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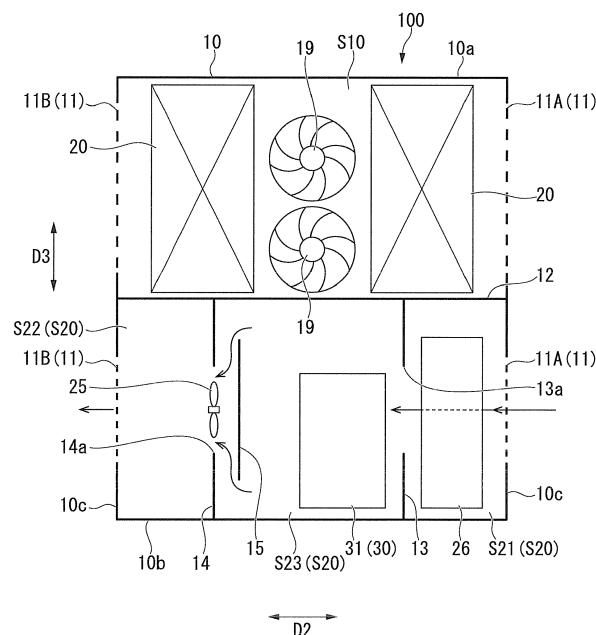
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(54) **TRANSPORTATION REFRIGERATION UNIT AND TRAILER**

(57) A transportation refrigeration unit (100) includes a box (10) having openings (11) at respective opposite sides in a width direction (D2), a drive blowing part (25) configured to send air, which flows in from an opening (11A) of a first side in the width direction (D2), to a drive source (30), and to discharge the air from an opening (11B) of a second side in the width direction (D2), an

upper and lower partition plate (12) configured to partition an inside of the box (10) into an upper space (S10) and a lower space (S20) in which the drive source (30) is disposed, a first partition plate (13) configured to partition the lower space (S20) into a first space (S21), and a second partition plate (14) configured to partition the lower space (S20) into a second space (S22).

FIG. 3



Description

[Technical Field]

5 **[0001]** The present invention relates to a transportation refrigeration unit, and a trailer.

[Background Art]

10 **[0002]** Among trailers such as a semi-trailer pulled by a tractor unit, there are some on which a container having a transportation refrigeration unit is mounted. Such transportation refrigeration units include a so-called nose mount type transportation refrigeration unit that extends from a front wall of the container to an upper space of the tractor unit, a so-called flush mount type transportation refrigeration unit that is installed in a narrow space between the container and the tractor unit, and an under-mount type transportation refrigeration unit that is suspended at either the left or right lateral face of the tractor unit in a longitudinal direction.

15 **[0003]** Such transportation refrigeration units include a type that is driven by power supplied from the tractor unit, and an independent type that can be driven independently of the tractor unit. Such types of independent transportation refrigeration units are mounted with a sub-engine as a drive source used exclusively for refrigerating machines apart from an engine of the tractor unit.

20 **[0004]** As such a transportation refrigeration unit, an under-mount type transportation refrigeration unit mounted with a sub-engine for producing power is disclosed in Patent Literature 1. The transportation refrigeration unit of Patent Literature 1 is configured to supply power by driving a compressor using the sub-engine. In such a transportation refrigeration unit, after air introduced into the inside of a box from a front end face via a heat-exchange guard cools the inside, the air is diffused from a rear end face in all directions by a diffuser, and is released to the outside. Thereby, in such a transportation refrigeration unit, releases of noise such as engine noise and fan rotation sounds from inside are reduced.

[Citation List]

[Patent Literature]

30 **[0005]** [Patent Literature 1] Japanese Unexamined Patent Application, First Publication No. 2009-150616

[Summary of Invention]

35 [Technical Problem]

40 **[0006]** In the transportation refrigeration unit described in Patent Literature 1 as described above, the engine that is the drive source is also cooled using air taken into the inside of the box with a fan to cool a heat-exchanger constituting a refrigeration cycle of the transportation refrigeration unit. Likewise, even in a flush mount type transportation refrigeration unit having the narrow installation space, to cool the engine that is the drive source while saving the installation space, the drive source is cooled using air taken into the inside of the box with a fan to cool a heat-exchanger.

45 **[0007]** However, the fan for taking in the air to cool the heat-exchanger takes external air into the inside of the box via an opening formed in the box of the transportation refrigeration unit. The opening of the box is frequently formed to a large size in order to efficiently take in the air from the outside. As a result, as the large opening formed in the box and a space in which the drive source is disposed is connected, a sound generated from the drive source easily leaks to the outside via the opening of the box. Thus, noise generated by the transportation refrigeration unit may be increased.

[0008] The present invention provides a transportation refrigeration unit and a trailer capable of reducing noise while cooling a drive source.

50 [Solution to Problem]

[0009] To solve the problem, the present invention proposes the following means.

55 **[0010]** A transportation refrigeration unit in a first aspect of the present invention includes: a box provided on a front face of a transported container of a trailer and having openings at respective opposite sides of the transported container of the trailer in a width direction; a compressor disposed at an inside of the box to compress a refrigerant; a heat-exchanger disposed at the inside of the box to cool the refrigerant supplied from the compressor; a heat-exchange blowing part disposed at the inside of the box to send air to the heat-exchanger; a drive source disposed at the inside of the box to drive the compressor; a drive blowing part configured to send air, which flows in from the opening of a first

side in the width direction, to the drive source, and to discharge the air from the opening of a second side in the width direction; an upper and lower partition plate configured to partition the inside of the box into an upper space in which at least the heat-exchanger and the heat-exchange blowing part are disposed and a lower space which is shut off from the upper space and in which the drive source is disposed; a first partition plate configured to partition the lower space into a first space communicating with the opening of the first side; and a second partition plate configured to partition the lower space into a second space communicating with the opening of the second side, wherein the lower space is partitioned into a central space, in which the drive source is disposed between the first space and the second space in the width direction, by the first and second partition plates, the first partition plate has a first flow passage which is capable of flowing the air from the first space to the central space, and the second partition plate has a second flow passage which is capable of flowing the air from the central space to the second space.

[0011] According to this configuration, an internal space of the box can be divided into the upper space and the lower space by the upper and lower partition plate. In addition, the central space in which the drive source is disposed can be separated from the first space facing the opening of the first side in the width direction and the second space facing the opening of the second side in the width direction by the first partition plate and the second partition plate. That is, the central space can be formed via the first and second partition plates at positions separated from the openings connected to the outside of the box. The central space is connected to the first space via the first flow passage, and is connected to the second space via the second flow passage. For this reason, if sound such as an engine sound generated by the drive source disposed in the central space does not pass through the first flow passage or the second flow passage, the sound cannot directly reach the openings. That is, part of the sound generated by the drive source can be cut off by the first partition plate, the second partition plate, and the upper and lower partition plate. Therefore, a sound resulting from a driving source leaking to the outside of the box via the openings can be suppressed. Also, the air flowing in from the opening of the first side by the drive blowing part can be sent to the drive source via the first flow passage formed in the first partition plate, and be discharged from the opening of the second side via the second flow passage formed in the second partition plate. Therefore, even in the state in which the drive source is disposed in the central space separated by the first partition plate, the second partition plate, and the upper and lower partition plate, the drive source can be efficiently cooled.

[0012] A transportation refrigeration unit of a second aspect of the present invention may be configured to include, in the first aspect, a shield part disposed on a straight line connecting the opening of the second side and the second flow passage and formed to cover and block the second flow passage when viewed from the second side.

[0013] According to this configuration, the sound generated by the drive source does not directly arrive at the opening of the second side from the drive source via the second flow passage, but proceeds to the opening of the second side to go around the shield part. Therefore, before the sound generated by the drive source reaches the opening of the second side, the sound can be heavily attenuated. Accordingly, the sound leaking from the opening of the second side to the outside of the box can be suppressed, and noise can be further reduced.

[0014] A transportation refrigeration unit of a third aspect of the present invention may be configured to include, in the second aspect, an electric unit disposed in the first space to control driving of the compressor, wherein the electric unit may be disposed on a straight line connecting the opening of the first side and the first flow passage and disposed to cover and block the first flow passage when viewed from the first side.

[0015] According to this configuration, the sound generated by the drive source does not pass through the first flow passage to directly arrive at the opening of the first side, but proceeds to the opening of the first side while advancing in the first space to go around the electric unit. Therefore, before the sound generated by the drive source passes through the first flow passage to reach the opening of the first side, the sound can be heavily attenuated. Accordingly, the sound leaking from the opening of the first side to the outside of the box can be suppressed, and the noise can be further reduced.

[0016] A transportation refrigeration unit of a fourth aspect of the present invention may be configured such that, in any one of the first to third aspects, the drive source is a diesel engine and has an engine body and an exhaust pipe configured to discharge an exhaust gas discharged from the engine body to an outside of the box, and the exhaust pipe is connected to the engine body at a position away from a straight line connecting the opening of the first side and the first flow passage.

[0017] According to this configuration, the exhaust pipe can be installed away from a flow path of air that flows from the first flow passage into the central space. Thereby, as an air flow velocity is suppressed in the central space around the exhaust pipe that is raised in temperature by flow of the exhaust gas, a heat transfer coefficient is kept low, and a rise in temperature in the central space can be suppressed.

[0018] A transportation refrigeration unit of a fifth aspect of the present invention may be configured such that, in any one of the first to fourth aspects, the drive source is a diesel engine, and has an engine body and a transmission part configured to transmit a driving force of the engine body to a cooling part cooling the engine body, and the transmission part is configured such that at least a part thereof is disposed on a straight line connecting the opening of the first side and the first flow passage.

[0019] According to this configuration, the transmission part can be installed toward the flow path of the air that flows

from the opening of the first side into the first space and flows from the first flow passage into the central space. Thereby, a component used in the transmission part can be cooled by the air flowing from the first flow passage into the central space. Therefore, a rise in temperature in the transmission part that transmits the driving force of the engine body can be suppressed.

