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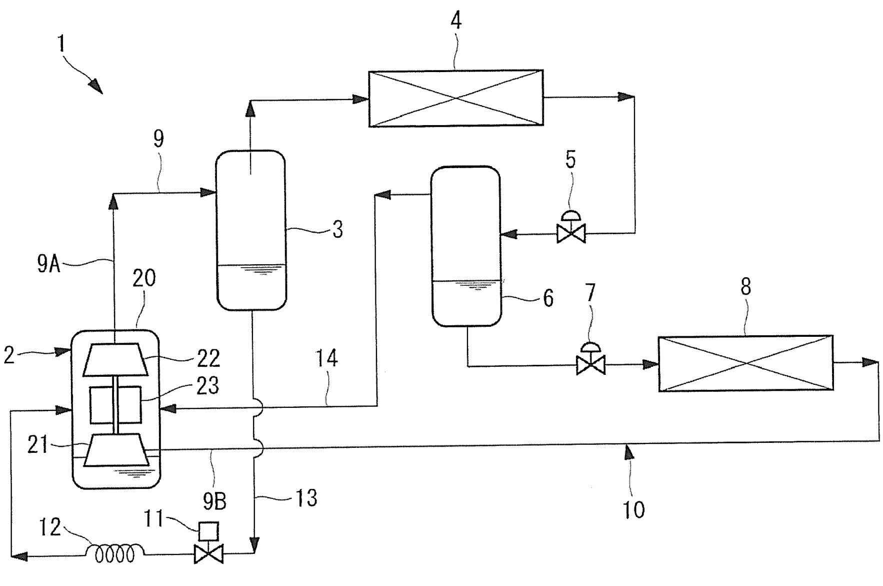
(54) **TWO-STAGE COMPRESSION REFRIGERATION SYSTEM**

(57) A two-stage compression refrigeration system 1 includes a two-stage compressor 2 that is provided with a low-stage compressor 21 and a high-stage compressor 22 in a closed housing 20 and whose interior is under an intermediate pressure, an oil separating device 3 that is provided on a discharge pipe 9A, an oil return pipe 13 that returns the oil separated by the oil separating device 3, into the closed housing 20 under the intermediate pressure, and a gas injection pipe 14 that injects an intermediate-pressure refrigerant gas from a gas-liquid separating device 6 provided on a refrigerant circuit 10, into the closed housing 20, and the oil return pipe 13 and the gas injection pipe 14 individually communicate with the closed housing 20, between the low-stage compressor 21 and high-stage compressor 22 of the two-stage compressor 2.

FIG. 1



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Description

{Technical Field}

[0001] The present invention relates to a two-stage compression refrigeration system including a two-stage compressor that is provided with a low-stage compressor, a high-stage compressor and an electric motor in a closed housing, and that discharges an intermediate-pressure refrigerant compressed by the low-stage compressor into the closed housing, compresses the intermediate-pressure refrigerant by the high-stage compressor, and then discharges the resulting refrigerant.

{Background Art}

[0002] As the above two-stage compression refrigeration system, conventionally, there have been proposed systems shown in Patent literature 1, 2, and the like. In the disclosure of Patent literature 1, a low-stage compressor is provided at a lower portion in a closed housing, and a high-stage compressor is provided at an upper portion. An intermediate refrigerant compressed by the low-stage compressor is taken out of the compressor, and is cooled by an intermediate cooler. Thereafter, the intermediate-pressure refrigerant is introduced into a suction opening of the high-stage gas having passed through an internal heat exchanger (supercooling heat exchanger), which is an economizer, and is compressed in two stages to be discharged out of the compressor. Therewith, the oil in the refrigerant gas is separated by an oil separating device provided on the discharge pipe, and the separated oil is returned into the closed housing of the two-stage compressor, through an oil cooler and an oil return pipe.

[0003] Further, in the disclosure of the above Patent literature 2, a low-stage compressor is provided at a lower portion in a closed housing, a high-stage compressor is provided at an upper portion, and an electric motor is provided at an intermediate portion between them. An intermediate-pressure refrigerant compressed by the low-stage compressor is discharged into the closed housing. The intermediate-pressure refrigerant gas is sucked by the high-stage compressor, and is compressed in two stages to be discharged out of the compressor. Therewith, the oil in the refrigerant gas is separated by an oil separating device provided on the discharge pipe. The oil is merged with an intermediate-pressure refrigerant gas (injection gas) having passed through a gas-liquid separating device, which is an economizer, and thereafter, is introduced into the closed housing under an intermediate pressure.

{Citation List}

{Patent Literature}

[0004]

{PTL 1}
Japanese Unexamined Patent Application, Publication No. 2011-7351(the Publication of Japanese Patent No. 5586880)
{PTL 2}
Japanese Unexamined Patent Application, Publication No. 2011-232000 (the Publication of Japanese Patent No. 5705455)

{Summary of Invention}

{Technical Problem}

[0005] In the two-stage compression refrigeration system described above, it is important to suppress the degradation of the performance that is caused because the low-pressure refrigerant gas to be sucked in the low-stage compressor is heated by the high-temperature oil to be returned from the oil separating device to the two-stage compressor, the specific volume increases, the weight of the suction gas decreases and the suction efficiency degrades. Further, since the temperature of the high-stage compressor becomes high by the compression operation, it is necessary to prevent the overheating of the high-stage compressor by not obstructing the heat radiation from the closed housing, and to suppress an abnormal rise of the discharge temperature of the refrigerant to be discharged from the two-stage compressor.

