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RÉFRIGÉRATEUR

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Description

TECHNICAL FIELD

[0001] The present invention relates to a refrigerator equipped with a fixing member capable of suppressing noise and vibration of a condenser easily with a low cost in the refrigerator of which the condenser and a compressor are air-cooled by an air blower.

[0002] The present invention also relates to a refrigerator equipped with a condenser that can be accommodated in a small space, and capable of dissipating heat efficiently in the refrigerator of which the condenser and a compressor are air-cooled by an air blower.

BACKGROUND ART

[0003] In household refrigerators, there is a type having a combined use of condensers, one of which is air-cooled by an air blower in addition to another fixed to an inner side of a cabinet enclosure and cooled naturally through the cabinet enclosure in the light of energy saving. For household refrigerators, however, sizes of condenser main bodies and airflow paths are subject to limitations in view of space saving. It is therefore important to establish a fixing method to the refrigerator's main body and technique of suppressing noise and vibration attributable to physical contact with a cover, besides such techniques as improving circulation of air and increasing heat dissipating capability. Those conventionally used are such structures that suppress vibration and reduce the noise by fixing condensers firmly and without bringing them into contact with other components. One of the structures, for example, is to attach a condenser to a fixing plate made of resin mold, to make them into substantially an integrated unit, and fix a predetermined portion of it to a main body (refer to Patent Literature 1, for instance).

[0004] There have also been concerns for household refrigerators that airflow paths may be clogged due to accumulation of house dust, besides the limitations on sizes of condenser main bodies and airflow paths from the viewpoint of space saving.

[0005] Certain designs of condensers have therefore been disclosed in consideration of space saving and accumulation of dust.

[0006] In particular, condensers that have been used are the spiral finned-tube type in which a metal strip fin is spirally wound around a refrigerant tube. This is because they are relatively easy to form any shape freely, besides being less prone to dust accumulation, so that they are used to obtain high heat dissipating capability when mounted within small machinery compartments and the like of household refrigerators (refer to Patent Literature 2, for instance). From JP 2001 153530 A a finned condenser is known that comprises finned pipes formed by fixing radiation fins to the outer circumference of a pipe, bent in a plurality of stages and rows. Upper and lower securing members are provided for securing the upper and lower sections of the finned condenser, respectively. The upper securing member comprises a part for holding the finned pipe on the upper surface of the finned condenser, a fixing part is located above the holding part and is fixed to the machine room, and a resilient coupling part is provided for coupling the fins vertically. Description is provided hereinafter of a conventional refrigerator with reference to the accompanying drawings.

[0007] Fig. 9 is a rear view of a lower machinery compartment of a conventional refrigerator, and Fig. 10 is an exploded perspective view showing a structure of a condenser and surrounding area of the conventional refrigerator.

[0008] In Fig. 9 and Fig. 10, machinery compartment 100 is formed in a lower rear section of a main body of the refrigerator. Compressor 101, condenser 102, cooling fan 103, and the like components are provided in machinery compartment 100.

[0009] Condenser 102 constitutes a part of refrigeration cycle, and is made of three stacked layers of plate-like elements, each of which includes wires 102b used as cooling fins welded to both sides of refrigerant tube 102a fabricated into serpentine form. Condenser 102 is mounted to the refrigerator's main body via fixing plate 104 on the rear side of machinery compartment 100. Fixing plate 104 is a molded synthetic resin formed by injection molding, and plate-like body has a size analogous with a plane of condenser 102. Fixing plate 104 has hanging aperture 104a formed in an upper center area of the plate surface for temporary fixation to a rear plate (not shown) of an outer cabinet. Fixing plate 104 is also provided with a plurality of retaining ribs 104b of a protruded shape across an upper end to a lower end on both right and left sides thereof for retaining curved portions 102d on both sides of serpentine-formed three layers of refrigerant tube 102a in a manner to maintain given spaces between the layers. In addition, fixing plate 104 is provided with fixing pieces 104c at upper right and left sides thereof for fixing condenser 102 to the main body together with fixing plate 104.

[0010] Each of fixing pieces 104c includes through hole 104d for a screw to secure fixing plate 104 itself to the rear plate (not shown) of the outer cabinet, and integrally-formed fastening lug 104e for fastening metal hooks 106 used to hang and fix refrigerant tube 102a. Each of metal hooks 106 includes retaining section 106a for refrigerant tube 102a, and base section 106b provided with a through hole that engages with fastening lug 104e of fixing piece 104c. In addition, fixing plate 104 is provided with tube support 104f having a shape extending from one side of fixing plate 104 into a position corresponding to inlet tube 102c of condenser 102.

[0011] When fixing condenser 102 to the main body, straight portions near curved portions 102d at both sides of refrigerant tube 102a are engaged in advance with retaining ribs 104b formed vertically along two sides of

fixing plate 104. This step practically integrates condenser 102 assembled with fixing plate 104. This assembly unit of condenser 102 and fixing plate 104 is positioned and temporary fixed by engaging hanging aperture 104a of fixing plate 104 to a hook on the rear plate (not shown) of the outer cabinet. Following the above, retaining sections 106a of metal hooks 106 are engaged with refrigerant tube 102a, metal hooks 106 are attached by sliding base sections 106b into engagement with fixing pieces 104c of fixing plate 104, and metal hooks 106 are fixed together with fixing pieces 104c to the rear plate (not shown) of the outer cabinet by fastening screws into through holes 104d. Condenser 102 is thus fixed to the main body.

[0012] In addition, inlet tube 102c of condenser 102 is retained with pressure while being positioned by fitting into metal support 107, which is then fastened together with a screw to angle reinforcing plate 108 located at insulating material side behind the rear plate (not shown) of the outer cabinet through tube support 104f. Condenser 102 is robustly fixed to the main body together with fixing plate 104 by virtue of this structure that fixes the inlet side of condenser 102 and the lower side of fixing plate104 on the other side to the rear plate (not shown) of the outer cabinet. Furthermore, inlet tube 102c leading to the condenser is fastened with metal support 107 to angle reinforcing plate 108 on the main body side via fixing plate 104, and hence inlet tube 102c liable to the influence of vibration of compressor 101 can be fixed rigidly. Since vibration from compressor 101 is absorbed in a portion around inlet tube 102c and not transmitted to refrigerant tube 102a on the downstream side of the refrigeration cycle, the vibration of condenser 102 can be reduced considerably with aid of fixing plate 104 securing various parts of refrigerant tube 102a, and thereby suppressing noise to develop. This can also suppress vibration of refrigerant tube 102a.

[0013] In the structure of the conventional refrigerator, however, it is necessary to provide fixing plate 104, i.e., a large resin component, having a projected area generally equivalent to condenser 102, and fixing plate 104 needs to be fixed so rigidly as to be integrated with condenser 102. It also requires a large number of small parts such as metal hooks 106 and screws for mounting, since various parts of condenser 102 need to be fixed. This causes an increase in cost of materials, a number of man-hours for assembling the unit and then mounting the unit to the main body of refrigerator, which gives rise to a problem, as a result, that the product becomes not so affordable for many users. Moreover, such increases in size and number of the component parts demand an additional installation space to some extent. It also leads directly to poor usability such as an increase in the installation space of the refrigerator's main body, and decrease in volume of inner compartment of the refrigerator. There are also such drawbacks as increase in the possibility of becoming into contact with surrounding components and decrease in the quality like noises attributed to large variations in the assembly of the component parts.

[0014] In addition, vibration of the refrigerant tube tends to propagate directly to the refrigerator's main body because of the structure aimed to suppress the vibration of refrigerant tube 102a and inlet tube 102c by fixing them to the refrigerator's main body. There is therefore a possibility of having such problems as noise and food hitting against each other inside the storage compartment due to vibration of the refrigerator's main body and resonance of the refrigerator door.

[0015] It has therefore been the challenge to manage both the usability and quality by reducing sizes and a number of fastening parts such as fixing plate 104 and metal hooks 106, and reducing a number of contacting points between retaining ribs 104b and condenser 102, and also a number of contact points such as through holes 104d of screws with the refrigerator's main body.

[0016] The present invention addresses the above problems of the conventional art, and it is an object to improve quality and to provide a less expensive, space saving and highly usable refrigerator by adopting noble fixing methods that can minimize a number of component parts as well as a number of assembling and mounting man-hours, in addition to having a vibration and noise isolation function.

[0017] Description is provided hereinafter of another conventional refrigerator with reference to the accompanying drawings.

[0018] Fig. 11 is a vertically sectioned view of a lower machinery compartment of
a conventional refrigerator, and Fig. 12 is a horizontally sectioned view of the lower machinery compartment of the conventional refrigerator.

[0019] As shown in Fig. 11, insulation wall 111 of a storage compartment (not shown) is formed on an upper face of lower machinery compartment 110 of the refrigerator, and base plate 112 is formed on a lower face. Condenser 113 and air blower 114 for cooling condenser 113 are disposed inside lower machinery compartment 110. A cabinet of the refrigerator including lower machinery compartment 110 is supported by legs 115.

[0020] Here, condenser 113 is made from a spiral finned-tube in which strip fin 117 is wound around refrigerant tube 116, and that refrigerant tube 116 is bent into a serpentine form on a same single plane.

[0021] In general, refrigerant tube 116 is bent to form smallest possible curves of bending radius R in order to minimize spacing between adjoining tubes, when refrigerant tube 116 of condenser 113 made of the spiral finned-tube is bent into a serpentine form on one single plane. In addition, strip fin 117 is wound around refrigerant tube 116 while changing a distance between adjoining fins (hereafter referred to as "fin pitch") in a manner so that the distance become smaller toward the downwind side.

[0022] Air blower 114 is disposed at a rear-face side of lower machinery compartment 110, and it cools con-

denser 113 by drawing outside air from a plurality of intake openings 118 provided in base plate 112 and another intake opening 119 provided in front face of lower machinery compartment 110. The number of intake openings 118 provided in base plate 112 is changed in a manner that it becomes smaller toward the downwind side.

[0023] As shown in Fig. 12, evaporating tray 120 for storing defrosted water from a storage compartment (not shown) and immersion tube 121 for heating the water stored in evaporating tray 120 are disposed at the windward side of air blower 114 in lower machinery compartment 110. Compressor 122 is disposed at the downwind side of air blower 114 in lower machinery compartment 110, and discharge opening 123 is formed in the downwind side of compressor 122. Lower machinery compartment 110 is separated by partition wall 124.

[0024] Here, the air that has passed while cooling condenser 113 is collected in an upper part of evaporating tray 120 by partition wall 124, cools compressor 122 as it passes through air blower 114, and is discharged from discharge opening 123 to the outside. At this same time, an area around evaporating tray 120 is dried by the air warmed as the heat is exchanged with condenser 113, and promotes evaporation of the water collected in evaporating tray 120.

[0025] The conventional refrigerator constructed as above operates in a manner which is described hereinafter.

[0026] Condenser 113 is configured to have larger fin pitches at the windward side, and a larger number of intake openings 118 are formed also at the windward side. With this structure, a flow-path resistance at the windward side of condenser 113 becomes smaller whereas a flow-path resistance at the downwind side becomes relatively larger. It can inhibit the air discharged through discharge opening 123 from shortcutting into intake openings 118 of the downwind side. As a result, the heat exchanging capability can be used effectively, especially of the windward side of condenser 113 far from air blower 114.

[0027] Since both condenser 113 and compressor 122 are disposed along the same airflow path, compressor 122 can be cooled at the same time by using the air that passes and cools condenser 113.

[0028] However, in the case of lower machinery compartment 110 employed in the above-said refrigerator of the conventional art, it is imperative to cool condenser 113 formed into a plane configuration within a space of strictly limited height. It is thus important that the comparatively warm air discharged through discharge opening 123 is prevented from being pulled again, or shortcutting, into intake openings 118 in the downwind side. The
shortcutting, if occurs, gives rise to such problems as a substantial reduction in the heat dissipating capability of condenser 113 and an increase in the amount of electric power consumption.

[0029] In the structure of the conventional refrigerator, however, fin pitches on the windward side of condenser 113 are increased in order to reduce the flow-path resistance of condenser 113, which results in a decrease in per-unit-length value of the heat dissipating capability. Since refrigerant tube 116 needs to be lengthened to ensure the necessary heat dissipating capability, this gives rise to another problem that the space occupied by condenser 113 increases.

[0030] Since the flat-shaped lower machinery compartment 110 exclusively for condenser 113 is located between insulation wall 111 and base plate 112 under the refrigerator, it reduces a frontage size of the storage compartment, thereby giving rise to a drawback of impairing usability for the users.

