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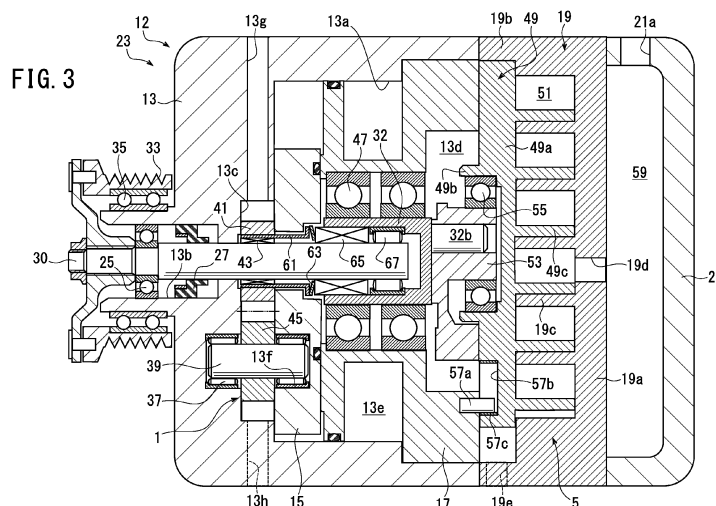
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(54) **Rankine cycle system**

(57) In a configuration in which a first shaft portion configured to drive a pump mechanism and a second shaft portion configured to drive an expansion mechanism are coupled to each other, a Rankine cycle system which is capable of continuing the circulation of working fluid by an expansion machine even when the pump mechanism is locked is provided. This Rankine cycle sys-

tem of the invention employs a pump 1 and an expansion machine 5 coupled in a tandem manner. A first shaft 30 of the pump 1 and a second shaft 32 of the expansion machine 5 are concentric and the first shaft 30 is capable of transmitting power to the second shaft 32. A pump torque limiter 43 is provided between the first shaft 30 and a main gear 41. A one-way clutch 65 is provided between a sensing shaft 61 and the second shaft 32.



Description

Technical Field

[0001] The present invention relates to a Rankine cycle system.

Background Art

[0002] A Rankine cycle system of the background art is disclosed in patent publication 1. The Rankine cycle system of this type includes a pump, a boiler, an expansion machine, a condenser, and pipes. The pipes are configured to allow working fluid to circulate from the pump, through the boiler and the expansion machine, and to the condenser.

[0003] This Rankine cycle system employs a fluid machine including the pump and the expansion machine coupled in a tandem manner. In other words, the fluid machine includes a housing, a rotary shaft axially rotatably supported by the housing, and a pump mechanism and an expansion mechanism configured in the housing. The pump mechanism is configured to be capable of sucking working fluid from a first intake port by the rotation of the rotary shaft, and discharging the working fluid from a first outlet port. The expansion mechanism is configured to be capable of rotating the rotary shaft by causing expandable working fluid to flow into a second inlet port and to flow out from a second outlet port after expansion. In the housing, a power generating mechanism is also provided between the pump mechanism and the expansion mechanism.

[0004] In this fluid machine, a pulley of an electromagnetic clutch is fixed to the rotary shaft projecting partly from the housing. This pulley is driven by an engine. The rotary shaft consists a first shaft portion, a second shaft portion, and a one-way clutch. The first shaft portion drives the pump mechanism and the power generating mechanism. The second shaft portion is provided concentrically with the first shaft portion. The second shaft portion is driven by the expansion mechanism. The one-way clutch is provided between the first shaft portion and the second shaft portion.

[0005] In this Rankine cycle system, the first outlet port of the pump mechanism of the fluid machine is connected to the boiler by the pipe, and the boiler is connected to the second inlet port of the expansion mechanism by the pipe. The second outlet port of the expansion mechanism is connected to the condenser by the pipe, and the condenser is connected to the first inlet port of the pump mechanism by the pipe.

[0006] In this Rankine cycle system, the working fluid circulates from the pump mechanism via the boiler and the expansion mechanism to the condenser by turning the electromagnetic clutch ON and driving the pump mechanism of the fluid machine by the engine. During the time, the working fluid is heated by waste heat of the engine in the boiler. The heated working fluid drives the

expansion mechanism. The working fluid flowing through the expansion mechanism is heat-discharged by the condenser.

[0007] Therefore, if the first shaft portion and the second shaft portion rotate in the same direction and the rotational speed of the second shaft portion is smaller than the rotational speed of the first shaft portion, the one-way clutch blocks power transmission between the second shaft portion and the first shaft portion. Therefore, when the high-low pressure difference of the Rankine cycle system is small at the time of start of the engine or the like, there is a merit that a drag loss does not occur.

[0008] Then, when the rotational speed of the second shaft portion reaches to exceed the rotational speed of the first shaft portion, the one-way clutch allows power transmission between the second shaft portion and the first shaft portion, and hence the second shaft portion and the first shaft portion rotate integrally. Therefore, the electromagnetic clutch is turned OFF and the power generating mechanism is driven by the first shaft portion. In this manner, in this Rankine cycle system, waste heat may be effectively utilized.

Citation List

Patent Publication

[0009] Patent Publication 1 JP-A-2008-274834

Summary of Invention

Problems to be Solved

[0010] However, in the Rankine cycle system of the background art described above, when the pump mechanism is locked by seizure or the like, the first shaft portion stops together with the pump mechanism, and hence engine torque cannot be transmitted to the expansion mechanism via the second shaft portion, and the expansion mechanism is stopped. In this case, the expansion mechanism cannot be operated as a blower by driving the expansion mechanism by the engine, and hence the circulation of the working fluid cannot be continued.

[0011] In view of such circumstance of the background art described above, it is an object of the invention to provide a Rankine cycle system which is, in a configuration in which a first shaft portion configured to drive a pump mechanism and a second shaft portion configured to drive an expansion mechanism are coupled to each other, capable of continuing the circulation of working fluid by the expansion mechanism even when the pump mechanism is locked.

Solution to Problem

[0012] In order to solve the above-described problem, a Rankine cycle system of the invention comprises:

a pump; a boiler; an expansion machine; a condenser; and pipes,
 the pipes are connecting the pump to the condenser via the boiler and the expansion machine for circulating the working fluid, wherein
 the pump includes a first shaft portion coupled to a drive source, and a pump mechanism capable of being rotated by the first shaft portion,
 the expansion machine includes a second shaft portion coupled to the first shaft portion, and an expansion mechanism rotatable by the second shaft portion, and
 a pump torque limiter is provided between the first shaft portion and the pump mechanism.

[0013] Other aspects and advantages of the invention will become apparent from the following description, taken in conjunction with the accompanying drawings, illustrating by way of example the principles of the invention.

{Brief Description of Drawings}

[0014]

Fig. 1 is a schematic structure drawing illustrating a Rankine cycle system of Embodiment 1 to Embodiment 4.

Fig. 2 illustrates the Rankine cycle system of Embodiment 1 and is a cross-sectional view of a fluid machine.

Fig. 3 illustrates the Rankine cycle system of Embodiment 2 and is a cross-sectional view of a fluid machine.

Fig. 4 illustrates the Rankine cycle system of Embodiment 2 and is an enlarged partial plan view of a one-way clutch.

Fig. 5 illustrates the Rankine cycle system of Embodiment 2 and is an enlarged partial cross-sectional view of the one-way clutch.

Fig. 6 illustrates the Rankine cycle system of Embodiment 2 and is an enlarged partial cross-sectional view of the one-way clutch.

Fig. 7 illustrates the Rankine cycle system of Embodiment 2 and is an enlarged partial cross-sectional view of the one-way clutch.

Fig. 8 illustrates the Rankine cycle system of Embodiment 3 and is an enlarged partial plan view of a one-way clutch.

Fig. 9 illustrates the Rankine cycle system of Embodiment 3 and is an enlarged partial cross-sectional view of the one-way clutch.

Fig. 10 illustrates the Rankine cycle system of Embodiment 3 and is an enlarged partial cross-sectional view of the one-way clutch.

Fig. 11 illustrates the Rankine cycle system of Embodiment 3 and is an enlarged partial cross-sectional view of the one-way clutch.

Fig. 12 illustrates the Rankine cycle system of Em-

bodiment 4 and is a cross-sectional view of a fluid machine.

{Description of Embodiments}

[0015] Referring now to the drawings, Embodiments 1 to 4 in which the invention is embodied have been described.

