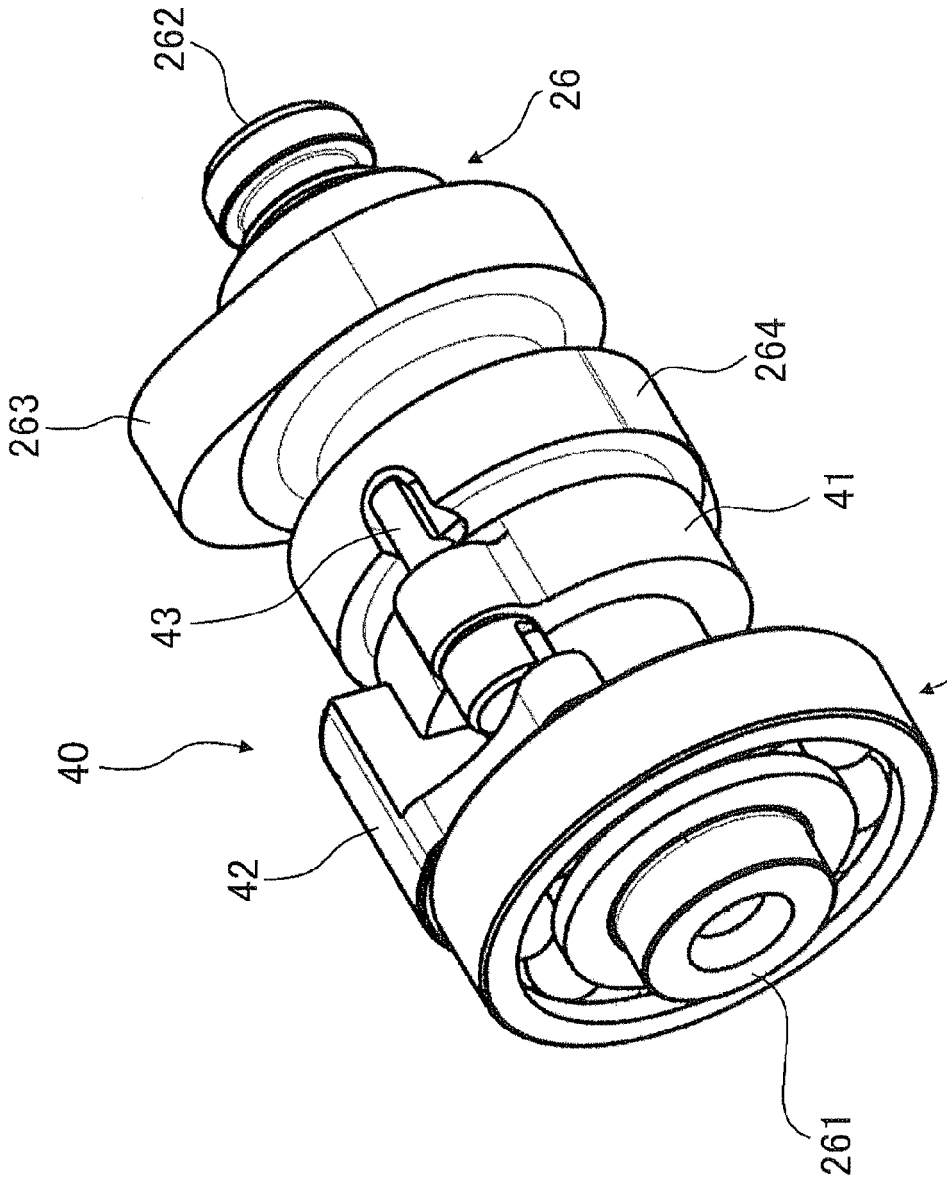


FIG. 5

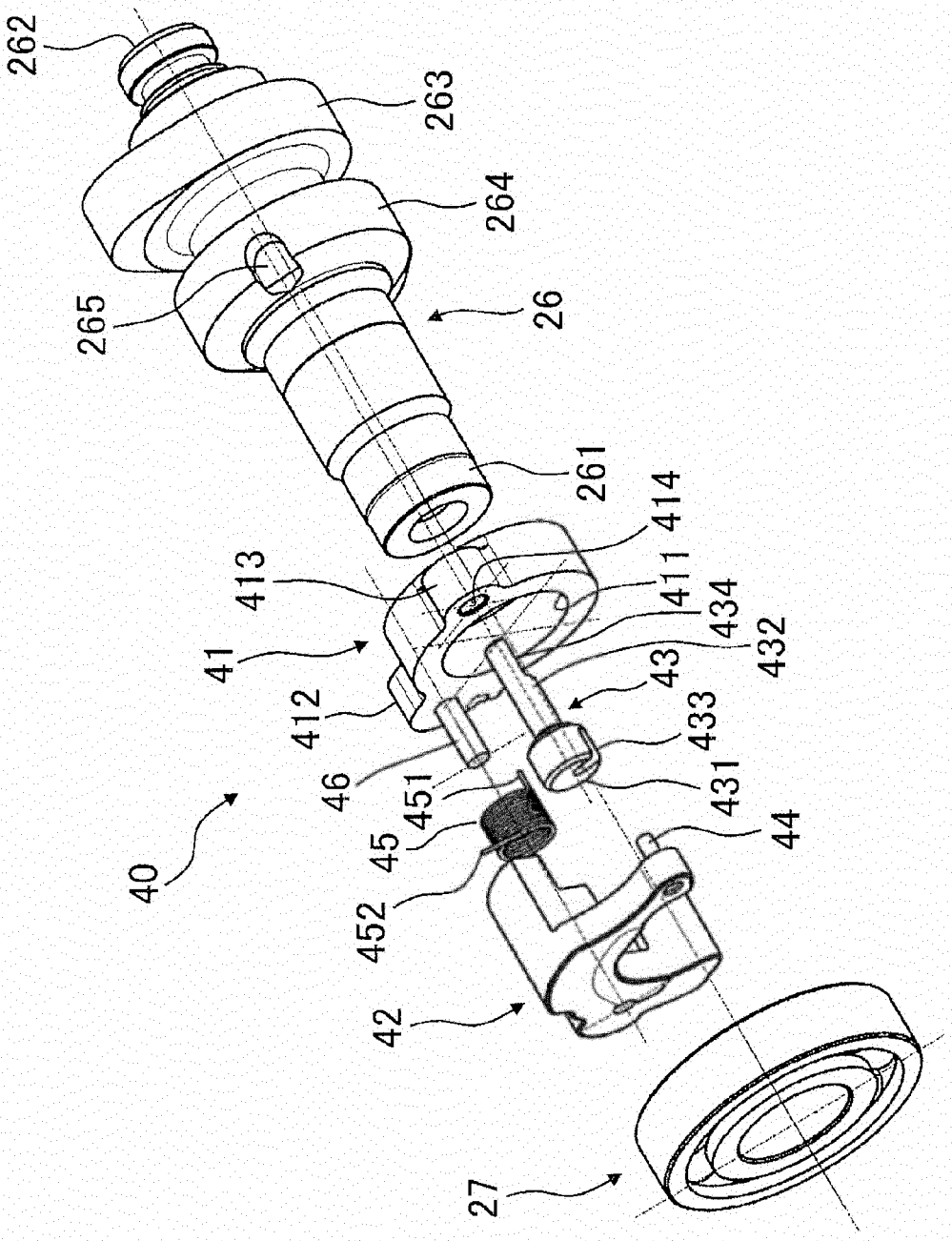

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FIG. 6

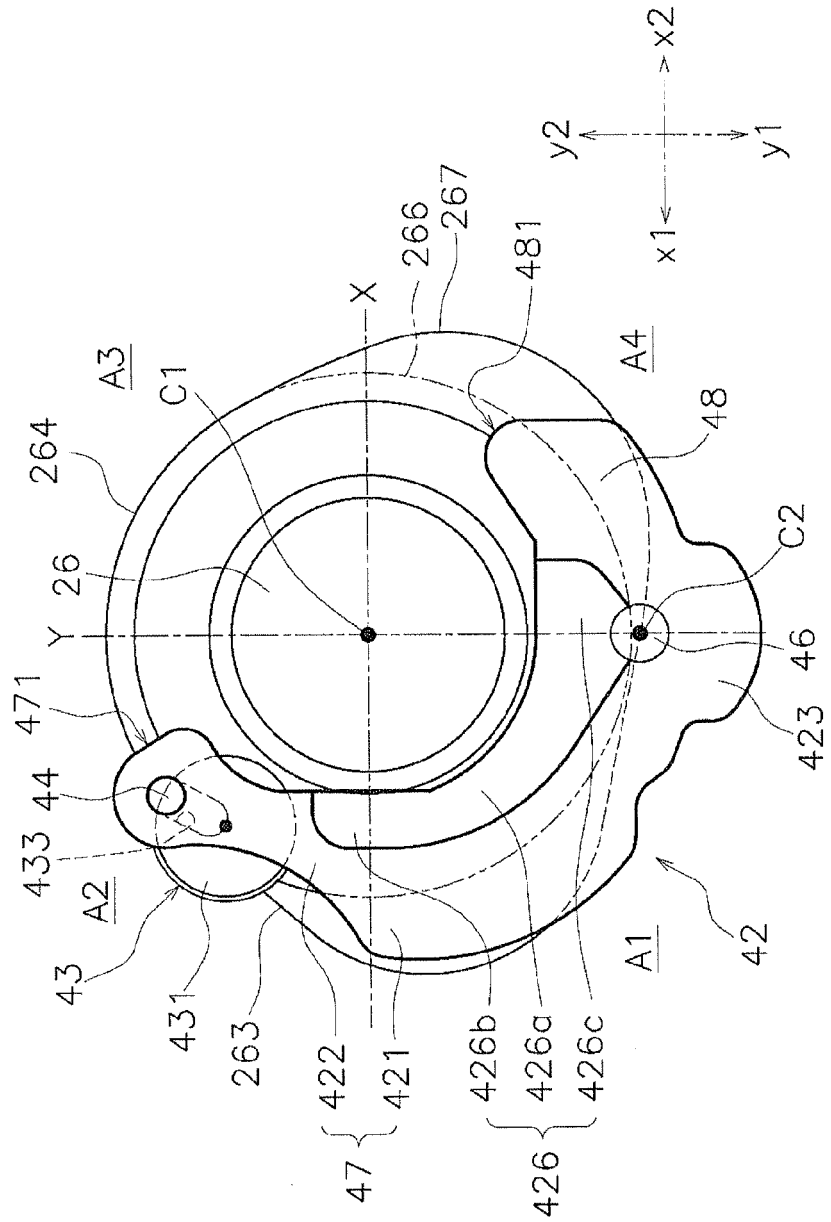

x2
y2
y1
x1
X
Y
266
267
481
A3
A4