[0006] In the system shown in Patent literature 1, the intermediate-pressure refrigerant compressed by the low-stage compressor is taken out of the compressor, is cooled by the intermediate cooler, is returned into the two-stage compressor together with the injection gas from the economizer, and is compressed in two stages by the high-stage compressor, while the oil separated from the refrigerant gas by the oil separating device is returned into the closed housing of the two-stage compressor through the oil cooler and the oil return pipe. Thereby, the system suppresses the degradation of the suction efficiency and the degradation of the performance due to the heating of the suction gas by the high-temperature return oil in the compressor. However, there are, for example, problems of requiring the intermediate cooler and the oil cooler and causing the increase in constituent devices, the complication of the configuration and the rise in cost.

[0007] Further, in the system shown in Patent literature 2, the high-temperature oil separated by the oil separating device is merged with the intermediate-pressure injection gas having passed through the gas-liquid separating device, which is an economizer, and is returned into the closed housing, at the vicinity of the high-stage compressor. Since the oil can be cooled by the injection gas before being returned into the closed housing, it is possible to suppress the heating of the suction gas and high-stage compressor by the high-temperature oil. However, the oil expressly separated from the refrigerant gas by the oil separating device is mixed with the refrigerant gas again, and the mixed gas is sucked and compressed by the high-stage compressor at the vicinity of the return portion, to be discharged to the exterior. Therefore, the oil rise from the compressor is promoted, and the oil circulation rate tends to increase. Accordingly, there is, for example, a problem of requiring a high-performance oil separating device.

[0008] The present invention has been made in view of such circumstances, and has an object to provide a two-stage compression refrigeration system that can suppress the heating of the suction gas and the overheating of the high-stage compressor within the two-stage compressor by the high-temperature oil to be returned from the oil separating device, without using the intermediate cooler and the oil cooler, and that can prevent the degradation of the performance, the complication of the configuration, and the like.

{Solution to Problem}

[0009] To solve the above problem, the two-stage compression refrigeration system in the present invention employs the following solutions.

[0010] That is, a two-stage compression refrigeration system according to the present invention includes: a two-stage compressor that includes a low-stage compressor at a lower portion in a closed housing, a high-stage compressor at an upper portion and an electric motor at an intermediate portion, the two-stage compressor discharging an intermediate-pressure refrigerant compressed by the low-stage compressor into the closed housing, sucking and compressing the intermediate-pressure refrigerant by the high-stage compressor, and then discharging the resulting refrigerant; an oil separating device that is provided on a discharge pipe from the two-step compressor and that separates oil contained in compressed refrigerant gas; an oil return pipe that returns the oil separated by the oil separating device, into the closed housing under an intermediate pressure; and a gas injection pipe that injects an intermediate-pressure refrigerant gas from a gas-liquid separating device or an internal heat exchanger into the closed housing of the two-stage compressor, the gas-liquid separating device or the internal heat exchanger constituting an economizer that is provided downstream of a gas cooler on a refrigerant circuit, in which the oil return pipe and the gas injection pipe individually communicate with the closed housing, between the low-stage compressor and the high-stage compressor of the two-stage compressor.

[0011] According to the present invention, it is possible to return the oil separated by the oil separating device into the closed housing from each of the oil return pipe and gas injection pipe that individually communicate, between the low-stage compressor and high-stage compressor in the closed housing under an atmosphere of the intermediate-pressure refrigerant gas to be compressed and discharged by the low-stage compressor of the two-stage compressor, and it is possible to inject the intermediate-pressure refrigerant gas extracted through the gas-liquid separating device or the internal heat exchanger, which constitutes the economizer. Therefore, the high-temperature return oil is unlikely to interfere with the heat radiation of the high-stage compressor, and it is possible to maintain the heat radiation performance of the high-stage compressor and to prevent the overheating. Therewith, it is possible to cool the high-temperature return oil by the injection gas having a low temperature, and it is possible to suppress the degradation of the suction efficiency and the degradation of the compressor performance that are caused because the return oil heats the suction gas to the low-stage compressor. Accordingly, it is possible to suppress the heating of the suction gas and the overheating of the high-stage compressor within the two-stage compressor by the return oil from the oil separating device and prevent the degradation of the performance, without using the intermediate cooler and the oil cooler, and it is possible to achieve the simplification of the configuration and the reduction in cost. Further, the oil from the oil separating device is returned into the closed housing, at a position distant from the high-stage compressor, and therefore, it is possible to prevent the oil rise due to the suction of the return oil by the high-stage compressor, and to reduce the oil circulation volume.

[0012] Furthermore, a two-stage compression refrigeration system in the present invention is the above two-stage compression refrigeration system, in which the oil return pipe and the gas injection pipe communicate with a space portion between the low-stage compressor and the electric motor in the closed housing.

[0013] According to the present invention, since the oil return pipe and the gas injection pipe communicate with the space portion between the low-stage compressor and the electric motor in the closed housing, both of the oil return pipe and the gas injection pipe communicate with the closed housing, at a position sufficiently distant from the high-stage compressor, and thereby, it is possible to block the heating of the high-stage compressor by the high-temperature return oil, and to prevent the overheating. Further, the intermediate-pressure refrigerant gas having a low temperature is injected into the same space portion, and thereby, it is possible to surely cool the high-temperature return oil. Accordingly, it is possible to effectively suppress the heating of the refrigerant gas to be sucked in the low-stage compressor 21, and it is possible to minimize the degradation of the suction efficiency and the associated degradation of the performance. Further, it is possible to effectively suppress the oil rise due to the suction of the return oil by the high-stage compressor.