[0020] A transportation refrigeration unit of a sixth aspect of the present invention may be configured such that, in any one of the first to fifth aspects, the drive blowing part includes a first drive blowing part disposed in the first flow passage, and a second drive blowing part disposed in the second flow passage.

[0021] According to this configuration, the first drive blowing part and the second drive blowing part are provided. Thereby, even if the number of rotations of each of the first drive blowing part and the second drive blowing part is reduced, an amount of air sent to the drive source can be secured. As the number of rotations of each of the first drive blowing part and the second drive blowing part is reduced, noise generated from each of the first drive blowing part and the second drive blowing part can be reduced. Therefore, sound generated by the drive blowing parts can be inhibited from leaking to the outside of the box while inhibiting the reduction of cooling efficiency of the components in the box.

[0022] A transportation refrigeration unit of a seventh aspect of the present invention may be configured to include, in the sixth aspect, a measurement part configured to measure a temperature of external air of the box, and a control part having control to stop one of the first drive blowing part and the second drive blowing part when the temperature measured by the measurement part is less than a predetermined reference value.

[0023] According to this configuration, the drive blowing parts can be driven according to necessary cooling performance. Therefore, the drive blowing parts can be efficiently driven, and fuel efficiency of the transportation refrigeration unit itself can be improved.

[0024] A transportation refrigeration unit of an eighth aspect of the present invention may be configured such that, in any one of the first to seventh aspects, when a full length of the box in the width direction is defined as L1, a length of the box from a lateral face of the first side to the first partition plate is defined as L2, and a length of the box from a lateral face of the second side to the second partition plate is defined as L3, the first partition plate and the second partition plate are disposed to satisfy $L2/L1 \geq 0.15$ and $L3/L1 \geq 0.15$.

[0025] According to this configuration, the sound generated by the drive source can be inhibited from leaking to the outside of the box while efficiently forming the first space, the second space, and the central space in order to dispose the components such as the drive source in the box. Therefore, the noise can be reduced while efficiently disposing the components in the box.

[0026] A transportation refrigeration unit of a ninth aspect of the present invention may be configured such that, in any one of the first to eighth aspects, the box is configured such that a ratio of a total value of areas of the openings to a total value of surface areas of a top face located at an upper side of the box, a bottom face located at a lower side of the box, and lateral faces located at opposite sides of the box in the width direction is equal to or less than 9%.

[0027] According to this configuration, the sound generated by the drive source can be inhibited from leaking to the outside of the box while inhibiting the reduction of the cooling efficiency of the components in the box.

[0028] A trailer in a tenth aspect of the present invention includes a transported container of the trailer which has the transportation refrigeration unit according to any one of the first to ninth aspects.

[0029] According to this configuration, since the transportation refrigeration unit is not made large, a load capacity can be inhibited from being reduced. Further, since quietness can be enhanced, marketability can be further improved.

[Advantageous Effects of Invention]

[0030] According to the present invention, the space in which the drive source is disposed is divided in the box, and thereby the noise can be reduced while cooling the drive source.

[Brief Description of Drawings]

[0031]

Fig. 1 is a side view of a vehicle in a first embodiment of the present invention.

Fig. 2 is a view showing a schematic configuration of a transportation refrigeration unit in the first embodiment of the present invention.

Fig. 3 is a schematic view showing a layout when a box is viewed from the front in the transportation refrigeration unit of the first embodiment of the present invention.

Fig. 4 is a schematic view showing a layout when the box is viewed from above in the transportation refrigeration unit of the first embodiment of the present invention.

Fig. 5 is a perspective view showing an appearance of the transportation refrigeration unit of the first embodiment of the present invention.

Fig. 6 is a schematic view showing disposition of first and second partition plates of the first embodiment of the present invention.

Fig. 7 is a schematic view showing a layout when a box is viewed from above in a transportation refrigeration unit of a second embodiment of the present invention.

Fig. 8 is a schematic view showing a layout when a box is viewed from above in a transportation refrigeration unit of a third embodiment of the present invention.

Fig. 9 is a schematic view showing a layout when a box is viewed from the front in a transportation refrigeration unit of a fourth embodiment of the present invention.

Fig. 10 is a schematic view showing a layout when the box is viewed from above in the transportation refrigeration unit of the fourth embodiment of the present invention.

[Description of Embodiments]

«First embodiment»

[0032] Next, a transportation refrigeration unit 100 and a trailer 3 in a first embodiment of the present invention will be described with reference to the drawings. As shown in Fig. 1, a vehicle 1 in the present embodiment is equipped with the trailer 3 that is pulled by a tractor unit 2.

[0033] The tractor unit 2 is equipped with a frame 4 and a cab 5.

[0034] The frame 4 extends in a longitudinal direction D1 of the tractor unit 2. A coupler (not shown) for connecting the trailer 3 is provided on a rear upper surface of the frame 4. The cab 5 that is a driving room is provided in the front of the frame 4. The cab 5 of the tractor unit 2 in the present embodiment is disposed above an engine (not shown) for traveling. That is, the tractor unit 2 of the present embodiment is shown as a so-called cab-over type tractor unit. In this cab-over type tractor unit, wheels are provided in the front and rear of the frame 4.

[0035] The longitudinal direction D1 of the present embodiment is a direction (a left and right direction of the sheet of Fig. 1) in which the trailer 3 extends, and is a traveling direction of the vehicle 1. Here, in the present embodiment, a horizontal direction perpendicular to the longitudinal direction D1 is defined as a width direction D2 (a depth direction of the sheet of Fig. 1) of a transported container (hereinafter referred to simply as "container") 7 of the trailer, and a vertical direction perpendicular to the longitudinal direction D1 is defined as a vertical direction D3 (an up and down direction of the sheet of Fig. 1). Also, when viewed from the front of the vehicle 1, the right side in the width direction D2 is defined as a first side, and the left side is defined as a second side.

[0036] The trailer 3 is equipped with a chassis 6 and the container 7.

[0037] The chassis 6 is formed to extend in the longitudinal direction D1. This chassis 6 is equipped with a connecting pin (not shown) in the front thereof. The connecting pin is provided to protrude downward from the chassis 6. The connecting pin can be inserted into or removed from the coupler of the aforementioned tractor unit 2. As the connecting pin is inserted into the coupler, the trailer 3 is connected to the tractor unit 2.

[0038] The container 7 is formed in the shape of a box supported from below by the chassis 6. The container 7 in the present embodiment is in a rectangular parallelepiped shape that is long in the longitudinal direction D1 in which the chassis 6 extends. In the state in which the trailer 3 is connected to the tractor unit 2, this container 7 is disposed on the frame 4 of the tractor unit 2 in the front thereof. In the state in which the trailer 3 is connected to the tractor unit 2, a predetermined space is formed between a front face of the container 7 and a rear face of the cab 5.

[0039] The container 7 has the transportation refrigeration unit 100 which cools air therein. The transportation refrigeration unit 100 of the present embodiment is a flush mounting type that is mounted on the front face of the container 7.

[0040] As shown in Figs. 2 to 4, the transportation refrigeration unit 100 has a box 10 that is an outer case, an upper and lower partition plate 12 that horizontally partitions an inner space of the box 10, a first partition plate 13 that partitions an inner lower space of the box 10 in the width direction D2, a second partition plate 14 that partitions the inner lower space of the box 10 in the width direction D2 along with the first partition plate 13, and a shield part 15 that is disposed between the second partition plate 14 and the first partition plate 13.

[0041] The transportation refrigeration unit 100 has a compressor 18 that compresses a refrigerant, outdoor heat-exchangers (condensers) 20 that cool the refrigerant supplied from the compressor 18, outdoor heat-exchange fans (heat-exchange blowing parts) 19 that send external air to the outdoor heat-exchangers 20, a drive source 30 that drives the compressor 18, an electric unit 26 that controls the compressor 18 and the drive source 30, and a drive blowing part 25 that sends the external air of the box 10 to the drive source 30, all of which are in the box 10.

[0042] The transportation refrigeration unit 100 has a pressure-reducing mechanism (an expansion valve) 21 that reduces a pressure of the refrigerant cooled by the outdoor heat-exchangers 20, an indoor heat-exchanger (an evaporator) 22 that cools air in the container 7 by the refrigerant whose pressure was reduced by the pressure-reducing mechanism 21, and an indoor heat-exchange fan 23 that sends the air in the container 7 to the indoor heat-exchanger 22, all of which are in the container 7.

[0043] As shown in Fig. 1, the box 10 is provided on the front face of the container 7. The box 10 of the present embodiment is disposed in the space between the front face of the container 7 and the rear face of the cab 5. The box 10 is formed with a sufficiently thin dimension in the longitudinal direction D1 so as not to affect a volume of the container 7. When the vehicle 1 is viewed from the front, the box 10 has a rectangular shape that is slightly smaller than the front face of the container 7 so as not to protrude above the container 7 and in the width direction D2. Also, when the vehicle 1 is viewed from above, the box 10 is set such that opposite ends thereof in the width direction D2 are thinned to avoid coming into contact with the cab 5 of the tractor unit 2 when the vehicle 1 is turned. To be specific, as shown in Fig. 4, the box 10 is curved and formed such that a face thereof facing the front is gradually directed backward with the approach to the opposite ends thereof in the width direction D2. As shown in Fig. 3, the box 10 has a plurality of internal spaces divided by the upper and lower partition plate 12, the first partition plate 13, and the second partition plate 14.

[0044] The box 10 has openings 11 that are connected with the outside and are formed at opposite sides in the width direction D2. The openings 11 are formed in lateral faces 10c of the box 10 in the width direction D2. As shown in Figs. 3 and 4, the openings 11 have first openings 11A that are openings formed at the first side in the width direction D2, and second openings 11B that are openings formed at the second side in the width direction D2.

[0045] In Fig. 2, for the convenience of illustration, the openings 11 for introducing air into a lower space S20 are disposed on the opposite side of the container 7 across the drive source 30, and the openings 11 for discharging the introduced air are disposed on the side of the container 7. However, as described above, the openings 11 in the present embodiment are formed in the lateral faces 10c of the box 10 in the width direction D2.