Embodiment 1

[0016] A Rankine cycle system of Embodiment 1 includes a pump 1, a boiler 3, an expansion machine 5, a condenser 7, and pipes 9a to 9d as illustrated in Fig. 1.

This Rankine cycle system is configured to circulate refrigerant as working fluid by these members.

[0017] This Rankine cycle system employs a fluid machine 11 including the pump 1 and the expansion machine 5 coupled in a tandem manner. In other words, the fluid machine 11 includes a housing 23 having a front housing 13, a first fixed block 15, a second fixed block 17, a fixed scroll 19, and a rear housing 21 as illustrated in Fig. 2.

[0018] The front housing 13 is formed with a block chamber 13a and a main shaft hole 13b. The main shaft hole 13b communicates the outside and the block chamber 13a. In the interior of the block chamber 13a, the first fixed block 15 and the second fixed block 17 are fixed. The block chamber 13a is partitioned into a gear pump chamber 13c, a storage chamber 13d, and a hollow chamber 13e. The gear pump chamber 13c is defined by the front housing 13 and the first fixed block 15. The storage chamber 13d is formed in the interior of the second fixed block 17. The hollow chamber 13e is defined by the front housing 13 and the second fixed block 17 for reducing the weight.

[0019] A bearing apparatus 25 and a shaft seal apparatus 27 are provided in the interior of the main shaft hole 13b. A rotary shaft 29 is axially rotatably supported by the bearing apparatus 25 and the shaft seal apparatus 27. The rotary shaft 29 corresponds to a first shaft portion and a second shaft portion. The rotary shaft 29 extends orthogonally to the gear pump chamber 13c and extends into the storage chamber 13d. A pulley 33 is fixed to the rotary shaft 29 projecting from the front housing 13. The front housing 13 is provided with a bearing apparatus 35. The pulley 33 is configured to be rotatable about the main shaft hole 13b by the bearing apparatus 35. The pulley 33 is configured to be driven by an engine by a belt, not illustrated. The engine corresponds to a drive source. The engine is supplied with compressed air by a turbo-charger.

[0020] The front housing 13 and the first fixed block 15 are formed with a secondary shaft hole 13f parallel to the main shaft hole 13b. Two bearing apparatuses 37 are provided in the interior of the secondary shaft hole 13f. A secondary shaft 39 is axially rotatably supported by the bearing apparatuses 37. The secondary shaft 39 ex-

tends orthogonally to the gear pump chamber 13c.

[0021] In the interior of the gear pump chamber 13c, a main gear 41 is provided on the rotary shaft 29 by a pump torque limiter 43. The main gear 41 is configured to be rotatable by the rotary shaft 29. The main gear 41 corresponds to a pump mechanism. The pump torque limiter 43 is configured not to transmit power between the rotary shaft 29 and the main gear 41 when the rotary shaft 29 generates torque equal to or higher than a predetermined value with respect to the main gear 41. In the interior of the gear pump chamber 13c, a secondary gear 45 is provided on the secondary shaft 39. The secondary gear 45 is press-fitted onto the secondary shaft 39. The main gear 41 and the secondary gear 45 engage with each other. The pump 1 is composed of the rotary shaft 29, the secondary shaft 39, the main gear 41, the secondary gear 45, the front housing 13, and the first fixed block 15.

[0022] The front housing 13 is formed with a first inlet port 13g and a first outlet port 13h both communicating with the gear pump chamber 13c.

[0023] The rotary shaft 29 integrally includes a large diameter portion 29a formed into a column shape having a large diameter at a portion behind the gear pump chamber 13c. Two bearing apparatuses 47 are provided in the interior of the second fixed block 17. The large diameter portion 29a is axially rotatably supported by the bearing apparatuses 47. An eccentric pin 29b deviated with respect to the rotary shaft 29 is formed behind the large diameter portion 29a. The large diameter portion 29a and the eccentric pin 29b both function as the second shaft portion together with the rotary shaft 29.

[0024] The fixed scroll 19 has a fixed base plate 19a, a fixed peripheral wall 19b, and a fixed spiral wall 19c. The fixed base plate 19a is orthogonal to the rotary shaft 29. The fixed peripheral wall 19b extends cylindrically in the axial direction around a peripheral edge of the fixed base plate 19a. The fixed peripheral wall 19b is fixed to the front housing 13. The fixed spiral wall 19c extends spirally in the axial direction toward the eccentric pin 29b on the inside of the fixed base plate 19a.

[0025] A movable scroll 49 is stored between the fixed scroll 19 and the second fixed block 17. The movable scroll 49 has a movable base plate 49a, a boss portion 49b, and a movable spiral wall 49c. The movable base plate 49a is orthogonal to the rotary shaft 29. The boss portion 49b extends cylindrically at a center of the movable base plate 49a in the axial direction toward the eccentric pin 29b. The fixed spiral wall 49c extends spirally and protrudes in the axial direction toward the fixed scroll 19 on the inside of the movable base plate 49a. The fixed scroll 19 and the movable scroll 49 engage each other whereby an expansion chamber 51 is defined. The movable scroll 49 corresponds to an expansion mechanism.

[0026] A bush balancer 53 is provided between the large diameter portion 29a of the rotary shaft 29 and the movable scroll 49. The bush balancer 53 is formed with a pin hole 53a extending in the axial direction. The eccentric pin 29b is inserted through the pin hole 53a. A

bearing apparatus 55 is provided in the interior of the boss portion 49b of the movable scroll 49. The bush balancer 53 is axially rotatably supported by the bearing apparatus 55.

[0027] A plurality of rotation preventing pins 57a are fixed to a back surface of the second fixed block 17. The respective rotation preventing pins 57a extend toward the movable base plate 49a of the movable scroll 49. A plurality of rotation preventing holes 57b are formed so as to be depressed on a front surface of the movable base plate 49a. Distal end portions of the rotation preventing pins 57a are loosely fitted into the respective rotation preventing holes 57b. Cylindrical rings 57c are loosely fitted into the respective rotation preventing holes 57b. When the rotary shaft 29 rotates, the respective rotation preventing pins 57a slide and roll in the inner peripheral surfaces of the rings 57c. Accordingly the movable scroll 49 is restricted from rotation and is only capable of revolving about the rotary shaft 29.

[0028] The fixed base plate 19a of the fixed scroll 19 is formed with an intake port 19d communicating with the expansion chamber 51 at a center thereof. The fixed scroll 19 and the rear housing 21 define an intake chamber 59 which communicates with the intake port 19d. The rear housing 21 is formed with a second inlet port 21a communicating with the intake chamber 59. The fixed scroll 19 is formed with a second outlet port 19e communicating with the expansion chamber 51 on the outer peripheral side. The expansion machine 5 includes the fixed scroll 19, the rear housing 21, the movable scroll 49, the second fixed block 17, the bush balancer 53, the large diameter portion 29a, the eccentric pin 29b, the respective rotation preventing pins 57a, and the respective rings 57c, or the like.

[0029] In this Rankine cycle system, as illustrated in Fig. 1, the first outlet port 13h of the pump 1 of the fluid machine 11 is connected to the boiler 3 by the pipe 9a and the boiler 3 is connected to the second inlet port 21a of the expansion machine 5 by the pipe 9b. The second outlet port 19e of the expansion mechanism 5 is connected to the condenser 7 by the pipe 9c, and the condenser 7 is connected to the first inlet port 13g of the pump 1 by the pipe 9d.

[0030] In this Rankine cycle system, by the rotation of the pulley 33 of the fluid machine 11 illustrated in Fig. 2 by the engine, the rotary shaft 29 is rotated. If the main gear 41 is not subjected to seizure or the like, and the pump torque limiter 43 transmits the power from the rotary shaft 29 to the main gear 41, the pump 1 is driven. The pump 1 sucks refrigerant from the first inlet port 13g and discharges the refrigerant from the first outlet port 13h. Accordingly, the refrigerant is supplied from the pump 1 to the boiler 3. In the boiler 3, the refrigerant is heated by heat of compressed air supplied to the engine. In the boiler 3, for example, the refrigerant may be heated by a back-flow exhaust air or the like flowing back to the engine, as a heat source.

[0031] The refrigerant expandable by being heated

flows from the second inlet port 21a of the expansion machine 5, and the refrigerant after the expansion flows out from the second outlet port 19e. Accordingly, the rotary shaft 29 is rotated. The rotation of the rotary shaft 29 may be regenerated for the engine or the like or may be provided for power generation for a power generator or the power generating mechanism. Heat of the refrigerant passing through the expansion machine 5 is radiated by the condenser 7. In this manner, in this Rankine cycle system, waste heat may be used effectively while cooling the compressed air.

