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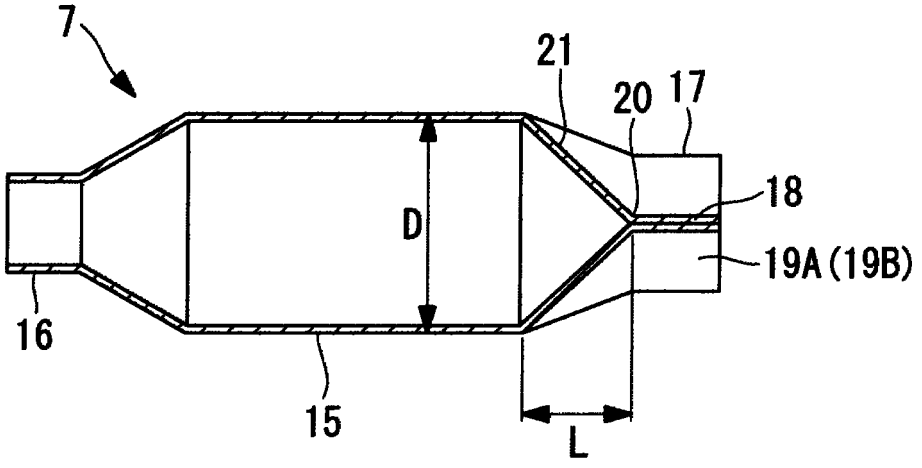
(54) Y-SHAPED MANIFOLD AND AIR CONDITIONER USING SAME

(57) A Y-shaped branch pipe (7) includes a pinch (18) formed by pinching middle portions at an end of a cylindrical pipe (15) to bring the portions into close contact with each other and a glasses-shaped bifurcated portion (17), formed on both sides of the pinch (18), that splits a refrigerant flow into two channels (19A, 19B), and L/D is 0.3 to 0.5, wherein L is the distance between a pinch base (20) at which the portions are brought into close contact with each other by pinching and a cylindrical portion of the cylindrical pipe (15), and D is the outer diameter of the cylindrical pipe (15).

FIG. 2B



EP 2 557 378 A1

Description

Technical Field

[0001] The present invention relates to Y-shaped branch pipes for installation at a branch point where a refrigerant flow splits into a plurality of heat exchangers or a plurality of heat exchanger circuits and to air conditioners using such pipes.

Background Art

[0002] In air conditioners, for example, branch pipes called Y-shaped branch pipes are conventionally used at a branch point where a refrigerant flow splits into a plurality of channels. A Y-shaped branch pipe has one end thereof connected to a main line on the refrigerant supply side and has two branch lines connected to a bifurcated portion at the other end thereof, thus functioning to split the refrigerant flowing from the main line into the branch lines. To evenly split the refrigerant into the branch lines, additionally, a strainer that functions to rectify the refrigerant flow is commonly built into the Y-shaped branch pipe (see, for example, PTLs 1 and 2).

[0003] A Y-shaped branch pipe, described above, includes a pinch formed by pinching middle portions at the end of a cylindrical pipe to bring the portions into close contact with each other and a bifurcated portion formed by forming two channels into which the refrigerant flow is split in a shape like a pair of glasses, to both sides of the pinch. This structure allows a strainer to be directly built into the cylindrical portion, reduces the center-to-center distance between the two channels of the bifurcated portion, and has some advantages over branch pipes using U-bend pipes, including a reduction in size (lengthwise and widthwise dimensions) of about 40% and reductions in the number of parts and cost.

Citation List

Patent Literature

[0004]

PTL 1
Japanese Unexamined Patent Application, Publication No. HEI-11-304297
PTL 2
Publication of Japanese Patent No. 3606732

Summary of Invention

Technical Problem

[0005] Manufacturers are obliged to affix the CE marking and to issue a declaration of conformity to declare that the products distributed comply with the European Union safety standards (EN). For air conditioners, units for which a CE declaration of conformity is to be issued must pass a pressure resistance test according to LVD (relevant standard: IEC 60335-2-40:2002 + A1:2005 + A2:2005), and refrigerant system components are required to have a sufficient pressure resistance to withstand the pressure that is three times the maximum pressure. In addition, the High Pressure Gas Safety Act stipulates that units with three or more legal refrigeration tons must withstand a pressure that is four or more times the design pressure.