[0046] Open areas of the first and second openings 11A and 11B of the present embodiment are preferably set according to sizes of surface areas of a top face 10a, a bottom face 10b, and the lateral faces 10c of the box 10. To be specific, as shown in Fig. 5, the surface area of the top face 10a that is an upper face of the box 10 is defined as A1, the surface area of the bottom face 10b that is a lower face of the box 10 is defined as A2, and the surface areas of the lateral faces 10c facing the first and second sides in the width direction D2 are defined as A3. The open areas of the first openings 11A are defined as B1, and the open areas of the second openings 11B are defined as B2. In this case, a ratio η of a total value B of the open areas of the first and second openings 11A and 11B to a total value A of the surface areas of the top face 10a, the bottom face 10b, and the lateral faces 10c of the box 10 is preferably equal to or less than 9%. Particularly, the first and second openings 11A and 11B are preferably formed such that the ratio η is approximately 3%. In the present embodiment, the open areas B1 of the first openings 11A and the open areas B2 of the second openings 11B are formed to be the same size.

[0047] As shown in Fig. 3, the upper and lower partition plate 12 divides the internal space of the box 10 into upper and lower parts. That is, the upper and lower partition plate 12 partitions the inside of the box 10 into an upper space S10 and the lower space S20. The upper and lower partition plate 12 of the present embodiment is disposed near the middle of the inside of the box 10 in the vertical direction D3. The upper and lower partition plate 12 has the shape of a flat plate that spreads in a direction perpendicular to the vertical direction D3.

[0048] The upper space S10 is separated from the lower space S20 by the upper and lower partition plate 12. The compressor 18, the outdoor heat-exchangers 20, and the outdoor heat-exchange fans 19 are disposed in the upper space S10. In the present embodiment, the two outdoor heat-exchange fans 19 are vertically juxtaposed in the center of the upper space S10 in the width direction D2. The outdoor heat-exchangers 20 are disposed in the upper space S10 at both sides of the outdoor heat-exchange fans 19 in the width direction D2 one by one. In the upper space S10, the first side in the width direction D2 faces the first opening 11A. In the upper space S10, the second side in the width direction D2 faces the second opening 11B. In the upper space S10, air introduced by the outdoor heat-exchange fans 19 can be discharged from the first and second openings 11A and 11B.

[0049] The lower space S20 is the internal space of the box 10 which is formed under the upper space S10. The lower space S20 is divided from the upper space S10. The drive source 30, the drive blowing part 25, and the electric unit 26 are disposed in the lower space S20. In the lower space S20, a central space S23 in which the drive source 30 is disposed between a first space S21 and a second space S22 in the width direction D2 is partitioned by the first and second partition plates 13 and 14. That is, the lower space S20 is divided into the first space S21, the central space S23, and the second space S22 starting from the first side in the width direction D2. In the lower space S20, the shield part 15 is provided between the second partition plate 14 and the drive source 30. In the lower space S20, the first side in the width direction D2 faces the first opening 11A. In the lower space S20, the second side in the width direction D2 faces the second opening 11B. In the lower space S20, air introduced from the first opening 11A by the drive blowing part 25 is discharged from the second opening 11B.

[0050] As shown in Fig. 4, the first partition plate 13 is disposed in the lower space S20 at the first side in the width direction D2 relative to the drive source 30. The first partition plate 13 partitions the lower space S20 into the first space S21 communicating with the first opening 11A. The first partition plate 13 has a first flow passage 13a that is capable of flowing air from the first space S21 to the central space S23 in which the drive source 30 is disposed. The first partition plate 13 of the present embodiment has the shape of a flat plate that spreads in a direction perpendicular to the width direction D2. An upper end of the first partition plate 13 in the vertical direction D3 is connected to the upper and lower

partition plate 12. A rear end of the first partition plate 13 in the longitudinal direction D1 and a lower end of the first partition plate 13 in the vertical direction D3 are also connected to the box 10. A front end of the first partition plate 13 in the longitudinal direction D1 is disposed to have a gap with the box 10. In the present embodiment, this gap is formed as the first flow passage 13a.

[0051] The second partition plate 14 is disposed in the lower space S20 at the second side in the width direction D2 relative to the drive source 30. The second partition plate 14 partitions the lower space S20 into the second space S22 communicating with the second opening 11B. The second partition plate 14 has a second flow passage 14a that is capable of flowing air from the central space S23 to the second space S22. The second partition plate 14 of the present embodiment has the shape of a flat plate that spreads in the direction perpendicular to the width direction D2. Front and rear sides of the second partition plate 14 are connected to the box 10 at front and rear sides thereof in the longitudinal direction D1 and at a lower side thereof in the vertical direction D3. An upper side of the second partition plate 14 in the vertical direction D3 is connected to the upper and lower partition plate 12. In the present embodiment, a circular through-hole passing through the second partition plate 14 in the width direction D2 near the center of the second partition plate 14 in the vertical direction D3 and the longitudinal direction D1 is formed as the second flow passage 14a.

[0052] As shown in Fig. 6, when a full length of the box 10 in the width direction D2 is defined as L1, a length of the box 10 from the lateral face 10c of the first side in the width direction D2 to the first partition plate 13 is defined as L2, and a length of the box 10 from the lateral face 10c of the second side in the width direction D2 to the second partition plate 14 is defined as L3, the first and second partition plates 13 and 14 are disposed to satisfy the following relationships.

$$L2/L1 \geq 0.15, \text{ and } L3/L1 \geq 0.15$$

[0053] As shown in Fig. 3, when viewed from the second side, the shield part 15 is formed to cover and block the second flow passage 14a. As shown in Fig. 4, when viewed from above, the shield part 15 is disposed on a straight line connecting the second opening 11B and the second flow passage 14a. The shield part 15 of the present embodiment has the shape of a flat plate in which a cross section thereof in the vertical direction D3 is greater than the second flow passage 14a. The shield part 15 is disposed in parallel to the second partition plate 14 in the central space S23 at an interval from the second partition plate 14 in the width direction D2.

[0054] For example, a diesel engine may be used as the drive source 30. The aforementioned compressor 18 is driven using power output from this drive source 30. As shown in Fig. 2, the diesel engine that is the drive source 30 of the present embodiment has an engine body 31, and an exhaust pipe 32 that discharges an exhaust gas discharged from the engine body 31 to the outside of the box 10.

[0055] The engine body 31 is disposed in the central space S23.

[0056] The exhaust pipe 32 extends upward from the engine body 31. The exhaust pipe 32 passes through the upper and lower partition plate 12 to extend to an upper side of the box 10 through the upper space S10. The exhaust pipe 32 is connected to a muffler 32a in the upper space S10. The exhaust pipe 32 discharges the exhaust gas discharged from the engine body 31 from the upper side of the box 10 to the outside via the muffler 32a.

[0057] The electric unit 26 controls driving of the drive source 30 and the compressor 18. As shown in Fig. 4, the electric unit 26 is disposed on a straight line connecting the first opening 11A and the first flow passage 13a in the first space S21. When viewed from the first side, the electric unit 26 is disposed to cover and block the first flow passage 13a. That is, in the first space S21, when the electric unit 26 is viewed from above, a flow path along which air flows from the first opening 11A to the first flow passage 13a is curved and formed by the electric unit 26. To avoid interference with the front face of the box 10 which is curved and formed, the electric unit 26 is inclined such that a face thereof facing the front side is directed backward with the approach to the first side in the width direction D2. Thus, when viewed from above, the electric unit 26 is formed in a trapezoidal shape. The electric unit 26 is disposed such that a trapezoidal inclined face comes into contact with a front wall portion of the box 10 at an interval from a rear wall portion of the box 10.

[0058] The drive blowing part 25 sends air, which flows in from the first opening 11A, to the drive source 30 in the lower space S20, and discharges the air from the second opening 11B. The drive blowing part 25 of the present embodiment is a ventilation fan disposed at the second side in the width direction D2 relative to the drive source 30. The drive blowing part 25 is provided at a boundary between the central space S23 and the second space S22. That is, the drive blowing part 25 is disposed at the second flow passage 14a. Therefore, the drive blowing part 25 of the present embodiment sends air, which flows from the first opening 11A into the first space S21, to the central space S23 via the first flow passage 13a. The drive blowing part 25 discharges the air, which flows from the central space S23 into the second space S22, from the second opening 11B via the second flow passage 14a.

[0059] In the aforementioned transportation refrigeration unit 100, as shown in Fig. 2, the refrigerant is compressed by the compressor 18 driven by the drive source 30 while being controlled by the electric unit 26. The compressed refrigerant is sent to the outdoor heat-exchangers 20 via pipes. The refrigerant sent to these outdoor heat-exchangers

20 is cooled by heat exchanging with external air supplied by the outdoor heat-exchange fans 19. The cooled refrigerant is sent to the pressure-reducing mechanism 21 in the container 7 and is reduced in pressure, and then is sent to the indoor heat-exchanger 22. Air in the container 7 is supplied to the indoor heat-exchanger 22 by the indoor heat-exchange fan 23. For this reason, the air in the container 7 and the refrigerant are heat-exchanged by the indoor heat-exchanger 22, and the air in the container 7 is cooled. Afterwards, the refrigerant that was heat-exchanged with the air in the container 7 is sent back to the compressor 18 in the box 10, and repeats the aforementioned refrigeration cycle.

[0060] At this point, as shown in Figs. 3 and 4, in the lower space S20, the air flowing from the first opening 11A into the first space S21 by an operation of the drive blowing part 25 flows around the electric unit 26, and flows from the first space S21 into the central space S23 via the first flow passage 13a. The air flowing into the central space S23 flows around the drive source 30, and thereby the drive source 30 is cooled. The air cooling the drive source 30 flows to go around the shield part 15, and flows through the second flow passage 14a, in which the drive blowing part 25 is disposed, into the second space S22. The air flowing into the second space S22 is discharged from the second opening 11B to the outside of the box 10.

