

[Document Name] DESCRIPTION

[Title of Invention] COOLING DEVICE AND COOLING SYSTEM

[Technical Field]

[0001]

5           The present invention relates to a cooling device and a cooling system and particularly relates to a cooling device and a cooling system that cools an electronic device using a phase change phenomenon of refrigerant.

[Background Art]

10           [0002]

          In recent years, the amount of information has substantially increased due to expansion of Internet services and the like. For this reason, a data center dealing with information is required to install a lot of electronic devices, such as a server and a network device that perform  
15 information processing. Installation of a lot of electronic devices in this manner increases air conditioning power required for cooling such electronic devices.

[0003]

          Accordingly, as an example of a cooling method requiring low air  
20 conditioning power, technologies relating to a phase change cooling method in which a phase change phenomenon of refrigerantrefrigerant is used are known, and, for example, PTL 1 discloses a technology relating to an electronic device cooling system. The technology described in PTL 1 enables electronic devices in a casing to be cooled by connecting a rear  
25 door and a cooling bath by means of a flexible tube and, between the rear door and the cooling bath, making refrigerant undergo a phase change.

[0004]

          Since a substantial increase in the amount of information causes an increase in the amount of heat generated by the electronic devices, it is

required to increase the diameter of the flexible tube, which serves as a flow path for refrigerant, according to the increase in the amount of heat. In addition, since an increase in the diameter of the flexible tube also causes an increase in the bending radius of the flexible tube, it is required  
5 to distance the cooling bath from the rear door. However, the above-described technology described in PTL 1 employs a configuration in which the cooling bath is disposed in a vicinity of the rear door, that is, a configuration that prevents the diameter of the flexible tube from being increased. Because of the configuration, there is a possibility that, when  
10 a lot of electronic devices are installed, the above-described technology described in PTL 1 cannot sufficiently dissipate heat generated by the electronic devices.

[0005]

Accordingly, as a configuration that enables the diameter of a  
15 flexible tube to be increased, a cooling system 900, exemplified in Figs. 11 and 12, is known. Using Figs. 11 and 12, the related cooling system 900 will be described. Figs. 11 and 12 are a plan view and a side view of the related cooling system 900, respectively.

[0006]

20 A cooling device 920 of the cooling system 900 includes an evaporating unit 927, a flexible tube 923, and a refrigerant relay 912. The refrigerant relay 912 is disposed at a position distanced from the evaporating unit 927. The refrigerant relay 912 and the evaporator 927 are connected to each other by means of the flexible tube 923, and the  
25 flexible tube 923 is made longer than the straight line distance between the refrigerant relay 912 and the evaporator 927, that is, is disposed provided with a surplus length. The configuration of the cooling device 920 enables opening and closing of the rear-surface door even when the diameter of the flexible tube 923 is increased.

Note that other technologies related to the present invention are also disclosed in PTLs 2 and 3.

[Citation List]

[Patent Literature]

5 [0007]

[PTL 1] JP 2009-134531 A

[PTL 2] JP 2012-179728 A

[PTL 3] JP 2006-101817 A

[Summary]

10 [0008]

However, the above-described cooling device 920 having the refrigerant relay 912 and the evaporator 927 distanced from each other causes an increase in the space for installation. For this reason, while the cooling device 920 has no problem when there is enough space for installing a lot of casings in a data center, a lot of cooling devices 920 cannot be installed in the data center when enough space is not available. In addition, in the cooling device 920, disposition of the refrigerant relay 912 closer to the side on which the evaporator 927 is disposed causes the flexible tube 923 to extend out of the place for installation, which eventually increases the space for installation. This constraint requires the cooling device 900 to secure a distance equal to or longer than a predetermined distance between the casing 912 and other casings, which has caused an increase in the space for installation.

[0009]

25 An object of the present disclosure is to provide a cooling device and a cooling system that are capable of suppressing an increase in space for installation.

[0010]

In an aspect, the present disclosure provides a cooling device, comprising: an evaporator that is disposed on a rear-surface door that is mounted on a casing in an openable and closable manner; a refrigerant  
5 relay that is placed above the casing and connected to a condenser; and a freely bendable flexible tube one end and the other end of which are connected to the evaporator and a side of the refrigerant relay different from a side of the refrigerant relay on which the evaporator is disposed, respectively, wherein at least a portion of the flexible tube is disposed  
10 below the refrigerant relay so as to cross the refrigerant relay in a grade-separated manner.