[0006] For R410A refrigerants, which are used for air conditioners currently manufactured, the high-pressure-side design pressure is 4.15 MPa, with the low-pressure-side design pressure being 2.21 MPa, and accordingly the pressures that are three and four times this pressure are 12.45 and 16.6 MPa, respectively. A Y-shaped branch pipe, described above, includes a pinch formed by pinching middle portions at the end of a cylindrical pipe to bring the portions into close contact with each other and a glasses-shaped bifurcated portion that splits a refrigerant flow into two channels, and the distance between the pinch base and the cylindrical portion of the cylindrical pipe is relatively long, being substantially equal to the outer diameter of the cylindrical pipe. When exposed to the internal pressure according to the pressure resistance standards, therefore, the portion between the pinch base and the cylindrical portion of the cylindrical pipe expands into a spherical shape and experiences such a large displacement that the pinch base is stretched, becoming thin, which causes a problem in that a crack occurs easily.

[0007] For improved pressure resistance, one possible solution is to employ a branch pipe using a U-bend pipe, which has superior pressure resistance, although the branch pipe is, as mentioned above, at least 40% larger in size, which causes a problem in that it needs a change in piping layout because the piping layout might not be feasible, depending on the unit.

[0008] An object of the present invention, which has been made in light of such circumstances, is to obtain a compact Y-shaped branch pipe that satisfies the above pressure resistance standards and to provide an air conditioner using such a Y-shaped branch pipe.

Solution to Problem

[0009] To solve the problem described above, a Y-shaped branch pipe and an air conditioner using the Y-shaped branch pipe according to the present invention employ the following solutions.

That is, a Y-shaped branch pipe according to a first aspect of the present invention includes a pinch formed by pinching middle portions at an end of a cylindrical pipe to bring the portions into close contact with each other and a glasses-shaped bifurcated portion, formed on both sides of the pinch, that splits a refrigerant flow into two channels, and L/D is 0.3 to 0.5, wherein L is the distance between a pinch base at which the portions are brought into close contact with each other by pinching and a cylindrical portion of the cylindrical pipe, and D is the outer diameter of the cylindrical pipe.

[0010] For the Y-shaped branch pipe according to the first aspect of the present invention, L/D is 0.3 to 0.5, wherein L is the distance between the pinch base at which the portions are brought into close contact with each other by pinching the Y-shaped branch pipe and the cylindrical portion of the cylindrical pipe, and D is the outer diameter of the cylindrical pipe; because the distance L between the pinch base and the cylindrical portion of the cylindrical pipe is short relative to the outer diameter D of the cylindrical pipe, namely, L/D = 0.3 to 0.5, the pinch base expands by a smaller volume when exposed to an internal pressure satisfying the pressure resistance standards (a pressure that is three times the maximum pressure or, for units with three or more legal refrigeration tons, four or more times the design pressure), thus avoiding cracking of the pinch base. It is therefore possible to provide a compact Y-shaped branch pipe that can pass a pressure resistance test according to the household electrical appliance safety regulation "IEC 60335-2-40:2002 + A1: 2005 + A2:2005" of the international household electrical appliance safety standards "IEC 60335-1 Ed. 4" and therefore satisfies the pressure resistance standards.

[0011] In addition, a Y-shaped branch pipe according to a second aspect of the present invention includes a pinch formed by pinching middle portions at an end of a cylindrical pipe to bring the portions into close contact with each other and a glasses-shaped bifurcated portion, formed on both sides of the pinch, that splits a refrigerant flow into two channels, and a portion between a pinch base at which the portions are brought into close contact with each other by pinching and a cylindrical portion of the cylindrical pipe has a spherical shape.