[0031] In the structure of the conventional refrigerator, fin pitches of condenser 113 are narrowed and the number of intake openings 118 is decreased in the downwind side. This causes a problem in which dust collects on condenser 113 in the vicinity of intake openings 118 in the downwind side, and blocks intake openings 118 in a short period of time. When intake openings 118 in the downwind side of condenser 113 are blocked, a temperature of the air coming from the windward side rises while exchanging the heat with condenser 113, and this becomes a cause of increasing an amount of the power consumption due to the rise of condensing temperature in condenser 113.

[0032] The present invention addresses the problems of the conventional art, and it is an object to provide a refrigerator equipped with a condenser of high heat dissipating capability without providing an exclusive machinery compartment, and capable of ensuring the heat dissipating capability for an extended period of time.

Citation List:

Patent Literatures

[0033]

PTL 1: Japanese Patent Unexamined Publication No. 2007-71462
PTL 2: Japanese Patent Unexamined Publication No. 1997-282188

SUMMARY OF THE INVENTION

[0034] A refrigerator of the present invention has a machinery compartment in a rear-face side thereof, and the machinery compartment includes a spiral finned-tube condenser, an air blower serving as a primary driving source of a ventilation circuit, and a compressor for circulating a refrigerant in a refrigeration system to cool the refrigerator. The condenser is so configured that a refrigerant tube is spirally wound into an elliptic shape, a center of the spiral winding is serpentine-formed along a direction perpendicular to a principal axis of the air blower,

and portions of the refrigerant tube at an inlet port and an outlet port of the refrigerant are linked with a connecting member made of rubber.

[0035] Since the connecting member plays a role of rubber vibration isolator to absorb vibration of the condenser, it can suppress the vibration of the condenser. In addition, the connecting member helps reduce a number of component parts since it also plays a role of securing relative positions of the inlet port and the outlet port, and makes additional positioning part unnecessary. Moreover, the connecting member can reduce a number of assembling man-hours since other ancillary parts such as screws need not be used to mount the rubber, and a number of mounting man-hours is also reducible because installation to the refrigerator's main body can be made independently of the connecting member.

[0036] Another refrigerator of the present invention has a machinery compartment in a rear-face side thereof, and the machinery compartment includes a spiral finned-tube condenser, an air blower serving as a primary driving source of a ventilation circuit, and a compressor for circulating a refrigerant in a refrigeration system to cool the refrigerator. The condenser is so configured that a refrigerant tube is wound into a spiral shape, and the center of the spiral shape is serpentine-formed along a direction perpendicular to a principal axis of the air blower. In addition, an angle formed between a spiral plane of the spiral shape and a bottom surface of the machinery compartment is set larger at a windward side than that at a downwind side.

[0037] Since this structure allows downsizing of the condenser in both depth direction and width direction, it becomes possible to dispose the condenser in the same machinery compartment with the compressor. In addition, the reduction of the size in the width direction can also decrease a flow-path resistance since it reduces a distance for the air to pass through the condenser. Furthermore, this structure can reduce a density of the refrigerant tube in the upwind side of the condenser in addition to providing an intake opening of an equal height to a height of the machinery compartment, which can reduce clogging attributed to accumulation of dust, and ensure performance of the condenser for an extended period of time.

BRIEF DESCRIPTION OF DRAWINGS

[0038]

Fig. 1 is a rear perspective view of a refrigerator according to first exemplary embodiment of the present invention.

Fig. 2 is a plan view of a connecting member of the refrigerator according to the first exemplary embodiment of the invention.

Fig. 3 is a characteristic diagram showing effect of vibration reduction of the connecting member of the refrigerator according to the first exemplary embodiment of the invention.

Fig. 4 is an exploded rear perspective view of a refrigerator according to second exemplary embodiment of the invention.

Fig. 5 is an exploded rear perspective view of a refrigerator according to a first example provided to better understand the invention.

Fig. 6 is a detailed perspective view of a condenser of the refrigerator according to the first example provided to better understand the invention.

Fig. 7 is a cross-sectional view taken along a line 7 - 7 of Fig. 6.

Fig. 8 is an exploded rear perspective view of a refrigerator according to fourth exemplary embodiment of the invention.

Fig. 9 is a rear perspective view showing a lower machinery compartment of a conventional refrigerator.

Fig. 10 is an exploded perspective view showing a condenser and surrounding area of the conventional refrigerator.

Fig. 11 is a vertically sectioned view of a lower machinery compartment in another conventional refrigerator.

Fig. 12 is a horizontally sectioned view of the lower machinery compartment in the conventional refrigerator.

DESCRIPTION OF EMBODIMENTS

[0039] Description will be provided hereinafter of exemplary embodiments of the present invention by referring to the accompanying drawings. Note that the following embodiments should not be construed as limiting the scope of the present invention.

FIRST EXEMPLARY EMBODIMENT

[0040] Fig. 1 is a rear perspective view of a refrigerator according to the first exemplary embodiment of this invention, and Fig. 2 is a plan view of a connecting member of the refrigerator according to the first exemplary embodiment of the invention.

[0041] In Fig. 1, refrigerator 1 has cabinet 2, upper machinery compartment 3 provided in an upper section of cabinet 2, condenser 4, air blower 5 and compressor 6. Condenser 4, air blower 5 and compressor 6 are disposed in this order from the windward side within upper machinery compartment 3, and that condenser 4 and compressor 6 are air-cooled with air 7 in an upper area of refrigerator 1 suctioned by operating air blower 5. Air blower 5 is mounted to fixing member 8, and fixing member 8 divides an airflow path in upper machinery compartment 3 into a windward side space and a downwind side space of air blower 5.

[0042] Here, condenser 4 is made from a spiral finned-tube having strip fin 4b wound around refrigerant tube 4a, and it is formed by spirally winding refrigerant tube

4a into an elliptic shape. A height of condenser 4 can be set equivalent to that of compressor 6 by making the center of the spiral into a serpentine-form with respect to a shaft of air blower 5. In this way, it becomes possible to install condenser 4 in parallel with compressor 6 within upper machinery compartment 3 prepared for compressor 6, without providing an additional machinery compartment exclusively for condenser 4.

[0043] Condenser 4 is also provided with inlet port 4c located in the uppermost stream of refrigerant tube 4a and outlet port 4d located in the downstream of refrigerant tube 4a. Inlet port 4c and outlet port 4d are linked together by connecting member 9 made of rubber. In this case, a distance between inlet port 4c and outlet port 4d is designed to become 7 to 15 times the diameter of refrigerant tube 4a by adjusting a bending dimension of refrigerant tube 4a.

[0044] Condenser 4 is secured to screw mounting boss 12 provided on an inner wall of the machinery compartment by using a screw and metal clamper 10 attached to a portion of refrigerant tube 4a between connecting member 9 and fin 4b, and fixed in a state of being suspended. Clamper 10 is secured to refrigerant tube 4a through rubber cushion 11 wrapped around refrigerant tube 4a in a manner to tighten rubber cushion 11 with a screw.

[0045] Clamper 10 may be formed of a resin. When this is the case, clamper 10 may be provided with flexibility in itself, or a vibration-proofing structure may be added between clamper 10 and an inner wall of the machinery compartment since refrigerant tube 4a is not liable to get damaged by clamper 10. Since this makes rubber cushion 11 unnecessary, it can further reduce a number of component parts and make it a simple design. The means to fix clamper 10 to the inner wall of upper machinery compartment 3 is not limited to the screw. The structure may be altered so that clamper 10 can be fixed by single step, such as providing a hole to insert boss 12 on the inner wall of upper machinery compartment 3, or a tab to be inserted in a slit formed in the inner wall of upper machinery compartment 3. Any such structure can reduce assembling variations and prevent condenser 4 from hitting against surrounding objects since a rotatable element like the screw is eliminated, in addition to the advantage of reducing man-hours for mounting.

[0046] Connecting member 9 comprises two tube holders 9a for holding refrigerant tube 4a, and connecting section 9b having two tube holders 9a at both ends, as shown in Fig. 2. Each of tube holders 9a has hole 9c for holding refrigerant tube 4a, and slit 9d for slide-fitting refrigerant tube 4a into hole 9c. Here, slit 9d is so formed that an angle θ formed between slit 9d and a longitudinal direction of connecting section 9b becomes an acute angle (i.e., θ <90°, and preferably θ<80°). In addition, hole 9c is designed to have an inner diameter smaller than an outer diameter of refrigerant tube 4a so that refrigerant tube 4a is held fitted with pressure. Furthermore, corner edges 9e of slit 9d are rounded or chamfered.

[0047] A material used for connecting member 9 is any of ethylene propylene rubber, silicone rubber, chlorination butyl rubber and the like having an excellent thermal resistance and hardness of 40 to 90 degrees, and more preferably between 50 to 70 degrees.

[0048] The refrigerator constructed as above according to the first embodiment of this invention operates in a manner which is described hereinafter.

[0049] When compressor 6 is operated, the refrigerant in the refrigeration cycle is compressed, and it is introduced into condenser 4 from inlet port 4c by passing through refrigerant discharge tube 13 connected with a discharge port of compressor 6. After the heat is dissipated in condenser 4, the refrigerant flows out from outlet port 4d and into internal refrigerant tube 14 disposed at inside of an outer wall of the refrigerator. At this time, refrigerant discharge tube 13 and condenser 4 vibrate due to operational vibration of compressor 6 and pulsation in pressure of the discharged refrigerant, and they become a cause of generating noises due to these components coming into contact with surrounding parts, causing fatigue in bent sections and welded sections of the tubing, or impairing the quality.

[0050] In the refrigerator according to this embodiment, vibration of condenser 4 can be suppressed since inlet port 4c and outlet port 4d of the condenser are linked by connecting member 9 made of rubber and the vibration is absorbed by connecting member 9. Fig. 3 shows amplitudes of vibration of outlet port 4d with and without connecting member 9 attached. It becomes possible to suppress the maximum amplitude of condenser 4 and keep the amplitude smaller for all the usable frequencies by mounting connecting member 9, as shown in Fig. 3. Since the distance between inlet port 4c and outlet port 4d is as large as 7 to 15 times the diameter of refrigerant tube 4a, it inevitably increases the size as well as the weight of connecting member 9. It can hence provide an effect equivalent to what is given when a large rubber cushion is used.

[0051] Assume that refrigerant tube 4a has 5mm in diameter, and a distance of 50mm between inlet port 4c and outlet port 4d, for instance. In this case, a rubber cushion of 15mm in width by 8mm in thickness is needed for each of inlet port 4c and outlet port 4d to obtain, for example, a weight equivalent to connecting member 9 of 10mm in width by 5mm in thickness. It is therefore safe to state that the connecting member in this embodiment can achieve a high quality product of which vibration is suppressed with a low cost with an advantage of space saving.

[0052] In addition, condenser 4 has an effect of attenuating the vibration since it is formed of refrigerant tube 4a, spirally wound into the elliptic shape to have a spring-like property. Because the amplitude of vibration of outlet port 4d is inherently small, it is appropriate to state that the vibration of inlet port 4c can be absorbed more effectively by linking outlet port 4d with inlet port 4c. Clamper 10 is attached via rubber cushion 11 to the portion of inlet

port 4c where the vibration is suppressed by connecting member 9, as described above. This means that condenser 4 is provided with a double vibration-proof structure before it is secured to the inner wall of upper machinery compartment 3. This suppresses the vibration transmitted from condenser 4 to cabinet 2, and it can therefore reduce the possibility of causing vibration of cabinet 2, vibration of refrigerator door (not shown), and food hitting against each other inside the storage compartment due to these vibrations. It is by virtue of this structure that limits the securing point of condenser 4 only to clamper 10, to minimize the path for transmitting the vibration, reduce the number of assembling man-hours, and thereby provide the product of high quality with a low cost.

[0053] Connecting member 9 has a high Young's modulus of elasticity because it uses a comparatively hard material of 40 to 90 degrees in hardness, and more preferably between 50 to 70 degrees. It thus ensures a high holding strength of tube holder 9a. Large shocks and impacts attributed to loading, unloading and transportation by a ship and/or a track will be applied to condenser 4 during delivery to a refrigerator factory and to the refrigerator before reaching a user. For this reason, it is imperative for connecting member 9 not to disengage from condenser 4 when it is subjected to a force at least equal to a weight of condenser 4.

[0054] Although a holding strength can be increased by changing a dimension of thickness or width of the tube holder, it results in an increase in size in order to increase the holding strength. Therefore, a space-saving structure can be achieved when the necessary holding strength is obtained by means of hardness. Since the hardness of rubber is dependent upon formulation of additives, the cost of materials does not rise by increasing the hardness. Although there has been apprehension about degradation in vibration damping property due to the increase of hardness, it has later been confirmed that there is very little influence upon the effect of reducing vibration by the hardness up to 90 degrees, according to the experiment by the inventors (refer to Fig. 3).

