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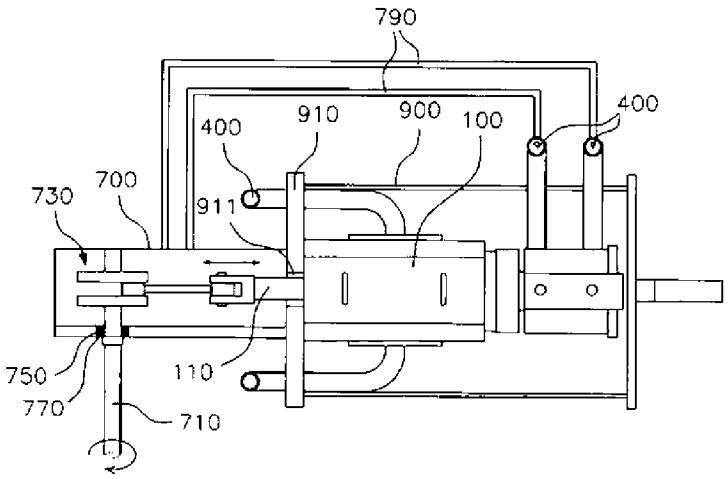
(54) **Title:** EXTERNAL-COMBUSTION ENGINE

[Fig. 4]



(57) **Abstract:** Disclosed therein is an external combustion engine, which obtains driving power by circulating heat medium, particularly, which reciprocates a piston located inside a cylinder block by circulating heat medium using a compressor to thereby obtain driving power. The external combustion engine includes: a housing having the compressor and the cylinder block mounted therein; a piston shaft mounted to protrude to the outside of the housing; a crank shaft connected at one end thereof to the piston shaft and connected at the other end thereof to an external device; and a crank case coupled to the outer surface of the housing in a state where the crank shaft passes therethrough, the crank case adapted to protect a connection portion between the crank shaft and the piston shaft, the crank case having a sealing ring mounted on a crank shaft hole, through which the crank shaft passes, for preventing the secondary leakage of the heat medium leaked from the housing. The external combustion engine can prevent a loss of the heat medium to the outside, provide a safer sealing effect, and extend its lifespan by sealing the crank shaft.

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Description

EXTERNAL-COMBUSTION ENGINE

Technical Field

[1] The present invention relates to an external combustion engine, and more particularly, to an external combustion engine, which can prevent a loss of heat medium. Particularly, the present invention relates to a compressor and a piston used in the external combustion engine.

Background Art

[2] In general, a steam turbine system and a stirling engine system are used to obtain high-temperature energy or kinetic energy using solar light or the external heat source. The steam turbine system is used in a place where a heat quantity of more than several M[W] is needed, but the stirling engine system is used in a place where heat of a small quantity ranging from several K[W] to several tens K[W] is converted into kinetic energy. However, the stirling engine system, which is the sole system for converting heat of the small quantity into kinetic energy, has a problem in that it is not economical due to its low output per unit gravity and high system price.

[3] In order to solve the above problem of such a stirling engine system, an external combustion engine has been disclosed which obtains kinetic energy by supplying heat medium through a compressor, heating the supplied heat medium by a condenser, and actuating a piston mounted inside a cylinder block using the heated heat medium.

[4] FIG. 1 is a conceptual diagram of an external combustion engine, FIG. 2 is a brief diagram of an external combustion engine according to a prior art, and FIG. 3 is a perspective view of a piston shaft and a piston of the external combustion engine. As shown in FIGS. 1 to 3, the external combustion engine obtains kinetic energy by undergoing the steps of supplying heat medium through a compressor 200, heating the supplied heat medium by a condenser 600, and actuating a piston mounted inside a cylinder block using the heated heat medium.

[5] First, the compressor 200 discharges the heat medium to a heat medium pipe 400. The heat medium of low temperature and high pressure discharged from the compressor 200 is converted into heat medium of high temperature and high pressure by a heat absorber 500 and then introduced into the cylinder block 100. Thereafter, the heat medium introduced into the cylinder block 100 moves the piston mounted inside the cylinder block 100, and then, is discharged to the outside of the cylinder block 100, namely, to the inside of a housing 900. The discharged heat medium is converted into heat medium of low temperature and low pressure through a cooling pipe 300, and then sucked into the compressor 200. Thereafter, the heat medium sucked into the

compressor 200 repeatedly carries out the above process.

[6] In this instance, the cylinder piston mounted inside the cylinder block 100 moving by the heat medium is fixed on a piston shaft 110, and a compressor piston is coupled to an end portion of the piston shaft 110. So, power for sucking and discharging the heat medium of the compressor 200 is obtained by the cylinder piston moving inside the cylinder block 100, and a reciprocating motion of the piston shaft 110 is converted into a rotational motion through a crank shaft 710 mounted inside a crank case 700, and then, supplies rotational energy to a flywheel 800 mounted on the crank shaft 710.

[7] In the meantime, the heat medium contained in the cylinder block 100 leaks to the outside of the housing 900 through a piston shaft hole 911 formed on a left plate 910 of the housing 900 along the piston shaft 110, and so, it causes a loss of the heat medium.

[8] When the heat medium leaks due to the above problem, pressure of the heat medium lowers, and so, the external combustion engine is operated abnormally.

[9] To solve the above problem, a method has been suggested which tightly seals the piston shaft hole 911 of the left plate 910, through which the piston shaft 110 passes, but has a problem in that a sealing material is transformed or the lifespan is reduced since the sealing material directly comes in contact with the heat medium of high temperature and high pressure discharged from the cylinder block.

[10] In addition, a power consumption rate of the compressor of the external combustion engine using a gas heat medium, which does not raise a phase change, is about 50% of the total generation rate of energy produced in the cylinder block. However, in case where efficiency of the compressor is less than 70%, since the power consumption rate is similar to the total energy generation rate, a cycle of a heat engine cannot be constructed.

[11] So, in case where a check valve, in which a ball and a spring are coupled with each other, is used at an inlet in the compressor, since the power consumption rate is increased due to a high inflow resistance of inflow gas, efficiency of the entire system lowers severely or the system is not operated.

[12] Moreover, to enhance efficiency of the external combustion engine, a leakage of the heat medium around the cylinder piston and through a gap between an intake connection rod and an exhaust connection rode passing through the cylinder piston mounted inside the cylinder must be prevented. To minimize the leakage of the heat medium, sizes of an intake connection rod hole and an exhaust connection rod hole of the piston must be nearly equal to diameters of the intake connection rod and the exhaust connection rod. In this instance, the external combustion engine has a problem to reduce assembly and machining tolerances of the cylinder piston, two intake valves and two exhaust valves.

[13] Furthermore, the external combustion engine has another problem in that efficiency

is low and machining and assembly are deteriorated because gaps between components are wide since the external combustion engine does not have a structure to absorb heat expansion of each component when the heat medium of high temperature and high pressure is supplied and not supplied.

Disclosure of Invention

Technical Problem

[14] Accordingly, the present invention has been made in an effort to solve the above-mentioned problems occurring in the prior arts, and it is an object of the present invention to provide an external combustion engine, in which a crank shaft hole of a crank case is tightly sealed to thereby prevent a loss of heat medium.

[15] Another object of the present invention is to provide a compressor of an external combustion engine, which has inlet opening and closing plates formed inside the compressor for simultaneously opening and closing a plurality of inlets, thereby circulating the heat medium more smoothly.

[16] A further object of the present invention is to provide a piston structure and a leakage preventing device of an external combustion engine, which can effectively prevent a leakage of the heat medium to a gap between an exhaust connection rod hole formed inside a cylinder piston and an exhaust connection rod and a gap between an intake connection rod hole and an intake connection rod, and which can make machining and assembly easy by increasing assembly and machining tolerances of each component.

Technical Solution

[17] To achieve the above objects, the present invention provides an external combustion engine, which reciprocates a piston mounted inside a cylinder block by circulating heat medium using a compressor to thereby obtain driving power, the external combustion engine comprising: a housing having the compressor and the cylinder block mounted therein; a piston shaft mounted to protrude to the outside of the housing; a crank shaft connected at one end thereof to the piston shaft and connected at the other end thereof to an external device; and a crank case coupled to the outer surface of the housing in a state where the crank shaft passes therethrough, the crank case adapted to protect a connection portion between the crank shaft and the piston shaft, the crank case having a sealing ring mounted on a crank shaft hole, through which the crank shaft passes, for preventing the secondary leakage of the heat medium leaked from the housing.

[18] Particularly, the external combustion engine further comprises a bypass pipe mounted between the compressor and the crank case for allowing some of the heat medium discharged from the compressor to be introduced to the crank case.