C1
C2
264
26
48
46
471
44
423
433
A2
A1
42
43
431
263
422
421
426b
426a
426c
47
426

FIG. 7

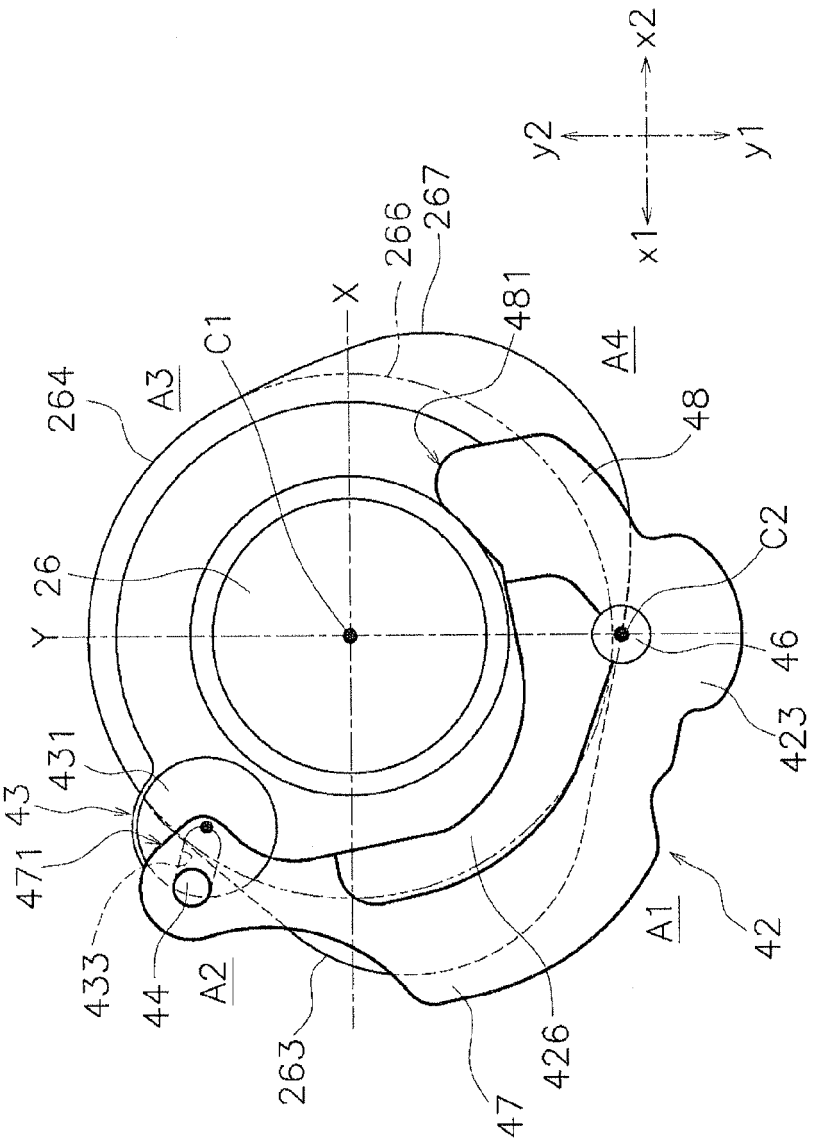

x2
y2
y1
x1
267
266
X
481
C1
A3
264
A4
48
C2
26
Y
46
423
431
43
471
433
44
A2
263
47
426
A1
42