[0032] When the pump 1 is locked by seizure or the like, the torque of the rotary shaft 29 with respect to the pump 1 exceeds a predetermined value, and the pump torque limiter 43 blocks power transmission between the rotary shaft 29 and the main gear 41. Therefore, even when the pump 1 is stopped, the rotary shaft 29 allows continuation of the rotation. Therefore, the power is transmitted to the eccentric pin 29b, and the expansion machine 5 is driven by the engine continuously. Therefore, the expansion machine 5 may be used as a blower to continue circulation of the refrigerant.

[0033] Therefore, in this Rankine cycle system, even when the pump 1 is locked, the compressed air may be cooled preferably by continuing the circulation of the refrigerant by the expansion machine 5.

Embodiment 2

[0034] The Rankine cycle system of Embodiment 2 employs a fluid machine 12 illustrated in Fig. 3. The fluid machine 12 includes a first shaft 30 axially rotatably supported in the main shaft hole 13b of the front housing 13. The first shaft 30 corresponds to the first shaft portion. A sensing shaft 61 formed into a cylindrical shape and concentric with the first shaft 30 is provided between the pump torque limiter 43 and the main gear 41.

[0035] The two bearing apparatuses 47 provided in the second fixed block 17 axially rotatably support a bottomed cylindrical second shaft 32. The second shaft 32 corresponds to the second shaft portion. The first shaft 30 and the second shaft 32 are concentric. The second shaft 32 is formed with an eccentric pin 32b deviated with respect to the first shaft 30 and the second shaft 32.

[0036] A one-way clutch 65 and a bearing apparatus 67 are provided between the first shaft 30 and the second shaft 32 in the radial direction. A rear end of the sensing shaft 61 is bent radially outward in a flange shape. A disc spring 63 is provided between the rear end of the sensing shaft 61 and the one-way clutch 65 in the axial direction. The disc spring 63 corresponds to a sensing spring.

[0037] As illustrated in Figs. 4 to 7, the one-way clutch 65 includes an outer race 71, an inner race 72, a plurality of column-shaped rollers 73 and a holder 74. The outer race 71 rotates integrally with the second shaft 32. The inner race 72 rotates integrally with the first shaft 30. The respective rollers 73 are provided between the outer race 71 and the inner race 72. The holder 74 holds the re-

spective rollers 73.

[0038] The inner peripheral surface of the outer race 71 forms a cylindrical inner peripheral rolling surface 71a. The outer peripheral surface of the inner race 72 is formed into a polygonal shape being concentric with the first shaft 30. The outer peripheral surface of the inner race 72 has a plurality of plane portions 720 and a plurality of corner portions 721 and 722. Hereinafter, the corner portions 721 are on the front side in a direction of rotation R of the first shaft 30. The corner portions 722 are on the rear side in a direction of rotation R of the first Shaft 30. All the entire plane portions 720 and the corner portions 721 and 722 correspond to an outer peripheral rolling surface 72a. The respective rollers 73 are stored between the inner peripheral rolling surface 71a and the outer peripheral rolling surfaces 72a. The same number of stators 75 as the rollers 73 are fixed to the inner race 72. A forward urging spring 77 is provided between each of the stators 75 and each of the rollers 73. The respective forward urging springs 77 have a forward urging force which causes the respective rollers 73 to be positioned on the front side in the direction of rotation R of the first shaft 30. Boss portions 74a and 74b extending in the axial direction are formed in the holder 74 between the inner peripheral rolling surface 71a and the outer peripheral rolling surface 72a. The both boss portions 74a and 74b sandwich front ends and rear ends of the respective rollers 73. Accordingly, the both boss portions 74a and 74b rotatably hold the front ends and the rear ends of the respective rollers 73. The disc spring 63 illustrated in Fig. 3 is provided between the sensing shaft 61 and the holder 74. Other configurations are the same as Embodiment 1.

[0039] In this Rankine cycle system, by the rotation of the pulley 33 of the fluid machine 12 illustrated in Fig. 3 by the engine, the first shaft 30 is rotated. If the pump 1 is not subjected to seizure or the like, and the pump torque limiter 43 transmits the power from the first shaft 30 to the sensing shaft 61 and the main gear 41, the pump 1 is driven. The pump 1 sucks refrigerant from the first inlet port 13g and discharges the refrigerant from the first outlet port 13h. Therefore, the refrigerant is supplied from the pump 1 to the boiler 3. In the boiler 3, the refrigerant is heated by compressed air.

[0040] The refrigerant expandable by being heated flows from the second inlet port 21a of the expansion machine 5, and the refrigerant after the expansion flows out from the second outlet port 19e. Therefore, the second shaft 32 is rotated in the same direction as the first shaft 30.

[0041] Here, if the rotational speed of the second shaft 32 is smaller than the rotational speed of the first shaft 30, as illustrated in Fig. 6, the respective rollers 73 held in the holder 74 compress the respective forward urging springs 77 and, at the same time, move relatively in the direction opposite to the direction of rotation R (move counterclockwise in the drawing) due to the difference in rotating speed between the first shaft 30 and the holder 74. Accordingly, in the one-way clutch 65, the respective

rollers 73 are positioned respectively on the respective plane portions 720 of the inner race 72, engagement between the inner peripheral rolling surface 71a and the outer peripheral rolling surface 72a by the respective rollers 73 is released. Therefore, the one-way clutch 65 blocks power transmission between the second shaft 32 and the first shaft 30.

[0042] As illustrated in Fig. 5, when the rotational speed of the second shaft 32 reaches to exceed the of the first shaft 30, the respective rollers 73 rotate relatively in the same direction as the direction of rotation R (move clockwise in the drawing) in the one-way clutch 65. Accordingly, in the one-way clutch 65, the respective rollers 73 are positioned respectively on the sides of the respective corner portions 721 of the inner race 72, and are engaged between the outer race 71 and the inner race 72. Therefore, the inner peripheral rolling surface 71a and the outer peripheral rolling surface 72a engage by the respective rollers 73. Accordingly, the one-way clutch 65 allows power transmission between the second shaft 32 and the first shaft 30. Then, the second shaft 32 and the first shaft 30 rotate integrally by being directly connected. The rotation of the first shaft 30 may be regenerated for the engine or the like or may be provided for power generation for the power generator or the power generating mechanism. Heat of the refrigerant passing through the expansion machine 5 is discharged by the condenser 7. In this manner, in this Rankine cycle system, waste heat may be used effectively while cooling the compressed air.

[0043] When the pump 1 is locked by seizure or the like, the pump torque limiter 43 does not transmit the power from the first shaft 30 to the sensing shaft 61 and the main gear 41. Therefore, the sensing shaft 61 stops rotation and hence, the first shaft 30 continues to rotate even when the pump 1 is stopped. In this case, the sensing shaft 61 pulls the holder 74 of the one-way clutch 65 toward the rear side in the direction of rotation R by the disc spring 63. Therefore, in the one-way clutch 65, as illustrated in Fig. 7, even when the rotational speed of the second shaft 32 is smaller than the rotational speed of the first shaft 30, the respective rollers 73 are positioned respectively at the respective corner portions 722 on the rear side of the inner race 72 and are engaged between the outer race 71 and the inner race 72. Therefore, the inner peripheral rolling surface 71a and the outer peripheral rolling surface 72a engage by the respective rollers 73. Accordingly, the one-way clutch 65 allows power transmission between the second shaft 32 and the first shaft 30. Then, the second shaft 32 and the first shaft 30 rotate integrally by being directly connected. Therefore, power is transmitted from the engine to the second shaft 32 by the first shaft 30, so that the expansion machine 5 may be used as a blower to continue circulation of the working fluid.

[0044] Therefore, the Rankine cycle system may achieve the same effects and advantages as Embodiment 1. In addition, in this Rankine cycle system, when

the high-low pressure difference is small, there arises a merit that a drag loss of the expansion machine 5 does not occur. In this Rankine cycle system, the configuration is simple and costs are lower in comparison with the configuration in which the expansion machine 5 is driven by an external signal by sensing the lock of the pump 1.

{Embodiment 3}

[0045] The Rankine cycle system of Embodiment 3 employs a one-way clutch 66 illustrated in Figs. 8 to 11. The one-way clutch 66 includes a holder 78 and a plurality of rearward urging springs 79.