[19] In addition, the compressor for circulating the heat medium of the external combustion engine according to the present invention includes: a piston shaft protruding to the outside of the cylinder block; a compressor piston fixed to the piston shaft; a cylindrical body accommodating the compressor piston therein and having a plurality of inlets formed at right and left sides thereof through which the compressor piston shaft passes for sucking the heat medium and outlets formed on the outer surface thereof, the outlets having valves for discharging the heat medium; and two disc-type inlet opening and closing plates coupled to the piston shaft and accommodated in the body in such a way as to be located at the right and left of the compressor piston, and having through-holes for allowing the heat medium to flow in and out, the disc-type inlet opening and closing plates adapted to simultaneously open and close the plurality of inlets formed at the left side or the right side of the body according to movement of the compressor piston.

[20] Moreover, in combination among the cylinder block having the heat medium inlets formed therein and a cylindrical inner body, the cylinder piston and the piston shaft accommodated in the cylinder block, and an intake valve part and an exhaust valve part assembled on the same axis as the central axis of the cylinder piston, the external combustion engine further comprises metal rings and ring fixing plates adapted to prevent the escape of the metal rings to prevent a leakage of the heat medium to gaps formed between the piston and intake connection rods and gaps formed between the piston and exhaust connection rods.

Advantageous Effects

[21] The external combustion engine according to the present invention can prevent a leakage of heat medium to the outside by sealing a crank shaft, and extend a lifespan thereof since to seal the crank shaft can provide a safer sealing than to seal the piston shaft hole.

[22] In addition, the compressor of the external combustion engine according to the present invention can simultaneously open and close the plurality of inlets formed therein to thereby circulate the heat medium more smoothly and enhance efficiency of the external combustion engine.

[23] Furthermore, the external combustion engine according to the present invention can enhance its efficiency and make machining and assembly of the piston, the intake valves and the exhaust valves easy since the leakage of the heat medium to gaps of the intake connection rods and the exhaust connection rods passing through the cylinder piston mounted in the cylinder is reduced.

Brief Description of the Drawings

[24] FIG. 1 is a conceptual diagram of an external combustion engine.

[25] FIG. 2 is a brief diagram of an external combustion engine according to a prior art.

[26] FIG. 3 is a perspective view showing a state where a piston shaft and a piston of the external combustion engine are coupled with each other.

[27] FIG. 4 is a brief diagram of an external combustion engine according to a first preferred embodiment of the present invention.

[28] FIG. 5 is a sectional view of a compressor for circulating heat medium of an external combustion engine according to a second preferred embodiment of the present invention.

[29] FIGS. 6 and 7 are operational views showing an operation of the compressor for circulating the heat medium of the external combustion engine according to the second preferred embodiment of the present invention.

[30] FIG. 8 is a view showing an assembly between a cylinder and valves according to a third preferred embodiment of the present invention.

[31] FIG. 9 is a view showing a state where a piston, an intake valve and an exhaust valve are coupled with one another according to the third preferred embodiment of the present invention.

[32] FIG. 10 is a detailed diagram of a cylinder piston according to the third preferred embodiment of the present invention.

[33] FIG. 11 is a three-dimensional diagram of an intake valve part according to the third preferred embodiment of the present invention.

[34] FIG. 12 is a three-dimensional diagram of an exhaust valve part according to the third preferred embodiment of the present invention.

[35] FIG. 13 is a view showing a state where the piston, a metal ring and a ring fixing plate are coupled with one another according to the third preferred embodiment of the present invention.

[36] FIG. 14 is a detailed diagram of the piston according to the third preferred embodiment of the present invention.

[37] FIG. 15 is a sectional view of FIG. 13.

[38] FIG. 16 is a detailed diagram of the metal ring according to the third preferred embodiment of the present invention.

[39] FIG. 17 is a detailed diagram of the ring fixing plate according to the third preferred embodiment of the present invention.

[40] FIG. 18 is a sectional view showing a state where the piston, which has no leakage preventing device, and a connection rod are coupled with each other according to the third preferred embodiment of the present invention.

[41] FIG. 19 is a sectional view showing a state where the piston, on which the metal ring and the ring fixing plate are bonded, and the connection rod are coupled with each other according to the third preferred embodiment of the present invention.

Mode for the Invention

[42] Reference will be now made in detail to the preferred embodiment of the present invention with reference to the attached drawings.

[43]

[44] <First Embodiment>

[45] FIG. 4 is a brief diagram of an external combustion engine according to a first preferred embodiment of the present invention. As shown in FIG. 4, an external combustion engine according to the present invention is an engine to obtain driving power by circulating heat medium by a compressor 200 to thereby reciprocate a piston mounted inside a cylinder block 100. The external combustion engine according to the present invention includes: a housing 900; the compressor 200 accommodated in the housing 900, the compressor 200 adapted to suck the heat medium contained in the housing 900 and discharge heat medium of high pressure to the outside of the housing 900; the cylinder block 100 mounted inside the housing 900, the cylinder block 100 adapted to operate the piston by receiving the heat medium discharged from the compressor 200 and discharge the received heat medium to the inside of the housing 900 after the operation of the piston; a heat medium pipe 400 adapted to guide the heat medium discharged from the compressor 200 to be introduced into the cylinder block 100 through a heating means; a piston shaft 110 adapted to connect a compressor piston 150 and a cylinder piston with each other, the piston shaft 110 mounted to protrude to the outside of the housing 900; and a crank case 700 having a sealing ring 770 and adapted to protect a crank shaft 710 connected with the piston shaft 110 and a connection portion 730 formed between the piston shaft 110 and the crank shaft 710.

[46] Now, FIG. 2 and FIG. 4 will be compared with each other. As you can see, the present invention adopts a structure that the sealing ring 770 and a bypass pipe 790 are added to the external combustion engine according to the prior art. So, detailed descriptions of the same parts as the external combustion engine according to the prior art will be omitted, and hereinafter, the sealing ring 770 and the bypass pipe 790, which are not included in the external combustion engine according to the prior art, will be described in detail.

[47] First, the sealing ring 770 is mounted on a crank shaft hole 750 of the crank case 700 adapted to protect a connection portion 730 formed between the piston shaft 110 mounted to protrude to the outside of the housing 900 and the crank shaft 710, which is at one end thereof to the piston shaft 110 and connected at the other end thereof to an external device, so that the sealing ring 770 can prevent the secondary leakage of the heat medium leaked from a piston shaft hole 911 of a left plate 910 of the housing 900.

[48] So, even though the heat medium contained in the cylinder block 100 leaks to the

piston shaft hole 911 formed on the housing left plate 910 along the piston shaft, the heat medium is prevented from leaking to the outside more since the heat medium is confined in the crank case 700.

[49] In the meantime, it is preferable that the sealing ring 770 is a ring for high temperature, which is not damaged even at high temperature of about 200?. Since the crank shaft hole 750 of the crank case 700 is not in contact with the cylinder block 100, the crank shaft hole 750 can provide a sufficient effect even though an expensive ring, which can endure high temperature of more than 800?, to thereby reduce a manufacturing cost.

[50] The above is possible since the inside temperature of the crank case 700 does not exceed 200?. Furthermore, the present invention can provide an enhanced sealing effect since the piston shaft 110 performs a straight motion but the crank shaft 710 performs a rotational motion.

[51] Next, the bypass pipe 790 is mounted between the compressor 200 and the crank case 70, adapted to allow some of the heat medium discharged from the compressor 200 to introduced to the crank case 700. Moreover, when the heat medium charging the inside of the housing 900 tries to leak to the piston shaft hole 911 of the housing left plate 910, the heat medium is prevented from leaking out since the heat medium introduced into the crank case 700 through the bypass pipe 790 applies pressure in the reverse direction.

[52] That is, as shown in FIG. 4, when the heat medium contained in the cylinder block 100 tries to leak from the left to the right of the housing left plate 910, some of the heat medium discharged from the compressor 200 is diverged from the heat medium pipe 400 and introduced to the crank case 700 along the bypass pipe 790 to thereby apply pressure from the right to the left of the housing left plate 910, so that the heat medium cannot leak toward the crank case 700 by the heat medium of the crank case 700.

[53] In the meantime, since other holes of the housing 900, namely, a housing right plate hole and a heat medium pipe hole, are not in direct contact with the cylinder block 100, they can be sealed by rings suggested in the present invention or general rings.

[54] Especially, when heat medium of low temperature is introduced to the crank case 700 through the bypass pipe 790, since the heat medium of low temperature coming in contact with the piston shaft 110 of the cylinder block 100 cools a bearing while passing from the crank case 700 to the cylinder block 100, the present invention can reduce a damage of the bearing.

[55] Hereinafter, the operation of the external combustion engine according to the first preferred embodiment of the present invention will be described. First, the operation of the external combustion engine starts by discharge the heat medium from the compressor 200 to the heat medium pipe 400. Most of the heat medium of low

temperature and high pressure discharged from the compressor 200 is converted into heat medium of high temperature and high pressure by a heat absorber 500 through the heat medium pipe 400, and then introduced into the cylinder block 100. Some of the heat medium discharged from the compressor 200 is introduced into the crank case 700 through the bypass pipe 790.