[0055] Additionally, slits 9d are provided in such a shape that an angle θ formed between each of slits 9d and a longitudinal direction of connecting section 9b becomes an acute angle (i.e., $\theta<90°$, and preferably $\theta<80°$). It is for this shape which can prevent the holding strength of refrigerant tube 4a from becoming weaker and connecting member 9 from coming out of condenser 4, even if tube holders 9a are forced to turn and slits 9d shifted outward while a tensile stress is exerted on connecting member 9. On the other hand, there is not any concern about such disengagement while a compressive stress is exerted on connecting member 9 since tube holders 9a are turned into a direction of gripping refrigerant tube 4a. In this case, refrigerant tube 4a is kept in a press-fitted condition, since an inner diameter of holes 9c is designed to be smaller than an outer diameter of refrigerant tube 4a. Therefore, the holding strength can be increased since the compressive stress of tube holders 9a is added to the holding strength, and a frictional force against refrigerant tube 4a also increases at the same time. Because this helps suppress turning of tube holders 9a, it can further reduce the risk of disengagement when a tensile stress is exerted on connecting member 9.

[0056] Condenser 4 has a spring-like property in itself due to its shape and a large dimensional variation especially in a right-to-left direction, so that it effects a force in a direction of widening between inlet port 4c and outlet port 4d (i.e., an expanding direction of refrigerant tube 4a) even after the process of forming. Connecting member 9 suppresses it, and prevents the refrigerant tube from coming into contact with the surrounding parts (e.g., a sidewall of the machinery compartment, in this embodiment). An elongation of connecting member 9 in the longitudinal direction can be divided broadly into two parts, i.e., an elongation of tube holders 9a due to turning, expanding and simple stretching, and an elongation of connecting section 9b due to simple stretching. As stated above, it is very effective to increase the holding strength of the tube in order to control accurately the dimension between inlet port 4c and outlet port 4d, since the latter is about 1/10 of the former in rough estimation though it depends on the shape of the connecting member.

[0057] It is also possible to shift connecting section 9b toward an upper side of connecting member 9 along a direction tangential to tube holders 9a, instead of providing it along a straight line connecting the centers of tube holders 9a as is shown in this embodiment. Since this configuration shortens outer portions of tube holders 9a subject to turning when a tensile stress is exerted on connecting member 9, it can reduce a turning angle of tube holders 9a, and even further reduce an extent of decrease in the holding strength attributed to the tensile stress.

[0058] Moreover, corner edges 9e of slits 9d are rounded or chamfered. Since they help ease insertion of refrigerant tube 4a, they can reduce a number of assembling man-hours, and hence the cost of the product. On the other hand, corner edges inside of holes 9c, when not rounded, have practically no effect on the risk of connecting member 9 to come off.

[0059] As described above, condenser 4 in this embodiment is so configured that refrigerant tube 4a is spirally wound into an elliptic shape, and the center of the spiral winding is serpentine-formed along the direction perpendicular to the principal axis of air blower 5. Since inlet portion 4c and outlet portion 4d of the refrigerant tube are linked with connecting member 9 made of a rubber, connecting member 9 can play a role of rubber vibration isolator to absorb vibration of condenser 4, and suppress the vibration of condenser 4. In addition, connecting member 9 helps reduce a number of component parts since it also plays a role of setting relative positions of inlet port 4c and outlet port 4d, and makes additional positioning part unnecessary. Moreover, connecting member 9 can reduce a number of assembling man-

hours since it secures the necessary holding strength without using other ancillary parts such as screws for mounting, and also additional man-hours for mounting because installation to the refrigerator's main body can be made independently of the connecting member.

[0060] There is clamper 10 provided to secure refrigerant tube 4a at the upstream of fin 4b through rubber cushion 11 and fix refrigerant tube 4a to the inner wall of the machinery compartment in a state of being suspended. In addition, the holding portion of connecting member 9 holding inlet port 4c is disposed at the upstream side of clamper 10. This helps suppress transmission of vibration to the refrigerator's main body since the vibration of inlet port 4c of which amplitude is largest in condenser 4 is absorbed by connecting member 9 at the upstream side of the point where condenser 4 is secured to the refrigerator's main body. Connecting member 9 can exhibit a higher effect of vibration absorption than any of conventional rubber cushions configured to be attached to only one place of the tube, since connecting member 9 is also linked to outlet port 4d of which vibration amplitude is smallest so that it exerts a suppressive force.

[0061] Because connecting member 9 made of a rubber of 40 to 90 degrees in hardness can provide a high holding strength, it eliminates any concern about disengagement from refrigerant tube 4a even under large shocks and impacts during transportation of condenser 4 and refrigerator 1. It therefore makes other parts unnecessary to fix connecting member 9 to refrigerant tube 4a, and reduces a number of component parts as well as man-hours for assembling. In addition, the rubber of 40 to 90 degrees in the hardness has adequate viscoelasticity necessary to absorb vibration such that it does not interfere with the effect of suppressing vibration during operation of the refrigerator.

[0062] Since connecting member 9 has a length 7 to 15 times the diameter of refrigerant tube 4a, it can secure a sufficient weight to absorb the vibration without reducing the thickness or increasing the width of connecting member 9. It can hence make full use of the effect of downsizing the component.

[0063] Tube holders 9a of connecting member 9 are provided with slits 9d for use to attach to refrigerant tube 4a, and slits 9d point toward the inner side of condenser 4. In addition, holes 9c in tube holders 9a are formed to have an inner diameter smaller than an outer diameter of refrigerant tube 4a. This configuration can ensure the necessary holding strength even when slits 9d are forced to turn toward the outer side of condenser 4a due to a tensile stress exerted on connecting member 9. Holes 9c formed to have the inner diameter smaller than the outer diameter of refrigerant tube 4a keep refrigerant tube 4a fitted with pressure, and thereby improving the holding strength.

SECOND EXEMPLARY EMBODIMENT

[0064] Fig. 4 is an exploded rear perspective view of a refrigerator according to the second exemplary embodiment of this invention.

[0065] Description will be omitted for certain structural features and technological concepts to which those similar to the first exemplary embodiment apply. It is also possible that the present exemplary embodiment is practiced in combination with the structures of the first embodiment where applicable so long as such a combination does not pose any discrepancy.

[0066] In Fig. 4, refrigerator 21 comprises cabinet 22 of refrigerator 21, lower machinery compartment 23 provided in a lower section of cabinet 22. Lower machinery compartment 23 includes condenser 4, air blower 5 and compressor 6 disposed in this order from the windward side, and that condenser 4 and compressor 6 are air-cooled with air 7 in an upper area of the refrigerator suctioned by operating air blower 5.

[0067] Air blower 5 is mounted to fixing member 8, and fixing member 8 divides an airflow path inside lower machinery compartment 23 into windward side space 23a and downwind side space 23b of air blower 5.

[0068] Base plate 30 that constitutes a bottom surface of lower machinery compartment 23 is robustly joined at both right and left sides to cabinet 22 with screws or the like means. There is space 31 provided between one side facing the front of the refrigerator and cabinet 22, except that a part of space 31 in the downwind side is closed with air-sealing material 32 such as a tape to block air from passing therethrough.

[0069] Machinery compartment cover 33 that closes lower machinery compartment 23 has intake openings 33a and discharge openings 33b to introduce air 7 into lower machinery compartment 23. Intake openings 33a and discharge openings 33b may also be provided in an upper rear side of a cabinet casing (not shown) that forms a side-face section of an upper machinery compartment (not shown) rather than only in machinery compartment cover 33.

[0070] Here, condenser 4 is made from a spiral finned-tube having strip fin 4b wound around refrigerant tube 4a, and it is formed by spirally winding refrigerant tube 4a into an elliptic shape. A height of condenser 4 can be set equivalent to compressor 6 by making the center of the spiral into a serpentine-form with respect to a shaft of air blower 5. In this way, it becomes possible to install condenser 4 in parallel with compressor 6 within lower machinery compartment 23 prepared for compressor 6, without providing an additional machinery compartment exclusively for condenser 4.

[0071] An inlet portion and an outlet portion of condenser 4 are linked together by connecting member 9. In addition, condenser 4 is secured to screw mounting boss (not shown) provided on an inner wall of the machinery compartment by using a screw and metal clamper 10 attached to a portion of refrigerant tube 4a from connecting member 9 to fin 4b, and fixed in a state of being suspended. Clamper 10 is secured to refrigerant tube 4a through rubber cushion 11 wrapped around re-

frigerant tube 4a in a manner to tighten rubber cushion 11 with a screw.

[0072] The refrigerator constructed as above according to the second embodiment of this invention operates in a manner which is described hereinafter.

[0073] Air blower 5 is driven in ganged motion with operation of compressor 6. This operation of air blower 5 produces a negative pressure in windward side space 23a equipped with condenser 4 and separated by fixing member 8, and suctions the outside air. It also produces a positive pressure in downwind side space 23b equipped with compressor 6, and air inside lower machinery compartment 23 is discharged to the outside through discharge openings 33b. At this same time, air 7 is introduced not only from intake openings 33a but also from space 31. Since condenser 4 in this embodiment is suspended in the air, the heat can be dissipated more effectively by introducing air 17 from space 31. Furthermore, there is only one air-discharge area located in the rear side of lower machinery compartment 23 whereas there are two separate air-intake areas in both the front and the rear sides, which creates a difference in amounts of air 7 that passes through intake openings 33a and discharge openings 33b. As a result, the air discharged from discharge openings 33b can be prevented from being taken as it is, or shortcutting into intake openings 33a. The shortcutting, if occurs, leads to a reduction in the efficiency of heat dissipation at the same time with a degradation in the reliability of air blower 5 and compressor 6, because the air inside of the machinery compartment becomes too hot. It is therefore safe to state that the present exemplary embodiment has a structure that facilitates suctioning fresh air to suppress temperature rise in the machinery compartment, thereby providing a highly reliable product.

[0074] As described above, the present embodiment has lower machinery compartment 23 located in the rear side of the refrigerator, and lower machinery compartment 23 includes condenser 4 of spiral finned-tube type suspended from a sidewall of the machinery compartment. This structure is configured to introduce air 7 from intake openings 33a formed in base plate 30 that constitutes the bottom surface of the machinery compartment and machinery compartment cover 33, and to discharge air 7 from discharge openings 33b formed in machinery compartment cover 33. It is by virtue of this structure to guide the flow of air 7 smoothly around condenser 4, and prevent air 7 from shortcutting, thereby improving the efficiency of heat dissipation of the condenser and increasing the energy efficiency.

EXAMPLE TO BETTER UNDERSTAND THE INVENTION

[0075] Fig. 5 is an exploded perspective view of a refrigerator according to a first example to better understand the present invention, Fig. 6 is a detailed view of a condenser of the refrigerator, and Fig. 7 is a cross-sectional view taken along a line 7 - 7 of Fig. 6.

[0076] In Fig. 5 to Fig. 7, refrigerator 51 comprises cabinet 52, lower machinery compartment 53 provided in a lower section of cabinet 52, condenser 54, air blower 55, and compressor 56. Lower machinery compartment 53 includes condenser 54, air blower 55 and compressor 56 disposed in this order from the windward side. Condenser 54 and compressor 56 are air-cooled with air 57 in an upper area of the refrigerator suctioned by operating air blower 55. Air blower 55 is mounted to fixing member 58, and fixing member 58 divides an airflow path inside lower machinery compartment 53 into windward side space 53a and downwind side space 53b of air blower 55. Machinery compartment bottom surface 59 configured of a base plate of lower machinery compartment 53 may be formed integrally as a part of cabinet 52. Reference mark 60 denotes a machinery compartment cover that closes lower machinery compartment 53, and it has intake openings 61 and discharge openings 62 to introduce air 57 into lower machinery compartment 53. Intake openings 61 and discharge openings 62 may also be provided in any of a lower rear part of a side surface of cabinet 52 that forms a side-face section of lower machinery compartment 53, machinery compartment bottom surface 59, and an area between cabinet 52 and machinery compartment bottom surface 59, instead of only in machinery compartment cover 60.

[0077] Here, condenser 54 is made from a spiral finned-tube having strip fin 64 wound around refrigerant tube 63, and it is formed by spirally winding refrigerant tube 63 into an elliptic shape. A height of condenser 54 can be set equivalent to that of compressor 56 by making the center of the spiral into a serpentine-form with respect to a shaft of air blower 55. In this way, it becomes possible to dispose condenser 54 in parallel with compressor 56 within lower machinery compartment 53 prepared for compressor 56. Condenser 54 is designed to have such a structure that refrigerant tube 63 forms downwind-side spiral face 65a in the downwind side and windward-side spiral face 65b in the windward side, wherein downwind-side spiral angle θa designated as an angle formed between downwind-side spiral face 65a and machinery compartment bottom surface 59 and windward-side spiral angle θb designated as an angle formed between windward-side spiral face 65b and machinery compartment bottom surface 59 have a relation of $\theta a < \theta b$. This structure can accommodate condenser 54 snugly in a limited space of the machinery compartment since the size of condenser 54 can be reduced in the width direction (i.e., axial direction of air blower 55).