[0014] Furthermore, a two-stage compression refrigeration system in the present invention is any one of the above two-stage compression refrigeration systems, in which the oil return pipe communicates with the closed housing, at an opposite position that faces a connection position of a suction pipe with the low-stage compressor, and the gas injection pipe communicates with the closed housing, at an opposite position that faces a communication position of the oil return pipe.

[0015] According to the present invention, since the oil return pipe communicates with the closed housing at the opposite position that faces the connection position of the suction pipe with the low-stage compressor and the gas injection pipe communicates with the closed housing at the opposite position that faces the communication position of the oil return pipe, it is possible to return the high-temperature oil from the oil separating device into the closed housing, at a position distant from the suction pipe connection position of the low-stage compressor, and to minimize the heating of the suction gas by the high-temperature return oil. The gas injection pipe is close to the suction pipe position of the low-stage compressor, and the injection gas having a low temperature covers the suction port and the periphery of the suction pipe in the low-stage compressor. Thereby, it is possible to effectively suppress the heating of the suction gas. Accordingly, it is possible to minimize the degradation of the suction efficiency due to the heating of the suction gas and the associated degradation of.the performance, and to achieve a high efficiency and a high performance of the two-stage compressor.

[0016] Furthermore, a two-stage compression refrigeration system in the present invention is any one of the above two-stage compression refrigeration systems, in which the low-stage compressor of the two-stage compressor is a rotary-type compressor configured to directly suck a low-pressure refrigerant gas through a suction pipe and discharge a compressed intermediate-pressure refrigerant gas into the closed housing, and the high-stage compressor is a scroll-type compressor configured to suck and compress the intermediate-pressure refrigerant gas in the closed housing, discharge a high-pressure refrigerant gas to a discharge chamber, and directly discharge the high-pressure refrigerant gas out of the compressor.

[0017] According to the present invention, since the low-stage compressor of the two-stage compressor is the rotary-type compressor configured to directly suck the low-pressure refrigerant gas through the suction pipe and discharge the compressed intermediate-pressure refrigerant gas into the closed housing and the high-stage compressor is the scroll-type compressor configured to suck and compress the intermediate-pressure refrigerant gas in the closed housing, discharge the high-pressure refrigerant gas to the discharge chamber, and directly discharge the high-pressure refrigerant gas out of the compressor, the low-stage compressor, which is provided at a lower site in the closed housing, is a widely practiced and reliable rotary-type compressor configured to directly suck the low-pressure refrigerant gas through the suction pipe and discharge the compressed refrigerant gas into the closed housing, and the high-stage compressor, which is provided at an upper site in the closed housing, is a widely practiced and reliable scroll-type compressor configured to suck and compress the refrigerant gas in the closed housing, discharge the high-pressure refrigerant gas to the discharge chamber, and directly discharge the high-pressure refrigerant gas out of the compressor, resulting in a configuration of making the oil return pipe and the gas injection pipe communicate directly with the closed housing while securing the reliability and performance of the two-stage compressor. Thereby, it is possible to suppress the heating of the suction gas, the overheating of the high-stage compressor, the oil rise and others in the two-stage compressor, while achieving the simplification of the configuration of the system. Accordingly, it is possible to enhance the reliability and performance of the system, and to achieve a high efficiency and a high performance of the two-stage compression refrigeration system.

{Effect of Invention}

[0018] According to the present invention, the high-temperature return oil is unlikely to interfere with the heat radiation of the high-stage compressor, and it is possible to maintain the heat radiation performance of the high-stage compressor and to prevent the overheating. Therewith, it is possible to cool the high-temperature return oil by the injection gas having a low temperature, and it is possible to suppress the degradation of the suction efficiency and the degradation of the compressor performance that are caused because the return oil heats the suction gas to the low-stage compressor. Accordingly, it is possible to suppress the heating of the suction gas and the overheating of the high-stage compressor within the two-stage compressor by the return oil from the oil separating device and prevent the degradation of the performance, without using the intermediate cooler and the oil cooler, and it is possible to achieve the simplification of the configuration and the reduction in cost. Further, the oil from the oil separating device is returned into the closed housing, at a position distant from the high-stage compressor, and therefore, it is possible to prevent the oil rise due to the suction of the return oil by the high-stage compressor, and to reduce the oil circulation volume.

{Brief Description of Drawings}

[0019]

FIG. 1 is a configuration diagram of a two-stage compression refrigeration system according to an embodiment of the present invention; and

FIG. 2 is a longitudinal section view of a two-stage compressor that is used in the above two-stage compression refrigeration system.

DETAILED DESCRIPTION OF THE INVENTION

[0020] Hereinafter, an embodiment of the present invention will be described using FIG. 1 and FIG. 2.

[0021] FIG. 1 shows a configuration diagram of a two-stage compression refrigeration system according to an embodiment of the present invention, and FIG. 2 shows a longitudinal section view of a two-stage compression that is used in the two-stage compression refrigeration system.

[0022] As shown in FIG. 1, a two-stage compression refrigeration system 1 according to the embodiment configures a refrigerant circuit 10 with a closed cycle, by connecting, in order, a two-stage compressor 2, an oil separating device (oil separator) 3, a heat radiator (gas cooler) 4, a first expansion valve (decompression device) 5, a gas-liquid separating device (intermediate-pressure receiver) 6, a second expansion valve (decompression device) 7 and an evaporating device (evaporator) 8 through a refrigerant pipe 9. Such a refrigerant circuit 10 itself is well known.