[0061] According to the transportation refrigeration unit 100 as described above, the internal space of the box 10 can be divided into the upper space S10 and the lower space S20 in which the drive source 30 is disposed by the upper and lower partition plate 12. In addition, the central space S23 in which the drive source 30 is disposed can be separated from the first space S21 facing the first opening 11A and the second space S22 facing the second opening 11B by the first partition plate 13 and the second partition plate 14. That is, the central space S23 can be formed via the first and second partition plates 13 and 14 at positions separated from the first and second openings 11A and 11B connected to the outside of the box 10. The central space S23 is connected to the first space S21 via the first flow passage 13a, and is connected to the second space S22 via the second flow passage 14a. For this reason, if sound such as an engine sound generated by the drive source 30 disposed in the central space S23 does not pass through the first flow passage 13a or the second flow passage 14a, the sound cannot directly reach the openings 11. That is, part of the sound generated by the drive source 30 such as the engine sound can be cut off by the first partition plate 13, the second partition plate 14, and the upper and lower partition plate 12. Therefore, a sound resulting from a driving source 30 leaking to the outside of the box 10 via the first and second openings 11A and 11B can be suppressed.

[0062] Also, the air is sent to the drive source 30 by the drive blowing part 25, and thereby the air flowing in from the first opening 11A can be sent to the drive source 30 via the first flow passage 13a formed in the first partition plate 13 and be discharged from the second opening 11B to the outside via the second flow passage 14a formed in the second partition plate 14. Therefore, even in the state in which the drive source 30 is disposed in the central space S23 separated by the first partition plate 13, the second partition plate 14, and the upper and lower partition plate 12, the drive source 30 can be efficiently cooled. Thereby, the sound generated by the drive source 30 can be inhibited from leaking to the outside of the box 10 while efficiently cooling the drive source 30, and noise can be reduced.

[0063] Also, the shield part 15, which is disposed on the straight line connecting the second opening 11B and the second flow passage 14a and blocks the second flow passage 14a, is provided between the drive source 30 and the second opening 11B. To be specific, in the present embodiment, the shield part 15 is provided between the drive source 30 and the second partition plate 14. For this reason, the sound generated by the drive source 30 does not directly arrive at the second opening 11B from the drive source 30 via the second flow passage 14a, but proceeds to the second flow passage 14a while being reflected to go around the shield part 15. Therefore, before the sound generated by the drive source 30 reaches the second opening 11B via the second flow passage 14a, the sound can be heavily attenuated. Accordingly, the sound generated by the drive source 30 can be inhibited from leaking from the second opening 11B to the outside of the box 10, and the noise can be further reduced.

[0064] Also, the electric unit 26 is disposed on the straight line connecting the first opening 11A and the first flow passage 13a in the first space S21. For this reason, the sound generated by the drive source 30 does not pass through the first flow passage 13a from the drive source 30 to directly arrive at the first opening 11A, but advances in the first space S21 to proceed to the first opening 11A while being reflected to go around the electric unit 26. Therefore, before the sound generated by the drive source 30 passes through the first flow passage 13a to reach the first opening 11A, the sound can be heavily attenuated. Accordingly, the sound generated by the drive source 30 can be inhibited from leaking from the first opening 11A to the outside of the box 10, and the noise can be further reduced.

[0065] Also, in the first and second partition plates 13 and 14, when the full length of the box 10 in the width direction D2 is defined as L1, the length L2 of the box 10 from the lateral face 10c of the first side to the first partition plate 13 satisfies $L2/L1 \geq 0.15$, and the length L3 of the box 10 from the lateral face 10c of the second side to the second partition plate 14 satisfies $L3/L1 \geq 0.15$. Thereby, the sound generated by the drive source 30 can be inhibited from leaking to the outside of the box 10 while efficiently forming the first space S21, the second space S22, and the central space S23 in order to dispose the components such as the drive source 30 and the electric unit 26 in the box 10. Therefore, the noise can be reduced while efficiently disposing the components in the box 10.

[0066] Also, the ratio η of the total value B of the open areas of the first and second openings 11A and 11B to the total value A of the surface areas of the top face 10a, the bottom face 10b, and the opposite lateral faces 10c of the box 10

is configured to be equal to or less than 9%. Thereby, the sound generated by the drive source 30 can be inhibited from leaking to the outside of the box 10 while inhibiting the reduction of cooling efficiency of the components in the box 10.

[0067] Particularly, the ratio η of the total value B of the open areas of the first and second openings 11A and 11B to the total value A of the surface areas of the top face 10a, the bottom face 10b, and the opposite lateral faces 10c of the box 10 is set to approximately 3%. Thereby, the sound generated by the drive source 30 can be inhibited from leaking to the outside of the box 10 while most efficiently inhibiting the reduction of the cooling efficiency of the components in the box 10.

[0068] Also, since the transportation refrigeration unit 100 is not made large, a load capacity of the container 7 can be inhibited from being reduced. Further, since quietness can be enhanced, marketability of the trailer 3 can be improved.

«Second embodiment»

[0069] Next, a transportation refrigeration unit 100A of a second embodiment will be described with reference to Fig. 7.

[0070] In the second embodiment, the same constituent elements as in the first embodiment are given the same reference signs, and detailed description thereof will be omitted. The transportation refrigeration unit 100A of the second embodiment is different from that of the first embodiment with regard to the position of the exhaust pipe of the drive source 30.

[0071] That is, in a drive source 30A of the transportation refrigeration unit 100A of the second embodiment, when a box 10 is viewed from above, an exhaust pipe 32A is connected to an engine body 31A at a position away from a straight line connecting a first opening 11A and a first flow passage 13a. As shown in Fig. 7, the exhaust pipe 32A of the second embodiment is connected to the engine body 31A in the rear of the engine body 31A so as not to face the first flow passage 13a. That is, the exhaust pipe 32A is connected to the engine body 31A at a position blocked by the first partition plate 13.

[0072] According to the transportation refrigeration unit 100A of the second embodiment as described above, the exhaust pipe 32A can be installed away from a flow path of air that flows from the first opening 11A into a first space S21 and flows from the first flow passage 13a into a central space S23. Thereby, the air flowing from the first flow passage 13a into the central space S23 can be inhibited from being immediately heated by the exhaust pipe 32A that is raised in temperature by flow of an exhaust gas. Therefore, as an air flow velocity is suppressed in the central space S23 around the exhaust pipe 32A, a rise in temperature in the central space S23 can be suppressed.

«Third embodiment»

[0073] Next, a transportation refrigeration unit 100B of a third embodiment will be described with reference to Fig. 8.

[0074] In the third embodiment, the same constituent elements as in the first and second embodiments are given the same reference signs, and detailed description thereof will be omitted. The transportation refrigeration unit 100B of the third embodiment is different from those of the first and second embodiments with regard to the configuration of the drive source.

[0075] That is, a drive source 30B of the transportation refrigeration unit 100B of the third embodiment has a water pump (a cooling part) (not shown) that cools an engine body 31B, and a transmission part 33 that transmits a driving force of the engine body 31B to drive the water pump.

[0076] When a box 10 is viewed from above, the transmission part 33 is disposed on a straight line connecting a first opening 11A and a first flow passage 13a such that at least a part thereof faces the straight line. As shown in Fig. 8, the transmission part 33 of the present embodiment faces the first flow passage 13a and is disposed in front of the lateral face of the engine body 31B. The transmission part 33 of the present embodiment has, for instance, an engine pulley that is connected to the engine body 31B, and an engine water pump belt (not shown) that transmits rotation of the engine body 31B to a water pump pulley connected to the water pump. The engine water pump belt is formed of a rubber material that is an elastic member.

[0077] According to the transportation refrigeration unit 100B of the third embodiment as described above, the transmission part 33 can be installed toward a flow path of air that flows from the first opening 11A into a first space S21 and flows from the first flow passage 13a into a central space S23. Thereby, a component formed of a rubber material such as the water pump belt used in the transmission part 33 can be cooled by the air flowing from the first flow passage 13a into the central space S23. Therefore, a rise in temperature of the transmission part 33 having a material vulnerable to heat such as a belt used in a transmission mode of, for instance, a belt drive for transmitting the driving force of the engine body 31B can be suppressed.

«Fourth embodiment»

[0078] Next, a transportation refrigeration unit 100C of a fourth embodiment will be described with reference to Figs.

9 and 10.

[0079] In the fourth embodiment, the same constituent elements as in the first to third embodiments are given the same reference signs, and detailed description thereof will be omitted. The transportation refrigeration unit 100C of the fourth embodiment is different from those of the first to third embodiments in that a plurality of drive blowing parts are provided.

[0080] That is, as shown in Fig. 9, the transportation refrigeration unit 100C of the fourth embodiment has driven blowing parts 35, a measurement part 36 that measures a temperature of external air of a box 10, and a control part 37 that controls the drive blowing parts 35 on the basis of a result of the measurement by the measurement part 36.

[0081] The drive blowing parts 35 of the fourth embodiment include a first drive blowing part 35A that is disposed in a first flow passage 13a, and a second drive blowing part 35B that is disposed in a second flow passage 14a.

[0082] The first drive blowing part 35A is flowed air from a first opening 11A toward a second opening 11B in a lower space S20 along with the second drive blowing part 35B. The first drive blowing part 35A is a ventilation fan that is disposed at a first side in a width direction D2 relative to a drive source 30. The first drive blowing part 35A is provided at a boundary between a first space S21 and a central space S23. That is, the first drive blowing part 35A is disposed in the first flow passage 13a. The first drive blowing part 35A is controlled by the control part 37 which will be described below.

[0083] The second drive blowing part 35B is a ventilation fan that is disposed at a second side in the width direction D2 relative to the drive source 30. The second drive blowing part 35B is provided at a boundary between a second space S22 and the central space S23. That is, like the drive blowing part 25 of the first embodiment, the second drive blowing part 35B is disposed in the second flow passage 14a.