[0078] Reference mark 54a denotes an inlet port of condenser 54, and it is provided in the downwind side of condenser 54. Reference mark 66 denotes an upstream refrigerant tube communicating between compressor 56 and condenser 54 such that the refrigerant of high temperature and high pressure compressed by compressor 56 flows from the downwind side through upstream refrigerant tube 66 into condenser 54, and the heat dissi-

pated.

[0079] The refrigerator constructed as above according to the third embodiment of this invention operates in a manner which is described hereinafter.

[0080] Air blower 55 is driven in ganged motion with operation of compressor 56. This operation of air blower 55 produces a negative pressure in windward side space 53a equipped with condenser 54 and separated by fixing member 58, and suctions the outside air, while it produces a positive pressure in downwind side space 53b equipped with compressor 56, and discharges the air inside lower machinery compartment 53 to the outside through discharge openings 62.

[0081] In this case, intake openings 61 can introduce air 57 uniformly throughout a front face of the machinery compartment since these ports have a height equivalent to a height of the machinery compartment. Condenser 54 can be constructed to have a small dimension in a direction of its width (i.e., axial direction of air blower 55) by forming the spiral shape into a large angle in the downwind side. Since this structure decreases a distance for air 57 to pass through the condenser and decreases an air resistance, it can secure a large volume of airflow in lower machinery compartment 53, increase an amount of heat dissipation, and improve energy efficiency. In addition, all of introduced air 57 can be used to air-cool compressor 56, since compressor 56 is disposed in series with condenser 54 and air blower 55. It can thus improve reliability of compressor 56 while also increasing the heat dissipating capability of condenser 54 and decreasing the condensing temperature to achieve energy conservation at the same time. When a small axial-flow fan is used as air blower 55, it exhibits such a characteristic that the air flows in a manner to gather and bundle toward the periphery of the fan shaft in windward side space 53a, and the air flows in a manner to spread out radially from the fan in downwind side space 53b. It is therefore considered a good arrangement to dispose condenser 54 within windward side space 53a where flow of air 57 through the interior of condenser 54 is desired, and to dispose compressor 56
within downwind side space 53b where flow of air 57 around the exterior of compressor 56 is desired, in terms of high efficiency with an air resistance suppressed to the greatest extent possible.

[0082] Since this structure can secure a large area of intake openings 61, it can reduce clogging attributed to accumulation of dust even after an extended period of use in user's home. In condenser 54, downwind-side spiral angle θa and windward-side spiral angle θb are designed to satisfy the relation of $\theta a < \theta b$. This structure helps increase a distance between adjoining refrigerant tubes 63 such that tubes of condenser 54 at the upwind side are sparse (i.e., airflow passage between fins 64 is large, and volume occupied by condenser 54 is small), and it can hence reduce clogging attributed to accumulation of dust. Since such a sparse condition can be formed by configuration of refrigerant tube 63, there is no need to change fin pitches like the one shown in Patent Literature 2. Accordingly, a compact and high performance condenser can be obtained at a low cost while ensuring the required amount of heat dissipation with a short refrigerant tube, since clogging by dust can be avoided without reducing an amount of heat dissipation per unit length of refrigerant tube 63.

[0083] In addition, inlet port 54a of condenser 54 is disposed in the downwind side where accumulation of dust is not likely. The refrigerant of high temperature and high pressure compressed by operation of compressor 56 is introduced into condenser 54 from inlet port 54a after passing through upstream refrigerant tube 66 into condenser 54. Therefore, the efficiency of heat dissipation is considered to be high because the refrigerant that flows in the downwind side is higher than that in the windward side. Since the downwind side of high heat-dissipating efficiency is less prone to dust accumulation, it can reduce degradation of the performance for an extended period of use.

[0084] Because condenser 54 is disposed at the windward side of air blower 55 and compressor 56, condenser 54 helps reduce accumulation of dust on air blower 55 and compressor 56. When dust accumulates on air blower 55 and compressor 56, their operating temperatures rise considerably, thereby posing the possibility of degrading the long-term reliability since they are mechanical components equipped with movable parts. On the other hand, the condenser can be regarded as not suffering a substantial decrease in the reliability with a low risk of posing unsafe condition even with accumulation of dust because it is a structural component not having any movable part.

[0085] According to the present exemplary embodiment, condenser 54 is so configured that a refrigerant tube is spirally wound into an elliptic shape, and the center of the spiral winding is serpentine-formed along a direction perpendicular to the principal axis of the air blower, as described above. This configuration can make a height and a depth of condenser 54 to match with the size of the compressor, so that condenser 54 can be disposed in the same machinery compartment with the compressor. The angle formed between spirally wound spiral face 65 and machinery compartment bottom surface 59 is set larger at the windward side than at the downwind side to reduce the size in the width direction, so that condenser 54 can be accommodated snugly in the limited space. In addition, the above configuration decreases the distance for air 57 to pass through the condenser and reduces the air resistance, it can increase the volume of airflow and improve energy efficiency. This configuration also allows intake openings 61 to have a height equal to that of lower machinery compartment 53, and reduce a density of refrigerant tube 63 in the windward side of condenser 54, it can suppress clogging attributed to accumulation of dust, and hence ensure performance of the condenser for a long time.

[0086] Because compressor 56 and condenser 54 are

arranged in series by disposing air blower 55 to the downwind side of condenser 54, and compressor 56 to the downwind side of air blower 55, all of introduced air 57 can be used
to air-cool compressor 56. It can hence achieve energy conservation by increasing the heat dissipating capability of condenser 54 and lowering the condensing temperature, while also improving the reliability of compressor 56 at the same time. Since it reduces accumulation of dust on air blower 55 and compressor 56, it can suppress temperature rises of air blower 55 and compressor 56, and improve their reliability.

[0087] In the case of a refrigerator configured to flow refrigerant from the refrigerant tube in the downwind side of condenser 54 to the refrigerant tube in the windward side, accumulation of dust can be reduced on fins 64 of the upstream side carrying the refrigerant of higher temperature, thereby suppressing decrease in the performance for an extended period of use.

FOURTH EXEMPLARY EMBODIMENT

[0088] Fig. 8 is an exploded perspective view of a refrigerator according to the fourth exemplary embodiment of this invention.

[0089] Description will be omitted for certain structural features and technological concepts to which those similar to the third exemplary embodiment apply. It is also appreciated that the present exemplary embodiment may be practiced in combination with the structures of the third embodiment where applicable so long as such a combination does not pose any discrepancy.

[0090] In Fig. 8, refrigerator 71 comprises cabinet 72, and upper machinery compartment 73 provided in an upper section of cabinet 72. Upper machinery compartment 73 includes condenser 54, air blower 55 and compressor 56 disposed in this order from the windward side. Condenser 54 and compressor 56 are air-cooled with air 57 in an upper area of the refrigerator suctioned by operating air blower 55. Air blower 55 is mounted to fixing member 58, which divides an airflow path inside upper machinery compartment 73 into windward side space 73a and downwind side space 73b
of air blower 55. Upper machinery compartment 73 is provided with machinery-compartment bottom surface 79 formed of an insulation wall that separates upper machinery compartment 73 from a refrigerator compartment (not shown).

[0091] Upper machinery compartment 73 is covered with machinery compartment cover 80 having intake openings 81 and discharge openings 82 to introduce air 57 into upper machinery compartment 73.

[0092] Intake openings 81 and discharge openings 82 may also be provided in an upper rear part of a side surface of cabinet 72 that forms a side-face section of upper machinery compartment 73, rather than only in machinery compartment cover 80. At least a part of discharge openings 82 is formed in a top surface of the refrigerator.

[0093] The refrigerator constructed as above according to the fourth embodiment of this invention operates in a manner which is described hereinafter.

[0094] Air blower 55 is driven in ganged motion with operation of compressor 56. This operation of air blower 55 produces a negative pressure in windward side space 73a equipped with condenser 54 and separated by fixing member 58, and suctions the outside air. It also produces a positive pressure in downwind side space 73b equipped with compressor 56, and the air inside upper machinery compartment 73 is discharged to the outside through discharge openings 82.

[0095] At this same time, air 57 warmed by condenser 54 and compressor 56 is discharged smoothly from those discharge openings 82 opened in the top surface of the refrigerator because the warmed air 57 is less dense than the outside air. Refrigerators are generally installed in given spaces prepared in kitchen corners, where rear and side surfaces are often located closely to kitchen walls, furniture such as cupboards, sink cabinets, and the like.

[0096] On the other hand, a largest space available is between the top surface and kitchen ceiling among the spaces surrounding the refrigerator in most cases, because the height of the top surface is designed within reaches of users in the light of convenience. It is thus considered that air can be discharged smoothly from the top surface regardless of the installation environment. It is therefore safe to state that use of the top surface as the primary path to discharge air is adequate means to ensure the heat dissipating efficiency of condenser 54.

[0097] In a case where refrigerator 71 has a second machinery compartment (not shown) equipped with a second air blower (not shown) in a lower section of cabinet 72, air warmed in the second machinery compartment is blown up by the second air blower. Since the air is drawn into upper machinery compartment 73 from intake openings 81, it can increase a volume of the air that flows in upper machinery compartment 73 and hence an amount of the heat dissipation of condenser 54.

[0098] As described above, the refrigerator according to this embodiment is provided with upper machinery compartment 73 in the upper rear section of the refrigerator, and upper machinery compartment 73 has intake openings 81 for introducing air into upper machinery compartment 73, and discharge openings 82 for discharging the air. At least a part of discharge openings 82 is formed in the top surface of the refrigerator, from where the air in upper machinery compartment 73 can be discharged smoothly, thereby increasing the heat dissipating efficiency of the condenser as well as the energy efficiency.

[0099] As described previously, the refrigerator of the present invention has a machinery compartment in a back-face side thereof, and the machinery compartment includes a spiral finned-tube condenser, an air blower serving as a primary driving source of a ventilation circuit, and a compressor for circulating a refrigerant through a

refrigeration system to cool the refrigerator. The condenser is so configured that a refrigerant tube is spirally wound into an elliptic shape with the center of the spiral winding serpentine-formed along a direction perpendicular to the principal axis of the air blower. Furthermore, portions of the refrigerant tube at an inlet port and an outlet port of the refrigerant are linked with a connecting member made of rubber.

[0100] Since the connecting member plays a role of rubber vibration isolator to absorb vibration of the condenser, it can suppress the vibration of the condenser. In addition, the connecting member helps reduce a number of component parts since it also plays a role of securing relative positions of the inlet port and the outlet port, and makes additional positioning part unnecessary. Moreover, the connecting member can reduce a number of assembling man-hours since other ancillary parts such as screws need not be used to mount the connecting member, and a number of mounting man-hours is also reducible because installation to the refrigerator's main body can be made independently of the connecting member.

[0101] The present invention also includes a clamper provided to secure the refrigerant tube at a position upstream of a heat dissipation fin in the flow of refrigerant, through a rubber cushion placed under the clamper, and fix the refrigerant tube to an inner wall of the machinery compartment in a state of being suspended. In addition, a holding portion of the connecting member at the inlet port side is disposed at the upstream side of the clamper.

[0102] This helps suppress transmission of vibration to the refrigerator's main body since the vibration in the vicinity of the inlet port of which amplitude is largest in the condenser is absorbed by the connecting member at the upstream side of the point where the condenser is secured to the refrigerator's main body. The connecting member can exhibit a higher effect of vibration absorption than any of conventional rubber cushions configured to be attached to only one place of the tube, since the connecting member is also linked to the outlet port of which vibration amplitude is smallest such that it exerts a suppressive force.

[0103] The present invention is also characterized by having the connecting member of which rubber is 40 to 90 degrees in hardness.

[0104] It can provide a high holding strength to avoid any concern about disengagement from the refrigerant tube even under large shocks and impacts during transportation of individual piece of the condenser as well as the refrigerator. It therefore makes other parts unnecessary to fix the connecting member to the refrigerant tube, and reduces a number of component parts and assembling man-hours. In addition, the rubber of the hardness between 40 to 90 degrees has adequate viscoelasticity necessary to absorb vibration such that it does not interfere with the effect of suppressing vibration during operation of the refrigerator.

[0105] In the present invention, the connecting member is formed to have a length 7 to 10 times the diameter of the refrigerant tube.

[0106] This can provide the connecting member with a sufficient weight to absorb the vibration even if a thickness of the connecting member is reduced, and it can hence make full use of the advantage of downsized components.

[0107] Moreover, the present invention is characterized by having a slit in each of refrigerant tube holders of the connecting member for fitting the refrigerant tube, wherein the slits are formed to point toward the inner side of the condenser, and holes in the tube holders have an inner diameter smaller than an outer diameter of the refrigerant tube. This structure can ensure the necessary holding strength even when the slits are forced to become widened toward the outer side of the condenser due to a tensile stress exerted on the connecting member.