FIG. 8

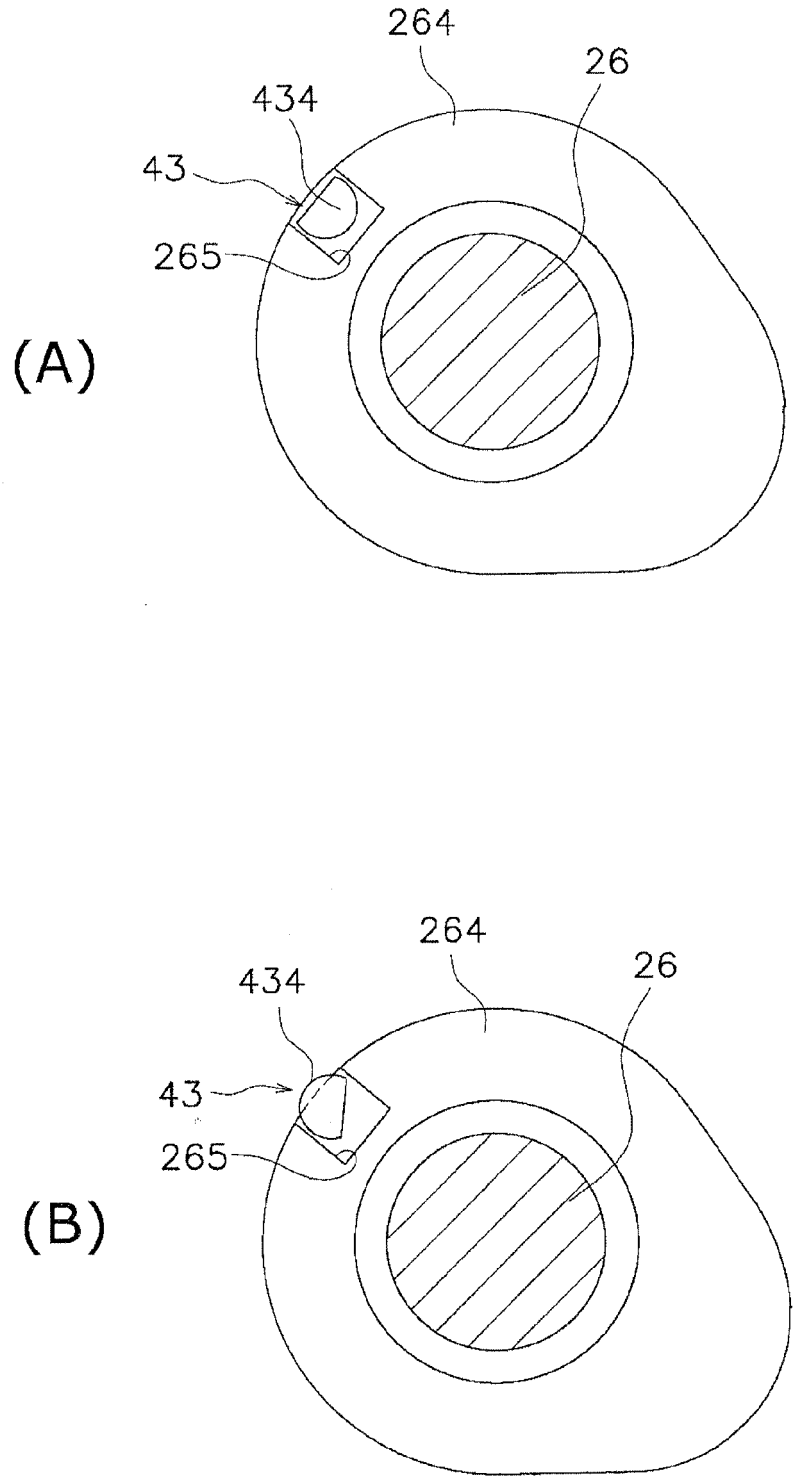


FIG. 9

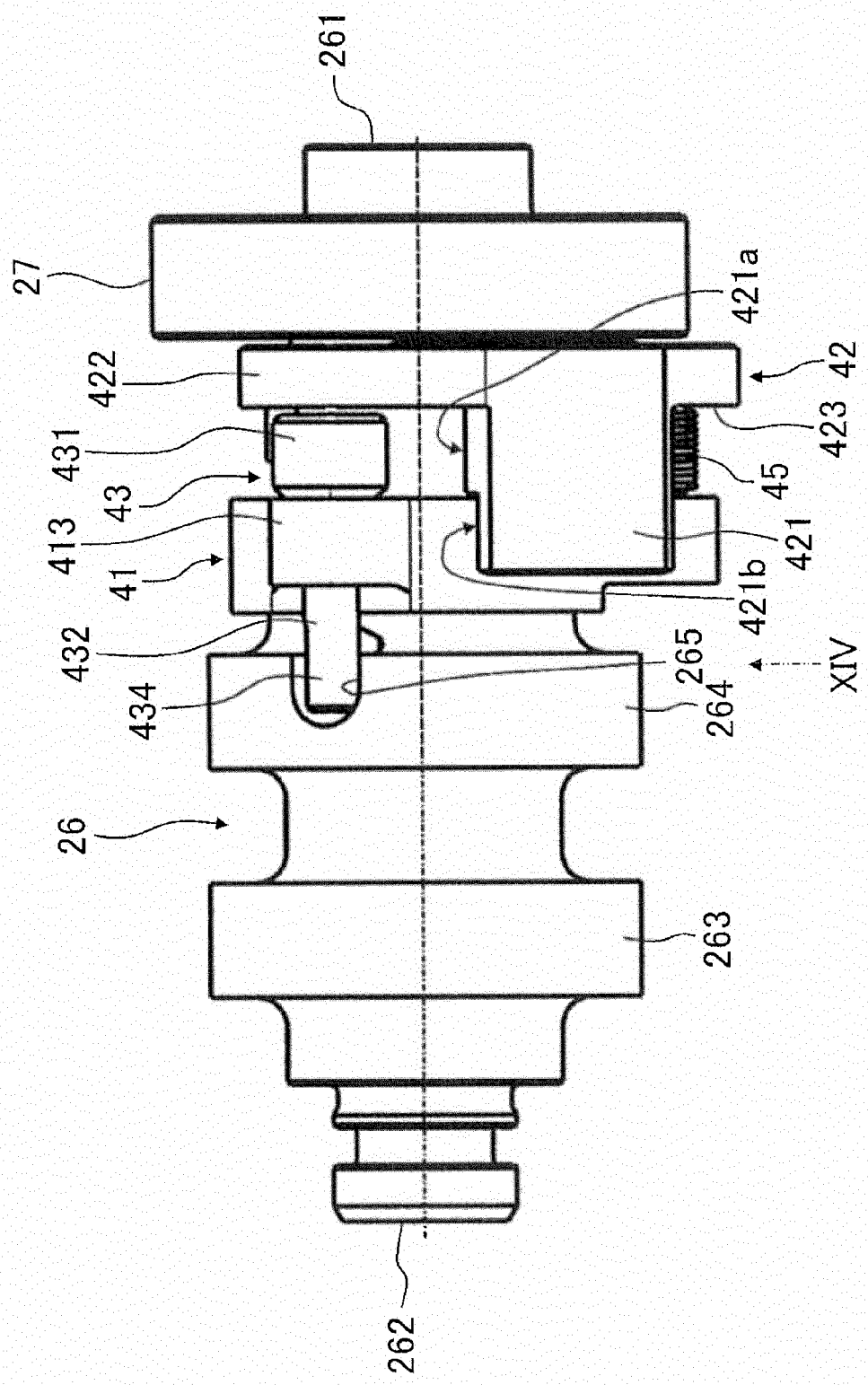

261
27
421a
422
42
431
423
43
45
413
421
41
421b
432
265
XIV
434