[56] The heat medium introduced into the cylinder block 100 moves the cylinder piston, and then, is discharged to the outside of the cylinder block 100, namely, to the inside of the housing 900. In this instance, by the heat medium introduced into the crank case 700 through the bypass pipe 790, the heat medium contained inside the cylinder block 100 is prevented from leaking to the crank case 700 through the piston shaft hole 911.

[57] The heat medium discharged to the housing 900 is converted into heat medium of low temperature and low pressure through a cooling pipe 300, and sucked into the compressor 200. Thereafter, the heat medium sucked into the compressor 200 repeats the above process.

[58] In this instance, the sealing ring 770 is mounted on the crank shaft hole 750 of the crank case 700 to prevent that the heat medium introduced into the crank case 700 leaks to the outside of the crank case 700, so that the heat medium remains in the crank case 700.

[59] So, the external combustion engine according to the present invention can extend its lifespan without a loss of the heat medium.

[60]

[61] <Second Embodiment>

[62] FIG. 5 is a sectional view of a compressor for circulating heat medium of an external combustion engine according to a second preferred embodiment of the present invention. As shown in FIG. 5, the compressor 200 for circulating heat medium of the external combustion engine is used for circulating heat medium of the external combustion engine performing a reciprocating motion of a cylinder piston 140 of a cylinder block 100 by circulating the heat medium to obtain driving power. The compressor 200 for circulating heat medium includes a piston shaft 110, a compressor piston 150, a body 210, and inlet opening and closing plates 231 and 233.

[63] First, the piston shaft 110 can be achieved by extending the piston shaft 110 of the cylinder block 100. As shown in FIG. 5, a part of the piston shaft 110 protrudes to the outside of the cylinder block 100, and is made of a metallic material like the conventional piston shaft.

[64] Next, as shown in FIG. 3, the compressor piston 150 is achieved by a piston fixed at an end portion of the piston shaft 110, and may be the same as the conventional piston.

[65] Next, the body 210 is formed in a cylinder of a metallic material. The compressor piston 1500 is fixed to the piston shaft 110, and accommodated in the body 210. The

compressor piston 150 is inserted into the body 210 in such a way as to be in close contact with the inner surface of the body 210. The body 210 includes a plurality of inlets 211 and 213 formed at disc-type right and left sides thereof, through which the piston shaft 110 passes, and outlets 215 and 217 formed on the outer surface thereof and having valves for discharging the heat medium introduced into the compressor 200.

[66] In this instance, the inlets 211 and 213 have no valves, and are formed at the left and right sides of the body 210. Preferably, the inlets 211 and 213 are formed near to a rim of the disc-type body 210.

[67] The outlets 215 and 217 have general valves, preferably, check valves having balls. At least two outlets are formed on the outer surface of the cylindrical body 210 excepting the right and left sides of the body 210, and formed near to the right and left sides of the body 210.

[68] Next, the inlet opening and closing plates 231 and 233 are in a disc form, and accommodated in the body 210 in such a way as to be located at the right and left sides of the compressor piston 150. The inlet opening and closing plates 231 and 233 respectively have through-holes 231a and 233a for allowing the heat medium to flow in and out, and simultaneously open and close the plurality of inlets 211 and 213 formed on the right and left sides of the body 210 according to the movement of the compressor piston 150.

[69] The inlet opening and closing plates 231 and 233 respectively have the through-holes 231a and 233a formed at any area excepting the position where the inlets 211 and 213 are in contact with the inlet opening and closing plates 231 and 233, and open and close the inlets 211 and 213 by moving laterally by vacuum pressure and pressure formed according to the movement of the compressor piston 150.

[70] So, a plurality of inlets 211 and 213 are mounted in a circumferential direction of the body 210 in such a way as to be opened and closed by the inlet opening and closing plates 231 and 233, whereby suction resistance generated when gas heat medium is sucked can be reduced and a great deal of heat mediums can be introduced thereto to thereby enhance efficiency of the entire system.

[71] That is, in case where the compressor piston 150 moves from the left to the right, the left inlet opening and closing plate 231 moves to the right by vacuum pressure to open the left inlet 211, and the right inlet opening and closing plate 233 moves to the right by pressure to close the right inlet 213.

[72] In the meantime, in case where the compressor piston 150 moves from the right to the left, the right inlet opening and closing plate 233 moves to the left by vacuum pressure to open the right inlet 213, and the left inlet opening and closing plate 231 moves to the left by pressure to close the left inlet 211.

[73] So, as the compressor piston 150 moves laterally, the inlet opening and closing plates 231 and 233 simultaneously open and close the left inlet 211 or the right inlet 213, so that the external combustion engine according to the present invention can enhance the intake quantity of the heat medium more than the external combustion engine according to the prior art that the check valves are mounted.

[74] FIGS. 6 and 7 are operational views showing an operation of the compressor for circulating the heat medium of the external combustion engine according to the second preferred embodiment of the present invention, wherein FIG. 6 illustrates a state where the heat medium is sucked through the left through-hole, and FIG. 7 illustrates a state where the heat medium is sucked through the right through-hole.

[75] First, FIG. 6 illustrates a state where the heat medium is sucked through the left through-hole 231a. As the compressor piston 150 moves from the left to the right, vacuum pressure is generated in a left inner space 210a of the compressor 200. In this instance, the left inlet opening and closing plate 231 stopping the left inlet 211 at the left of the compressor piston 150 moves from the left to the right by the vacuum pressure. Furthermore, as the left inlet 211 is opened, the heat medium discharged from the cylinder block 100 is sucked to the left inner space 210a of the compressor 200 through the left inlet 211 and the through-hole 231a of the left inlet opening and closing plate 231.

[76] In the meantime, as the compressor piston 150 moves from the left to the right in a right inner space 210b of the compressor 200, pressure is generated. In this instance, the right inlet opening and closing plate 233 located at the right of the compressor piston 150 moves from the left to the right by the pressure to close the right inlet 213. Moreover, as the right inlet 213 is closed, the heat medium contained in the right inner space 210b of the compressor 200 is discharged to the heat medium pipe 400 through the right outlet 217.

[77] Next, FIG. 7 illustrates a state where the heat medium is sucked through the right through-hole 233a. As the compressor piston 150 moves from the right to the left, vacuum pressure is generated in the right inner space 210b of the compressor 200. In this instance, the right inlet opening and closing plate 233 stopping the right inlet 213 at the right of the compressor piston 150 moves from the right to the left by the vacuum pressure. Furthermore, as the right inlet 213 is opened, the heat medium discharged from the cylinder block 100 is sucked to the right inner space 210b of the compressor 200 through the right inlet 213 and the through-hole 233a of the right inlet opening and closing plate 233.

[78] In the meantime, as the compressor piston 150 moves from the right to the left in the left inner space 210a of the compressor 200, pressure is generated. In this instance, the left inlet opening and closing plate 231 located at the left of the compressor piston

150 moves from the right to the left by the pressure to close the left inlet 211. Moreover, as the left inlet 211 is closed, the heat medium contained in the left inner space 210a of the compressor 200 is discharged to the heat medium pipe 400 through the left outlet 215.

[79]

[80] <Third Embodiment>

[81] Now, the third preferred embodiment to prevent a leakage of heat medium to a gap formed in the cylinder piston 140 in the cylinder of the external combustion engine according to the present invention will be described in detail.

[82] FIG. 8 is an assembly diagram showing a state where the cylinder piston 140, two intake valves 1310 and 1320 coupled with each other via intake connection rods and two exhaust valves 1410 and 1420 coupled with each other via exhaust connection rods, the intake valves 1310 and 1320 and the exhaust valves 1410 and 1420 being arranged at the right and left of the piston inside the cylinder block 100.

[83] That is, FIG. 8 illustrates an assembly between the cylinder of the external combustion engine and the valves mounted therein. The heat medium of high temperature and high pressure is injected to the inner space of the cylinder block through the inlet formed on the cylinder block, and acts to the piston to thereby generate driving power. Thereafter, the intake valves and the exhaust valves open and close the inlet and the outlet in order, so that the piston continuously performs a reciprocating motion.

[84] FIG. 9 is a three-dimensional diagram showing the cylinder piston and the valves of FIG. 8. In FIG. 8, the intake connection rods 1330A and 1330B and the exhaust connection rods 1430A and 1430B are coupled with each other after passing through the sides of the cylinder piston, and the exhaust connection rods pass through the intake valves.

[85] FIG. 10 illustrates a coupling between the cylinder piston 140 and the piston shaft 110 constituting a cylinder piston part, showing the arrangement and forms of the intake connection rod holes 1130A and 1130B and the exhaust connection rod holes 1140A and 1140B formed on the piston.

[86] FIG. 11 illustrates an intake valve part 1300 in which the first intake valve 1310 and the second intake valve 1320 are coupled with each other via the intake connection rods 1330A and 1330B. In FIG. 11, the intake valve has a piston shaft hole 1340 for allowing the piston shaft to pass therethrough and exhaust valve connection rod holes 1350A and 1350B.