[0011]

In order to achieve the above-described object, the cooling device according to the present disclosure includes a plurality of the evaporators,  
15 wherein each of the plurality of the evaporators is connected to the refrigerant relay.

[0012]

The present disclosure enables an increase in space for installation to be suppressed.

20 [Brief Description of Drawings]

[0013]

[Fig. 1] Fig. 1 is a plan view of a cooling system according to an example embodiment (first example embodiment) of the present invention;

25 [Fig. 2] Fig. 2 is a plan view of a cooling system according to another example embodiment (second example embodiment) of the present invention;

4a

[Fig. 3] Fig. 3 is a side view of the cooling system according

to the another example embodiment (second example embodiment) of the present invention;

[Fig. 4] Fig. 4 is a plan view of the cooling system according to the another example embodiment (second example embodiment) of the present invention and a diagram illustrating a state in which a rear-surface door of a casing is opened;

[Fig. 5] Fig. 5 is a side view of the cooling system according to the another example embodiment (second example embodiment) of the present invention and another diagram illustrating the state in which the rear-surface door of the casing is opened;

[Fig. 6] Fig. 6 is a plan view of a cooling system according to still another example embodiment (third example embodiment) of the present invention;

[Fig. 7] Fig. 7 is a side view of the cooling system according to the still another example embodiment (third example embodiment) of the present invention;

[Fig. 8] Fig. 8 is a rear view of the cooling system according to the still another example embodiment (third example embodiment) of the present invention;

[Fig. 9] Figs. 9 is a plan view of the cooling system according to the still another example embodiment (third example embodiment) of the present invention and a diagram illustrating a state in which a rear-surface door of a casing is opened;

[Fig. 10] Fig. 10 is a side view of the cooling system according to the still another example embodiment (third example embodiment) of the present invention and another diagram illustrating the state in which the rear-surface door of the casing is opened;

[Fig. 11] Fig. 11 is a plan view of a related cooling system;  
and

[Fig. 12] Fig. 12 is a side view of the related cooling system.

[Description of Embodiments]

[0014]

Hereinafter, example embodiments of the present invention will be  
5 described using the drawings.

[0015]

(First Example Embodiment)

An example embodiment (first example embodiment) of the present  
invention will be described using Fig. 1. Fig. 1 is a plan view of a  
10 cooling system 100 according to the present example embodiment (first  
example embodiment). The cooling system 100 is configured including a  
plurality of cooling devices 110, 120, 130, and 140 and a refrigerant relay  
112 that is connected to the respective ones of the plurality of cooling  
devices 110, 120, 130, and 140. Note that, since the plurality of cooling  
15 devices 110, 120, 130, and 140 have the same configuration, the cooling  
device 120 will be described and a description of the other cooling devices  
110, 130, and 140 will be omitted.

[0016]

The cooling device 120 is configured including an evaporator 127,  
20 the refrigerant relay 112, and a flexible tube 123. The evaporator 127 is  
disposed on a rear-surface door that is mounted on a casing 121 in an  
openable and closable manner. The refrigerant relay 112 is placed above  
the casing 121 and connected to a not-illustrated condenser. The flexible  
tube 123 has one end and the other end connected to the evaporator 127 and  
25 a side of the refrigerant relay 112 different from the side thereof on which  
the evaporator 127 is disposed, respectively. The flexible tube 123 is  
configured so as to be freely bendable. In addition, at least a portion of  
the flexible tube 123 is disposed below the refrigerant relay 112 so as to  
cross the refrigerant relay 112 in a grade-separated manner. In the above,

the side of the refrigerant relay 112 on which the evaporator 127 is disposed and the side of the refrigerant relay 112 different therefrom correspond to the rear-surface side and the front-surface side of the casing 121, respectively. In other words, the other end of the flexible tube 123 is connected to the front-surface side of the refrigerant relay 112 with respect to the casing 121. In addition, the crossing in a grade-separated manner corresponds to, by making the flexible tube 123, after passing below the refrigerant relay 112 from the side on which the evaporator 127 is disposed, reverse the extending direction thereof and be connected to the refrigerant relay 112, making the refrigerant relay 112 and the flexible tube 123 cross each other above the casing 121.

[0017]

As described above, the cooling device 120 has the refrigerant relay 112 placed above the casing 121 and the flexible tube 123 connected to the evaporator 127 and the side of the refrigerant relay 112 different from the side thereof on which the evaporator 127 is disposed. Making the refrigerant relay 112 and the flexible tube 123 cross each other in a grade-separated manner enables the cooling device 120 to keep the refrigerant relay 112 and the flexible tube 123 contained within an area above a space for installation of the casing 121. In consequence, an increase in space for installation may be suppressed in the present example embodiment.