264
26
263
262

FIG. 10

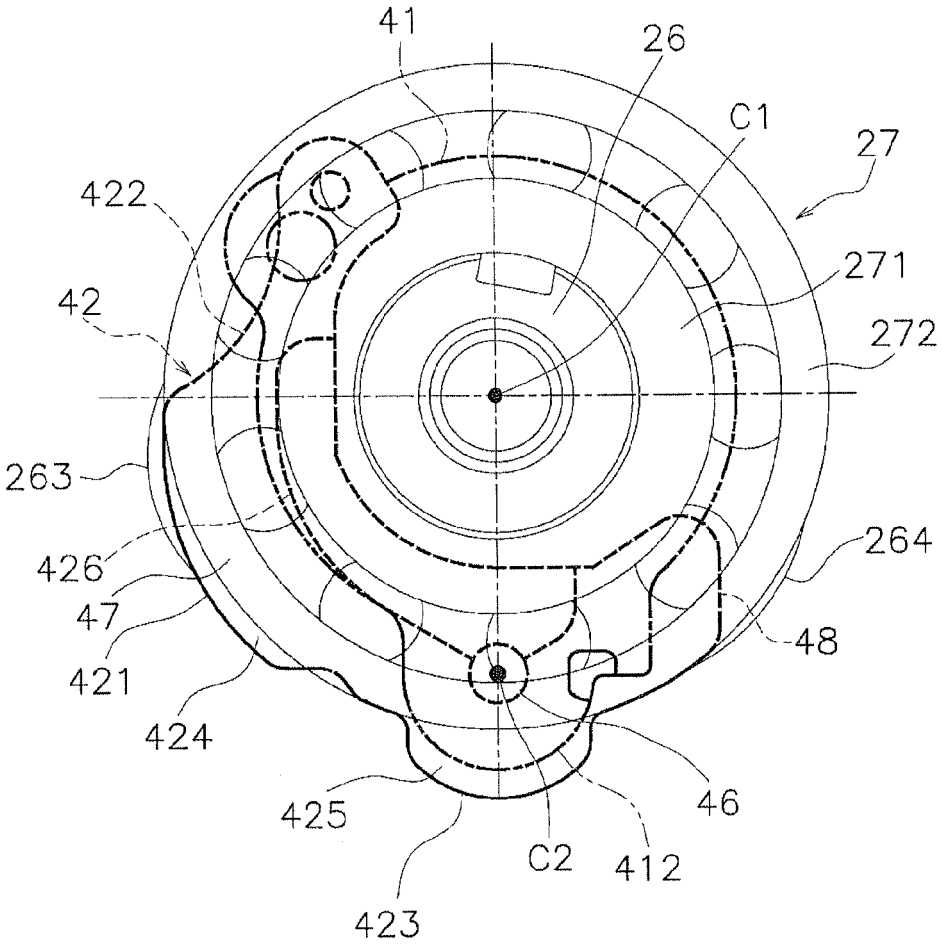

41
26
C1
27
422
271
42
272
263
264
426
47
48
421
424
46
425
C2
412
423

FIG. 11

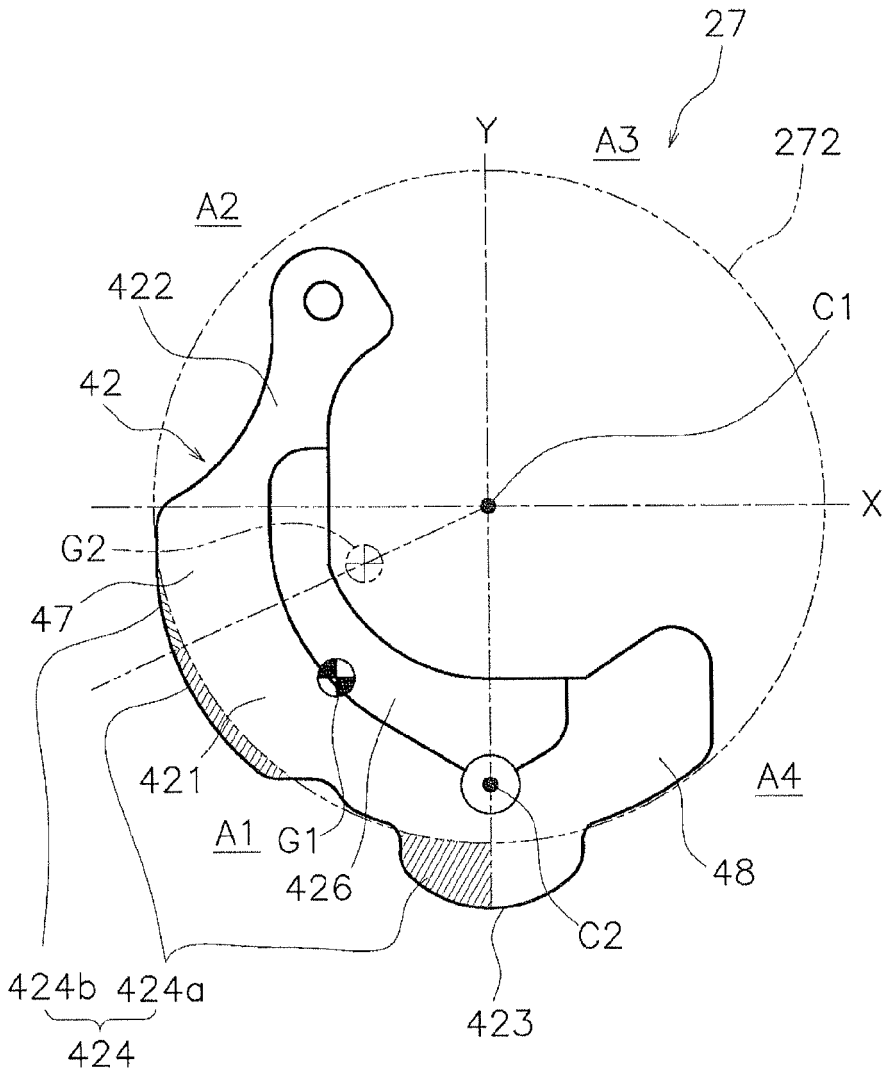