[0023] The above refrigerant circuit 10 communicates, between the oil separating device (oil separator) 3 and the two-stage compressor 2, with an oil return pipe 13 that returns the oil separated from a refrigerant gas by the oil separating device 3, to the two-stage compressor 2, and that includes an electromagnetic valve 11, which is opened at the time of operation, and a capillary tube 12 for flow rate regulation. Further, the gas-liquid separating device (intermediate-pressure receiver) 6 communicates, between the gas-liquid separating device 6 and a closed housing 20 of the two-stage compressor 2, with a gas injection pipe 14 that injects an intermediate-pressure refrigerant gas separated within the gas-liquid separating device 6, into the closed housing 20 of the two-stage compressor 2.

[0024] The gas-liquid separating device 6 configures an economizer cycle that separates, into gas and liquid, the refrigerant decompressed to an intermediate pressure by the first expansion valve (decompression device) 5 and injects the separated intermediate-pressure refrigerant gas into the intermediate-pressure refrigerant gas compressed by the two-stage compressor 2, and acts as a gas-liquid separation type economizer.

[0025] In the above two-stage compressor 2, a low-stage compressor 21 is fixedly disposed at a lower portion in the closed housing 20, a high-stage compressor 22 is fixedly disposed at an upper portion, and an electric motor 23 to drive both compressors 21, 22 is fixedly disposed at an intermediate portion between them. The electric motor 23 is constituted by a stator 24 that is fixedly provided in the closed housing 20 by shrinkage fitting, press fitting or the like, and a rotor 25 that is provided on the inner circumference portion through an air cap. The rotor 25 is integrally provided with a drive shaft 26 that has an eccentric crank portion 26A at a lower portion and has a crank pin portion 26B at an upper end portion.

[0026] The low-stage compressor 21 provided at a site below the electric motor 23 is a rotary-type compressor, and includes a cylinder body 27 that is fixedly provided in the closed housing 20, an upper bearing 29 and a lower bearing 30 that are fixedly provided on the upper and lower surfaces of the cylinder body 27 and that demarcate a cylinder chamber 28, a rotor 31 that is fitted into the eccentric crank portion 26A of the drive shaft 26 and that rotates in the cylinder chamber 28, a non-illustrated vane and vane pressing spring that partition the cylinder chamber 28 into a suction side and a discharge side, a discharge chamber 32, and the like. The low-stage compressor 21 is configured to compress, to an intermediate pressure, a low-pressure refrigerant gas sucked from the refrigerant circuit 10 side through a suction pipe 9B communicating with a suction port 33, and to discharge the refrigerant gas into the closed housing 20 through a discharge chamber 32. Such a rotary-type compressor is well known.

[0027] Further, the high-stage compressor 22 provided at a site above the electric motor 23 is a scroll-type compressor, and includes a bearing frame 34 that is fixedly provided in the closed housing 20, a fixed scroll 35 that is fixedly provided on the bearing frame 34, a revolving scroll 36 that meshes with the fixed scroll 35, that is slidably supported by a thrust bearing portion of the bearing frame 34, that is linked, through a drive bush and the like, with the crank pin portion 26B of the drive shaft 26 supported by the bearing frame 34, and that is driven in an orbital revolution manner, an Oldham ring 37 that blocks the rotation of the revolving scroll 36, a discharge valve 39 that opens and closes a discharge port 38 provided on the fixed scroll 35, a discharge chamber 41 that is formed by a cover 40, a discharge duct 42 that communicates with the discharge chamber 41, and the like.

[0028] The high-stage compressor 22 sucks the intermediate-pressure refrigerant gas compressed by the low-stage compressor 21 and discharged into the closed housing 20, compresses the refrigerant gas in two stages, discharges the resulting refrigerant gas into the discharge chamber 41 as a high-temperature and high-pressure compressed gas, and then discharges the refrigerant gas from the discharge chamber 41 through the discharge duct 42 to a discharge pipe 9A on the side of the refrigerant circuit 10 connected with the two-stage compressor 2. Here, the scroll-type compressor itself, which constitutes such a high-stage compressor 22, is well known.

[0029] Furthermore, a displacement oil pump 43 configured between the low-stage compressor 21 and the lower bearing 30 is provided at a lower end portion of the above drive shaft 26, and a lubricating oil (oil) 44 filled into a bottom portion in the closed housing 20 is fed to sliding portions of the low-stage compressor 21 and high-stage compressor 22, through an oil feeding hole 45 provided in the drive shaft 26, allowing for the lubrication of the sliding sites.

[0030] In the two-stage compressor 2 having the above configuration, the oil lubricating the sliding sites of the low-stage compressor 21 and high-stage compressor 22, because of having compatibility with the refrigerant, is dissolved into the compressed refrigerant gas, and is discharged from the two-stage compressor 2 to the refrigerant circuit 10 side together with the refrigerant. However, for lubrication, it is essential to secure a certain volume of oil in the two-stage compressor 2. Further, if the oil circulates to the refrigerant circuit 10 side, the performance of heat exchangers such as the heat radiator 4 and the evaporating device 8 degrades. Therefore, it is necessary to reduce the oil rise from the compressor 2 and the volume of the oil circulation to the refrigerant circuit 10 side, as much as possible.

[0031] Therefore, the oil separating device 3 is provided on the discharge pipe 9A connected with the two-stage compressor 2. The oil contained in the refrigerant gas is separated, and the volume of the oil circulating in the refrigerant circuit 10 is reduced. Therewith, the separated oil is returned into the closed housing 20 of the two-stage compressor 2, through the oil return pipe 13. The oil separated by the oil separating device 3 has the same temperature as the high-temperature refrigerant gas discharged from the two-stage compressor 2, and therefore, depending on the position of the return of the oil from the oil separating device 3, there is a fear of heating the low-pressure refrigerant gas to be sucked in the low-stage compressor 21 through the refrigerant suction pipe 9B and the suction port 33, or a fear of obstructing the heat radiation of the high-stage compressor 22.