[87] FIG. 12 illustrates an exhaust valve part 1400 in which the first exhaust valve 1410 and the second exhaust valve 1420 are coupled with each other via the exhaust connection rods 1430A and 1430B. In FIG. 12, the exhaust valve has a piston shaft

hole 1440 for allowing the piston shaft to pass therethrough.

[88] FIG. 13 is a detailed diagram of the cylinder piston. In FIG. 13, the cylinder piston has two piston ring grooves formed on the circumferential surface thereof to prevent a leakage of the heat medium to the circumferential surface, which is the well-known technique to those skilled in the art. The cylinder piston 140 includes the intake connection rod holes 1130A and 1130B and the exhaust connection rod holes 1140A and 1140B formed on the sides thereof, metal rings 1170A, 1170B, 1170C and 1170D mounted at both sides of the connection rod holes, and ring fixing plates 1180A, 1180B, 1180C and 1180D forcedly fit to both sides thereof for preventing the escape of the metal rings.

[89] FIG. 14 illustrates a structure of the cylinder piston of FIG. 13, from which the metal rings and the ring fixing plates are removed. In FIG. 14, the cylinder piston has ring fixing grooves 1150A, 1150B, 1150C and 1150D formed at both side surfaces thereof for accommodating the metal rings therein and ring fixing plate grooves 1160A, 1160B, 1160C and 1160D formed on the outer surfaces of the both sides thereof for fixing the ring fixing plates thereon.

[90] FIG. 15 is a sectional view of FIG. 13. In FIG. 15, when the intake connection rod 1330A passes through the cylinder piston 140, the metal ring 1170A fit to the intake connection rod and accommodated in the ring fixing groove 1150A formed on the cylinder piston, and then, the ring fixing plate 1180A for preventing the separation of the metal ring when the intake connection rod moves laterally is forcedly fit to the ring fixing groove 1160A formed on the piston.

[91] FIG. 16 is a detailed diagram of the metal ring. In FIG. 16, the inner diameter of the metal ring is formed in such a way as to allow a relative motion between the intake connection rod and the exhaust connection rod and minimize the gap between the metal ring and the connection rods to prevent the leakage of the heat medium when the metal ring is fit to the outer diameter of the intake connection rod and the exhaust connection rod, the outer diameter of the metal ring is formed smaller than the diameter of the ring fixing groove in such a way that the metal ring can radially move in the ring fixing groove to some extent, and the thickness of the metal ring is less than the depth of the ring fixing groove in such a way that the metal ring can slightly move in a space formed between the piston and the ring fixing plate in an axial direction.

[92] FIG. 17 is a detailed diagram of the ring fixing plate. In FIG. 17, the outer diameter of the ring fixing plate is smaller than the outer diameter of the metal ring to prevent the separation of the metal ring, and the outer diameter of the ring fixing plate is equal to the diameter of the ring fixing plate groove in such a way that the ring fixing plate is forcedly fit to the ring fixing plate groove.

[93] FIG. 18 is a sectional view showing a coupling between the piston, which has no

leakage preventing device, and the connection rod. Since there is a machining tolerance in locations of the connection rod holes formed on the cylinder piston, the two intake valves and the two exhaust valves, the diameter of the intake connection rod hole 1130A must be larger than the diameter of the intake connection rod 1330A beyond the maximum value of the tolerance.

[94] So, since the gap between the cylinder piston 140 and the intake connection rod 1330A gets wide, efficiency of the combustion engine is reduced due to an increase in the leakage of the heat medium of high temperature and high pressure.

[95] FIG. 19 is a sectional view showing a coupling between the piston, which has the metal rings and the ring fixing plates mounted on both sides thereof, and the connection rod. Even though there is the machining tolerance in the locations of the connection rod holes formed on the cylinder piston, since the metal ring 1170A for preventing the leakage is fit to the connection rod and accommodated in the ring fixing groove and the ring fixing plate is forcedly fit to the ring fixing plate groove, the connection rod is not separated from the piston.

[96] So, the external combustion engine according to the present invention enhances the efficiency and is easy in machining and assembly since the leakage of the heat medium is prevented by the metal ring, which is movable in the axial and radial directions of the connection rod even though the gap between the piston and the connection rod gets wide.

Industrial Applicability

[97] As described above, the external combustion engine according to the present invention can prevent the leakage of heat medium to the outside by sealing the crank shaft, extend a lifespan thereof since to seal the crank shaft can provide a safer sealing than to seal the piston shaft hole, and enhance the efficiency thereof.

Claims

[1] An external combustion engine, which reciprocates a piston mounted inside a cylinder block by circulating heat medium using a compressor to thereby obtain driving power, the external combustion engine comprising:
a housing having the compressor and the cylinder block mounted therein;
a piston shaft mounted to protrude to the outside of the housing;
a crank shaft connected at one end thereof to the piston shaft and connected at the other end thereof to an external device; and
a crank case coupled to the outer surface of the housing in a state where the crank shaft passes therethrough, the crank case adapted to protect a connection portion between the crank shaft and the piston shaft, the crank case having a sealing ring mounted on a crank shaft hole, through which the crank shaft passes, for preventing the secondary leakage of the heat medium leaked from the housing.

[2] The external combustion engine according to claim 1, further comprising a bypass pipe mounted between the compressor and the crank case for allowing some of the heat medium discharged from the compressor to introduced to the crank case.

[3] The external combustion engine according to claim 1, wherein the compressor comprises:
a compressor piston fixed to the piston shaft;
a cylindrical body accommodating the compressor piston therein and having a plurality of inlets formed at right and left sides thereof through which the compressor piston shaft passes for sucking the heat medium, and outlets formed on the outer surface thereof, the outlets having valves for discharging the heat medium; and
two disc-type inlet opening and closing plates coupled to the piston shaft and accommodated in the body in such a way as to be located at the right and left of the compressor piston, and having through-holes for allowing the heat medium to flow in and out, the disc-type inlet opening and closing plates adapted to simultaneously open and close the plurality of the inlets formed at the left side or the right side of the body according to movement of the compressor piston.

[4] The external combustion engine according to claim 3, wherein the inlet opening and closing plate has a piston shaft hole formed at the center thereof for allowing the compressor piston shaft to pass therethrough and a number of through-holes formed around the piston shaft hole excepting a position where the inlets are in contact with the inlet opening and closing plate, so that the inlet opening and

closing plate moves laterally by vacuum pressure and pressure generated according to the movement of the compressor piston to thereby open and close the inlets.

[5] The external combustion engine according to claim 1, wherein the cylinder piston performing a reciprocating motion inside the cylinder block comprises:

a piston shaft inserted and coupled to the top thereof;

intake connection rod holes and exhaust connection rod holes formed on the circumference thereof in turn, the intake connection rod holes being adapted to allow a pair of intake connection rods to inserted thereto, the exhaust connection rod holes being adapted to allow a pair of exhaust connection rods to be inserted thereto;

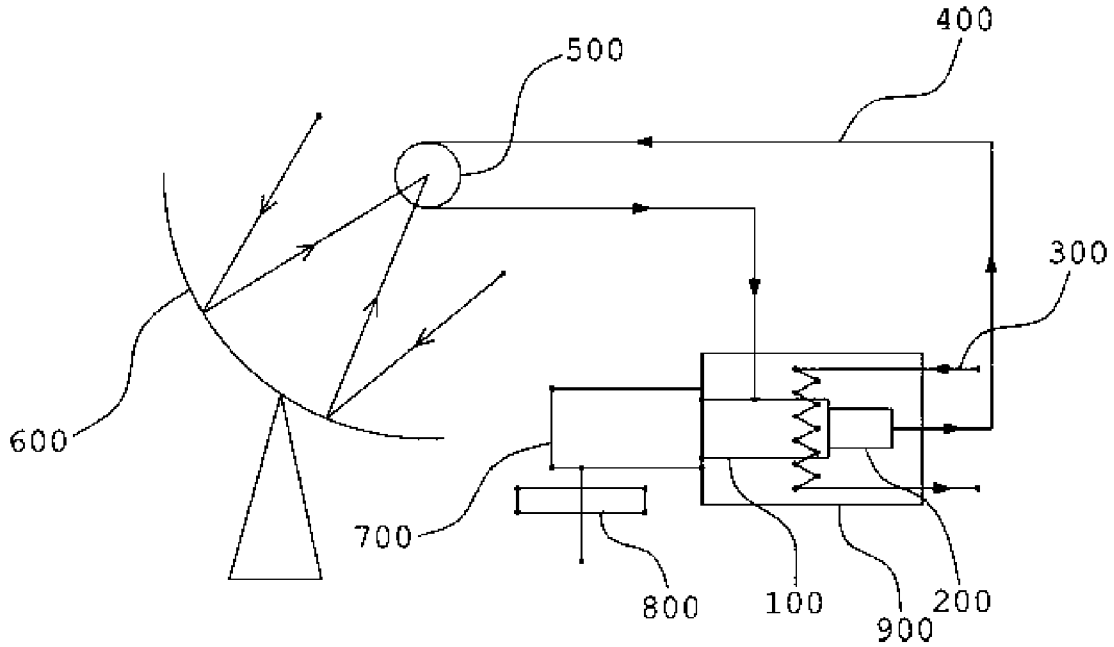
ring fixing grooves and ring fixing plate grooves steppedly formed on inner peripheries of each intake connection rod hole and each exhaust connection rod hole in a left-right symmetric fashion relative to the center of the cylindrical piston;

metal rings mounted on the ring fixing grooves for allowing the intake connection rods and the exhaust connection rods to be rotatably inserted thereto; and