27
Y
A3
272
A2
422
C1
42
X
G2
47
421
A4
A1
G1
426
48
C2
424b
424a
424
423

FIG. 12

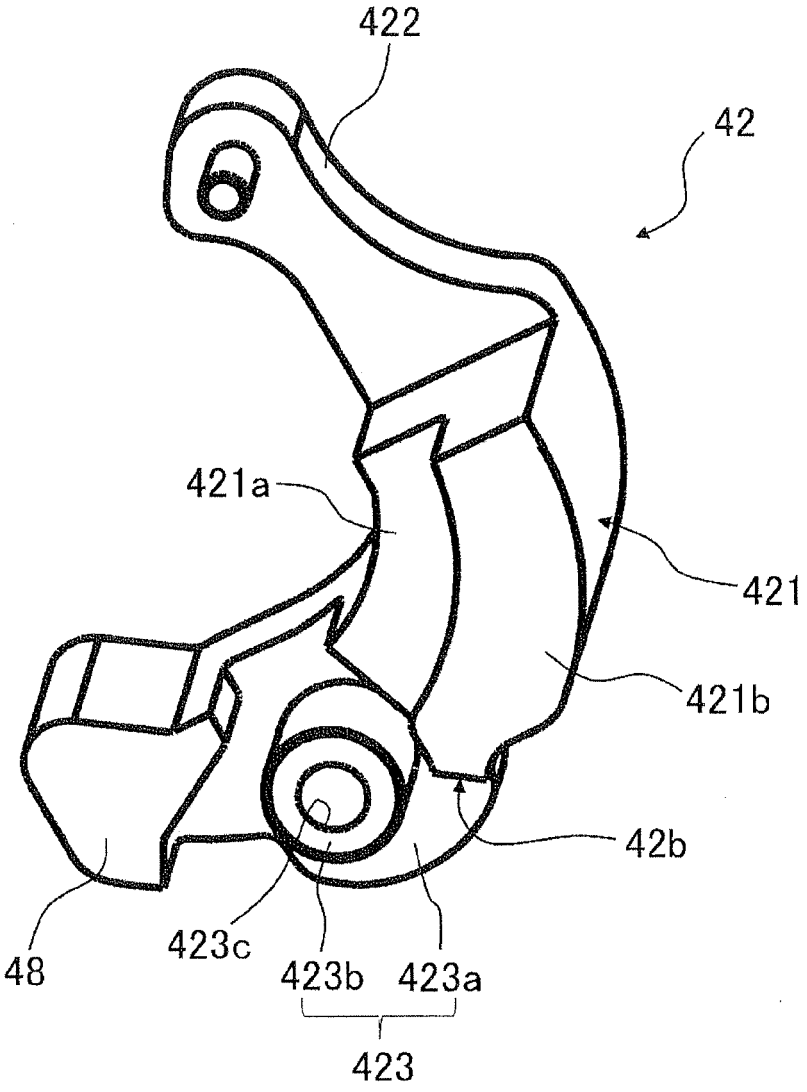


FIG. 13