[0018]

(Second Example Embodiment)

Another example embodiment (second example embodiment) of the present invention will be described using Figs. 2 to 5. Figs. 2 and 3 are a plan view and a side view of a cooling system 200 according to the present example embodiment (second example embodiment), respectively. Figs. 4 and 5 are a plan view and a side view of the cooling system 200

according to the present example embodiment (second example embodiment), respectively, and diagrams illustrating a state in which a rear-surface door of a casing 221 is opened.

[0019]

5        The cooling system 200 is configured including a plurality of cooling devices 210, 220, 230, and 240. Note that, since the plurality of cooling devices 210, 220, 230, and 240 have the same configuration, the cooling device 220 will be described and a description of the other cooling devices 210, 230, and 240 will be omitted. The cooling device 220 is  
10        configured including an evaporating unit 227, a not-illustrated condensing unit, a refrigerant relay 212, a refrigerant vapor tube 223, and a refrigerant liquid tube 224.

[0020]

      The evaporating unit 227 of the cooling device 220 is disposed so  
15        as to cover the rear-surface side of the casing 221. In the present example embodiment, the casing 221 is made up of a top surface, a bottom surface, a front surface, a rear surface, and side surfaces and is formed constituting a rectangular parallelepiped shape. Note that, hereinafter, the surface illustrated in Fig. 2 is referred to as the top surface, and the  
20        upper side, the lower side, and the right and left sides in the Fig. 2 are referred to as the front surface, the rear surface, and the side surfaces, respectively. In addition, based on the above definition, the up and down direction, the right and left direction, and the depth direction in the Fig. 2 are referred to as a front-to-rear direction, a side-to-side direction, and a  
25        top-to-bottom direction, respectively.

[0021]

      The evaporating unit 227 functions as the rear-surface door of the casing 221 and is mounted on the casing 221 in a freely openable and closable manner by means of a not-illustrated metal fitting having a

rotating shaft. In addition, the evaporating unit 227 is thermally connected to not-illustrated electronic devices contained inside the casing 221, and evaporation of refrigerant liquid stored inside the evaporating unit 227 takes heat away from the electronic devices. Note that, since the  
5 electronic devices are known technologies, a description thereof will be omitted. The evaporating unit 227 cools a heating element by, when taking heat away from the heating element, making the stored refrigerant liquid undergo a phase change to vapor (hereinafter, the vapor is referred to as refrigerant vapor). At this time, emitted heat from the heating  
10 element is absorbed by the refrigerant vapor. The refrigerant vapor flows into the refrigerant relay 212 via the refrigerant vapor tube. Further, the refrigerant vapor flows into a not-illustrated heat exchanger from the refrigerant relay 212.

[0022]

15 The condensing unit is installed at a higher position than the evaporating unit 227. The condensing unit makes the refrigerant vapor undergo a phase change to liquid (hereinafter, the liquid is referred to as refrigerant liquid) and radiates heat. At this time, the condensing unit condenses and liquefies the refrigerant vapor by performing heat exchange  
20 with a low temperature medium, such as air.

[0023]

The refrigerant vapor tube 223 serves as a flow path for flowing refrigerant vapor generated through a phase change in the evaporating unit 227 from the evaporating unit 227 to the refrigerant relay 212 by use of the  
25 buoyancy of the refrigerant vapor. In the present example embodiment, the refrigerant vapor tube 223 is configured using a freely bendable flexible tube made of metal. Note that, although, in the present example embodiment, the refrigerant vapor tube 223 is assumed to be made of metal, that is because the refrigerant vapor tube 223 made of resin, such as rubber

and Teflon (Registered Trademark), causes air to permeate from the outside into the inside and lower the degree of vacuum, and, thus, the material constituting the refrigerant vapor tube 223 is not limited to a metal as long as satisfying the degree of vacuum described above. One  
5 end and the other end of the refrigerant vapor tube 223 are connected to the refrigerant relay 212 and the evaporating unit 227 on the casing 221, respectively. Note that, although the size of the refrigerant vapor tube 223 is not limited to a specific value, the size may, as an example, be set at an inner diameter of approximately 50 mm when, for example, heat of 15  
10 kW is transported. As another example, the size may be set at an inner diameter of approximately 65mm when, for example, heat of 30kW is transported.

