Claims

[Claim 1]

A refrigeration device comprising: a compressor; a compressor downstream-side heat exchanger; an expander; and an expander downstream-side heat exchanger, wherein

a natural refrigerant flowing out of the compressor passes through the compressor downstream-side heat exchanger, the expander, and the expander downstream-side heat exchanger in this order and then circulates to the compressor,

the compressor and the expander are coupled to each other by a drive shaft that is common to the compressor and the expander,

the compressor downstream-side heat exchanger cools the natural refrigerant flowing out of the compressor,

the expander downstream-side heat exchanger exchanges heat between the natural refrigerant flowing out of the expander and a temperature control target, and

the compressor downstream-side heat exchanger and the expander downstream-side heat exchanger are arranged to be aligned in a direction parallel to an axial direction of the drive shaft or on the axial direction.

[Claim 2]

The refrigeration device according to claim 1, wherein the compressor downstream-side heat exchanger includes an external heat exchanger that cools the natural refrigerant flowing out of the compressor with a heat medium different from the natural refrigerant, and an internal heat exchanger that cools the natural refrigerant flowing out of the compressor with the natural refrigerant received from the expander downstream-side heat exchanger, and at least one of the external heat exchanger and the internal heat exchanger, and the expander downstream-side heat exchanger are aligned in a direction parallel to an axial direction of the drive shaft or on the axial direction.

[Claim 3]

The refrigeration device according to claim 2, wherein the expander downstream-side heat exchanger and the internal heat exchanger are aligned in this order along a direction from the expander toward the compressor in the axial direction.

[Claim 4]

The refrigeration device according to claim 3, wherein at least a part of a range occupied by the compressor, the drive shaft, and the expander overlaps at least a part of a range occupied by the expander downstream-side heat exchanger and the internal heat exchanger in a radial direction of the drive shaft orthogonal to the axial direction.

[Claim 5]

The refrigeration device according to claim 4, wherein the compressor, the drive shaft, and the expander are arranged between both ends in a direction parallel to the axial direction of a range occupied by the expander downstream-side heat exchanger and the internal heat exchanger.

[Claim 6]

The refrigeration device according to any one of claims 2 to 5, wherein the expander downstream-side heat exchanger, the internal heat exchanger, and the external heat exchanger are aligned in this order along a direction from the expander toward the compressor in the axial direction.

[Claim 7]

The refrigeration device according to claim 6, wherein the external heat exchanger, the internal heat exchanger, and the expander downstream-side heat exchanger are integrated.

[Claim 8]

The refrigeration device according to claim 2, wherein the internal heat exchanger and the expander downstream-side heat exchanger are integrated so as to be adjacent to each other, and

the internal heat exchanger and the external heat exchanger are integrated so as to be adjacent to each other in a direction orthogonal to a direction in which the internal heat exchanger and the expander downstream-side heat exchanger are adjacent to each other.

[Claim 9]

A heat exchanger unit comprising: a first external heat exchanger; an internal heat exchanger; and a second external heat exchanger, wherein

each of the first external heat exchanger, the internal heat exchanger, and the second external heat exchanger includes a heat exchange unit that enables heat exchange between fluids flowing through separate flow paths, and a casing that houses the heat exchange unit,

the casing of the first external heat exchanger, the casing of the internal heat exchanger, and the casing of the second external heat exchanger are integrated to form a common casing,

one of two fluid outlet ports of the heat exchange unit in the first external heat exchanger is connected to one of two fluid inlet ports of the heat exchange unit in the internal heat exchanger inside the common casing, and

one of two fluid outlet ports of the heat exchange unit in the second external heat exchanger is connected to the other of two fluid inlet ports of the heat exchange unit in the internal heat exchanger inside the common casing.

[Claim 10]

The heat exchanger unit according to claim 9, wherein the first external heat exchanger, the internal heat exchanger, and the second external heat exchanger are integrated so as to be linearly aligned in this order.

[Claim 11]

A cooling system comprising:

the refrigeration device according to claim 1; and

a fluid circulation device that is connected to the expander downstream-side heat exchanger and circulates a fluid as the temperature control target, the fluid being heat-exchanged with the natural refrigerant flowing out of the expander.