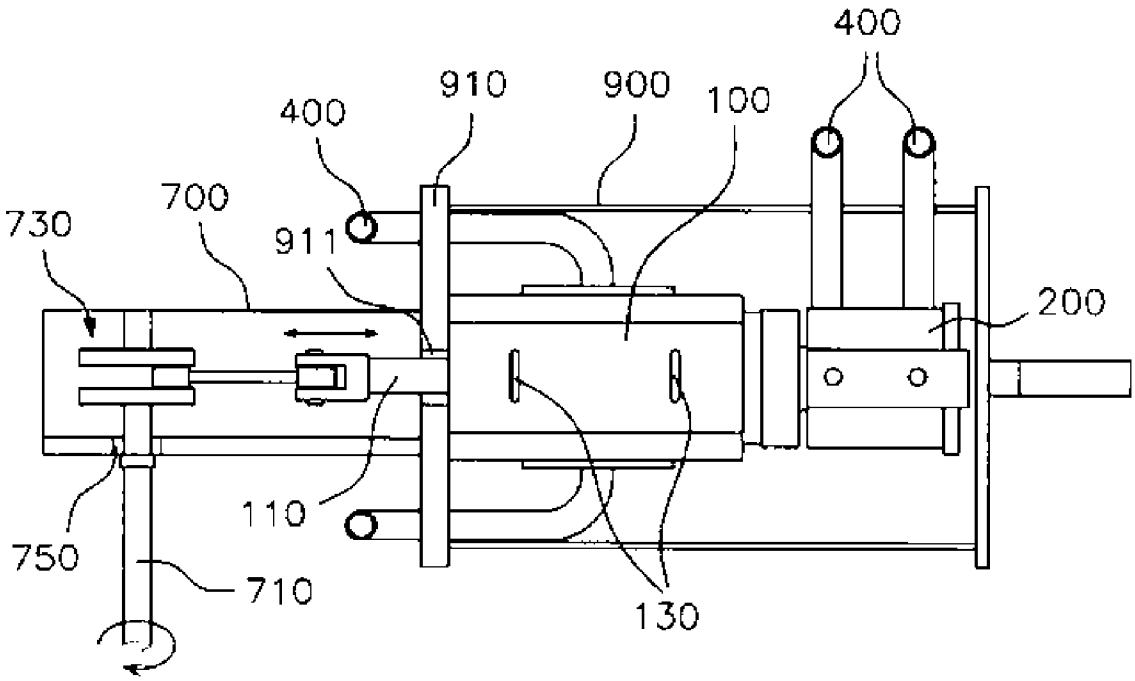
ring fixing plates forcedly fit to the ring fixing plate grooves for preventing the escape of the metal rings,

whereby the heat medium is prevented from leaking around the intake connection rods and the exhaust connection rods.

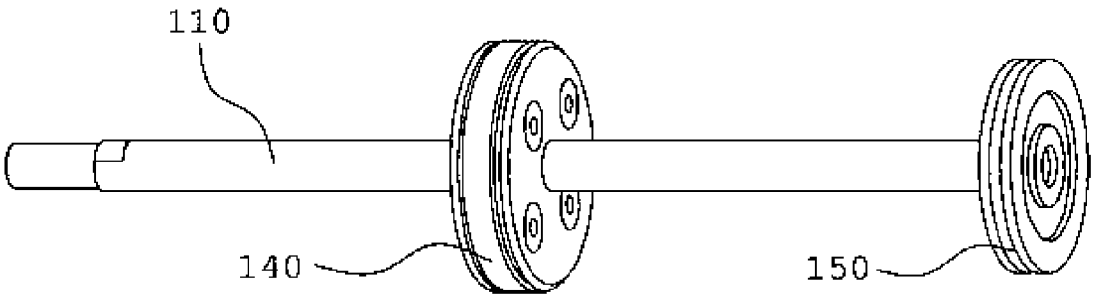
[Fig. 1]



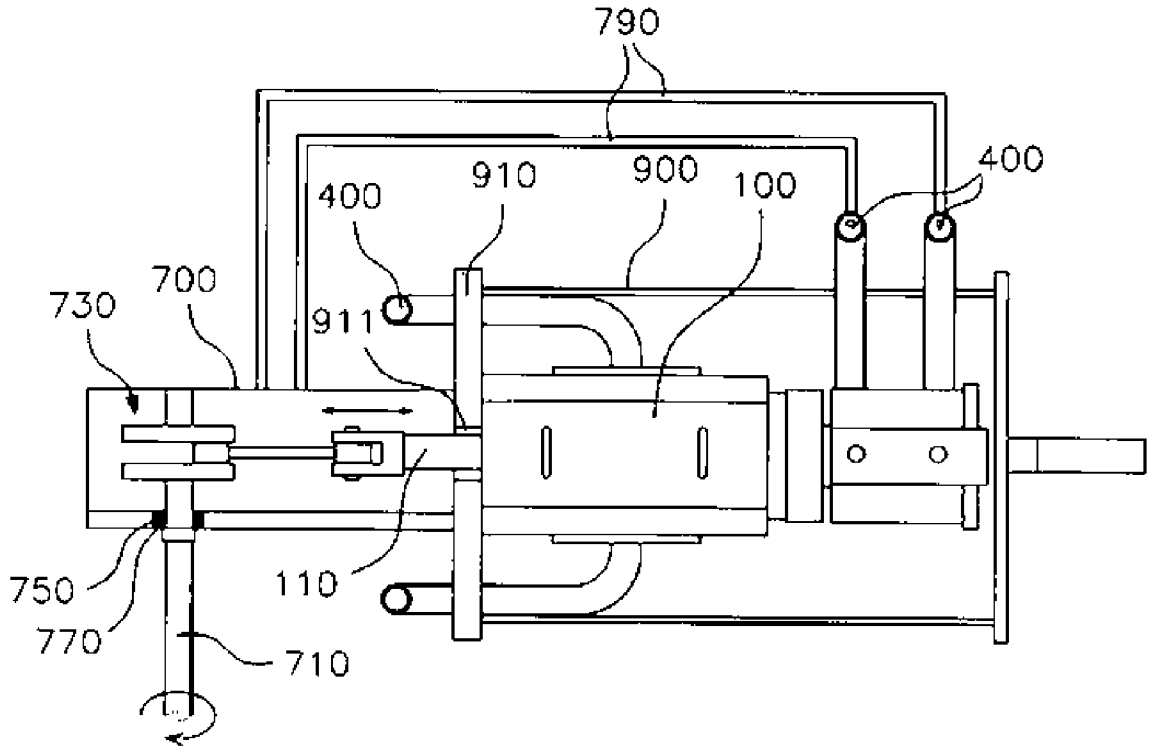
[Fig. 2]



[Fig. 3]



[Fig. 4]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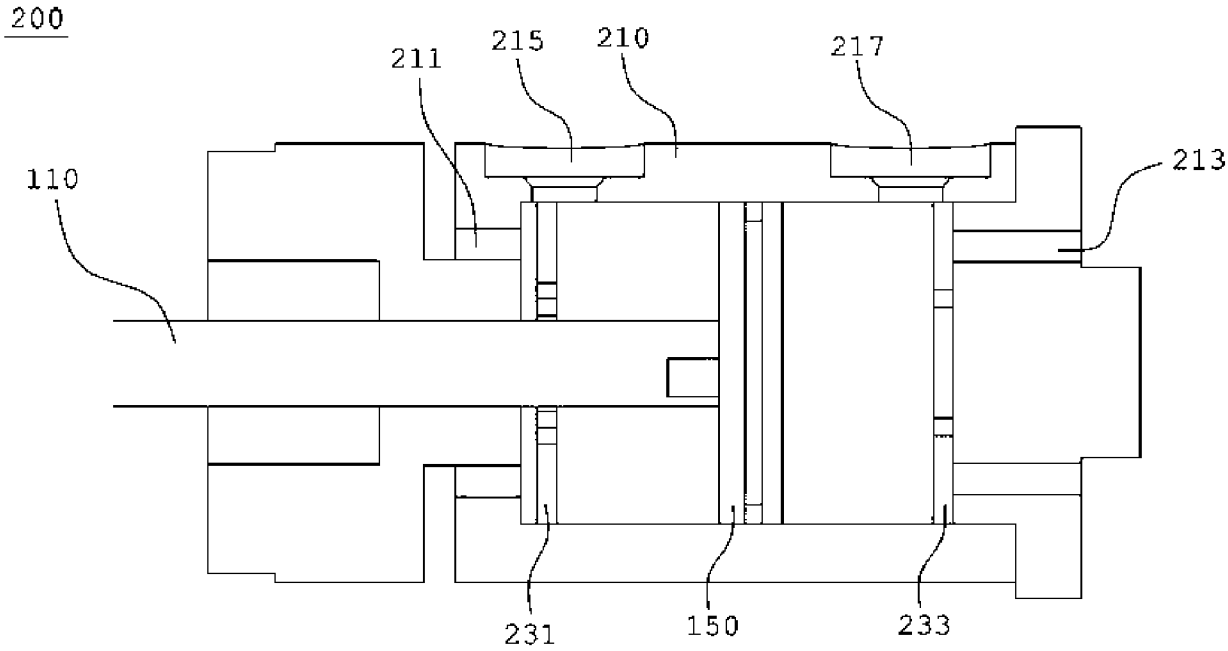
110