[0024]

The refrigerant liquid tube 224 serves as a flow path for flowing  
15 refrigerant liquid generated through a phase change in the heat exchanger from the refrigerant relay 212 on the upstream side to the evaporating unit 227 on the downstream side by use of the gravity of the refrigerant liquid. The refrigerant liquid tube 224 is also configured using a freely bendable flexible tube as with the refrigerant vapor tube 223. One end and the  
20 other end of the refrigerant liquid tube 224 are also connected to the refrigerant relay 212 and the evaporating unit 227, respectively, as with the refrigerant vapor tube 223.

[0025]

In the above configuration, the evaporating unit 227 functions as a  
25 rear-surface door that opens and closes by rotating around the rotating shaft, as described above. For this reason, as the rear-surface door opens and closes, the positions of the other ends of the refrigerant vapor tube 223 and the refrigerant liquid tube 224 are drawn in the rear-surface direction of the casing 221. Therefore, in the present example embodiment,

allowing the refrigerant vapor tube 223 and the refrigerant liquid tube 224 to be bent and stretched using surplus length and flexibility that the refrigerant vapor tube 223 and the refrigerant liquid tube 224 have enables opening and closing of the rear-surface door. In consequence, it becomes possible to, while retaining the connection between the refrigerant relay 212 and the evaporating unit 227, open and close the evaporating unit 227 as a rear-surface door.

[0026]

The refrigerant relay 212 has a cylindrical shape and is extended along the side-to-side direction of the casing 221. Note that, although, in the present example embodiment, the refrigerant relay 212 is formed into a cylindrical shape, the cross-sectional shape thereof is not limited to a circular shape and may be formed into, for example, a rectangular shape. In addition, the refrigerant relay 212 is, as described above, disposed in an area above the top surface of the casing 221. On the other hand, in the above-described related cooling system 900, in order to secure the surplus length of the flexible tube 923, the refrigerant relay 912 is disposed, instead of in an area above the space for installation of the casing 921, at a position outside the space for installation of the casing 921, as described above. For this reason, in the related cooling system 900, another casing cannot be installed in a space on the front-surface side of the casing 921, and, when a sufficient space for installation is not available, it is impossible to install a lot of casings. By contrast, in the present example embodiment, the refrigerant relay 212 is disposed within the space for installation of the casing 221. In the present example embodiment, this dispositional configuration enables a saving in space for installation to be achieved.

[0027]

In the present example embodiment, the refrigerant relay 212 is

placed at a position between substantially the middle and the rear-surface side in the front-to-rear direction of the casing 221. In addition, the refrigerant relay 212 is placed at a position distanced by a predetermined height from the top surface of the casing 221. This configuration enables the refrigerant vapor tube 223 and the refrigerant liquid tube 224 to be bent and disposed within an area in the space for installation of the casing 221. Note that, although the position at which the refrigerant relay 212 is disposed is not limited to a specific position as long as being located between substantially the middle and the rear-surface side in the front-to-rear direction of the casing 221, the refrigerant relay 212 may preferably be positioned at substantially the middle. This configuration enables a sense of oppression given to users by the refrigerant relay 212 to be suppressed.

[0028]

On the casing 221, a capping 218 is disposed. Note that the capping 218 is a component for controlling air flow in air conditioning and a product for achieving an efficient air conditioning environment by partitioning passages around the respective casings using walls, roofs, and the like and physically separating intake air (low temperature) and exhaust air (high temperature) to/from electronic devices. The capping 218 is erected at the edge on the front-surface side of the casing 221. This configuration enables the capping 218 to partition an area above the top surface of the casing 221 from an area on the front-surface side of the casing 221 and reduce influence of air flow on refrigerant flowing through the refrigerant relay 212, the refrigerant vapor tube 223, and the refrigerant liquid tube 224.

[0029]

On the other hand, in the related cooling system 900, the refrigerant relay 912 is disposed at a position outside an area equivalent to the space

for installation of the casing 921. For this reason, disposition of a capping to the cooling system 900 causes a necessity to open a hole through which the refrigerant vapor tube 923 is inserted on the capping. By contrast, in the cooling system 200 of the present example embodiment, since the refrigerant vapor tube 223 is disposed within the space for installation of the casing 221, it is not necessary to open a hole in the capping 218 that allows the refrigerant vapor tube 223 to pass therethrough, which enables air flow to be shielded more securely.