[0084] The measurement part 36 is disposed outside the box 10. The measurement part 36 measures a temperature of external air. The measurement part 36 sends a result of the measurement to the control part 37.

[0085] When the temperature measured by the measurement part 36 is less than a predetermined reference value, the control part 37 controls to stop one of the first drive blowing part 35A and the second drive blowing part 35B. The control part 37 of the present embodiment determines whether the result of the measurement by the measurement part 36 is less than the predetermined reference value. When the result of the measurement is less than the reference value, the control part 37 sends a signal to the first drive blowing part 35A to stop the first drive blowing part 35A.

[0086] Here, the reference value is a temperature of external air at which, when the drive source 30 is cooled only by one of the first drive blowing part 35A and the second drive blowing part 35B, an internal temperature of the box 10 becomes such a value as to sufficiently cool the drive source 30.

[0087] According to the transportation refrigeration unit 100C of the fourth embodiment as described above, the first drive blowing part 35A disposed in the first flow passage 13a and the second drive blowing part 35B disposed in the second flow passage 14a are provided. Thereby, even if the number of rotations of each of the first drive blowing part 35A and the second drive blowing part 35B is lower than that of the drive blowing part 25 of the first embodiment, an amount of air sent to the drive source 30 can be secured. As the number of rotations of each of the first drive blowing part 35A and the second drive blowing part 35B is reduced, noise generated by each of the first drive blowing part 35A and the second drive blowing part 35B can be reduced. Therefore, a sound generated by the drive blowing parts 35 can be inhibited from leaking to the outside of the box 10 while inhibiting the reduction of cooling efficiency of components in the box 10.

[0088] Also, when the temperature of the external air of the box 10 is less than the predetermined reference value, the first drive blowing part 35A is stopped by the control part 37. Thereby the first drive blowing part 35A can be driven according to a necessary cooling performance. Therefore, the drive blowing parts 35 can be efficiently driven, and fuel efficiency of the transportation refrigeration unit 100C itself can be improved.

[0089] Although the embodiments of the present invention have been described above in detail with reference to the drawings, the configurations and combinations thereof in each of the embodiments are examples. Additions, omissions, substitutions, and other modifications of the configuration are possible without departing from the scope of the present invention. The present invention is not limited by the above description, but is only limited by the appended claims.

[0090] In the first to third embodiments, the drive blowing part 25 is disposed in the second flow passage 14a, but without being limited to this disposition, it is satisfactory if the drive blowing part 25 can send the air from the first opening 11A to the second opening 11B. For example, the drive blowing part 25 may be disposed in the first space S21, the second space S22, or the central space S23, and may be disposed in the first flow passage 13a. Likewise, the positions at which the first and second drive blowing parts 35A and 35B of the fourth embodiment may be disposed are also in the first space S21, the second space S22, or the central space S23.

[0091] Fig. 2 is a view illustrating a schematic configuration of the refrigeration cycle of the transportation refrigeration unit 100 of the first embodiment of the present invention wherein the configuration is disposed at a checkable position for the convenience of illustration. The disposition of each configuration in the longitudinal direction D1 or the width direction D2 is not limited to this disposition.

[Industrial Applicability]

[0092] According to the transportation refrigeration unit 100, the space in which the drive source is disposed is divided inside the box, and thereby noise can be reduced while cooling the drive source.

[Reference Signs List]

[0093]

10	1	vehicle
	D1	longitudinal direction
	D2	width direction
	D3	vertical direction
	2	tractor unit
15	4	frame
	5	cab
	3	trailer
	6	chassis
	7	container
20	100, 100A, 100B, 100C	transportation refrigeration unit
	10	box
	10a	top face
	10b	bottom face
	10c	lateral face
25	11	opening
	11A	first opening
	11B	second opening
	12	upper and lower partition plate
	13	first partition plate
30	13a	first flow passage
	14	second partition plate
	14a	second flow passage
	15	shield part
	S10	upper space
35	S20	lower space
	S21	first space
	S22	second space
	S23	central space
	18	compressor
40	19	outdoor heat-exchange fan
	20	outdoor heat-exchanger
	21	pressure-reducing mechanism
	22	indoor heat-exchanger
	23	indoor heat-exchange fan
45	30, 30A, 30B	drive source
	31, 31A	engine body
	32, 32A	exhaust pipe
	32a	muffler
	25, 35	drive blowing part
50	26	electric unit
	33	transmission part
	35A	first drive blowing part
	35B	second drive blowing part
	36	measurement part
55	37	control part

Claims

1. A transportation refrigeration unit (100, 100A, 100B, 100C), comprising:

a box (10) configured to be provided on a front face of a transported container (7) of a trailer (3) and having openings (11) at respective opposite sides of the transported container of the trailer in a width direction (D2); a compressor (18) disposed at an inside of the box (10) to compress a refrigerant; a heat-exchanger (20) disposed at the inside of the box (10) to cool the refrigerant supplied from the compressor (18); a heat-exchange blowing part (19) disposed at the inside of the box (10) to send air to the heat-exchanger (20); a drive source (30, 30A, 30B) disposed at the inside of the box to drive the compressor (18); a drive blowing part (25, 35) configured to send air, which flows in from the opening (11A) of a first side in the width direction (D2), to the drive source, and to discharge the air from the opening (11B) of a second side in the width direction (D2); an upper and lower partition plate (12) configured to partition the inside of the box into an upper space (S10) in which at least the heat-exchanger (20) and the heat-exchange blowing part (19) are disposed and a lower space (S20) which is divided from the upper space (S10) and in which the drive source (30, 30A, 30B) is disposed; a first partition plate (13) configured to partition the lower space (S20) into a first space (S21) communicating with the opening (11A) of the first side; and a second partition plate (14) configured to partition the lower space (S20) into a second space (S22) communicating with the opening of the second side (11B), wherein the lower space (S20) is partitioned into a central space (S23), in which the drive source is disposed between the first space (S21) and the second space (S22) in the width direction (D2), by the first and second partition plates (13, 14), the first partition plate (13) has a first flow passage (13a) which is capable of flowing the air from the first space (S21) to the central space (S23), and the second partition plate (14) has a second flow passage (14a) which is capable of flowing the air from the central space (S23) to the second space (S22).

2. The transportation refrigeration unit (100, 100A, 100B, 100C) according to Claim 1, further comprising a shield part (15) disposed on a straight line connecting the opening (11B) of the second side and the second flow passage (14a) and formed to cover and block the second flow passage when viewed from the second side.

3. The transportation refrigeration unit (100, 100A, 100B, 100C) according to Claim 2, further comprising an electric unit (26) disposed in the first space (S21) to control driving of the compressor (18), wherein the electric unit (26) is disposed on a straight line connecting the opening (11A) of the first side and the first flow passage (13a) and disposed to cover and block the first flow passage when viewed from the first side.

4. The transportation refrigeration unit (100, 100A, 100B, 100C) according to any one of Claims 1 to 3, wherein:

the drive source (30A) is a diesel engine, and the drive source has an engine body (31A) and an exhaust pipe (32A) configured to discharge an exhaust gas discharged from the engine body to an outside of the box (10); and the exhaust pipe (32A) is connected to the engine body (31A) at a position away from a straight line connecting the opening (11A) of the first side and the first flow passage (13a).

5. The transportation refrigeration unit (100, 100A, 100B, 100C) according to any one of Claims 1 to 4, wherein:

the drive source (30B) is a diesel engine, and the drive source has an engine body (31B) and a transmission part (33) configured to transmit a driving force of the engine body (31B) to a cooling part cooling the engine body; and the transmission part (33) is configured such that at least a part thereof is disposed on a straight line connecting the opening (11A) of the first side and the first flow passage (13a).

6. The transportation refrigeration unit (100, 100A, 100B, 100C) according to any one of Claims 1 to 5, wherein the drive blowing part (35) includes:

a first drive blowing part (35A) disposed in the first flow passage (13a); and

a second drive blowing part (35B) disposed in the second flow passage (14a).

7. The transportation refrigeration unit (100, 100A, 100B, 100C) according to Claim 6, comprising:

a measurement part (36) configured to measure a temperature of external air of the box (10); and
a control part (37) configured to control to stop one of the first drive blowing part (35A) and the second drive blowing part (35B) when the temperature measured by the measurement part (36) is less than a predetermined reference value.

8. The transportation refrigeration unit (100, 100A, 100B, 100C) according to any one of Claims 1 to 7, wherein, when a full length of the box (10) in the width direction (D2) is defined as L1, a length of the box (10) from a lateral face of the first side to the first partition plate (13) is defined as L2, and a length of the box (10) from a lateral face of the second side to the second partition plate (14) is defined as L3, the first partition plate (13) and the second partition plate (14) are disposed to satisfy

$$L2/L1 \geq 0.15,$$

and

$$L3/L1 \geq 0.15.$$

9. The transportation refrigeration unit (100, 100A, 100B, 100C) according to any one of Claims 1 to 8, wherein the box (10) is configured such that a ratio of a total value of areas of the openings (11) to a total value of surface areas of a top face (10a) located at an upper side of the box (10), a bottom face (10b) located at a lower side of the box (10), and lateral faces (10c) located at opposite sides of the box (10) in the width direction (D2) is equal to or less than 9%.

10. A trailer (3) comprising a transported container (7) of the trailer which has the transportation refrigeration unit (100, 100A, 100B, 100C) according to any one of Claims 1 to 9.