[0032] Hence, the embodiment adopts a configuration in which an oil return connection duct 46 communicating with a space portion 20A between the electric motor 23 and the low-stage compressor 21 is provided so as to penetrate the closed housing 20, between the low-stage compressor 21 and high-stage compressor 22 in the closed housing 20, and the oil return pipe 13 from the oil separating device (oil separator) 3 communicates with the oil return connection duct 46. Preferably, the position of the oil return connection duct 46 should be an opposite position that faces the connection position of the suction pipe 9B with the suction port 33 of the low-stage compressor 21.

[0033] Therewith, the embodiment adopts a configuration in which an injection connection duct 47 for connecting the gas injection pipe 14, which injects the intermediate-pressure refrigerant gas from the gas-liquid separating device 6 into the closed housing 20 of the two-stage compressor 2, is provided so as to penetrate the space portion 20A in the closed housing 20, at an opposite position that faces the oil return connection duct 46, and communicates with the gas injection pipe 14. Accordingly, the gas injection pipe 14 also is between the low-stage compressor 21 and high-stage compressor 22 in the closed housing 20, and communicates with the space portion 20A between the electric motor 23 and the low-stage compressor 21.

[0034] By the configuration described above, the embodiment exerts the following function effects.

[0035] In the above two-stage compressor 2, the low-pressure refrigerant gas sucked in the low-stage compressor (rotary-type compressor) 21 through the suction pipe 9B and the suction port 33 is compressed to an intermediate pressure, and is discharged into the closed housing 20 through the discharge chamber 32. The intermediate-pressure refrigerant gas is further sucked in the high-stage compressor (scroll-type compressor) 22, and is compressed in two stages, to become the high-temperature and high-pressure refrigerant gas, which is discharged into the discharge chamber 41.

[0036] The high-temperature and high-pressure refrigerant gas discharged to the discharge chamber 41 is discharged to the discharge pipe 9A on the refrigerant circuit 10 side through the discharge duct 42, and is fed into the oil separating device (oil separator) 3 on the downstream side. In the oil separating device 3, the oil contained in the refrigerant gas is separated, for example, by cyclone separation, and the refrigerant gas after the oil separation is fed to the heat radiator.(gas cooler) 4. On the other hand, the separated oil is returned into the closed housing 20 of the two-stage compressor 2 through the oil return pipe 13, while being regulated to a constant flow rate by the capillary tube 12. Thereby, a predetermined volume of circulation oil is constantly secured in the closed housing 20.

[0037] The refrigerant fed to the heat radiator 4 is cooled by the heat exchange with the outside air or the like. Thereafter, the refrigerant passes through the first expansion valve (decompression device) 5, and in the process, is decompressed and cooled to the intermediate pressure. The refrigerant partially liquefies to become a gas-liquid two-phase state, and is introduced into the gas-liquid separating device (intermediate-pressure receiver) 6. In the gas-liquid separating device 6, the refrigerant is separated into gas and liquid, and the separated gas refrigerant having the intermediate pressure is injected into the closed housing 20 having the intermediate pressure of the two-stage compressor 2, through the gas injection pipe 14. On the other hand, the liquid refrigerant is further decompressed and cooled in the second expansion valve (decompression device) 7 to become a gas-liquid two-phase refrigerant having a low pressure, and is fed to the evaporating device (evaporator) 8.

[0038] The refrigerant fed to the evaporating device 8 is evaporated by the heat exchange with a cooling-target medium such as air, and a low-pressure refrigerant gas that is the evaporating gas is sucked again in the low-stage compressor 21 of the two-stage compressor 2 from the evaporating device 8 through the suction pipe 9B. Thereafter, the same operation is repeated. The cooling-target medium such as air cooled by the evaporation of the refrigerant in the evaporating device 8 is transferred to a cooling-target space or the like, and is used for air-conditioning or cooling the cooling-target space.

[0039] Here, the oil separated by the oil separating device 3 and returned into the closed housing 20 of the two-stage compressor 2 through the oil return pipe 13 has a high temperature, and depending on the return position, interferes with the heat radiation of the high-stage compressor 22 having a high temperature by the compression operation, or heats the low-pressure refrigerant gas to be sucked in the low-stage compressor 21, resulting in a fear of the degradation of the suction efficiency and the degradation of the performance of the compressor. However, in the embodiment, the oil return pipe 13, between the low-stage compressor 21 and the high-stage compressor 22, communicates with the space portion 20A between the low-stage compressor 21 and the electric motor 23, and the oil separated by the oil separating device 3 is returned into the space portion 20A. Therefore, it is possible to solve the problem that the oil heats the high-stage compressor 22 and interferes with the heat radiation of the high-stage compressor 22.

[0040] Moreover, the intermediate-pressure refrigerant gas separated by the gas-liquid separating device 6 is injected into the above space portion 20A between the low-stage compressor 21 and the electric motor 23, through the gas injection pipe 14. Accordingly, even when the high-temperature oil is returned from the oil return pipe 13, the oil can be cooled by the intermediate-pressure refrigerant gas with a low temperature that is injected into the same space portion 20A. Therefore, the low-pressure refrigerant gas to be sucked in the low-stage compressor 21 is not heated by the return oil from the oil separating device 3, and it is possible to suppress the degradation of the performance of the compressor due to the degradation of the suction efficiency.