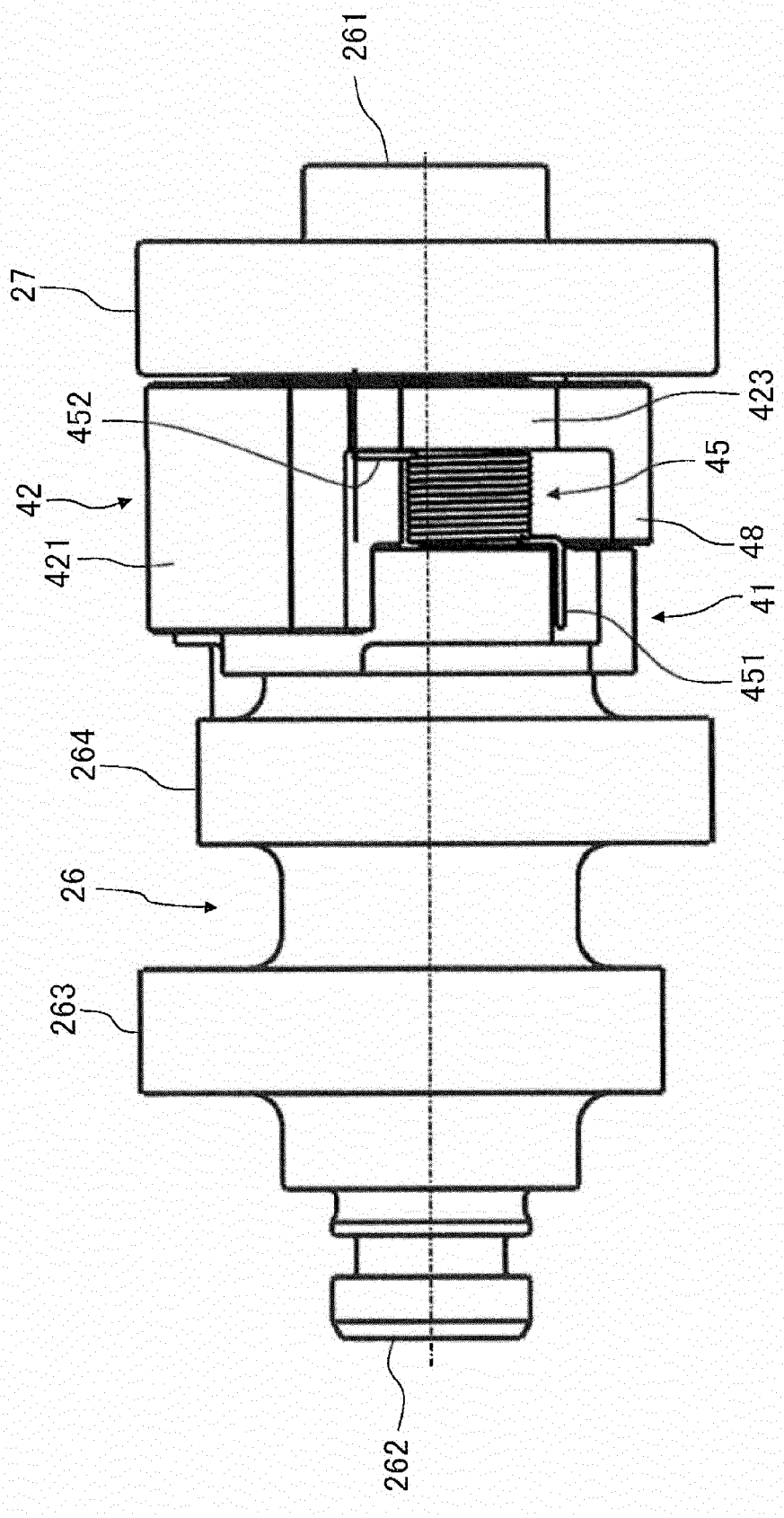


FIG. 14

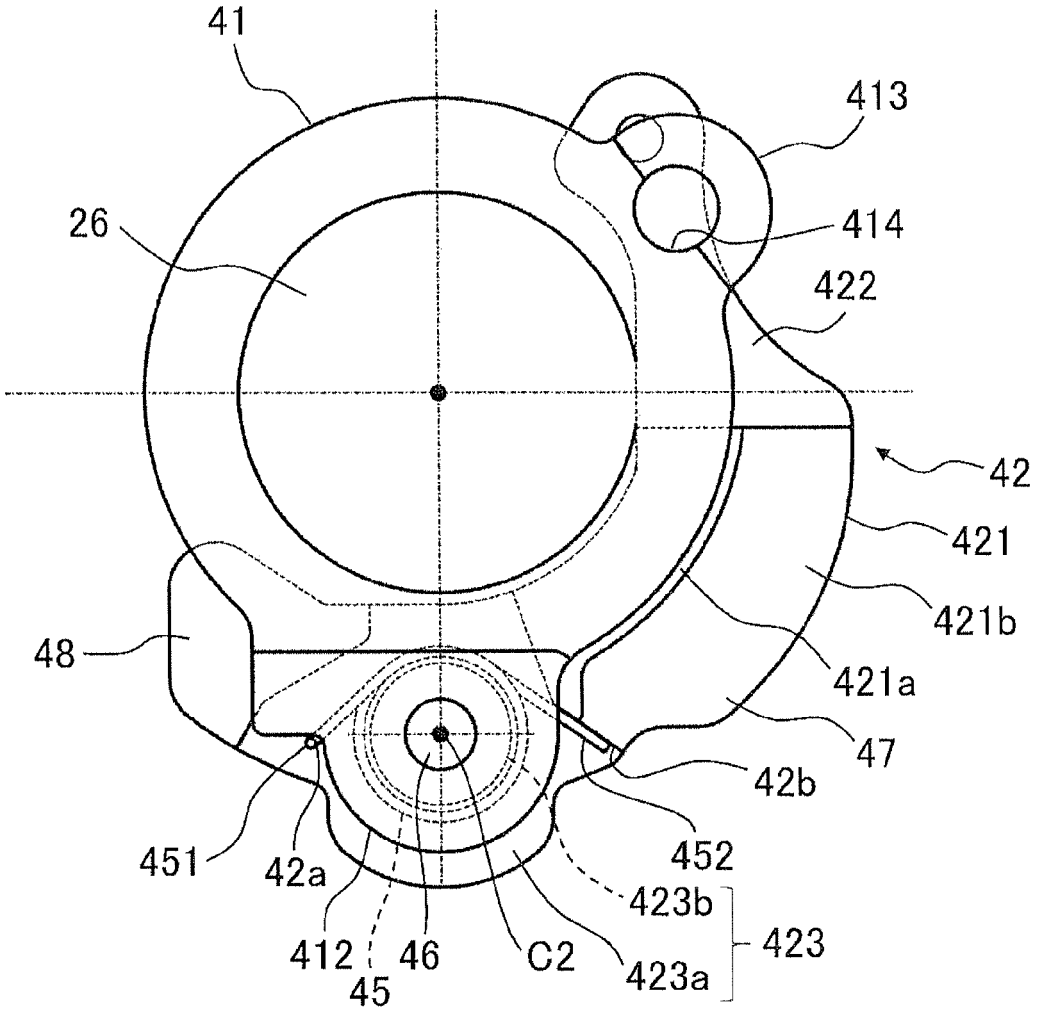

41
413
26
414
422
42
421
421b
48
421a
47
42b
451
42a
452
423b
423
412
46
C2
423a
45