FIG. 1

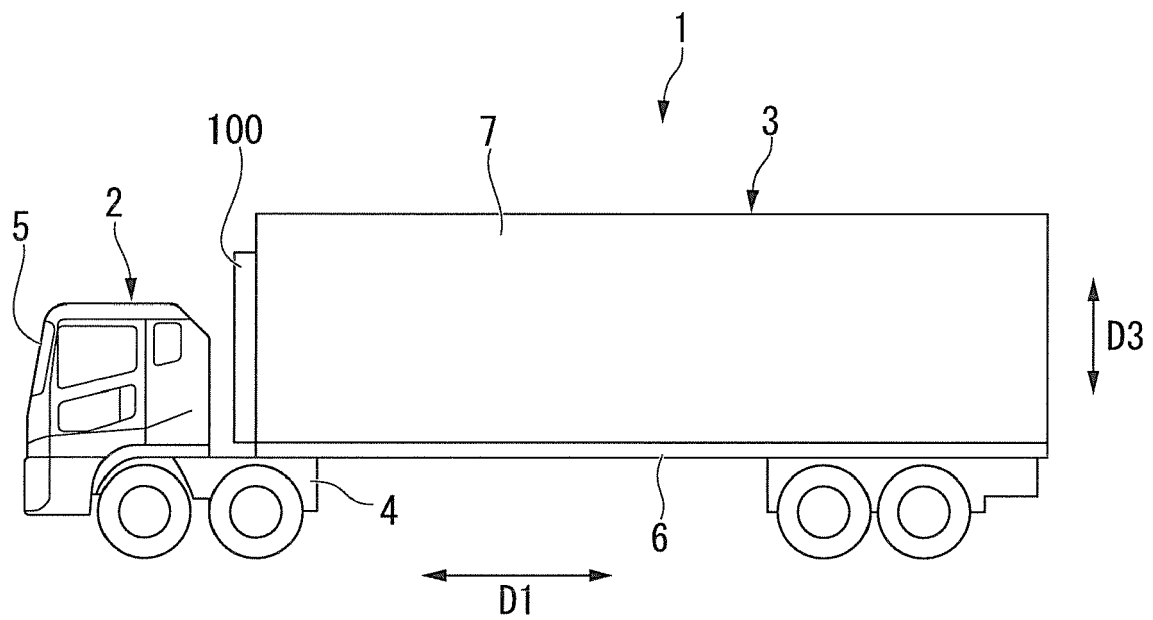


FIG. 2

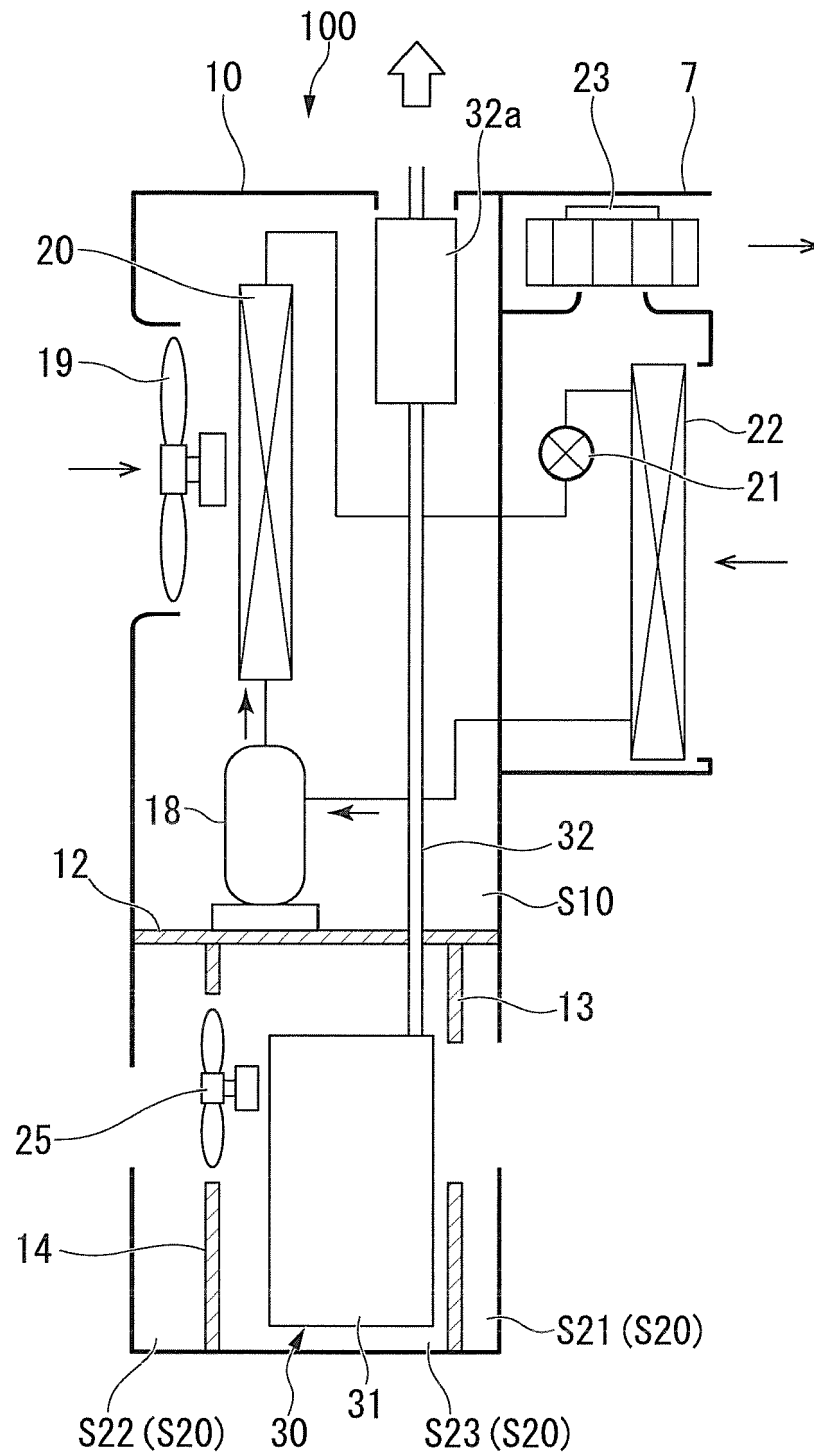


FIG. 3

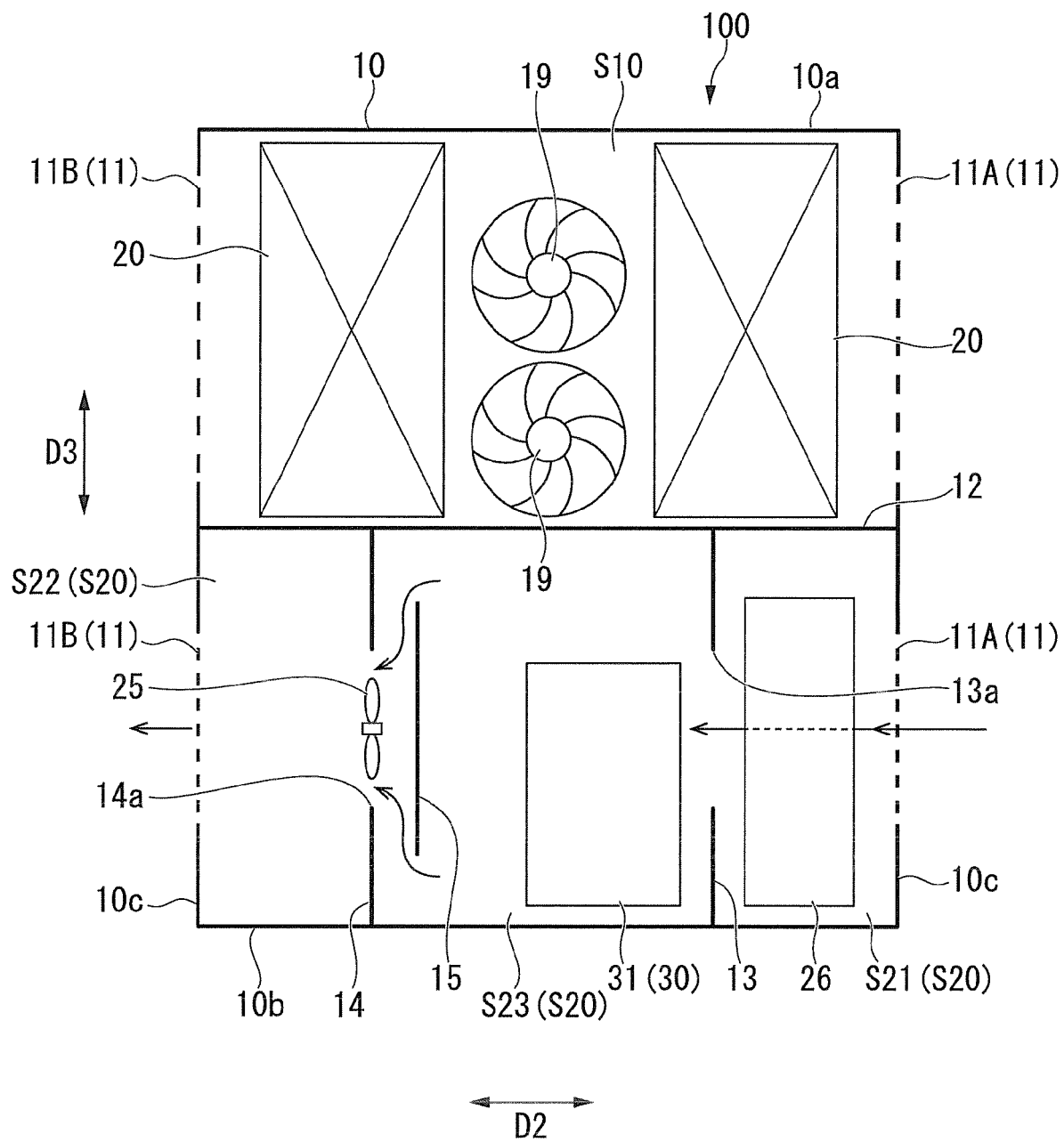


FIG. 4

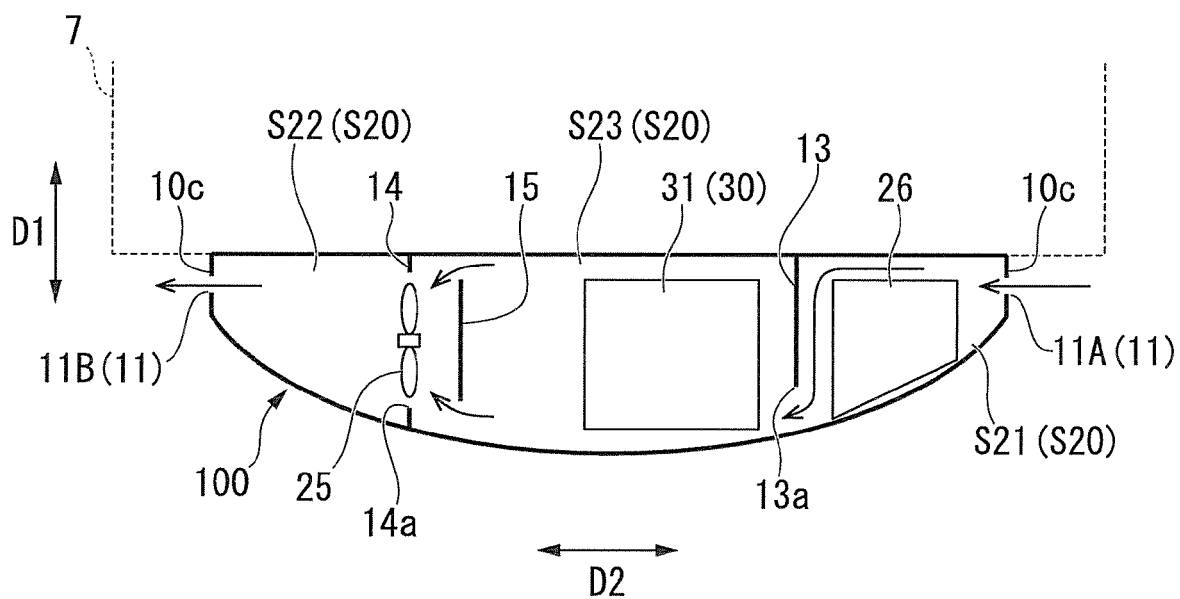


FIG. 5

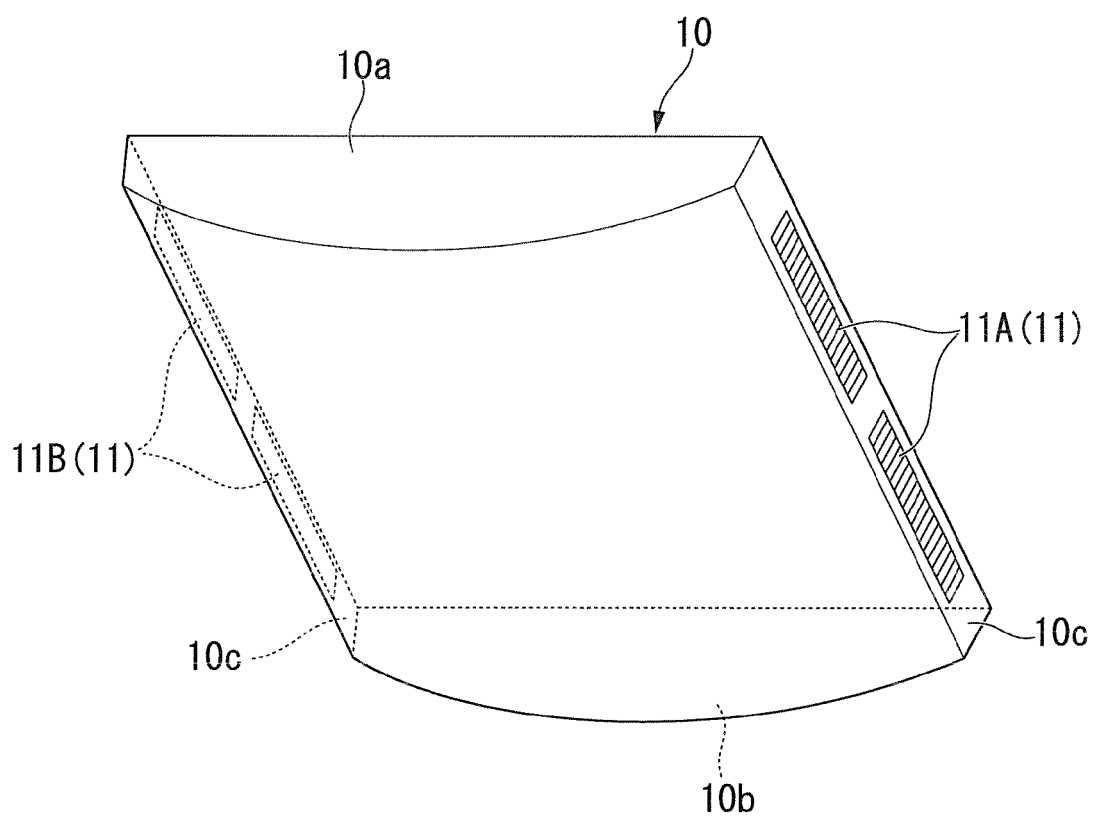