[0041] Thus, in the embodiment, the oil return pipe 13 and the gas injection pipe 14 individually communicate with the closed housing 20, between the low-stage compressor 21 and high-stage compressor 22 of the two-stage compressor 2. Therefore, though the intermediate-pressure refrigerant gas compressed by the low-stage compressor 21 is not cooled by an intermediate cooler and the oil from the oil separating device 3 is not cooled by the oil cooler, it is possible to avoid the heating of the refrigerant gas to be sucked in the low-stage compressor 21 within the two-stage compressor 2 and the interference with the heat radiation of the high-stage compressor 22, allowing for the prevention of the degradation of the performance. Further, it is possible to eliminate cost rise factors such as the increase in constituent devices and the complication of the configuration, and to achieve the simplification of the system configuration and the reduction in cost.

[0042] Further, the intermediate-pressure refrigerant gas to be injected into the closed housing 20 through the gas injection pipe 14, independently from the return oil from the oil separating device 3, can be injected into the closed housing 20, at a position distant from the high-stage compressor 22. Therefore, it is possible to reduce the volume of the oil contained in the refrigerant gas to be sucked in the high-stage compressor 22, to reduce the oil rise and thus the oil circulation volume, and to surely secure a required volume of lubricating oil in the two-stage compressor 2. Therewith, it is possible to suppress the degradation of the system efficiency due to the increase in oil circulation volume.

[0043] Furthermore, since both of the oil return pipe 13 and the gas injection pipe 14 communicate with the space portion 20A between the lower portion of the electric motor 23 and the low-stage compressor 21, the oil return pipe 13 and the gas injection pipe 14 can communicate with the closed housing 20, at a position sufficiently distant from the high-stage compressor 22. Therefore, it is possible to prevent the heating of the high-stage compressor 22 by the high-temperature return oil, to secure the heat radiation performance of the high-stage compressor 22, and to block the overheating. Further, it is possible to surely cool the high-temperature return oil by the low-temperature injection gas, and therefore, it is possible to effectively suppress the heating of the refrigerant gas to be sucked in the low-stage compressor 21, and to minimize the degradation of the suction efficiency and the degradation of the performance.

[0044] Particularly, the oil return pipe 13 communicates with the space portion 20A in the closed housing 20, at the opposite position that faces the connection position of the refrigerant suction pipe 9B with the low-stage compressor 21, and the gas injection pipe 14 communicates with the space portion 20A in the closed housing 20, at the opposite position that faces the oil return pipe 13. Therefore, the oil return pipe 13 is placed as far as possible from the refrigerant suction pipe position on the low-stage compressor 21, and thereby, it is possible to minimize the heating of the suction gas by the high-temperature return oil. Therewith, the gas injection pipe 14 is placed as close as possible to the refrigerant suction pipe position on the low-stage compressor 21, and the suction port 33 and the periphery of the suction pipe 9A in the low-stage compressor 21 are covered with the low-temperature injection gas. Thereby, it is possible to effectively suppress the heating of the suction gas.

[0045] Further, in the embodiment, the low-stage compressor 21 of the two-stage compressor 2, which is provided at the lower site in the closed housing 20, is a widely practiced and reliable rotary-type compressor configured to directly suck the low-pressure refrigerant gas through the suction pipe 9B and discharge the compressed refrigerant gas into the closed housing 20, and the high-stage compressor 22, which is provided at the upper site in the closed housing 20, is a widely practiced and reliable scroll-type compressor configured to suck and compress the intermediate-pressure refrigerant gas in the closed housing 20, discharge the high-pressure refrigerant gas to the discharge chamber 41, and directly discharge the high-pressure refrigerant gas out of the compressor. Therefore, it is possible to secure the reliability and performance of the two-stage compressor 2.

[0046] Further, the oil return pipe 13 and the gas injection pipe 14 are configured to directly communicate with the closed housing 20 of the two-stage compressor 2, and therefore, it is possible to suppress the heating of the suction gas, the overheating of the high-stage compressor 22, the oil rise and others in the two-stage compressor 2, while achieving the simplification of the configuration of the two-stage compression refrigeration system. As a result, it is possible to enhance the reliability and performance of the system, and to achieve a high efficiency and a high performance of the two-stage compression refrigeration system.

[0047] The present invention is not limited to the invention in the above embodiment, and modifications can be appropriately made without departing from the scope. For example, the above embodiment provides the gas-liquid separating device (intermediate-pressure receiver) 6 downstream of the first expansion valve (decompression device) 5 as an economizer, and configures the economizer cycle in which the intermediate-pressure refrigerant gas separated in the gas-liquid separating device 6 is injected into the refrigerant gas compressed in the two-stage compressor 2. However, it is allowed to adopt an internal heat exchanger type economizer cycle that is provided with an internal heat exchanger (supercooling heat exchanger) instead of the gas-liquid separating device 6.

[0048] The internal heat exchanger type economizer cycle is configured to partially split the refrigerant from the heat radiator (gas cooler), to perform the heat exchange of the split refrigerant with the refrigerant flowing through the refrigerant circuit 10 side in the internal heat exchanger after the decompression by an expansion valve (decompression device), to supercool the refrigerant flowing through the refrigerant circuit 10 side, and to inject the evaporated intermediate-pressure split refrigerant gas into the refrigerant gas compressed in the two-stage compressor 2, through the gas injection pipe 14, and can obtain the same economizer effect as the economizer cycle using the gas-liquid separating device 6.