[Fig. 5]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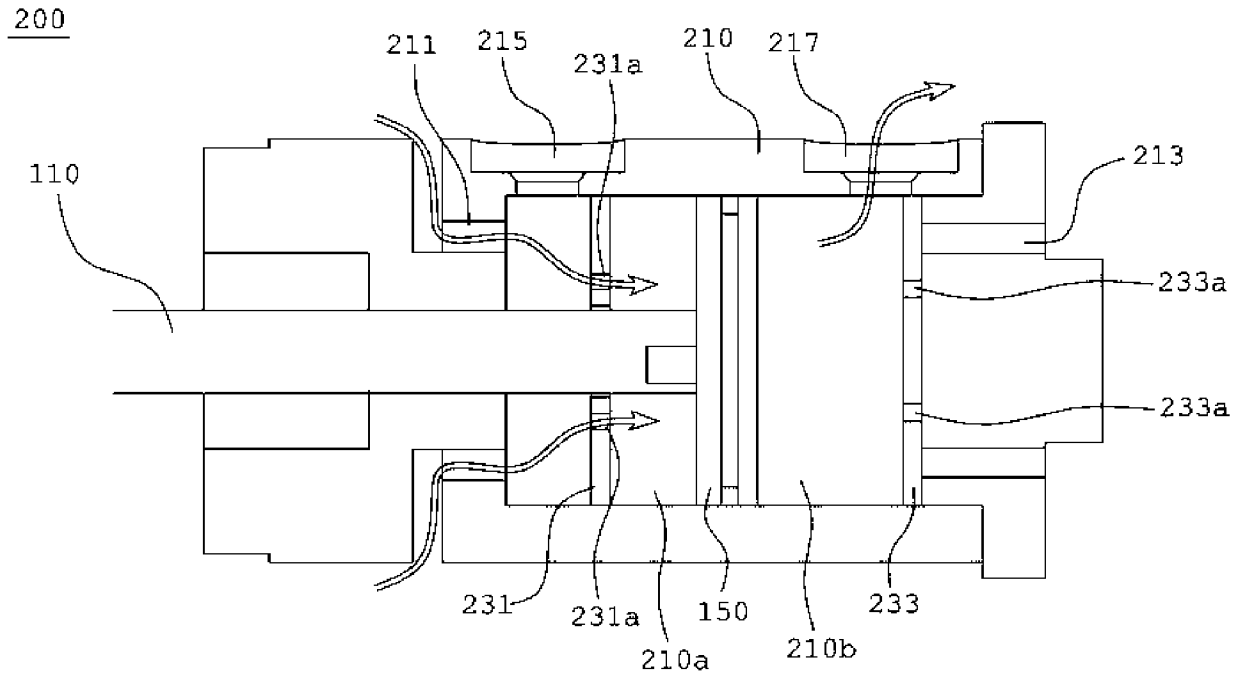
[Fig. 6]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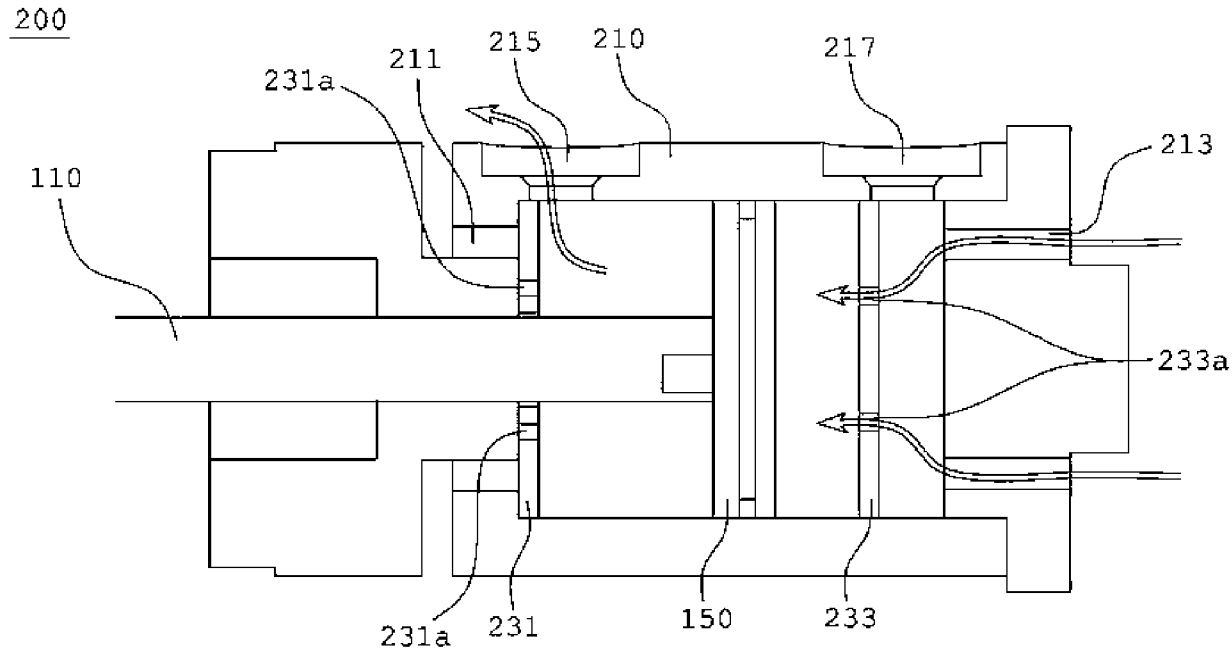
[Fig. 7]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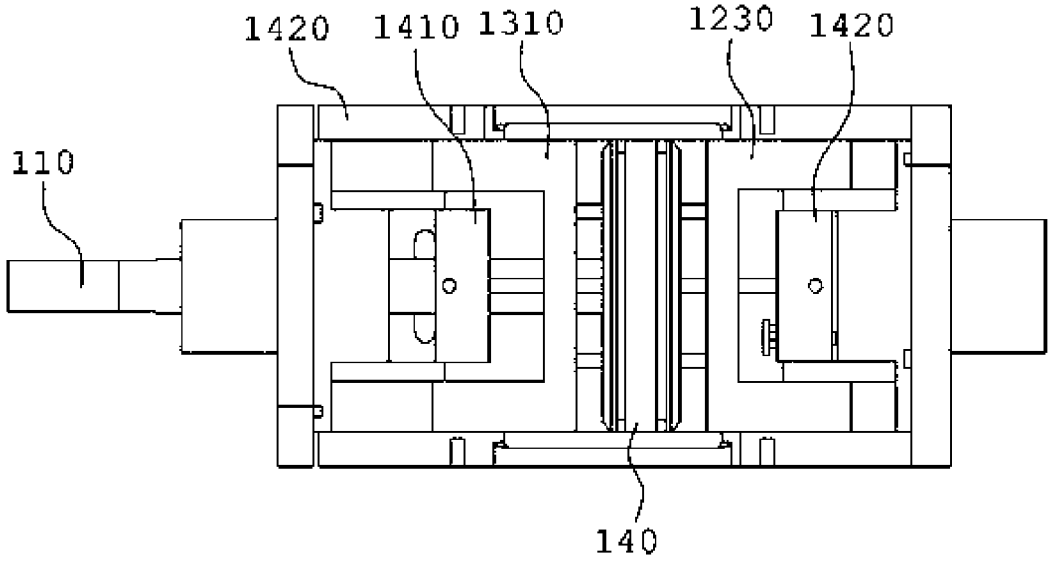
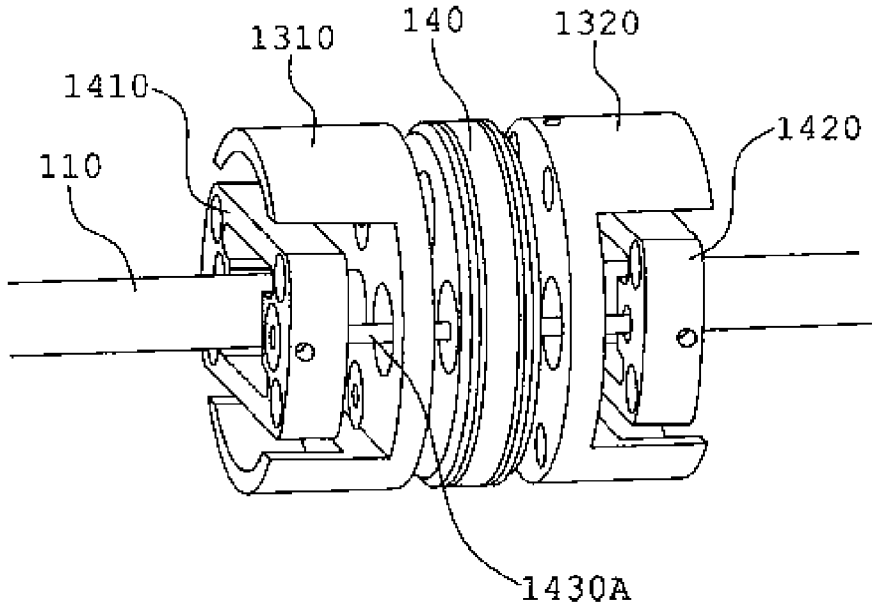
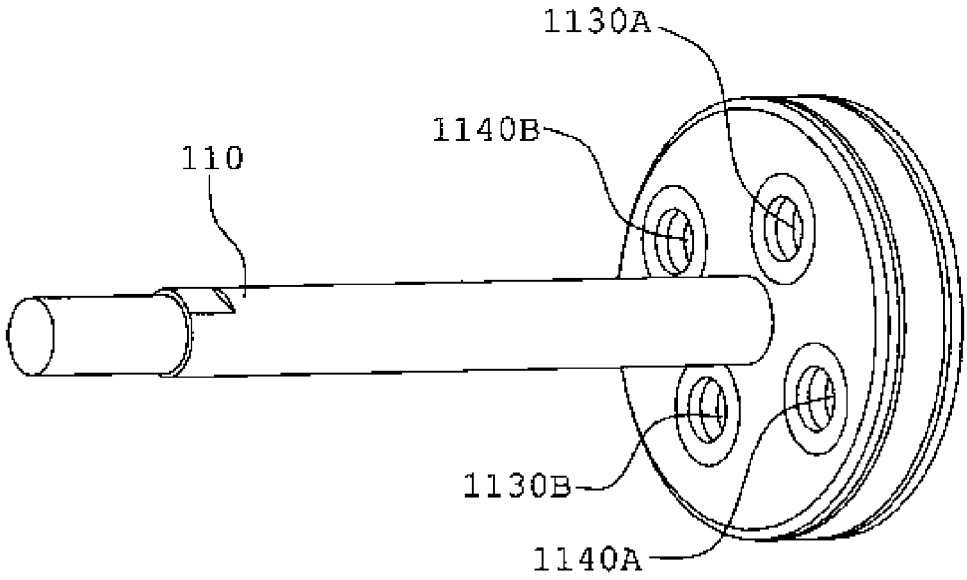
[Fig. 8]