[0046] The same number of pairs of stators 75 and 76 as the rollers 73 are fixed to the inner race 72. The respective rollers 73 are stored between the respective pairs of stators 75 and 76. The forward urging spring 77 is provided between each of the stators 75 and each of the rollers 73. The rearward urging spring 79 is provided between each of the rollers 73 and each of the stators 76. The respective rearward urging springs 79 have a rearward urging force which causes the respective rollers 73 to be positioned on the rear side in the direction of rotation R of the first shaft 30. The rearward urging force is set to be weaker than the forward urging force of the forward urging springs 77.

[0047] The same number of partitioning walls 78a as the rollers 73 extending in the axial direction are formed in the holder 78. The rollers 73 are stored between the both partitioning walls 78a. Other configurations are the same as Embodiment 2.

[0048] In this one-way clutch 66, if the rotational speed of the second shaft 32 is smaller than the rotational speed of the first shaft 30, the respective partitioning walls 78a move relatively in the direction opposite from the direction of rotation R as illustrated in Fig. 10 (move counterclockwise in the drawing) due to the difference in rotating speed between the first shaft 30 and the holder 78, and compress the respective forward urging springs 77 respectively. The respective rollers 73 move in the opposite direction from the direction of rotation R and are positioned on the respective plane portions 720 of the inner race 72 respectively. Therefore, engagement between the inner peripheral rolling surface 71a and the outer peripheral rolling surface 72a by the respective rollers 73 is released. Accordingly, the one-way clutch 66 blocks power transmission between the second shaft 32 and the first shaft 30.

[0049] On the other hand, as illustrated in Fig. 9, when the rotational speed of the second shaft 32 reaches to exceed the rotational speed of the first shaft 30, the respective partitioning walls 78a move relatively in the same direction as the direction of rotation R (move clockwise in the drawing) in the one-way clutch 66, and press the respective rollers 73. In this case, the rearward urging force of the rearward urging springs 79 is set to be weaker than the forward urging force of the forward urging springs 77 as described above, the respective rearward

urging springs 79 are compressed by the respective rollers 73. Accordingly, the respective rollers 73 move in the same direction as the direction of rotation R and are positioned at the respective corner portions 721 on the front side of the inner race 72, thereby becoming engaged between the outer race 71 and the inner race 72. Therefore, the inner peripheral rolling surface 71a and the outer peripheral rolling surface 72a engage by the respective rollers 73. The one-way clutch 66 allows power transmission between the second shaft 32 and the first shaft 30.

[0050] When the pump 1 is locked by seizure or the like, the pump torque limiter 43 does not transmit the power from the first shaft 30 to the sensing shaft 61 and the main gear 41. Therefore, the sensing shaft 61 stops rotation and hence the first shaft 30 continues to rotate even when the pump 1 is stopped. In this case, the sensing shaft 61 pulls the holder 78 of the one-way clutch 66 toward the rear side in the direction of rotation R by the disc spring 63. Therefore, in the one-way clutch 66, as illustrated in Fig. 11, even when the rotational speed of the second shaft 32 is smaller than the rotational speed of the first shaft 30, the respective rollers 73 are positioned respectively at the respective corner portions 722 on the rear side of the inner race 72 and are engaged between the outer race 71 and the inner race 72. Therefore, the inner peripheral rolling surface 71a and the outer peripheral rolling surface 72a engage by the respective rollers 73. The one-way clutch 66 allows power transmission between the second shaft 32 and the first shaft 30. Then, the second shaft 32 and the first shaft 30 rotate integrally by being directly connected. Therefore, power is transmitted from the engine to the second shaft 32 by the first shaft 30, so that the expansion machine 5 may be used as a blower to continue circulation of the working fluid.

[0051] In this Rankine cycle system, since the respective rollers 73 are stabilized between the inner race 72 and the outer race 71 by the forward urging springs 77, the partitioning walls 78a, and the rearward urging springs 79 respectively in the one-way clutch 66, whereby the preferable operability is exercised. Other effects and advantages are the same as Embodiment 2.

{Embodiment 4}

[0052] The Rankine cycle system of Embodiment 4, as illustrated in Fig. 12, an expansion machine torque limiter 69 is provided between the second shaft 32 and the first shaft 30. In contrast, the sensing shaft 61 and the disc spring 63 are not provided. Other configurations are the same as Embodiment 2.

[0053] In this Rankine cycle system, when the pump 1 is locked by seizure or the like, the first shaft 30 continues the rotation by the pump torque limiter 43. In this case, the second shaft 32 continues to rotate even when the pump 1 is stopped as long as the torque of the second shaft 32 with respect to the first shaft 30 does not exceed a predetermined value. Therefore, the expansion ma-

chine 5 may be used as a blower to continue circulation of the refrigerant. When the torque of the second shaft 32 with respect to the first shaft 30 exceeds the predetermined value, the expansion machine torque limiter 69 blocks the power transmission between the second shaft 32 and the first shaft 30.

[0054] In this Rankine cycle system, even when the expansion machine 5 is locked by seizure or the like, when the pump 1 is operated normally, the first shaft 30 continues to rotate by the expansion machine torque limiter 69, and the second shaft 32 stops rotation. In this case, since the pump 1 moves normally, circulation of the refrigerant can be continued by the pump 1. Other effects and advantages are the same as Embodiment 2.

[0055] Although the invention has been described with reference to Embodiments 1 to 4, the invention is not limited to Embodiments 1 to 4 described above, and may be applied by changing as needed within the range not departing the scope thereof.

[0056] For example, within the housing 23 of the fluid machines 11 and 12, the power generating mechanism may be provided between the pump 1 and the expansion machine 5.

{Industrial Applicability}

[0057] The invention is applicable to the Rankine cycle system for a vehicle, a waste heat utilizing apparatus or the like. Reference Signs List

1	pump
3	boiler
5	expansion machine
7	condenser
9a-9d	pipe
13	front housing
13g	first inlet port
13h	first outlet port
15	first fixed block
17	second fixed block
19	fixed scroll
19e	second outlet port
21	rear housing
21a	second inlet port
23	housing
29	rotary shaft (first shaft portion, second shaft portion)
30	first shaft (first shaft portion)
32	second shaft (second shaft portion)
41	main gear (pump mechanism)
43	pump torque limiter
49	movable scroll (expansion mechanism)
61	sensing shaft
63	disc spring (sensing spring)
65, 66	one-way clutch
69	expansion machine torque limiter
71	outer race
71a	inner peripheral rolling surface

72 inner race
 72a outer peripheral rolling surface
 73 roller
 74, 78 holder
 75 stator
 77 forward urging spring
 79 rearward urging spring

Claims

1. A Rankine cycle system comprising: a pump; a boiler; an expansion machine; a condenser; and pipes; the pipes are connecting the pump to the condenser via the boiler and the expansion machine for circulating the working fluid, wherein
 the pump includes a first shaft portion coupled to a drive source, and a pump mechanism capable of being rotated by the first shaft portion,
 the expansion machine includes a second shaft portion coupled to the first shaft portion, and an expansion mechanism rotatable by the second shaft portion, and
 a pump torque limiter is provided between the first shaft portion and the pump mechanism.

2. The Rankine cycle system according to Claim 1 wherein
 the first shaft portion and the second shaft portion are concentric,
 a one-way clutch is provided between the first shaft portion and the second shaft portion so as to block power transmission between the second shaft portion and the first shaft portion if the rotational speed of the second shaft portion is smaller than the rotational speed of the first shaft portion, and allow the power transmission between the second shaft portion and the first shaft portion if the rotational speed of the second shaft portion reaches to exceed the rotational speed of the first shaft portion,
 the pump is provided with a sensing shaft configured to rotate when the pump mechanism is in operation, and
 the one-way clutch allows the power transmission between the second shaft portion and the first shaft portion even when the rotational speed of the second shaft portion is smaller than the rotational speed of the first shaft portion when the rotation of the sensing shaft is stopped.