[0108] Furthermore, the holes are formed to have the inner diameter smaller than the outer diameter of the refrigerant tube so that they can hold the refrigerant tube fitted in them with pressure, and thereby improving the holding strength in addition to further preventing the slits from widening outward.

[0109] Another refrigerator of the present invention has a machinery compartment in a rear-face side thereof, and the machinery compartment includes a spiral finned-tube condenser, an air blower serving as a primary driving source of a ventilation circuit, and a compressor for circulating a refrigerant through a refrigeration system to cool the refrigerator. The condenser is so configured that a refrigerant tube is wound into a spiral shape, and the center of the spiral shape is serpentine-formed along a direction perpendicular to a principal axis of the air blower. In addition, an angle formed between a spiral plane of the spiral shape and a bottom surface of the machinery compartment is set larger at the windward side than the downwind side.

[0110] Since this structure allows downsizing of the condenser in both depth direction and width direction, it becomes possible to dispose the condenser in the same machinery compartment with the compressor. In addition, the reduction of the size in the width direction can also decrease a flow-path resistance since it reduces a distance for the air to pass through the condenser. Furthermore, this structure can reduce a density of the refrigerant tube in the windward side of the condenser in addition to providing an intake opening of an equal height to a height of the machinery compartment, which can reduce clogging due to accumulation of dust, and ensure performance of the condenser for an extended period of time.

[0111] In the present invention, the air blower is disposed at the downwind side of the condenser, and the compressor is disposed at further the downwind side of the air blower.

[0112] Since this structure can increase the heat dissipating capability of the condenser, and reduce accumulation of dust on the air blower and the compressor,

it can suppress temperature rises of the air blower and the compressor, and improve their reliability. In addition, it can also improve the heat dissipating efficiency since it increases a volume of the airflow for cooling the compressor and the condenser by the arrangement of disposing the compressor and the condenser in series.

[0113] The present invention also discloses a refrigerator configured to flow refrigerant in the refrigerant tube of the condenser from the downwind side to the windward side along the airflow path of the air blower.

[0114] This configuration can reduce accumulation of dust on the fins of the upstream side that carries the refrigerant of higher temperature, thereby suppressing decrease in the performance for an extended period of use.

[0115] Furthermore, the present invention discloses a refrigerator provided with a machinery compartment in an upper rear section thereof, and the machinery compartment has an intake opening for introducing air into the machinery compartment, and a discharge opening for discharging the air, and that at least a part of the discharge opening is formed in a top surface of the refrigerator.

[0116] This structure enables the refrigerator to discharge waste heat of the condenser more efficiently to the outside of the refrigerator, and increase the heat dissipating efficiency of the condenser as well as the energy efficiency.

INDUSTRIAL APPLICABILITY

[0117] As mentioned above, since the refrigerator according to the present invention suppresses vibration of a condenser with components of low cost and space-saving features, it can provide the refrigerator of high quality, which is also applicable to any product having a refrigeration cycle employing a compressor, such as vending machine.

[0118] The refrigerator of the present invention comprises a condenser of high heat dissipating capability without requiring a machinery compartment for exclusive use, and it can provide the refrigerator capable of securing the heat dissipating capability for an extended period, and therefore applicable to any product having a refrigeration cycle employing a compressor, such as vending machine.

REFERENCE MARKS IN THE DRAWINGS

[0119]

1	refrigerator
2	cabinet
3	upper machinery compartment
4	condenser
4a	refrigerant tube
4b	fin
4c	inlet port
4d	outlet port
5	air blower
6	compressor
7	air
8	fixing member
9	connecting member
9a	tube holder
9b	connecting section
9c	hole
9d	slit
9e	corner edge
10	clamper
11	rubber cushion
12	boss
13	refrigerant discharge tube
14	internal refrigerant tube
17	air
21	refrigerator
22	cabinet
23	lower machinery compartment
23a	windward side space
23b	downwind side space
30	base plate
31	space
32	air-sealing material
33	machinery compartment cover
33a	intake opening
33b	discharge opening
51	refrigerator
52	cabinet
53	lower machinery compartment
53a	windward side space
53b	downwind side space
54	condenser
54a	inlet port
55	air blower
56	compressor
57	air
58	fixing member
59	machinery-compartment bottom surface
60	machinery compartment cover
61	intake opening
62	discharge opening
63	refrigerant tube
64	fin
65a	downwind-side spiral face
65b	windward-side spiral face
66	upstream refrigerant tube
71	refrigerator
72	cabinet
73	upper machinery compartment
73a	windward side space
73b	downwind side space
79	machinery-compartment bottom surface
80	machinery compartment cover
81	intake opening
82	discharge opening
100	machinery compartment
101	compressor

102	condenser
102a	refrigerant tube
102b	wire
102c	inlet tube
102d	curved portion
103	cooling fan
104	fixing plate
104a	hanging aperture
104b	retaining rib
104c	fixing piece
104d	through hole
104e	fastening lug
104f	tube support
106	metal hook
106a	retaining section
107	metal support
108	angle reinforcing plate
110	lower machinery compartment
111	insulation wall
112	base plate
113	condenser
114	air blower
115	leg
116	refrigerant tube
117	fin
118	intake opening
119	intake opening
120	evaporating tray
121	immersion tube
122	compressor
123	discharge opening
124	partition wall
θa	downwind-side spiral angle
θb	windward-side spiral angle

Claims

1. A refrigerator (1) including a machinery compartment (3) on a rear-face side, the refrigerator (1) comprising in the machinery compartment:

   a spiral finned-tube condenser (4);
   an air blower (5) serving as a primary driving source of a ventilation circuit; and
   a compressor (6) configured to circulate a refrigerant in a refrigeration system for cooling the refrigerator (1), wherein the spiral finned-tube condenser (4) comprises a refrigerant tube (4a) and a fin (4b) wound around the refrigerant tube (4a), and
   wherein parts of the refrigerant tube (4a) at an inlet port (4c) and an outlet port (4d) of the refrigerant are linked with a connecting member (9)
   characterized in that the refrigerant tube (4a) is spirally wound into an elliptic shape to form spiral windings, wherein a center of the spiral windings is serpentine-formed along a direction perpendicular to a principal axis of the air blower (5), the connecting member (9) is made of rubber and the refrigerator (1) further comprises
   a clamper (10) for holding the refrigerant tube (4a) at an upstream side of the fin for heat dissipation in a flow direction of the refrigerant through a rubber cushion (11) placed under the clamper (10), and fixing the refrigerant tube (4a) to an inner wall of the machinery compartment (3) in a state of being suspended, and
   a tube holder (9a) of the connecting member (9) at an inlet-port side is disposed at an upstream side of the clamper (10) in the flow direction of the refrigerant.

2. The refrigerator (1) of claim 1, wherein the connecting member (9) has rubber hardness of 40 to 90 degrees.

3. The refrigerator (1) of claim 1, wherein the connecting member (9) has a length 7 to 15 times a diameter of the refrigerant tube of the condenser.

4. The refrigerator (1) according to any one of claims 1 - 3, wherein the connecting member (9) has the tube holder (9a) provided with a slit (9d) for attaching to the refrigerant tube (4a), the slit (9d) formed to point toward an inner side of the condenser (4), and an inner diameter of the refrigerant tube holder (9a) is smaller than an outer diameter of the refrigerant tube (4a).

Patentansprüche

1. Kühlschrank (1), enthaltend einen Maschinenbereich (3) auf einer Rückflächenseite, wobei der Kühlschrank (1) im Maschinenbereich umfasst:

   einen Spiral-Lamellenrohr-Kondensator (4);
   ein Luftgebläse (5), das als primäre Antriebsquelle eines Lüftungskreises dient; und
   einen Kompressor (6), ausgelegt, ein Kältemittel in einem Kältesystem zum Kühlen des Kühlschranks (1) umlaufen zu lassen, wobei der Spiral-Lamellenrohr-Kondensator (4) ein Kältemittelrohr (4a) und eine um das Kältemittelrohr (4a) gewickelte Lamelle (4b) umfasst, und
   wobei Teile des Kältemittelrohrs (4a) an einer Einlassöffnung (4c) und einer Auslassöffnung (4d) des Kältemittels mit einem Verbindungselement (9) verbunden sind,
   dadurch gekennzeichnet, dass das Kältemittelrohr (4a) spiralförmig zu einer elliptischen Form gewickelt ist, um Spiralwindungen zu bilden, wobei eine Mitte der Spiralwindungen entlang einer Richtung senkrecht zu einer Haupt-

achse des Luftgebläses (5) serpentinengeformt ist, das Verbindungselement (9) aus Gummi besteht und der Kühlschrank (1) weiter umfasst:

eine Schelle (10) zum Halten des Kältemittelrohrs (4a) an einer Stromaufwärtsseite der Lamelle zur Wärmeabgabe in einer Strömungsrichtung des Kältemittels durch ein unter die Schelle (10) gelegtes Gummikissen (11), und zum Befestigen des Kältemittelrohrs (4a) an einer Innenwand des Maschinenbereichs (3) in einem aufgehängten Zustand, und
eine Rohrhalterung (9a) des Verbindungselements (9) an einer Seite der Einlassöffnung, die an einer Stromaufwärtsseite der Schelle (10) in der Strömungsrichtung des Kältemittels angeordnet ist.

2. Kühlschrank (1) nach Anspruch 1, wobei das Verbindungselement (9) eine Gummihärte von 40 bis 90 Grad aufweist.

3. Kühlschrank (1) nach Anspruch 1, wobei das Verbindungselement (9) eine Länge des 7- bis 15-Fachen eines Durchmessers des Kältemittelrohrs (4a) des Kondensators aufweist.

4. Kühlschrank (1) nach einem beliebigen der Ansprüche 1 bis 3, wobei das Verbindungselement (9) die Rohrhalterung (9a) aufweist, an der ein Schlitz (9d) zum Anbringen des Kältemittelrohrs (4a) vorgesehen ist, wobei der Schlitz (9d) so ausgebildet ist, dass er zu einer Innenseite des Kondensators (4) weist, und ein Innendurchmesser der Kältemittelrohrhalterung (9a) kleiner ist als ein Außendurchmesser des Kältemittelrohrs (4a).

Revendications

1. Réfrigérateur (1) comportant un compartiment de machines (3) sur un côté de la face arrière, le réfrigérateur (1) comprenant dans le compartiment de machines:

un condenseur à serpentin à tubes à ailettes (4);
un souffleur d'air (5) servant en tant que source d'entraînement primaire d'un circuit de ventilation; et
un compresseur (6) configuré pour mettre en circulation un réfrigérant dans un système de réfrigération afin de refroidir le réfrigérateur (1), dans lequel le condenseur à serpentin à tubes à ailettes (4) comporte un tube de réfrigérant (4a) et une ailette (4b) enroulée autour du tube de réfrigérant (4a), et
dans lequel des parties du tube de réfrigérant (4a) à un orifice d'admission (4c) et à un orifice de sortie (4d) du réfrigérant sont reliées par un membre de connexion (9),
caractérisé en ce que le tube de réfrigérant (4a) est enroulé en spirale dans une forme elliptique pour former des spires de spirale, sachant qu'un centre des spires de spirale est formé en serpentin le long d'une direction perpendiculaire à un axe principal du souffleur d'air (5), le membre de connexion (9) est fabriqué en caoutchouc et le réfrigérateur (1) comprend en outre
une clampe (10) pour tenir le tube de réfrigérant (4a) sur un côté en amont de l'ailette pour la dissipation de la chaleur dans une direction d'écoulement du réfrigérant à travers un coussin en caoutchouc (11) placé sous la clampe (10), et pour fixer le tube de réfrigérant (4a) sur une paroi intérieure du compartiment de machines (3) dans un état suspendu, et
un porte-tube (9a) du membre de connexion (9) sur un côté de l'orifice d'admission est disposé sur un côté en amont de la clampe (10) dans la direction d'écoulement du réfrigérant.

2. Réfrigérateur (1) selon la revendication 1, dans lequel le membre de connexion (9) présente une dureté du caoutchouc de 40 à 90 degrés.

3. Réfrigérateur (1) selon la revendication 1, dans lequel le membre de connexion (9) a une longueur de 7 à 15 fois un diamètre du tube de réfrigérant du condenseur.

4. Réfrigérateur (1) selon l'une quelconque des revendications 1 à 3, dans lequel le membre de connexion (9) présente le porte-tube (9a) doté d'une fente (9d) pour être fixé sur le tube de réfrigérant (4a), la fente (9d) étant formée pour être dirigée vers un côté intérieur du condenseur (4), et un diamètre intérieur du porte-tube de réfrigérant (9a) est inférieur à un diamètre extérieur du tube de réfrigérant (4a).