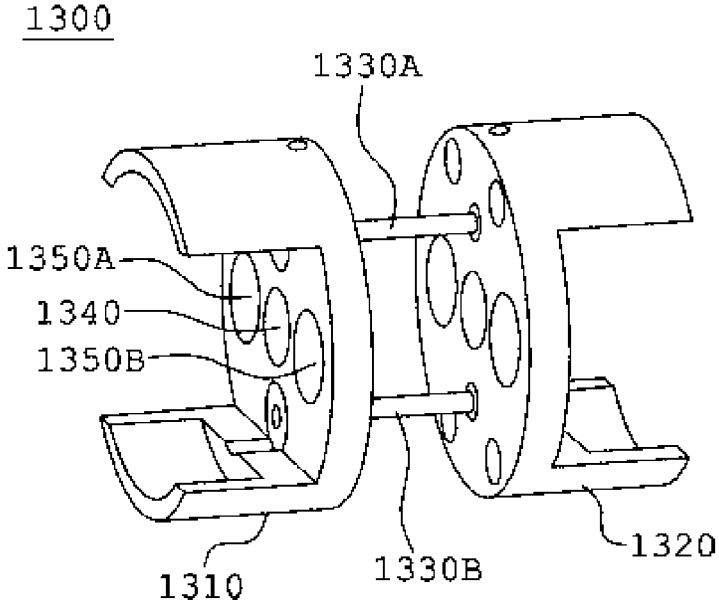
[Fig. 9]



[Fig. 10]



[Fig. 11]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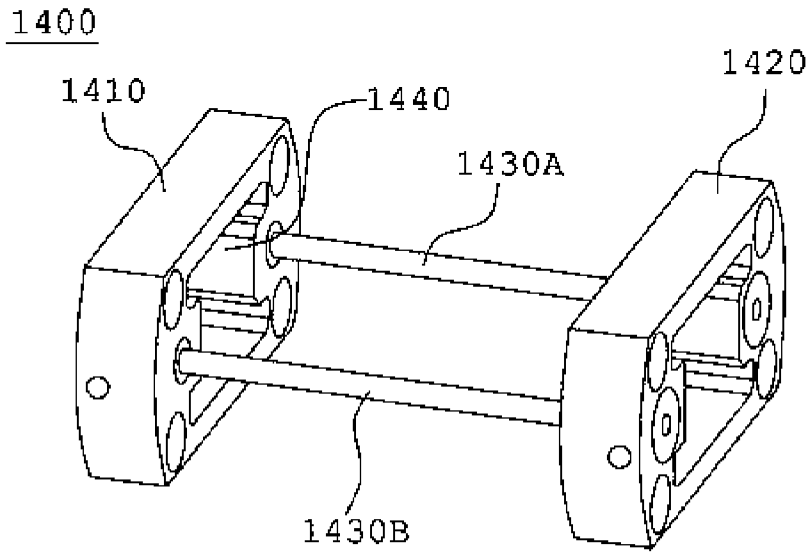
[Fig. 12]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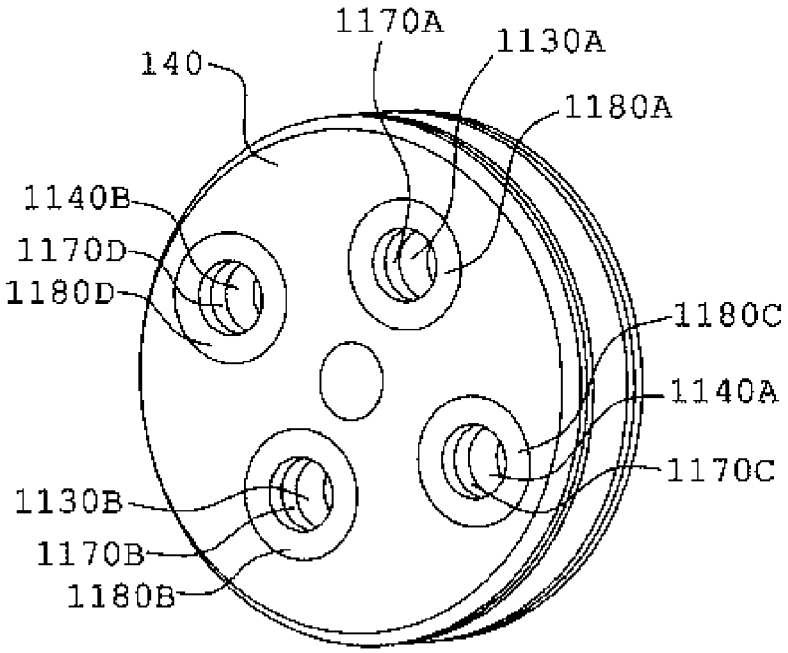
[Fig. 13]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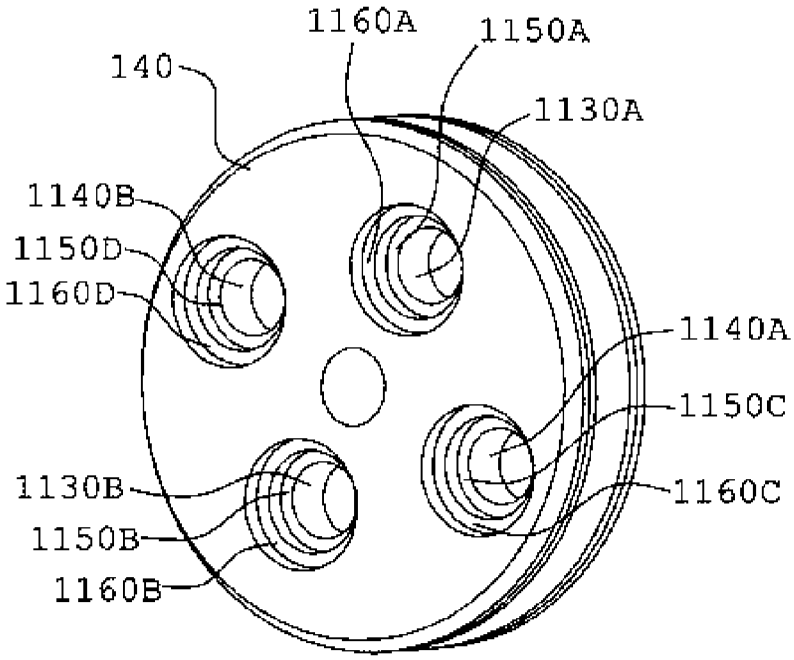
1130B
1170B
1180B