3. The Rankine cycle system according to Claim 2, wherein
 the sensing shaft is a cylindrical shape concentric with the first shaft portion,
 the one way clutch includes:

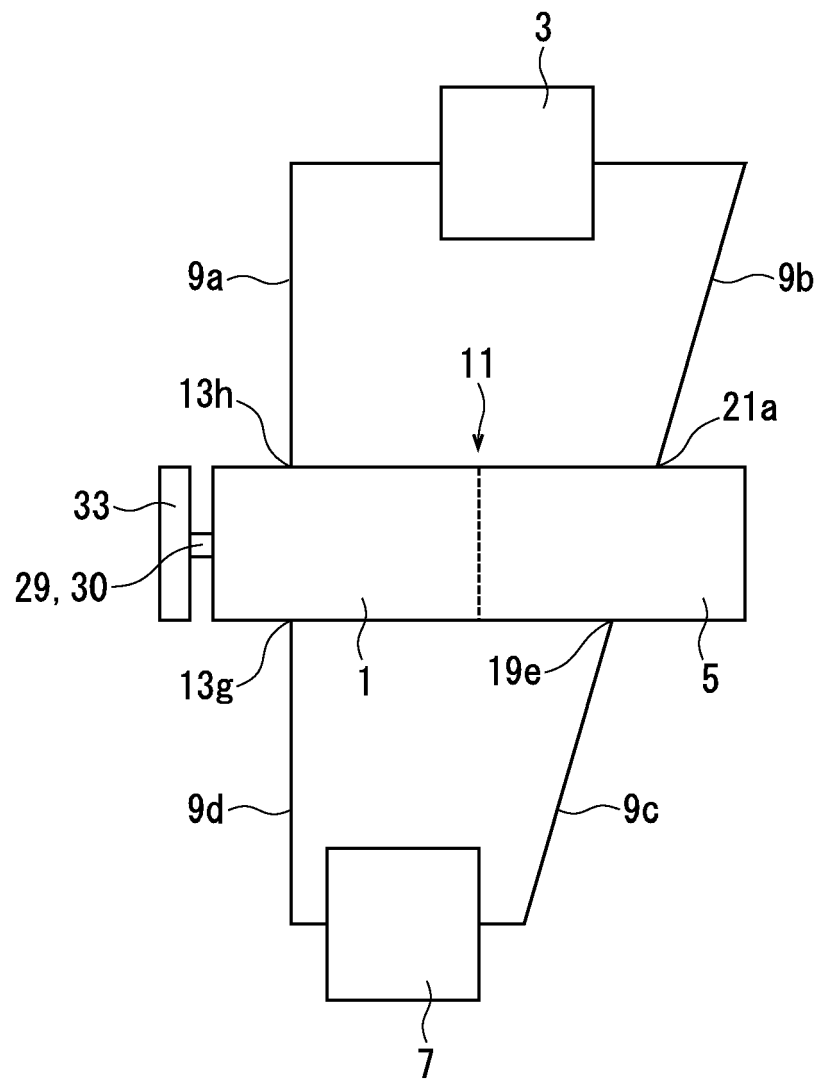
an outer race configured to rotate integrally with the second shaft portion and formed with a cy-

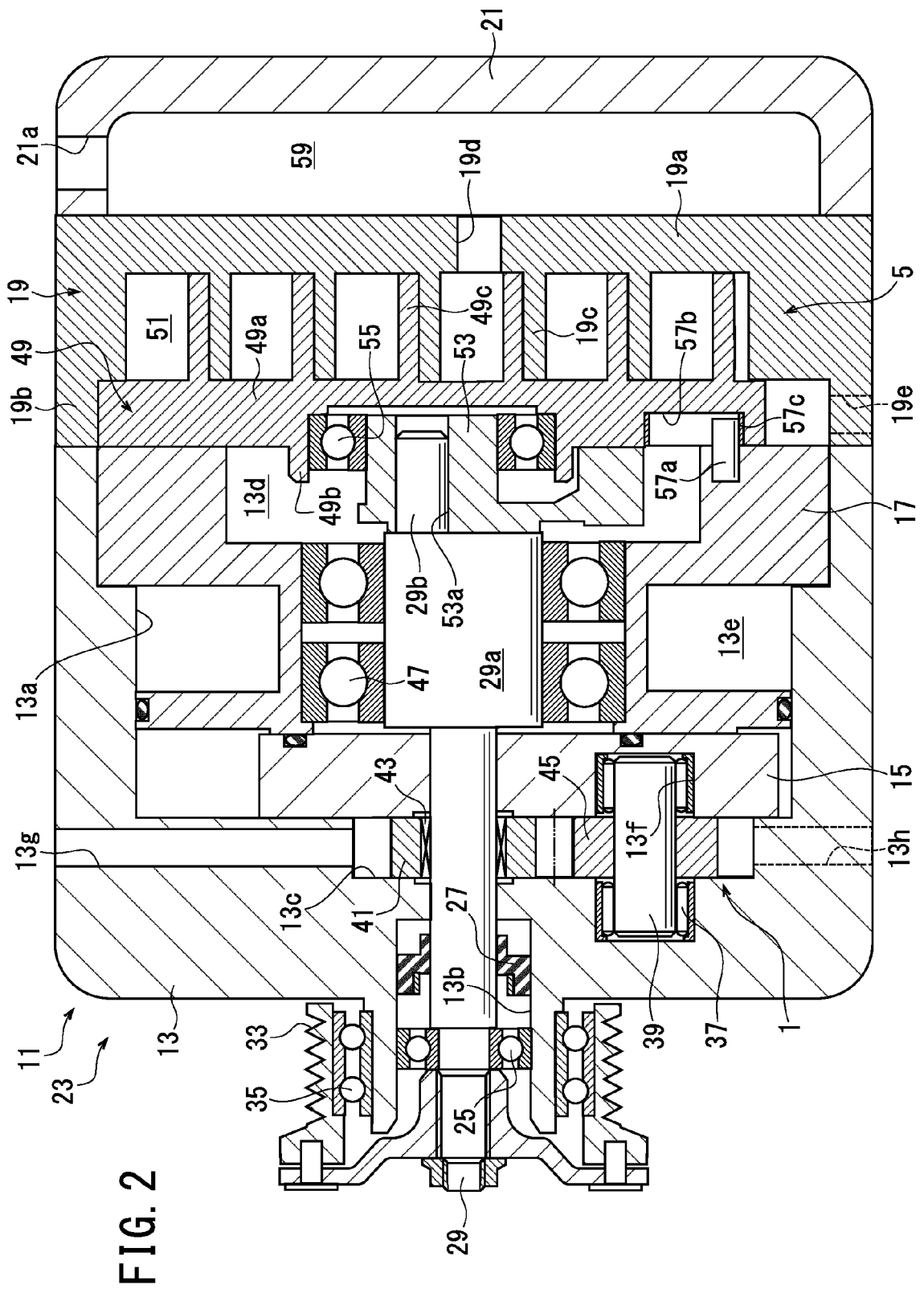
lindrical inner peripheral rolling surface;
 an inner race configured to rotate integrally with the first shaft portion and formed with a polygonal outer peripheral rolling surface;
 rollers configured to be stored between the inner peripheral rolling surface and the outer peripheral rolling surface;
 stators provided as many as the rollers and fixed to the inner race;
 forward urging springs provided between the stators and the rollers respectively, and having a forward urging force which causes the respective rollers to be positioned on the front side in the direction of rotation of the first shaft portion;
 a holder configured to hold the respective rollers between the inner peripheral rolling surface and the outer peripheral rolling surface; and
 a sensing spring provided between the sensing shaft and the holder.

4. The Rankine cycle system according to Claim 3, wherein
 the one-way clutch includes rearward urging springs provided between the respective stators and the respective rollers and having a rearward urging force which causes the respective rollers to be positioned on the rear side of the first shaft portion in the direction of rotation, and
 the rearward urging force is weaker than the forward urging force.

5. The Rankine cycle system according to Claim 1, wherein
 the first shaft portion and the second shaft portion are concentric, and
 an expansion machine torque limiter is provided between the second shaft portion and the first shaft portion.