FIG. 1

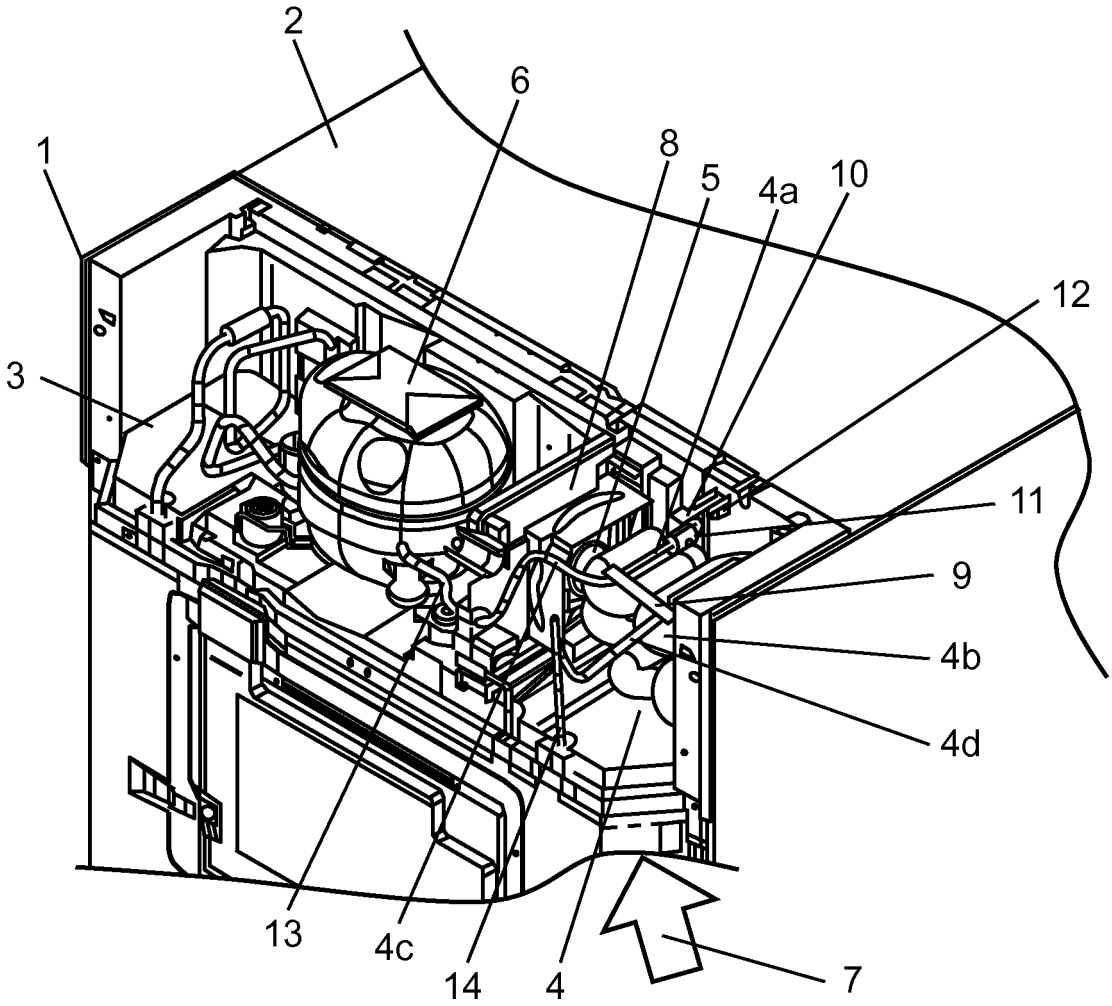


FIG. 2

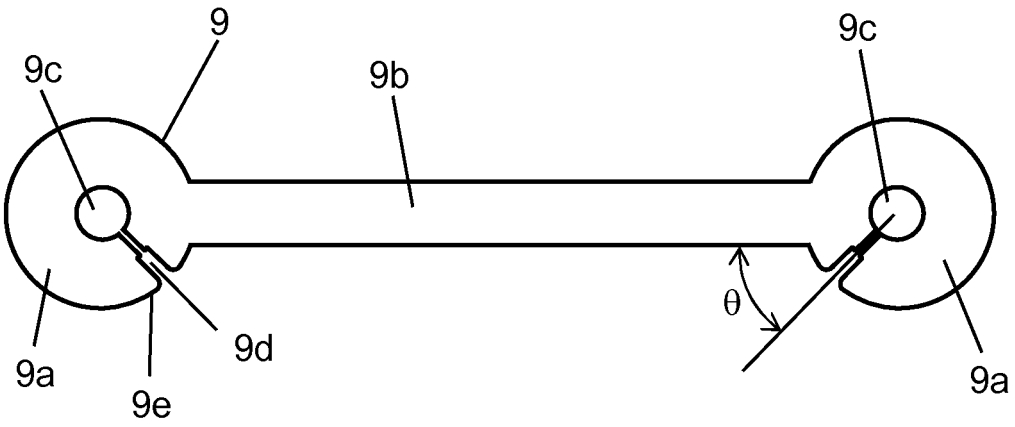

9
9c
9b
9c
θ
9d
9a
9e
9a

FIG. 3

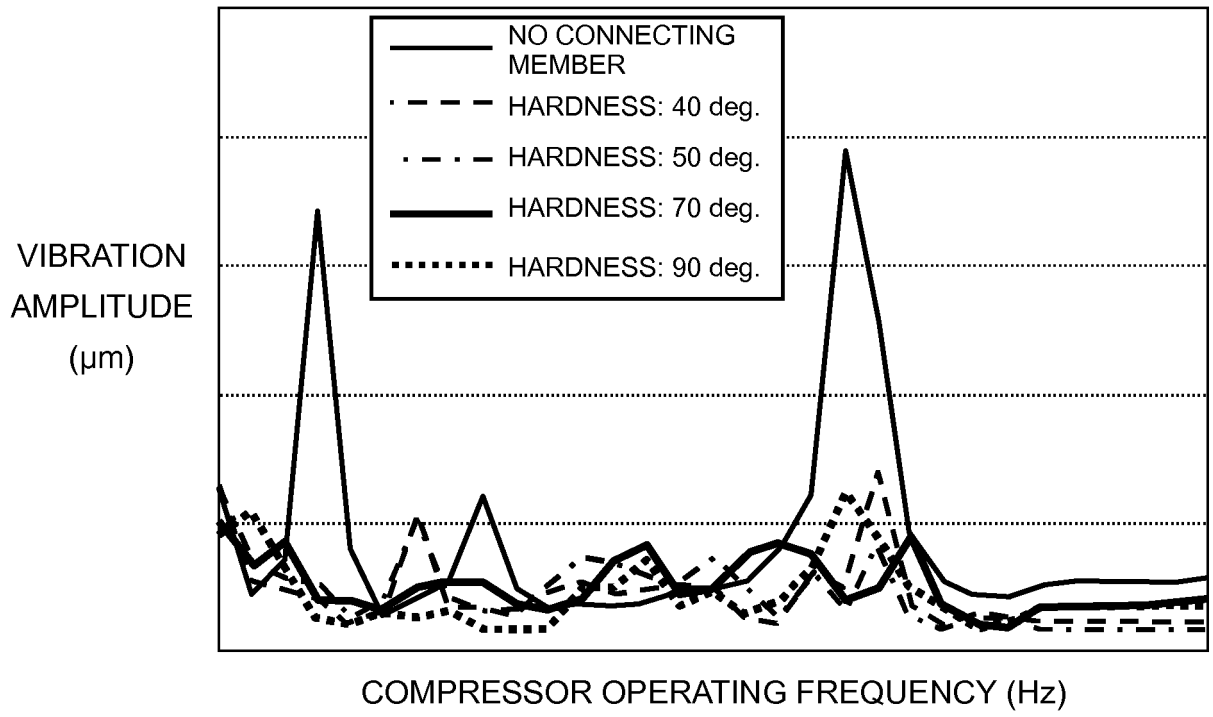

NO CONNECTING MEMBER
HARDNESS: 40 deg.
HARDNESS: 50 deg.
HARDNESS: 70 deg.
HARDNESS: 90 deg.
VIBRATION AMPLITUDE (μm)
COMPRESSOR OPERATING FREQUENCY (Hz)