FIG. 6

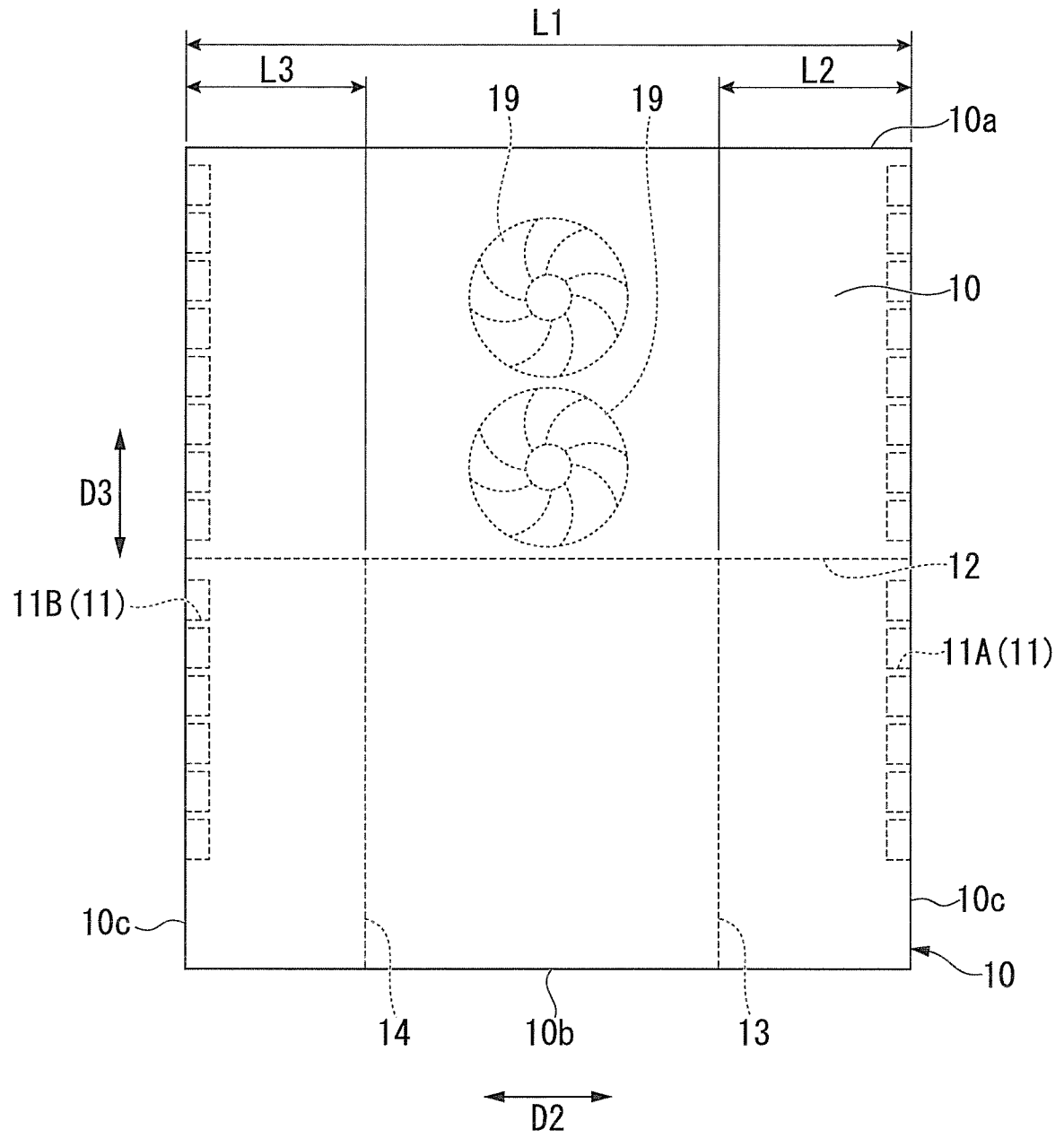


FIG. 7

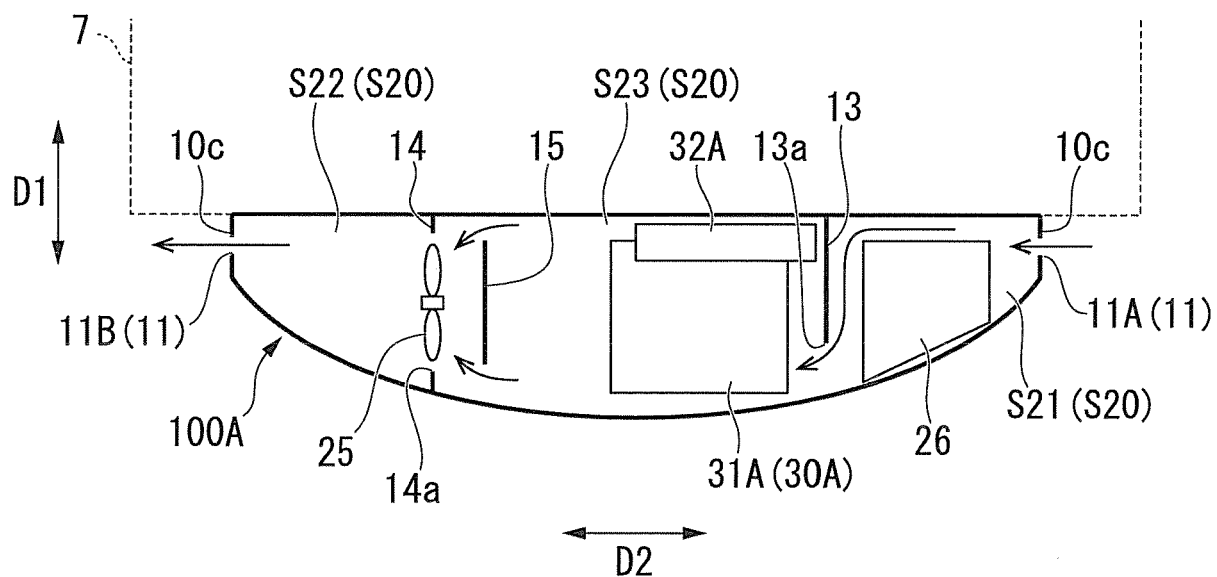


FIG. 8

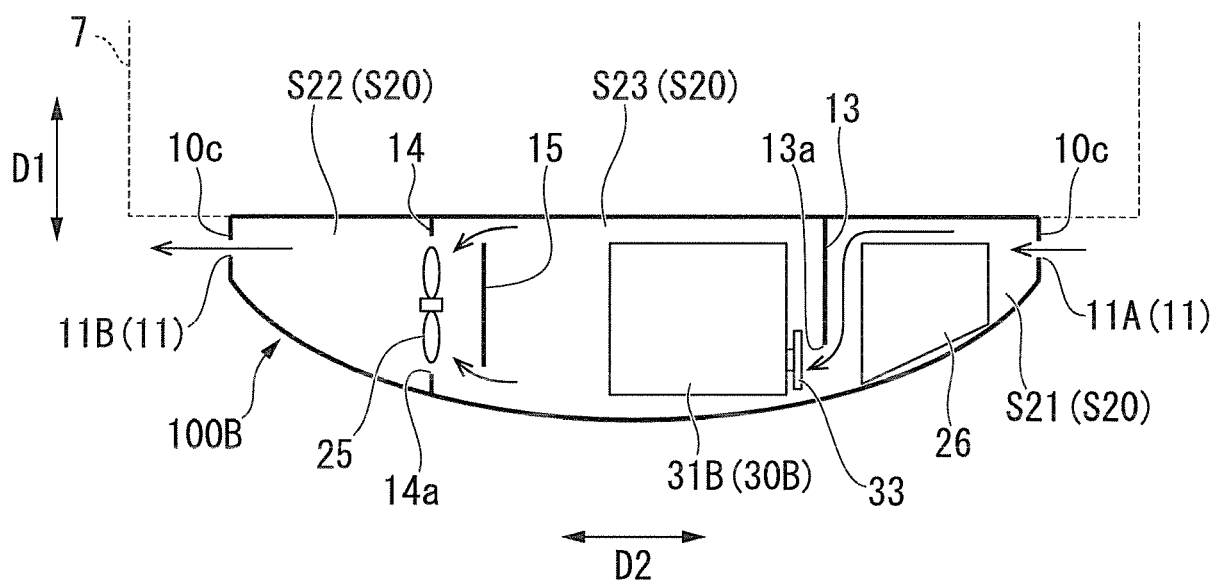


FIG. 9

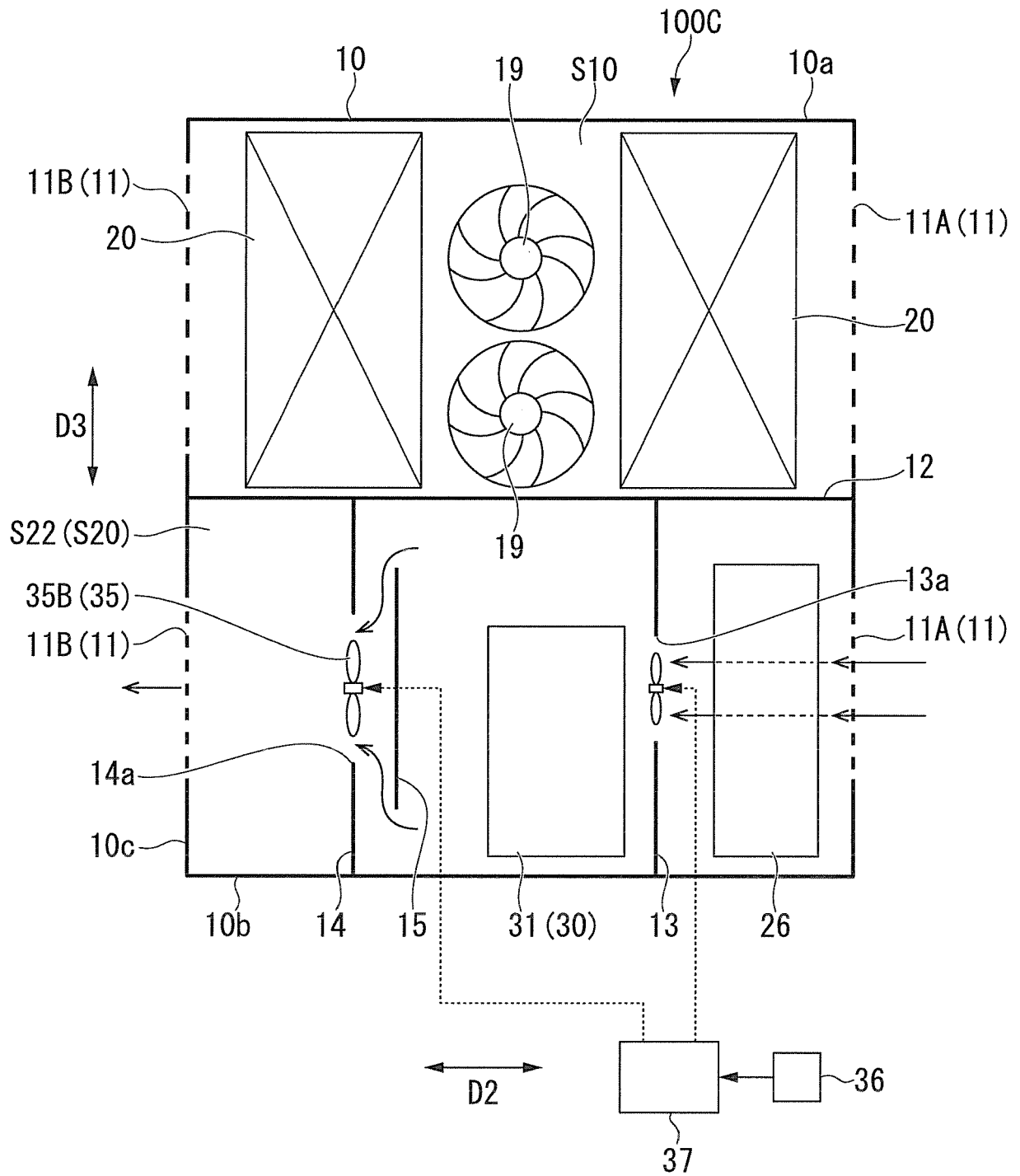
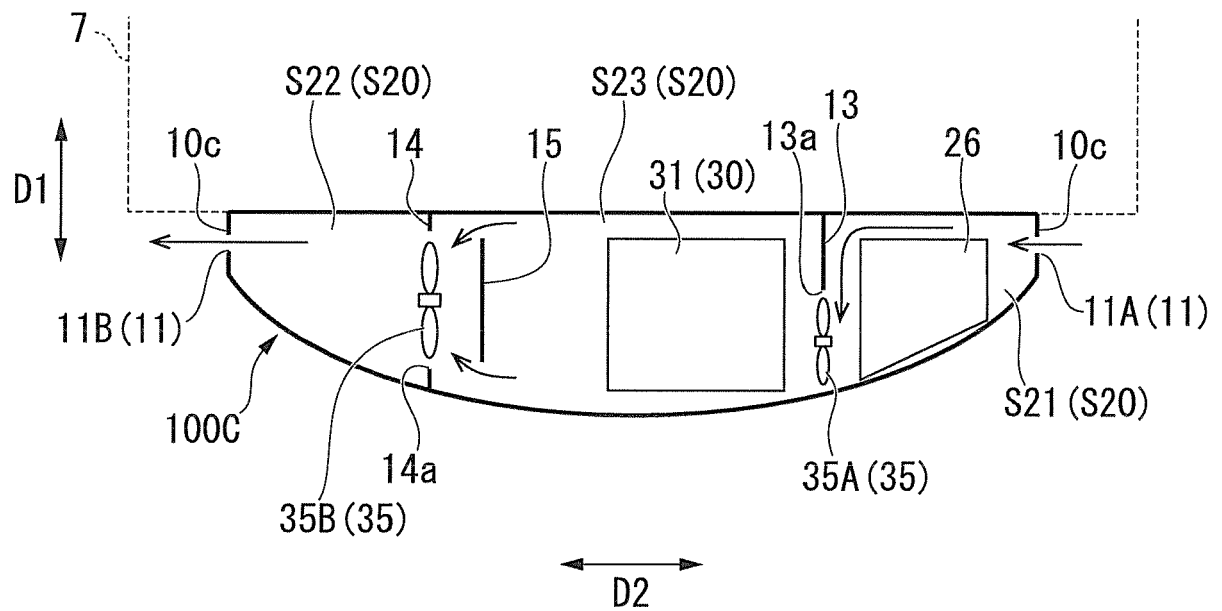


FIG. 10





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Place of search The Hague		Date of completion of the search 18 November 2016	Examiner Bejaoui, Amin
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