FIG. 1





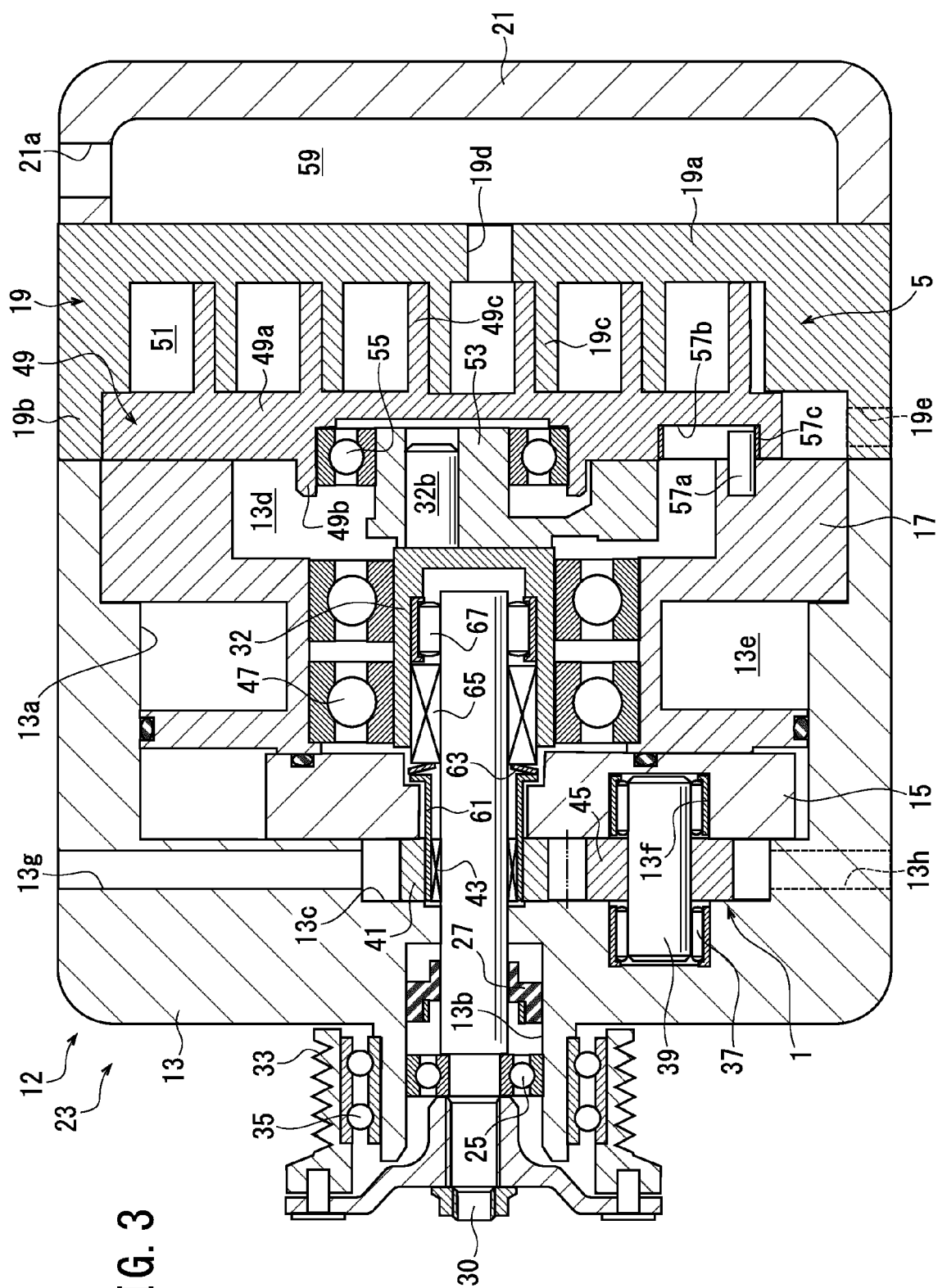


FIG. 3

FIG. 4

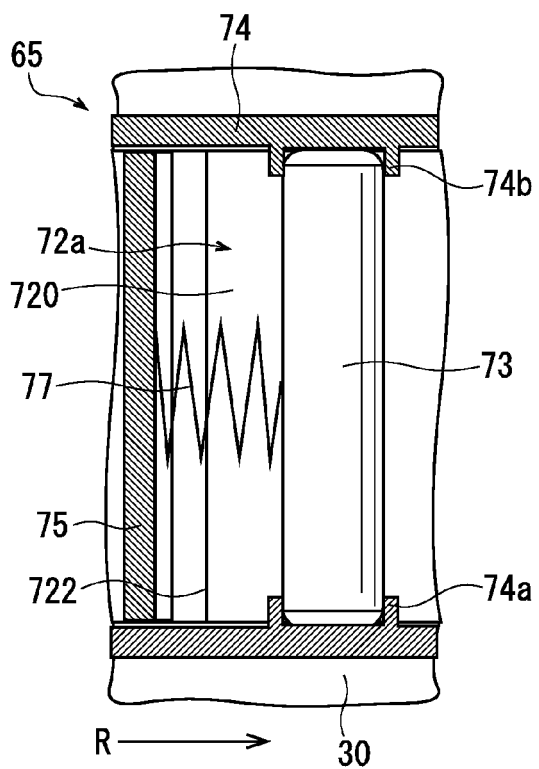


FIG. 5

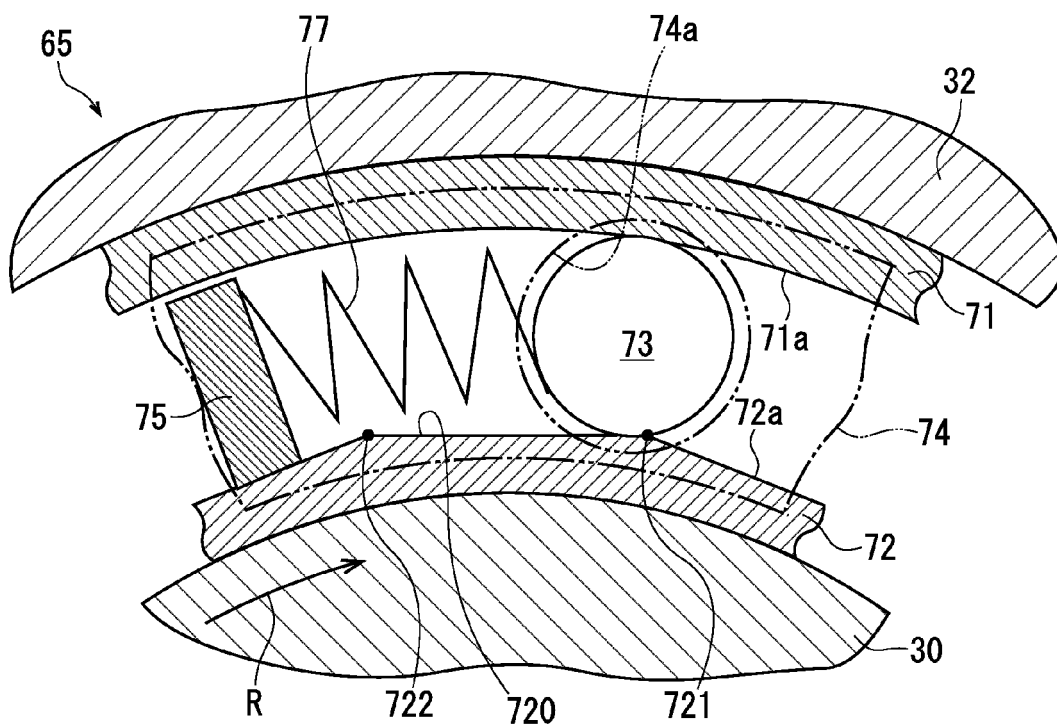


FIG. 6

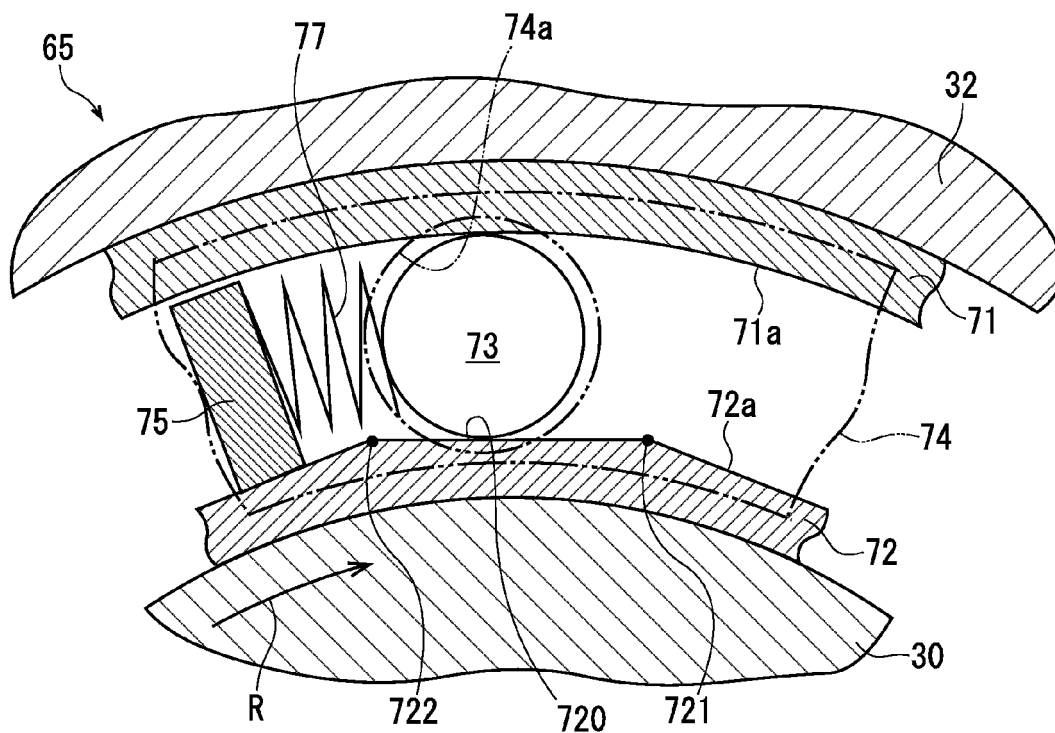