FIG. 4

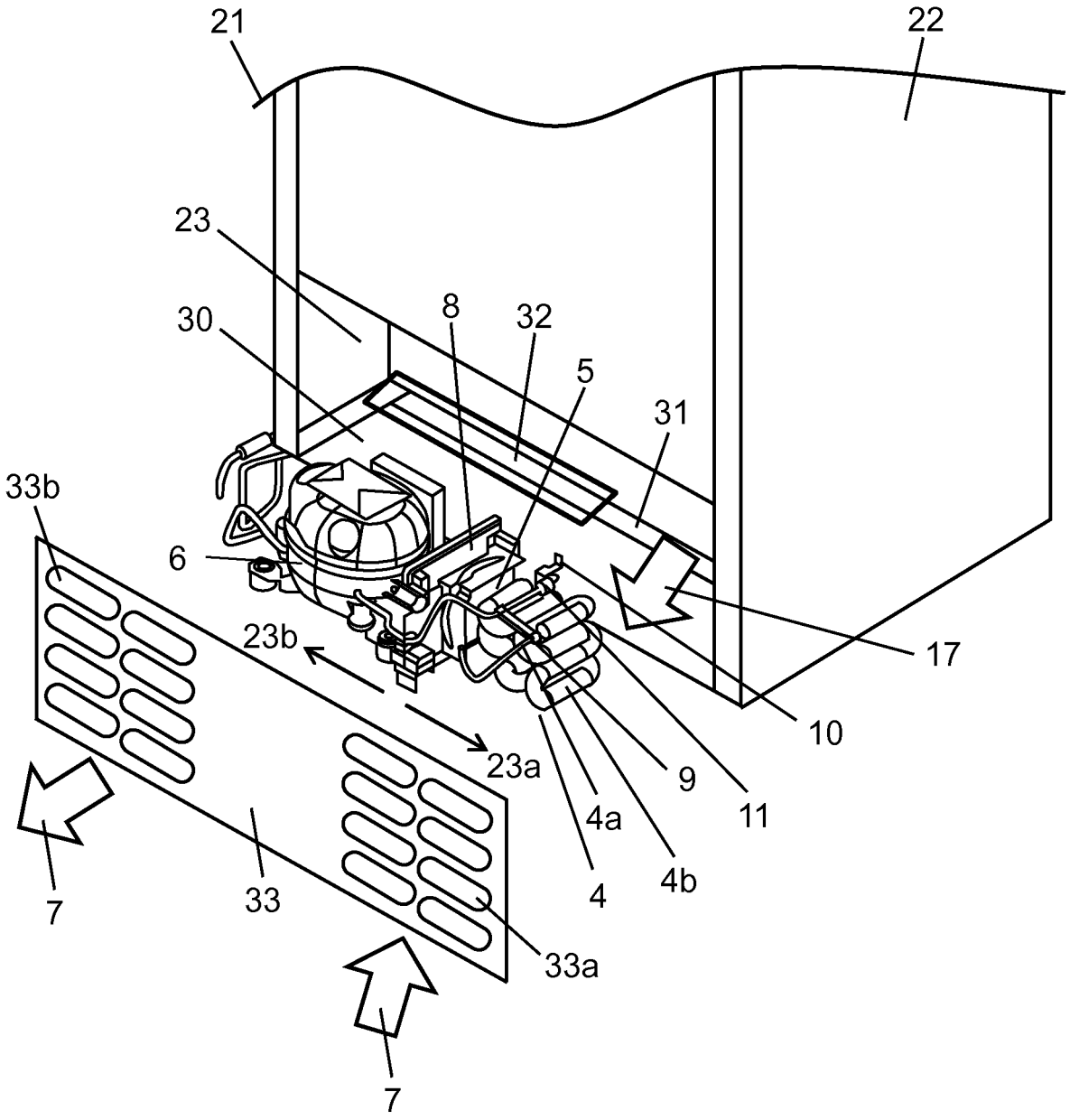


FIG. 5

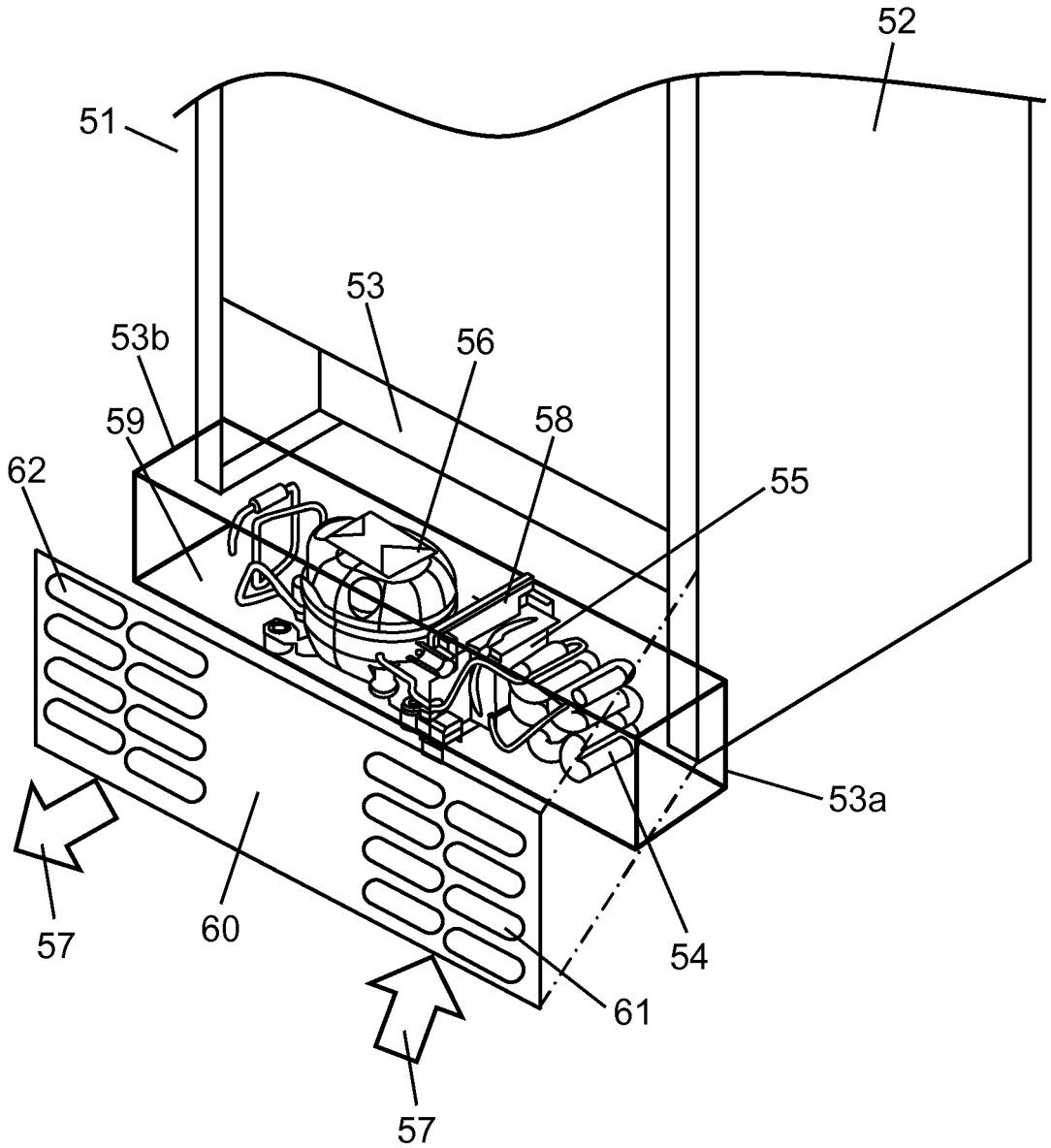


FIG. 6

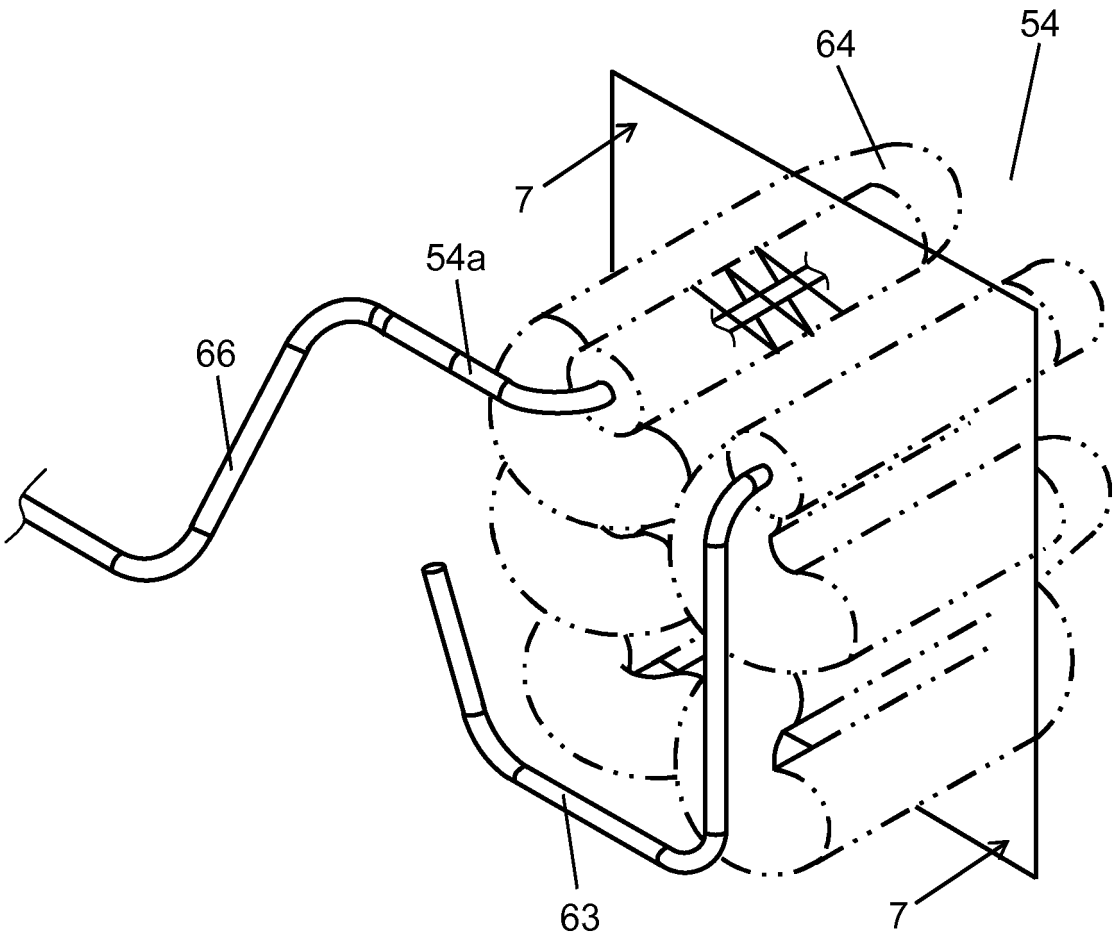


FIG. 7

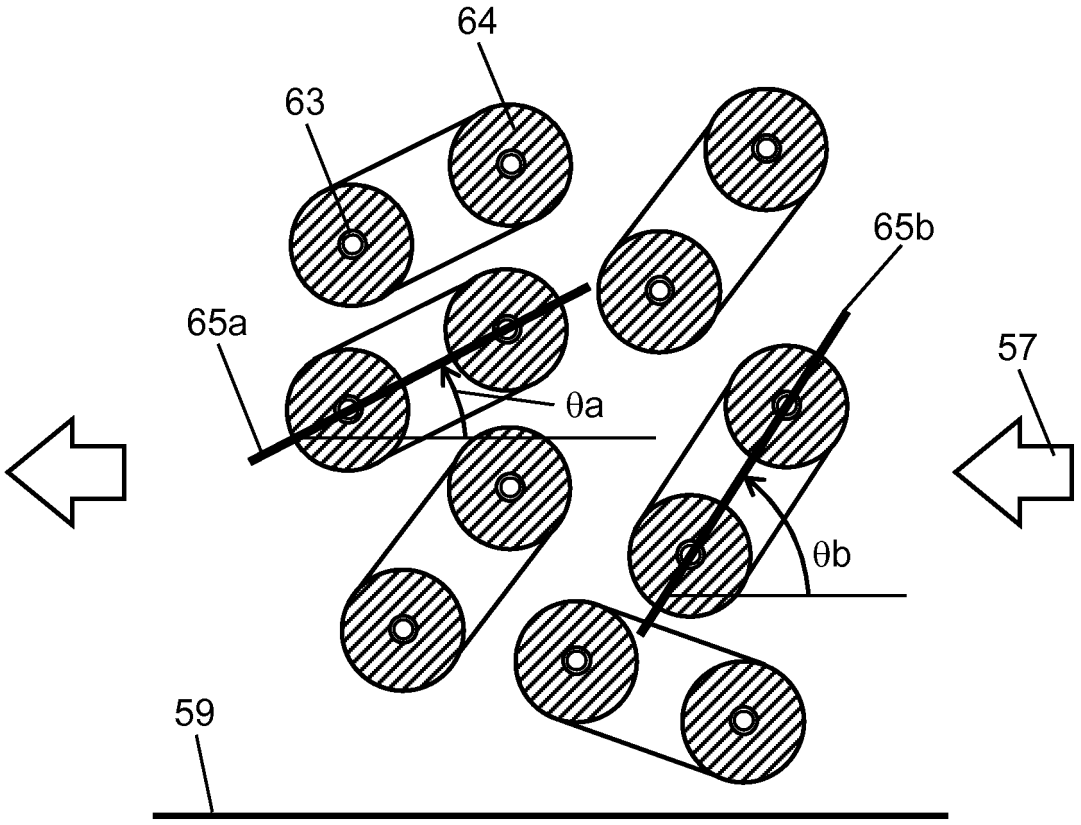


FIG. 8

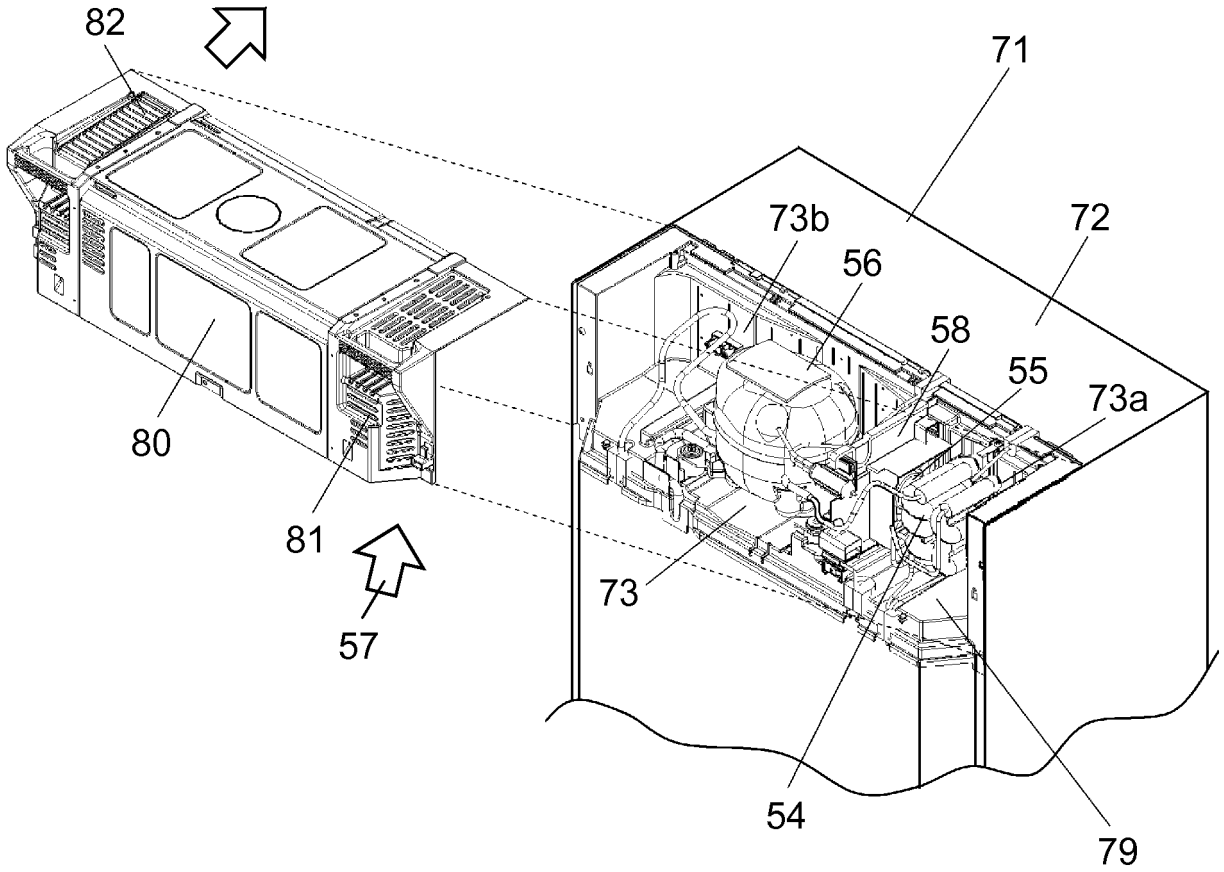


FIG. 9

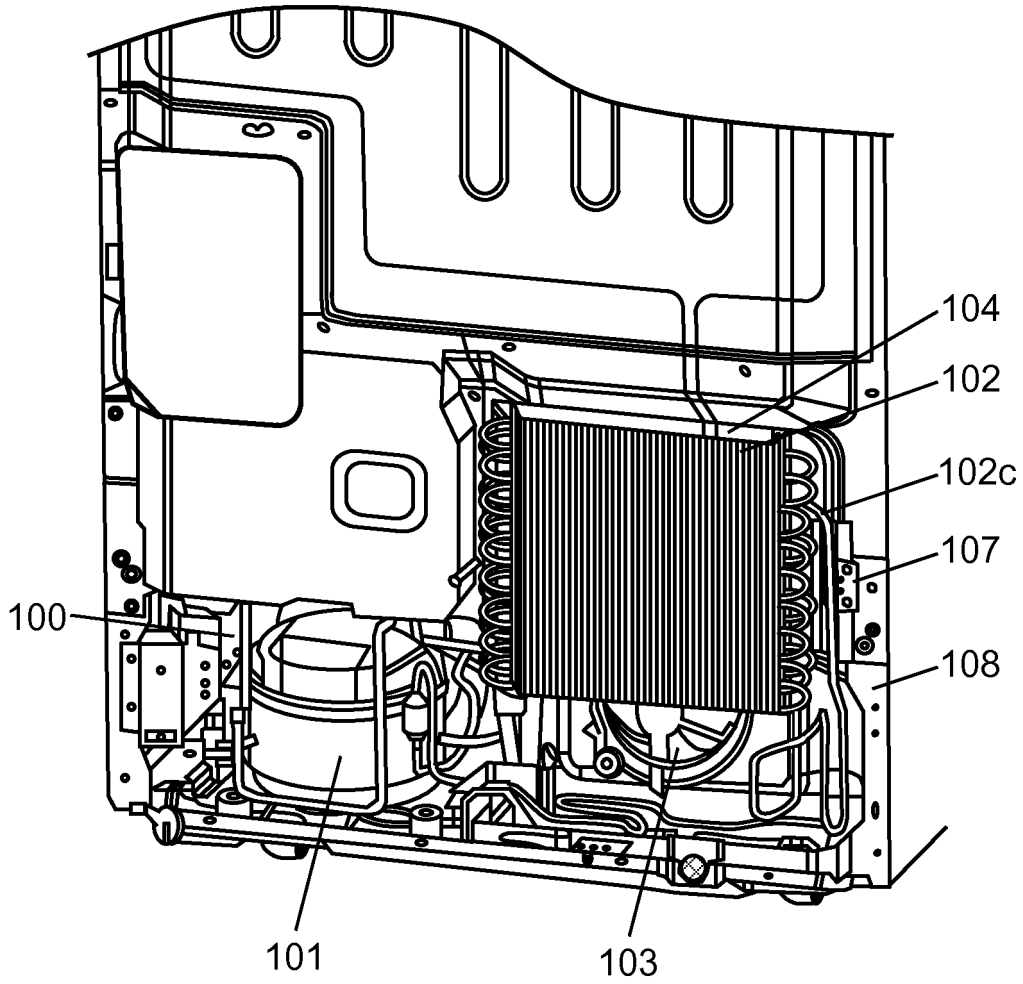


FIG. 10

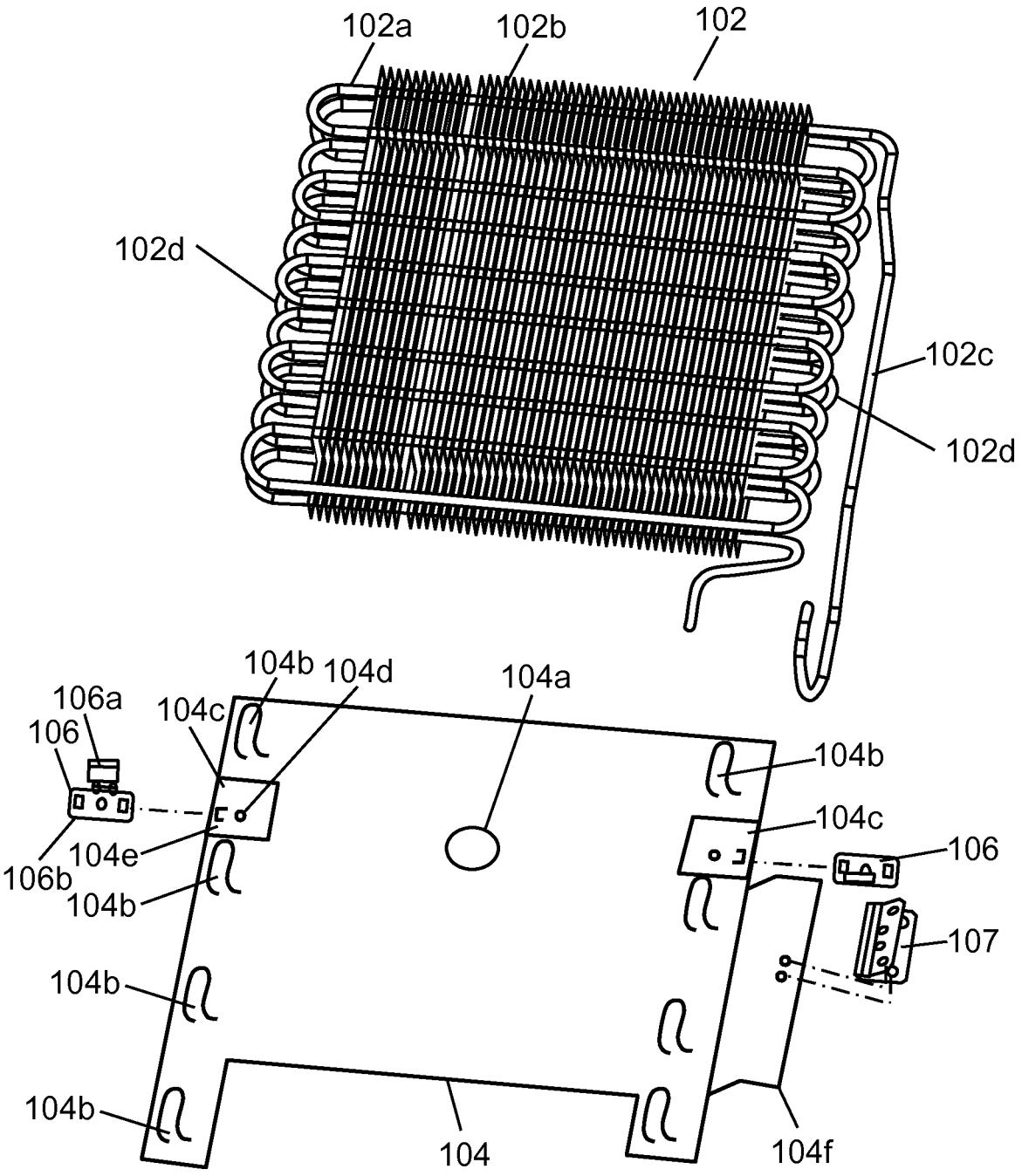