[Fig. 14]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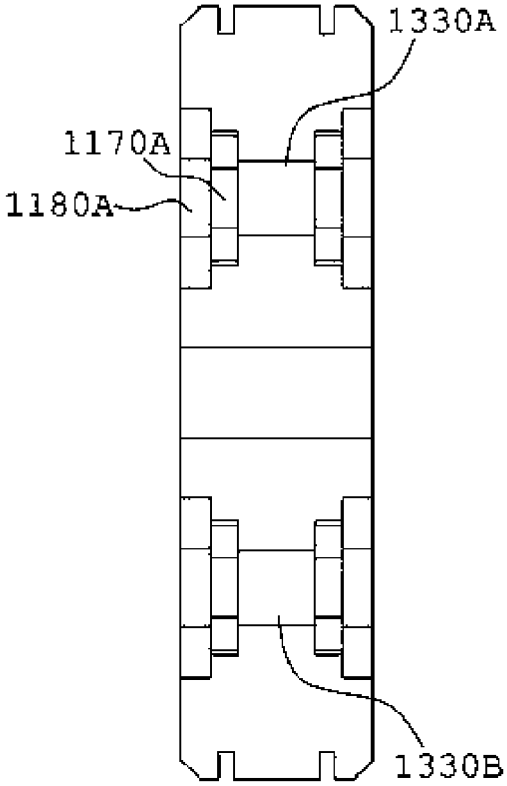
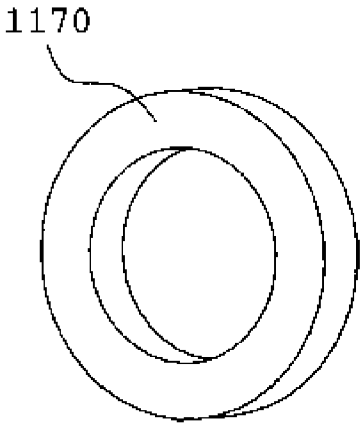
1160B

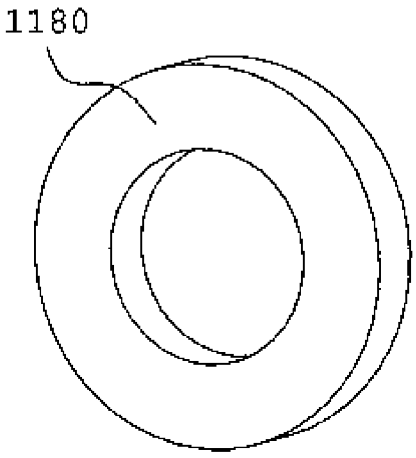
[Fig. 15]



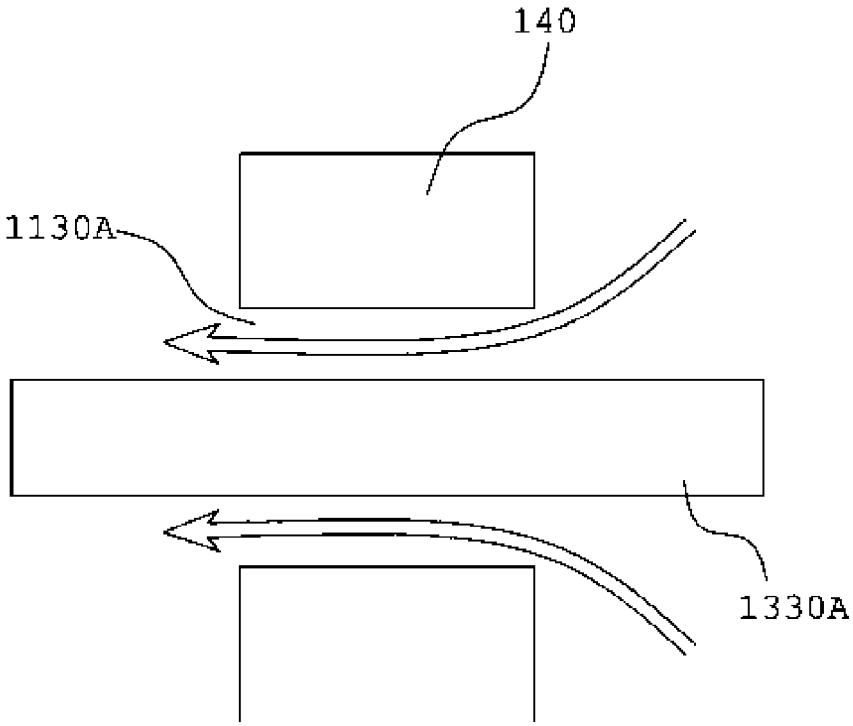
[Fig. 16]



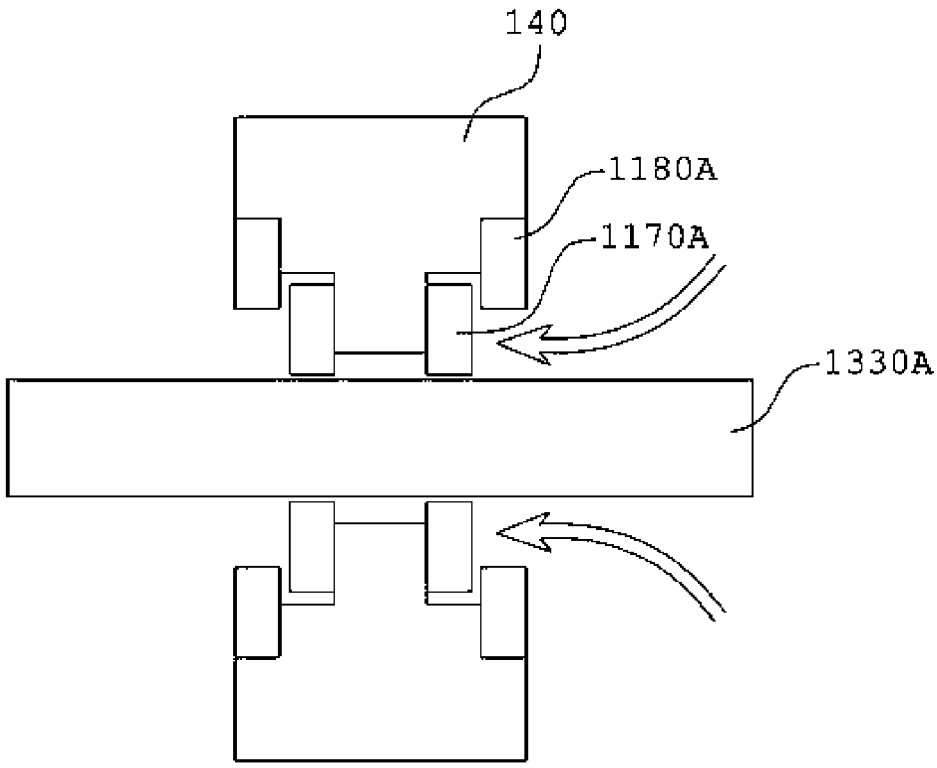
[Fig. 17]



[Fig. 18]



[Fig. 19]



INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2007/005938

A. CLASSIFICATION OF SUBJECT MATTER

F01B 29/08(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 8: F01B 29/08

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models since 1975

Japanese utility models and applications for utility models since 1975

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKIPASS (KIPO internal) & Keywords: external, heat, engine, compressor, heat medium, seal, ring, and similar terms

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	KR 10-2005-0118096 A (KIM, CHEOL SOO) 15 December 2005 See abstract, claims 1-4, and figures 1-5.	1-5
A	US 6775982 B1 (KITAMURA, KOUZOU; TSUKUMO, KIYOHIKO) 17 August 2004 See abstract, and figure 1.	1-5
A	JP 2001-193845 A (SMC CORP.) 17 July 2001 See abstract, and figures 2-3.	1-5
A	KR 20-1998-0053755 U (DAEWOO HEAVY INDUSTRY) 07 OCTOBER 1998 See claim 1, and figure 2.	1-5

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
14 MARCH 2008 (14.03.2008)	**14 MARCH 2008 (14.03.2008)**

Name and mailing address of the ISA/KR

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LEE, Eunju

Telephone No. 82-42-481-8431

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

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