[0030]

As described above, even when a tube that cannot be twisted, like the refrigerant vapor tube 223 made of metal, is used, the present example embodiment enables opening and closing of the rear-surface door with the connection of the refrigerant vapor tube 223 to the rear-surface door retained. In addition, even when the refrigerant vapor tube 223 is provided with surplus length in order to enable opening and closing of the rear-surface door, it becomes possible to keep the refrigerant vapor tube 223 contained within the space for installation of the casing 221. In consequence, the present example embodiment enables an increase in space for installation to be suppressed and more casings to be installed in a data center.

[0031]

(Third Example Embodiment)

Still another example embodiment (third example embodiment) of the present invention will be described using Figs. 6 to 10. Figs. 6 to 8 are a plan view, a side view, and a rear view of a cooling device 300 according to the present example embodiment (third example embodiment), respectively. Figs. 9 and 10 are a plan view and a side view of the cooling system 300 according to the present example embodiment (third example embodiment), respectively, and diagrams illustrating a state in

which a rear-surface door of a casing 321 is opened. Note that a cooling device 320 of the cooling system 300 of the present example embodiment is similar to the cooling device 220 of the second example embodiment described above except a difference in that a refrigerant vapor tube 323 and a refrigerant liquid tube 324 have a plurality of bend parts. Therefore, corresponding signs are assigned to the same components as those in the cooling device 220 of the second example embodiment described above and a description thereof will be omitted.

[0032]

10 In the present example embodiment, the refrigerant vapor tube 323 and the refrigerant liquid tube 324 are disposed having a plurality of bend parts. In this configuration, refrigerant flowing through the refrigerant vapor tube 323 is a mixed two phase flow of vapor and liquid. The liquid ascends toward a refrigerant relay 312 dragged by the force of vapor flow.

15 On this occasion, in the above-described second example embodiment, although the liquid flows along a lowest portion of the inner surface of the refrigerant vapor tube 223 until reaching a middle point, after the middle point, the inclination of the refrigerant vapor tube 223 turns to a reverse inclination, which causes the liquid flow to switch flow paths. For this

20 reason, in the above-described second example embodiment, there is a possibility that the liquid flow switching phenomenon causes a vibration of the refrigerant vapor tube 223 to occur and the life of the refrigerant vapor tube 223 to be shortened. In addition, in the above-described second example embodiment, there is also a possibility that crossing of the liquid

25 and the vapor at a position where the liquid flow switches flow paths causes the vapor flow to be hindered and a reduction in performance to be induced. By contrast, since, as described above, the refrigerant vapor tube 323 of the present example embodiment has a plurality of bend parts and a portion ascending to the refrigerant relay 312 is formed to obliquely

ascend, there is no turn to a reverse inclination and the liquid continuously ascends along lowest portions in cross sections of the refrigerant vapor tube 323. For this reason, the present example embodiment neither hinders the flow of vapor nor causes a vibration of the refrigerant vapor tube 323 to occur, which enables the life of the refrigerant vapor tube 323 to be prevented from deteriorating.

[0033]

As described above, the present example embodiment also enables opening and closing of the rear-surface door with the connection of the refrigerant vapor tube 323 to the rear-surface door retained. In addition, even when the refrigerant vapor tube 323 is provided with surplus length in order to enable opening and closing of the rear-surface door, it becomes possible to keep the refrigerant vapor tube 323 contained within the space for installation of the casing 321. In consequence, the present example embodiment enables an increase in space for installation to be suppressed and more casings to be installed in a data center.

[0034]

Further, since, as described above, a portion of the refrigerant vapor tube 323 ascending to the refrigerant relay 312 is formed to obliquely ascend, the present example embodiment neither hinders the flow of vapor nor causes a vibration of the refrigerant vapor tube 323 to occur, which enables the life of the refrigerant vapor tube 323 to be prevented from deteriorating.

[0035]

The present invention was described above through example embodiments (and examples) thereof, but the present invention is not limited to the above example embodiments (and examples). Various modifications that could be understood by a person skilled in the art may be applied to the configurations and details of the present invention within

the scope of the present invention.

In addition, all or part of the example embodiments described afore may be described as follows, but not limited thereto.

[Supplementary note 1]

5 A cooling device, including:

an evaporator that is disposed on a rear-surface door that is mounted on a casing in an openable and closable manner;

a refrigerant relay that is placed above the casing and connected to a condenser; and

10 a freely bendable flexible tube one end and the other end of which are connected to the evaporator and a side of the refrigerant relay different from a side of the refrigerant relay on which the evaporator is disposed, respectively, wherein

at least a portion of the flexible tube is disposed below the refrigerant relay so as to cross the refrigerant relay in a grade-separated manner.