FIG. 7

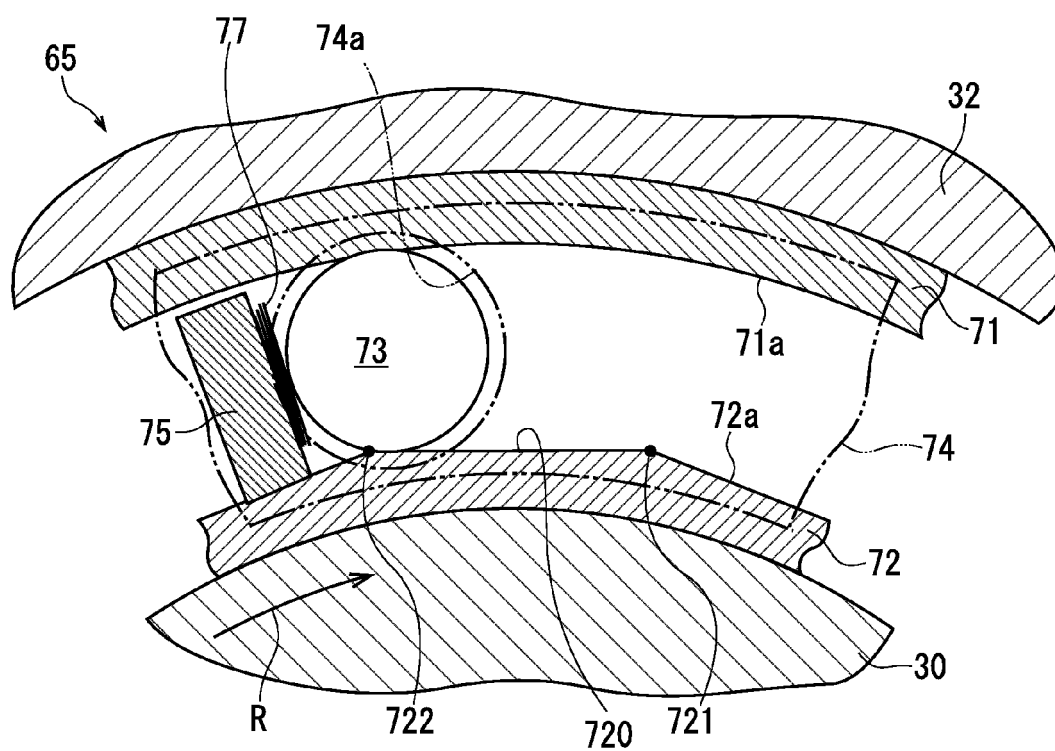


FIG. 8

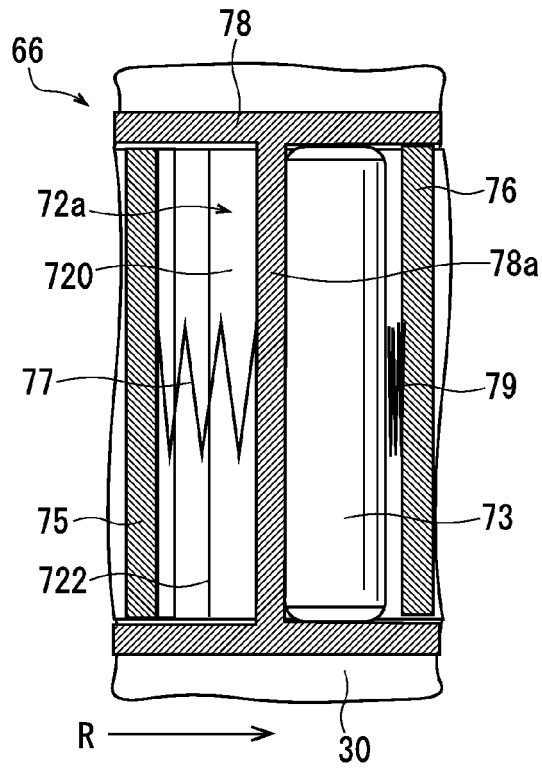


FIG. 9

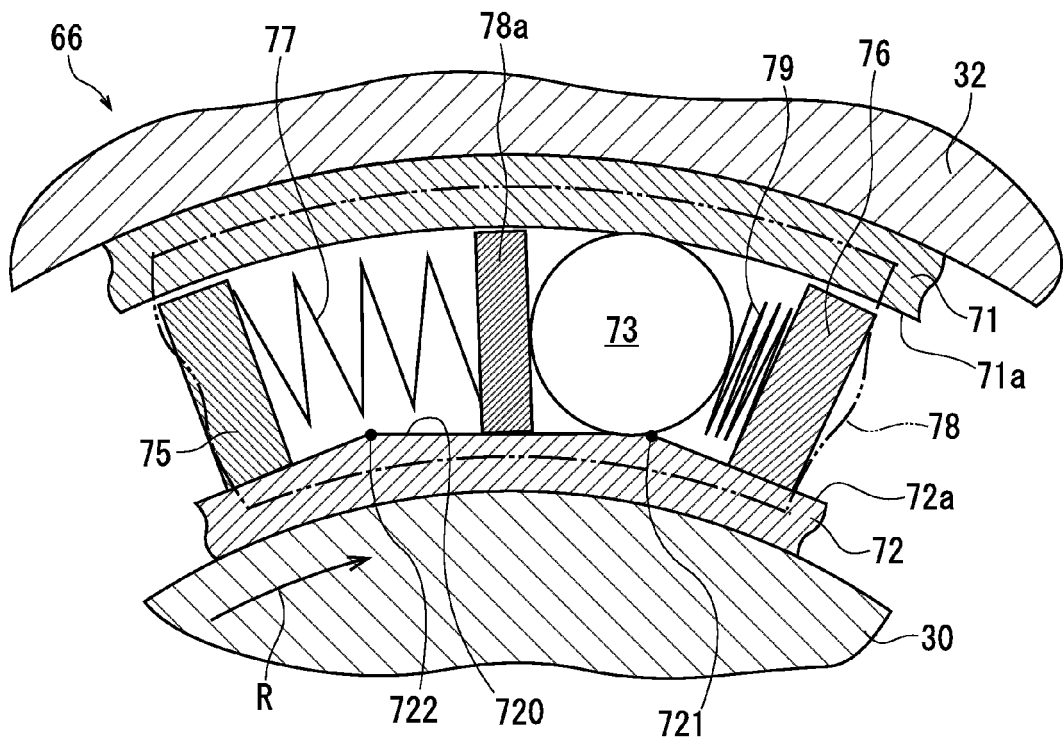


FIG. 10

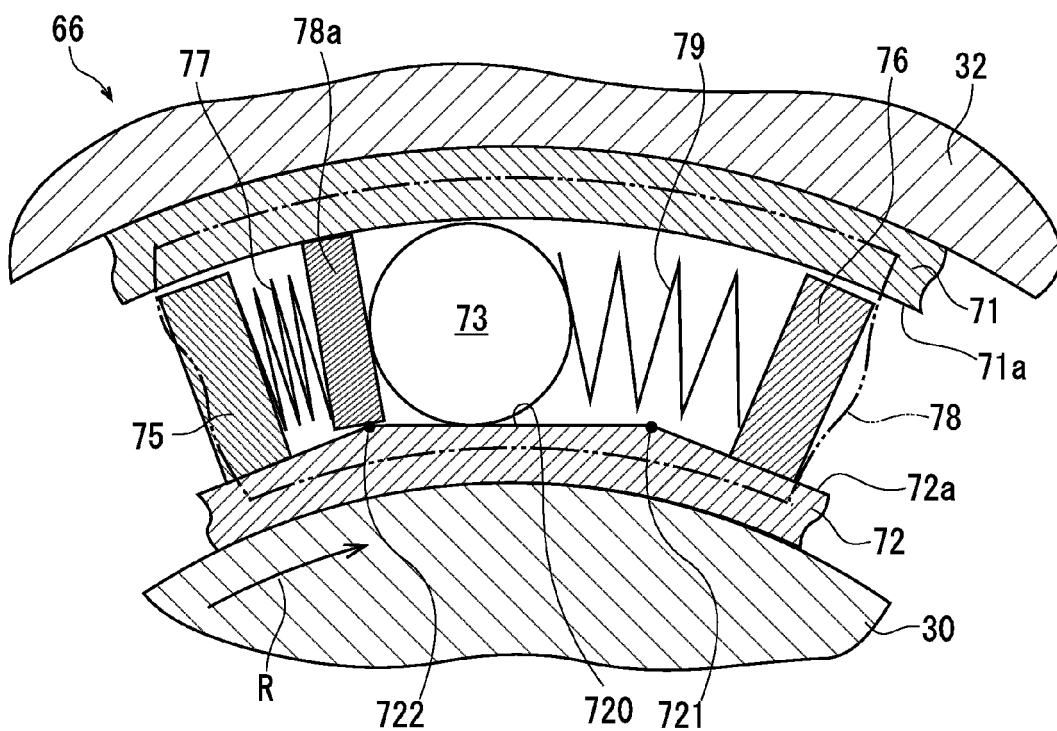