[0049] Further, the above embodiment adopts a configuration in which the oil return pipe 13 communicates with the space portion 20A in the closed housing 20 at the opposite position that faces the refrigerant suction pipe position on the low-stage compressor 21 and the gas injection pipe 14 communicates at the opposite position that faces the oil return pipe 13. The facing opposite positions do not always need to be opposite positions that face each other at 180 degrees, and only need to be positions that face each other in a certain range (for example, a range of plus or minus 45 degrees). That case is also included in the present invention.

{Reference Signs List}

[0050]

1	two-stage compression refrigeration system
2	two-stage compressor
3	oil separating device
4	heat radiator (gas cooler)
5	first expansion valve (decompression device)
6	gas-liquid separating device (economizer)
7	second expansion valve (decompression device)
8	evaporating device (evaporator)
9A	discharge pipe
9B	suction pipe
10	refrigerant circuit
13	oil return pipe
14	gas injection pipe
20	closed housing
20A	space portion
21	low-stage compressor (rotary compressor)
22	high-stage compressor (scroll compressor)
23	electric motor
41	discharge chamber
46	oil return connection duct
47	injection connection duct

Claims

1. A two-stage compression refrigeration system comprising:

a two-stage compressor that includes a low-stage compressor at a lower portion, a high-stage compressor at an upper portion and an electric motor at an intermediate portion, in a closed housing, the two-stage compressor discharging an intermediate-pressure refrigerant compressed by the low-stage compressor into the closed housing, sucking and compressing the intermediate-pressure refrigerant by the high-stage compressor, and then discharging the resulting refrigerant;

an oil separating device that is provided on a discharge pipe from the two-step compressor and that separates oil contained in compressed refrigerant gas;

an oil return pipe that returns the oil separated by the oil separating device, into the closed housing under an intermediate pressure; and

a gas injection pipe that injects an intermediate-pressure refrigerant gas from a gas-liquid separating device or an internal heat exchanger into the closed housing of the two-stage compressor, the gas-liquid separating device or the internal heat exchanger constituting an economizer that is provided downstream of a gas cooler on a refrigerant circuit,

wherein the oil return pipe and the gas injection pipe individually communicate with the closed housing, between the low-stage compressor and the high-stage compressor of the two-stage compressor.

2. The two-stage compression refrigeration system according to claim 1, wherein the oil return pipe and the gas injection pipe communicate with a space portion between the low-stage compressor and the electric motor in the closed housing.

3. The two-stage compression refrigeration system according to claim 1 or 2, wherein the oil return pipe communicates with the closed housing, at an opposite position that faces a connection position of a suction pipe with the low-stage compressor, and the gas injection pipe communicates with the closed housing, at an opposite position that faces a communication position of the oil return pipe.

4. The two-stage compression refrigeration system according to any one of claims 1 to 3, wherein the low-stage compressor of the two-stage compressor is a rotary-type compressor configured to directly suck a low-pressure refrigerant gas through a suction pipe and discharge a compressed intermediate-pressure refrigerant gas into the closed housing, and the high-stage compressor is a scroll-type compressor configured to suck and compress the intermediate-pressure refrigerant gas in the closed housing, discharge a high-pressure refrigerant gas to a discharge chamber, and directly discharge the high-pressure refrigerant gas out of the compressor.