102a
102b
102
102d
102c
102d
104b
104d
104a
106a
104c
106
104b
104c
106
104e
106b
104b
107
104b
104b
104
104f

FIG. 11

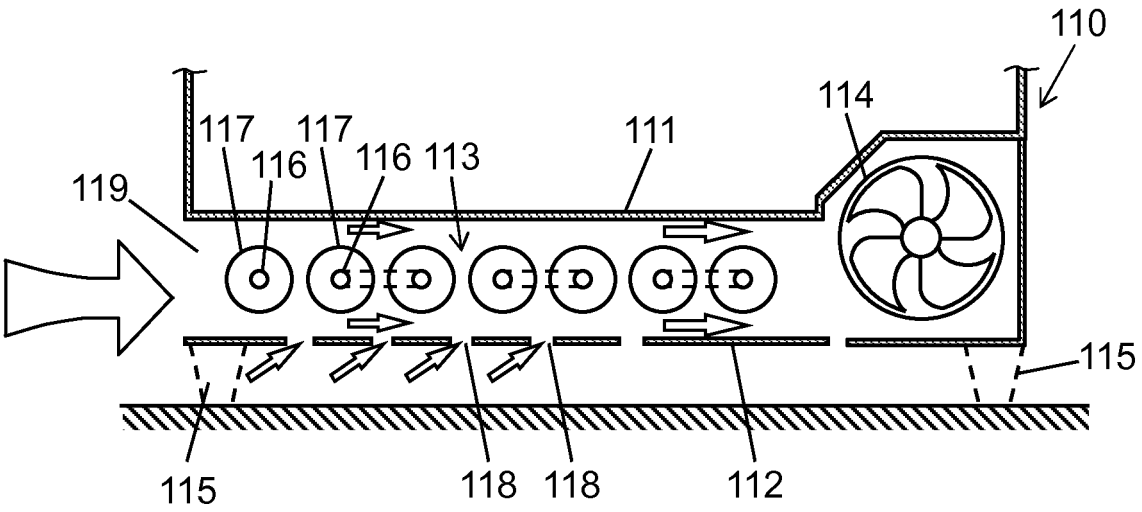
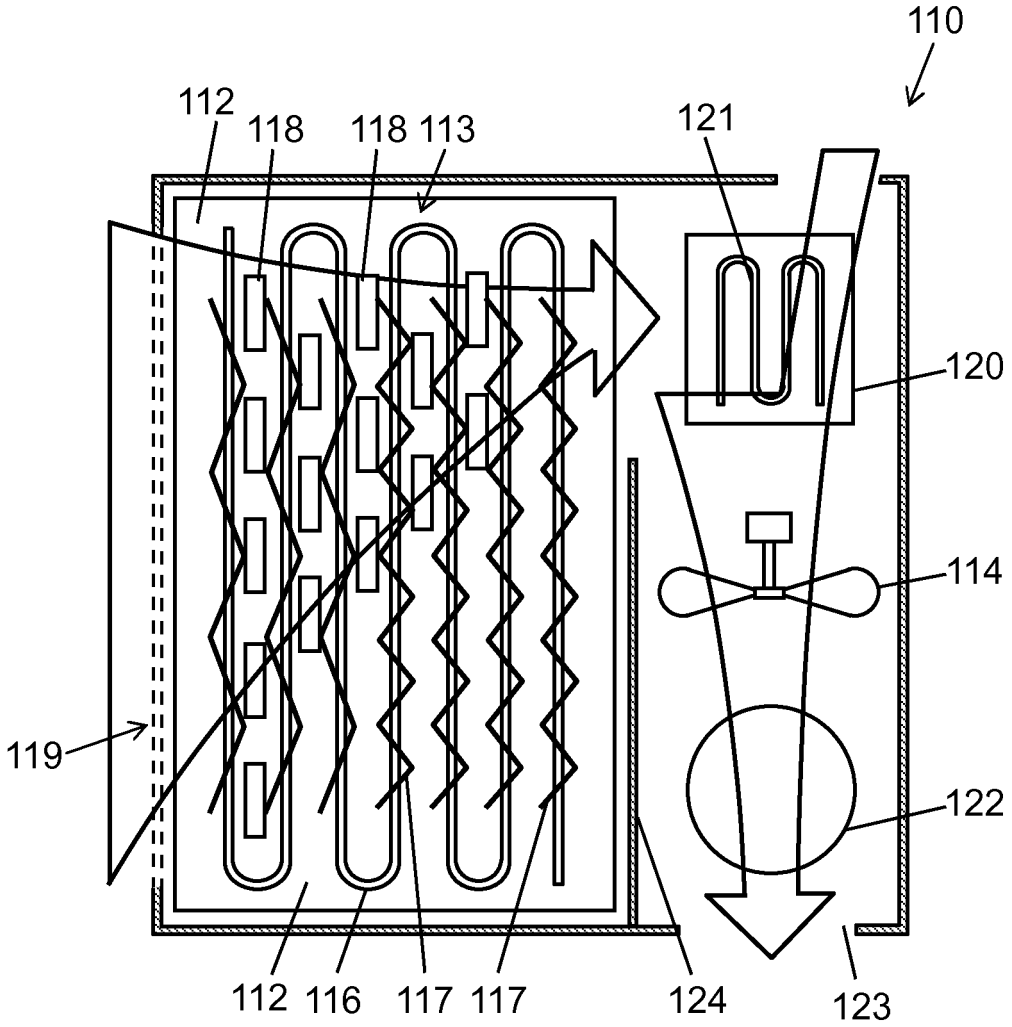


FIG. 12



REFERENCES CITED IN THE DESCRIPTION

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- JP 2007071462 A **[0033]**
- JP 9282188 A **[0033]**