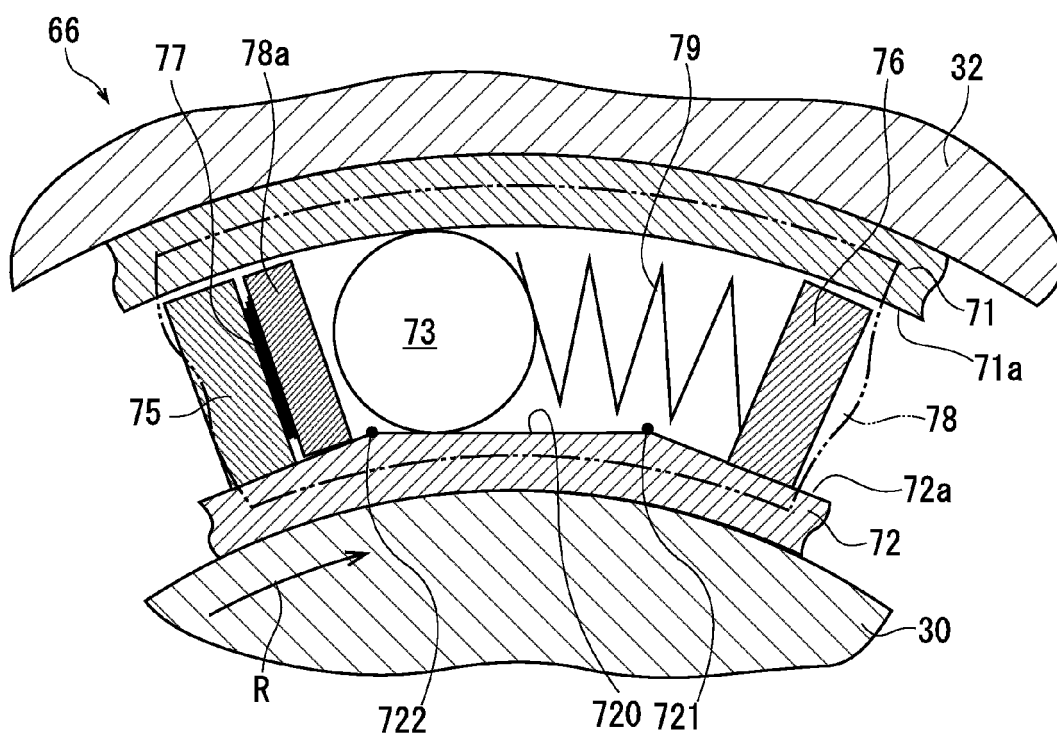
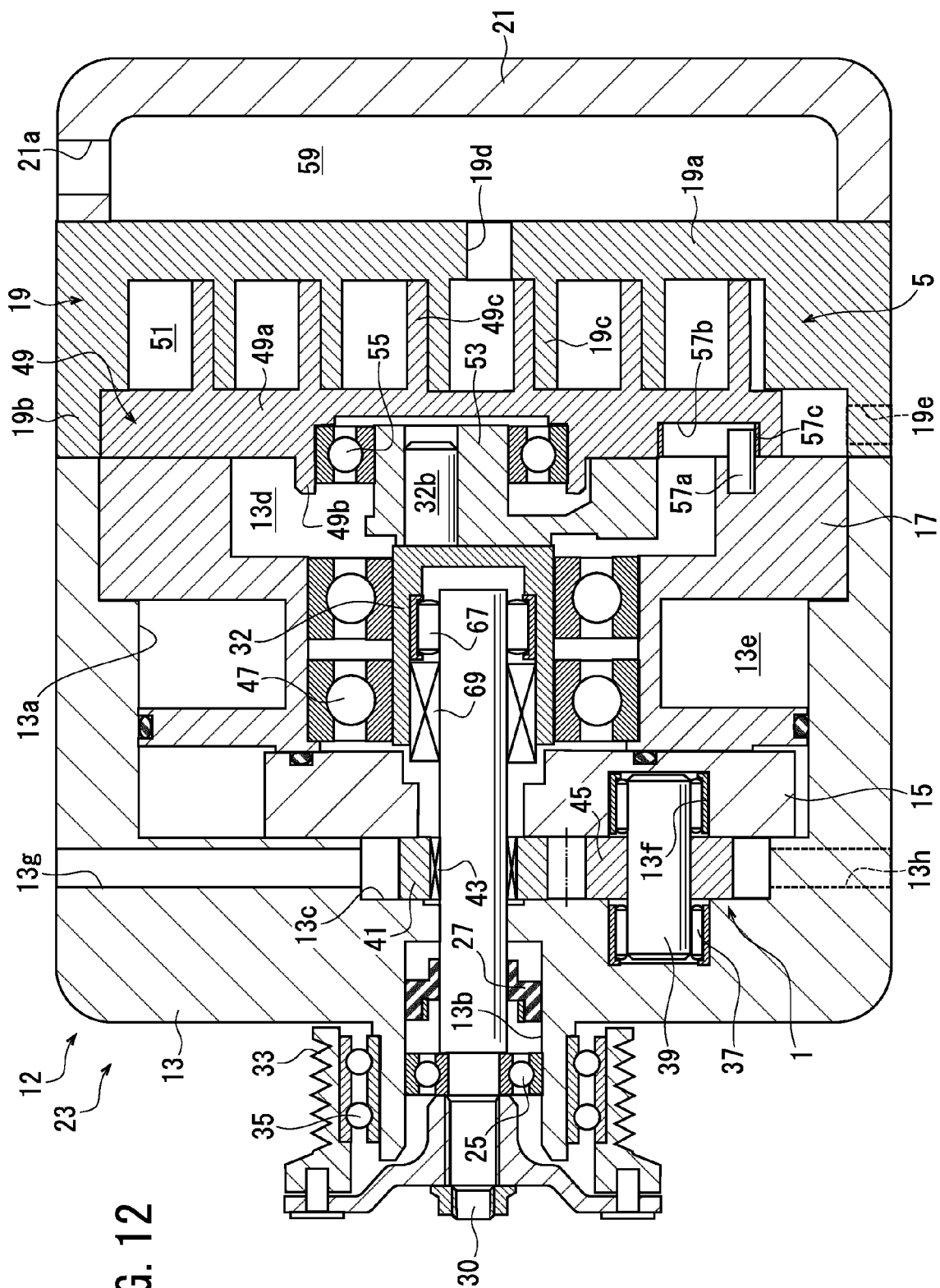


FIG. 11





REFERENCES CITED IN THE DESCRIPTION

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