FIG. 1

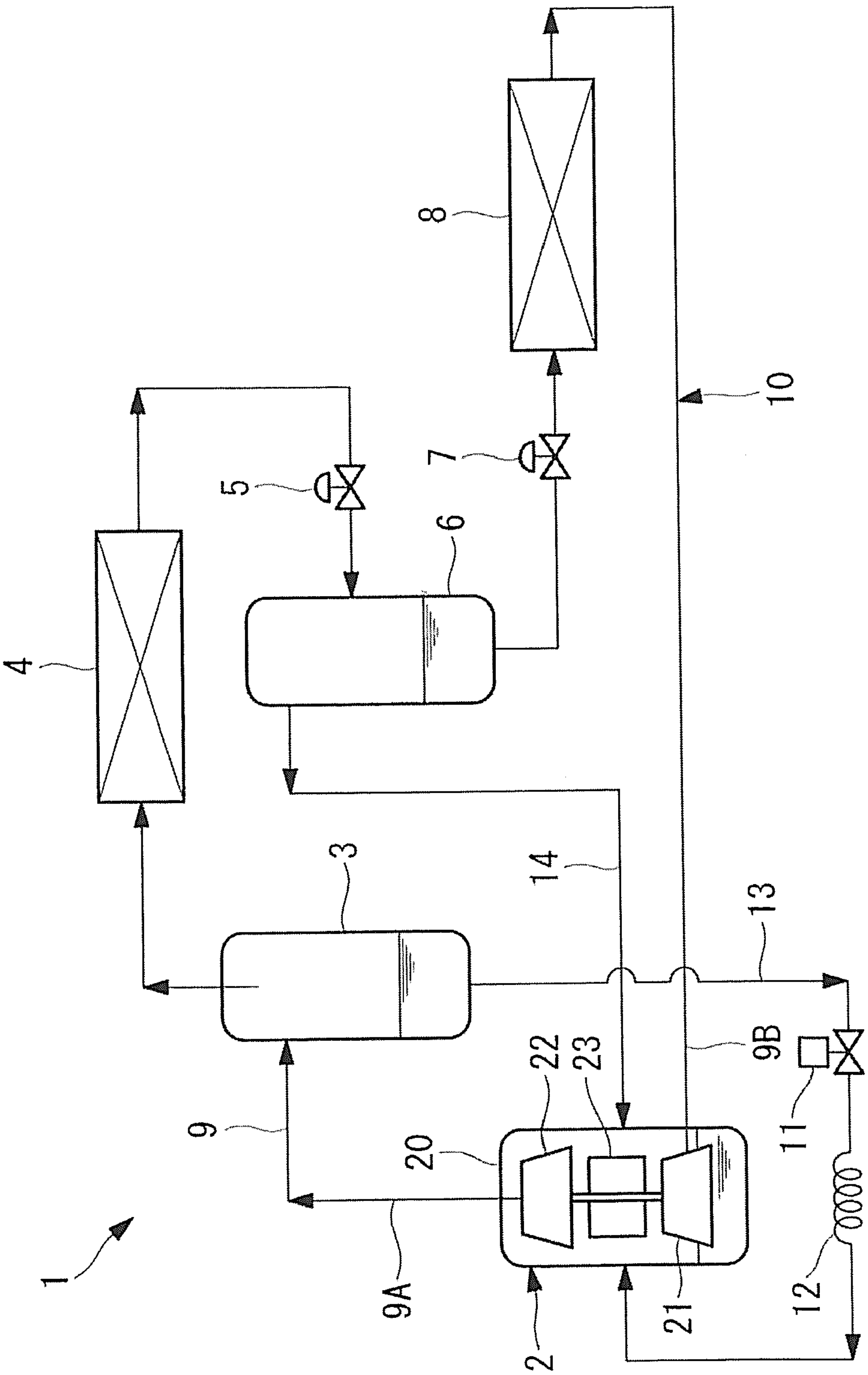
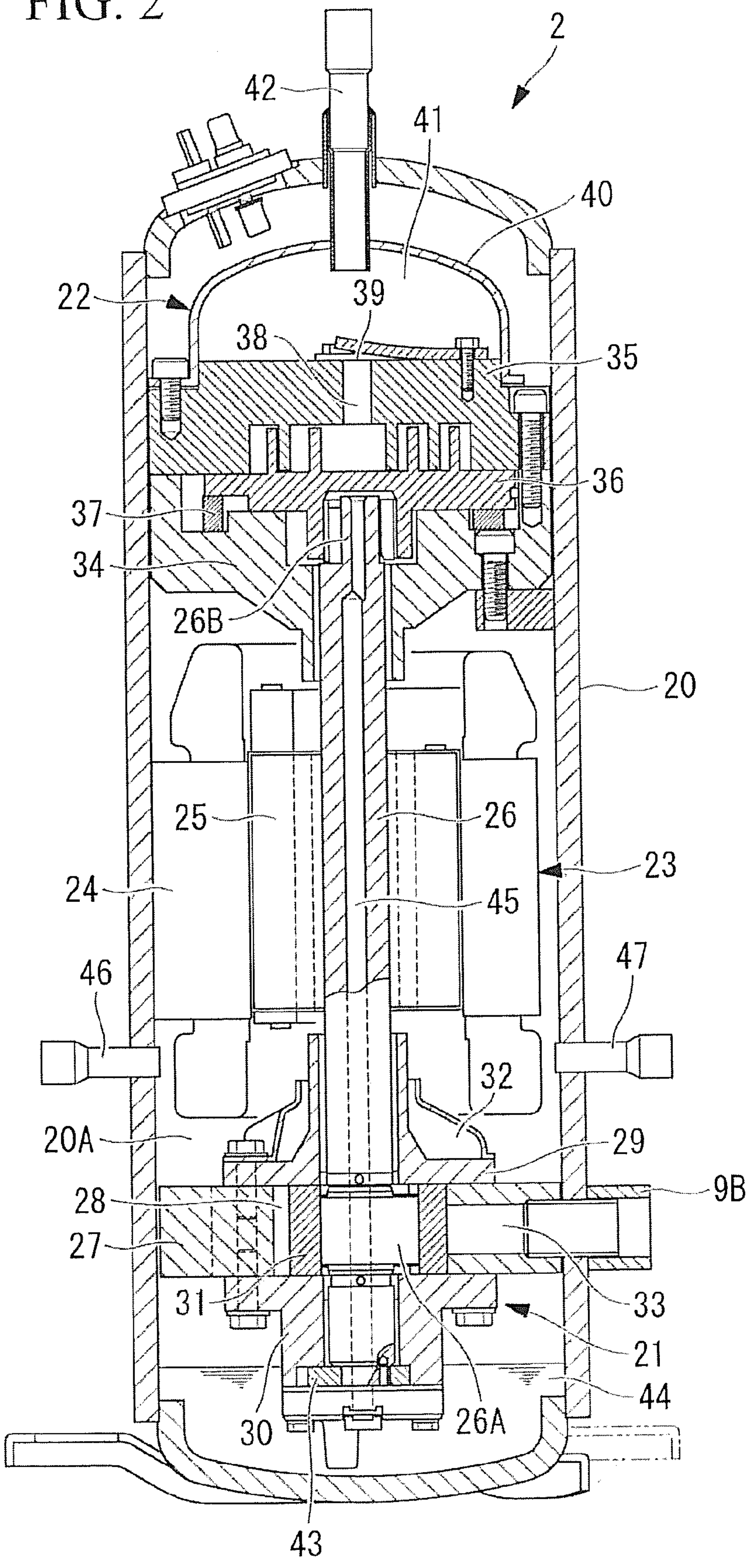


FIG. 2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EUROPEAN SEARCH REPORT

Application Number
EP 16 18 5537

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The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
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