[Supplementary note 2]

The cooling device according to supplementary note 1, wherein the refrigerant relay is positioned at substantially a middle above the casing.

[Supplementary note 3]

The cooling device according to supplementary note 1 or 2, wherein the flexible tube is disposed having a plurality of bend parts.

[Supplementary note 4]

25 The cooling device according to any one of supplementary notes 1 to 3, wherein

at least a portion of the flexible tube is formed to extend obliquely upward from a region of the flexible tube positioned below the refrigerant relay toward the refrigerant relay.

[Supplementary note 5]

The cooling device according to any one of supplementary notes 1 to 4, wherein

5 a side of the refrigerant relay different from a side of the refrigerant relay on which the evaporator is disposed is positioned on a front-surface side of the casing.

[Supplementary note 6]

The cooling device according to any one of supplementary notes 1 to 5, including

10 a plurality of the evaporators, wherein

each of the plurality of the evaporators is connected to the refrigerant relay by means of the flexible tube.

[Supplementary note 7]

A cooling device, including:

15 an evaporator that is disposed on a rear-surface door that is mounted on a casing in an openable and closable manner;

a refrigerant relay that is placed above the casing and connected to a condenser; and

20 a freely bendable flexible tube one end and the other end of which are connected to the evaporator and a side of the refrigerant relay different from a side of the refrigerant relay on which the evaporator is disposed, respectively, wherein

at least a portion of the flexible tube is disposed below the refrigerant relay so as to cross the refrigerant relay in a grade-separated  
25 manner.

[Supplementary note 8]

The cooling device according to supplementary note 7, wherein

the refrigerant relay is positioned at substantially a middle above the casing.

[Supplementary note 9]

The cooling device according to supplementary note 7 or 8, wherein the flexible tube is disposed having a plurality of bend parts.

[Supplementary note 10]

5 The cooling device according to any one of supplementary notes 7 to 9, wherein

at least a portion of the flexible tube is formed to extend obliquely upward from a region of the flexible tube positioned below the refrigerant relay toward the refrigerant relay.

10 [Supplementary note 11]

The cooling device according to any one of supplementary notes 7 to 10, wherein

a side of the refrigerant relay different from a side of the refrigerant relay on which the evaporator is disposed is positioned on a front-surface side of the casing.

[Supplementary note 12]

A cooling system, including

a plurality of evaporators according to any one of supplementary notes 7 to 11, wherein

20 each of the plurality of the evaporators is connected to the refrigerant relay.

[0036]

This application claims priority based on Japanese Patent Application No. 2015-203568, filed on Oct. 15, 2015, the entire disclosure of which is incorporated herein by reference.

[Reference signs List]

[0037]

100 Cooling system

112 Coolant relay

- 120 Cooling device
- 121 Casing
- 123 Flexible tube
- 127 Evaporator

## [Document Name] CLAIMS

[Claim 1] A cooling device, comprising:

an evaporator that is disposed on a rear-surface door that is mounted on a casing in an openable and closable manner;

5 a refrigerant relay that is placed above the casing and connected to a condenser; and

a freely bendable flexible tube one end and the other end of which are connected to the evaporator and a side of the refrigerant relay different from a side of the refrigerant relay on which the evaporator is disposed,  
10 respectively, wherein

at least a portion of the flexible tube is disposed below the refrigerant relay so as to cross the refrigerant relay in a grade-separated manner.

[Claim 2] The cooling device according to claim 1, wherein the  
15 refrigerant relay is positioned at substantially a middle above the casing.

[Claim 3] The cooling device according to claim 1 or 2, wherein the flexible tube is disposed having a plurality of bend parts.

[Claim 4] The cooling device according to any one of claims 1 to 3, wherein at least a portion of the flexible tube is formed to extend obliquely  
20 upward from a region of the flexible tube positioned below the refrigerant relay toward the refrigerant relay.

[Claim 5] The cooling device according to any one of claims 1 to 4, wherein a side of the refrigerant relay different from a side of the refrigerant relay on which the evaporator is disposed is positioned on a  
25 front-surface side of the casing.

[Claim 6] The cooling device according to any one of claims 1 to 5, comprising

a plurality of the evaporators, wherein

each of the plurality of the evaporators is connected to the

refrigerant relay by means of the flexible tube.