FIG. 15

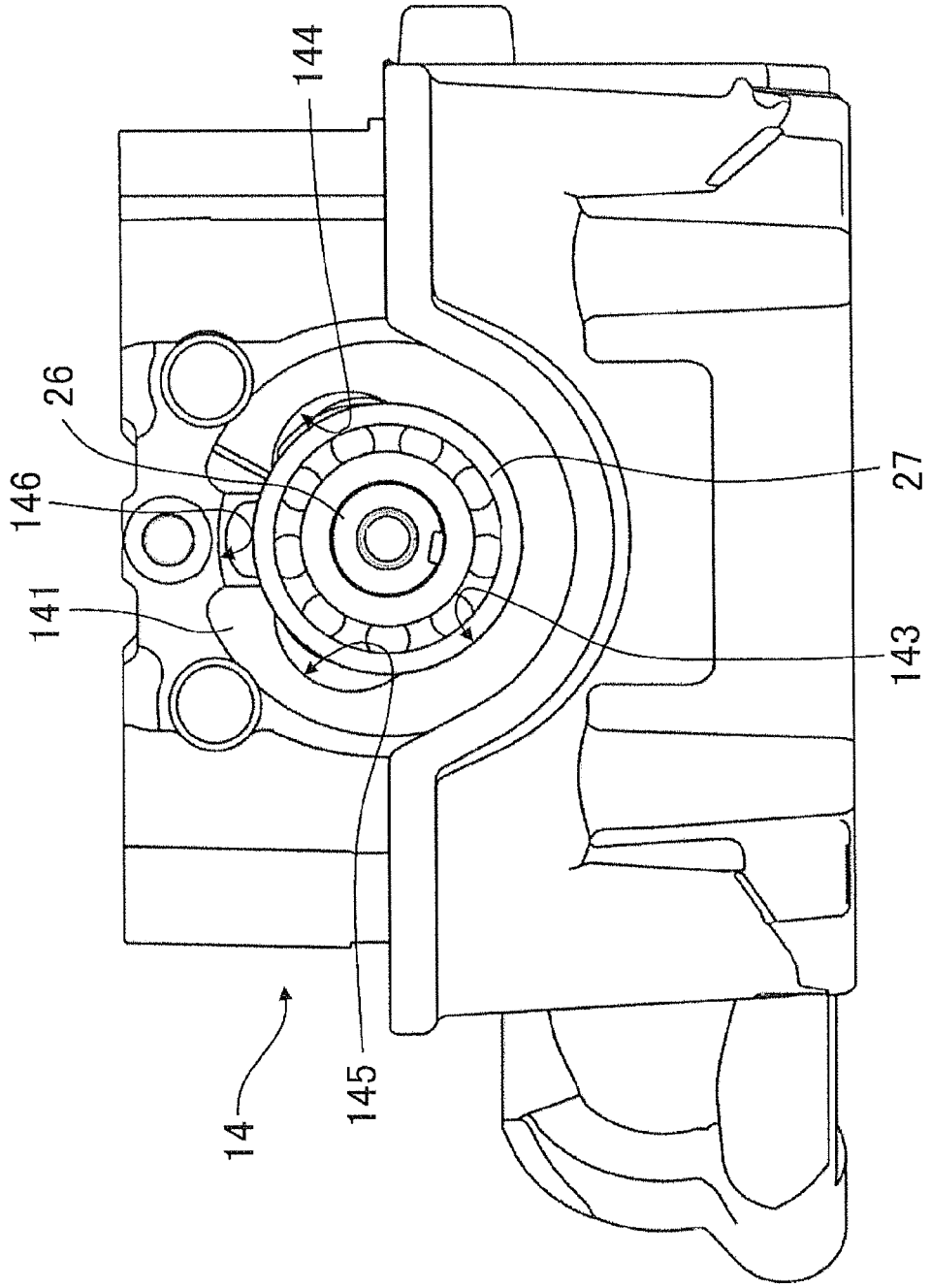


FIG. 16

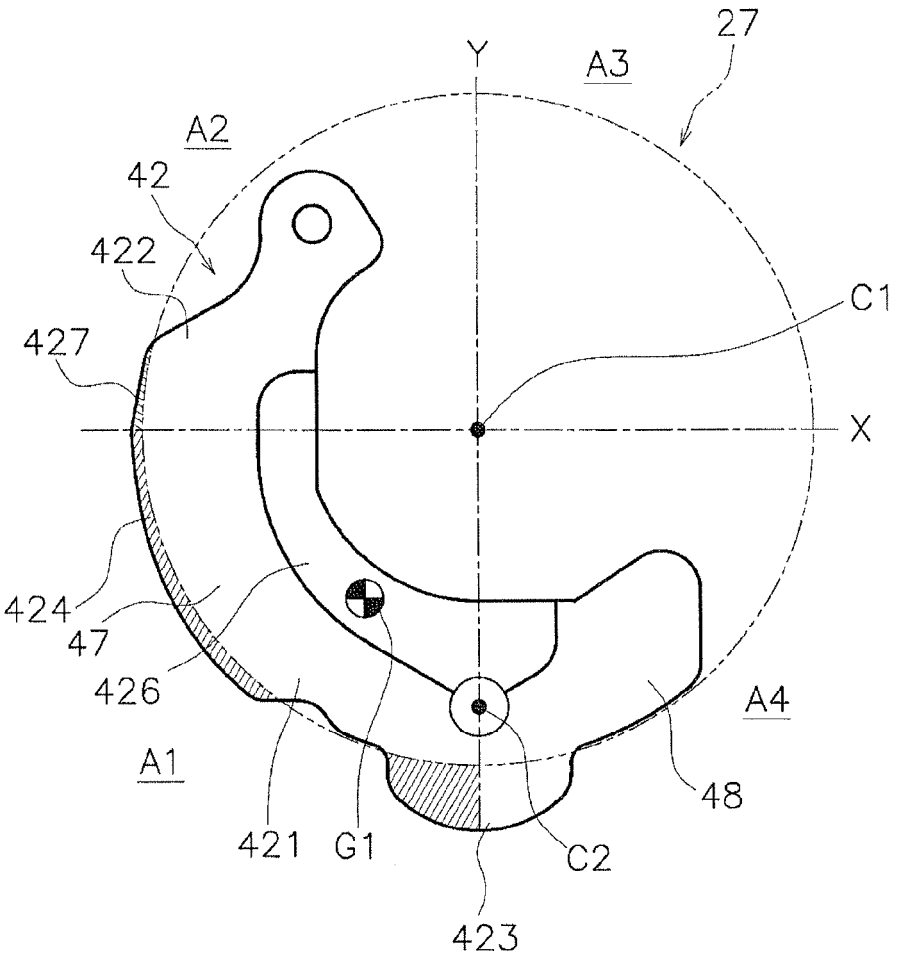


FIG. 17

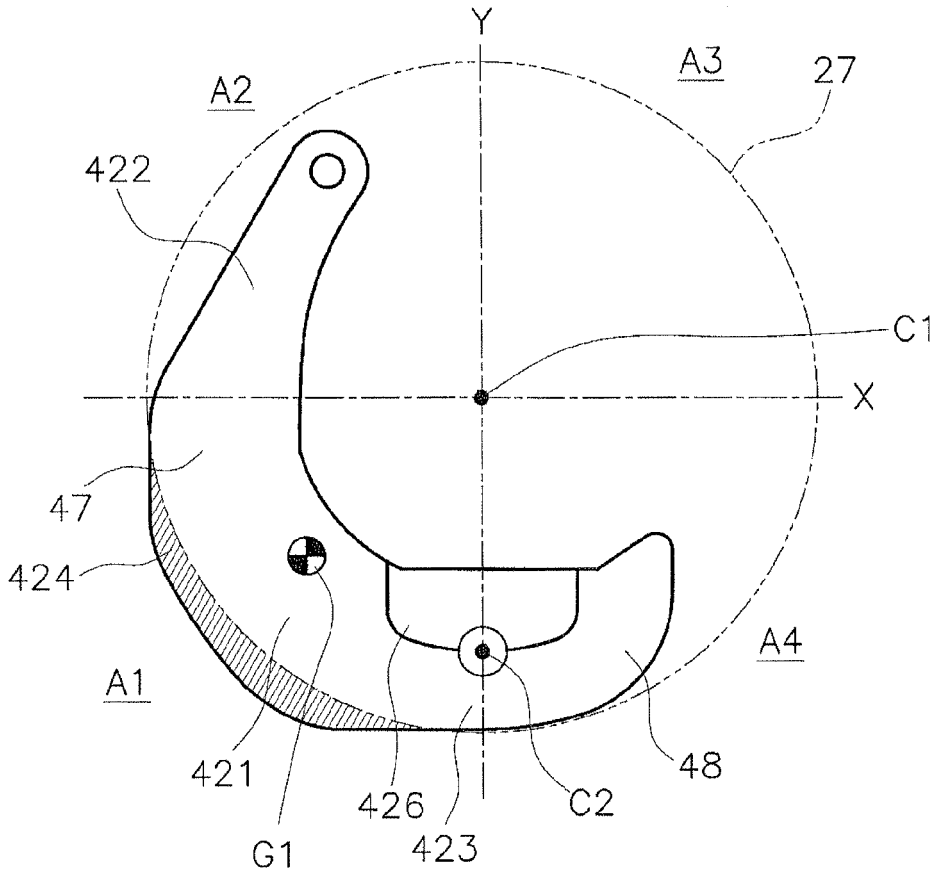


FIG. 18

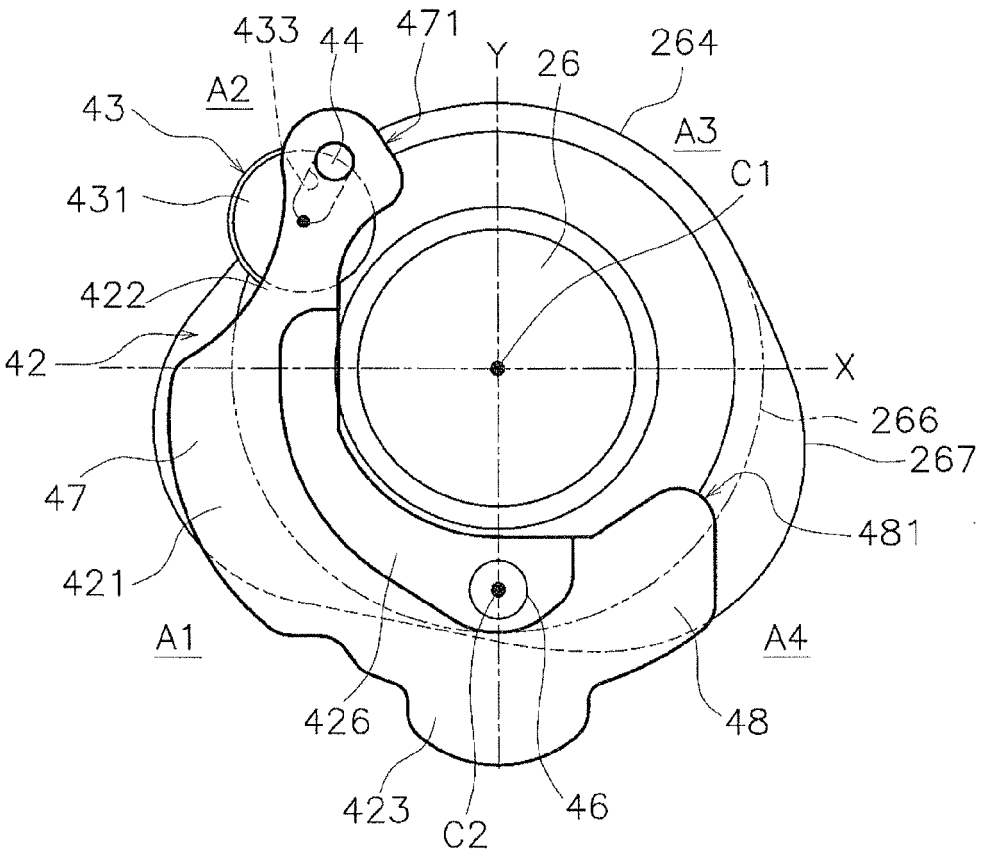

433
44
471
Y
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264
A2
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A3
C1
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X
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A4
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C2
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FIG. 19

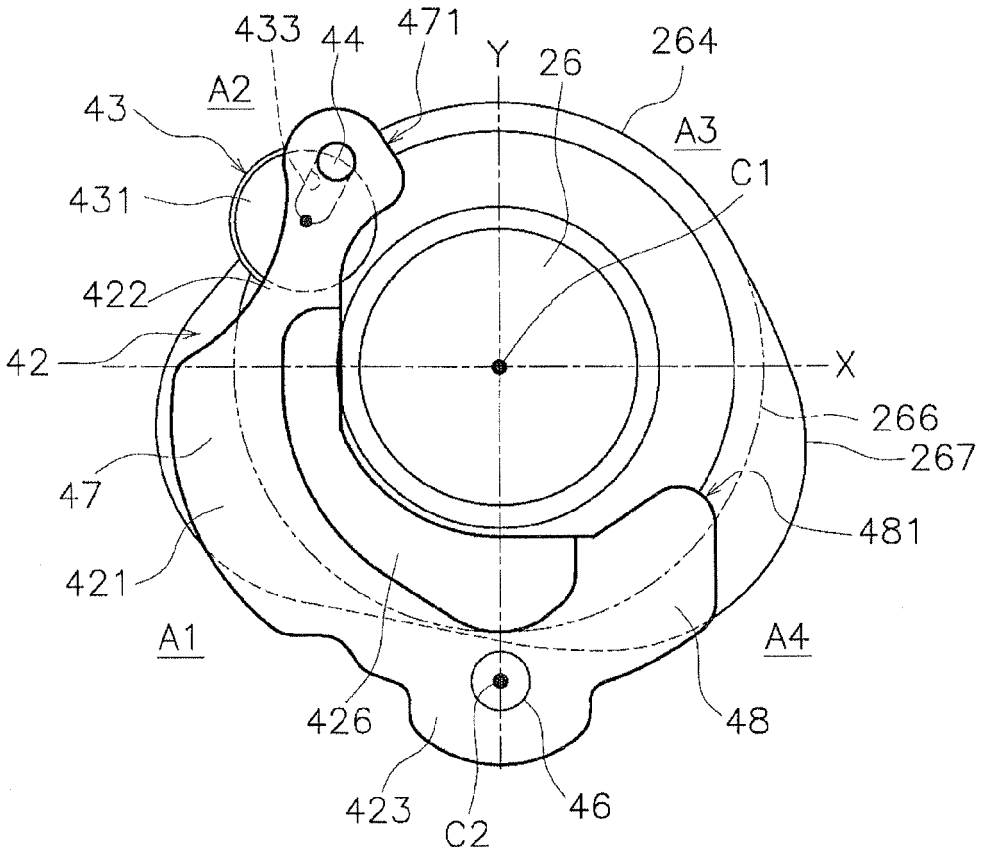

433
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FIG. 20

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EUROPEAN SEARCH REPORT

Application Number
EP 15 16 4176

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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A	JP H02 67409 A (YAMAHA MOTOR CO LTD) 7 March 1990 (1990-03-07) * abstract; figures * -----	1-9	

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F01L

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	17 July 2015	Paquay, Jeannot

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17-07-2015

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