[0012] For the Y-shaped branch pipe according to the second aspect of the present invention, the portion between the pinch base at which the portions are brought into close contact with each other by pinching the Y-shaped branch pipe and the cylindrical portion of the cylindrical pipe has a spherical shape; because the portion between the pinch base and the cylindrical portion of the cylindrical pipe has a spherical shape, which has the highest strength in terms of pressure resistance, the expansion of the pinch base upon exposure to an internal pressure satisfying the pressure resistance standards (a pressure that is three times the maximum pressure or, for units with three or more legal refrigeration tons, four or more times the design pressure) can be almost completely eliminated, thus avoiding cracking of the pinch base. It is therefore possible to provide a compact Y-shaped branch pipe that can pass a pressure resistance test according to the household electrical appliance safety regulation "IEC 60335-2-40:2002 + A1:2005 + A2: 2005" of the international household electrical appliance safety standards "IEC 60335-1 Ed. 4" and therefore satisfies the pressure resistance standards.

[0013] The Y-shaped branch pipes of the present invention preferably have through-holes provided in the pinch base.

[0014] For this configuration, because the through-holes are provided in the pinch base, when branch lines are brazed to the bifurcated portion of the Y-shaped branch pipe, the brazing alloy overflows from the through-holes, which makes it possible to determine that the brazing alloy has reached the pinch base and to further improve the pressure resistance strength by joining the through-holes to each other with the brazing alloy. It is therefore possible to provide a compact Y-shaped branch pipe that satisfies the pressure resistance standards and that can be easily inspected for its quality.

[0015] Furthermore, the Y-shaped branch pipes of the present invention preferably have a strainer installed in the cylindrical portion of the cylindrical pipe.

[0016] For this configuration, because the strainer is installed in the cylindrical portion of the cylindrical pipe, the refrigerant flow is rectified through the strainer installed in the cylindrical portion so that it can be evenly split into the two channels through the bifurcated portion. Therefore, the strainer can not only remove foreign matter from the refrigerant, but also enables a plurality of devices connected to the downstream side of the Y-shaped branch pipe to exhibit equal performance.

[0017] Furthermore, an air conditioner according to a third aspect of the present invention includes a Y-shaped branch pipe disposed at a branch point where a refrigerant flow splits into two channels in a refrigerant circuit, and the Y-shaped branch pipe is one of the Y-shaped branch pipes described above.

[0018] In the air conditioner according to the third aspect of the present invention, which includes the Y-shaped branch pipe disposed at the branch point where the refrigerant flow splits into the two channels in the refrigerant circuit, because the Y-shaped branch pipe is one of the Y-shaped branch pipes described above, the Y-shaped branch pipe, which is compact and satisfies the pressure resistance standards, can be used without modification for the branch point where the refrigerant flow splits into the two channels. It is therefore possible to provide a compact air conditioner that satisfies the pressure resistance standards without facing a problem such as the need to change the piping layout due to an increased branch pipe size for improved pressure resistance.

{Advantageous Effects of Invention}

[0019] For the Y-shaped branch pipe of the present invention, because the distance L between the pinch base and the cylindrical portion of the cylindrical pipe is short relative to the outer diameter D of the cylindrical pipe, namely, L/D = 0.3 to 0.5, the pinch base expands by a smaller volume when exposed to an internal pressure satisfying the pressure resistance standards, thus avoiding cracking of the pinch base. It is therefore possible to provide a compact Y-shaped branch pipe that can pass a pressure resistance test according to the household electrical appliance safety regulation "IEC 60335-2-40:2002 + A1:2005 + A2:2005" of the interna-

tional household electrical appliance safety standards "IEC 60335-1 Ed. 4" and therefore satisfies the pressure resistance standards.

[0020] In addition, for the Y-shaped branch pipe of the present invention, because the portion between the pinch base and the cylindrical portion of the cylindrical pipe has a spherical shape, which has the highest strength in terms of pressure resistance, the expansion of the pinch base upon exposure to an internal pressure satisfying the pressure resistance standards can be almost completely eliminated, thus avoiding cracking of the pinch base; therefore, it is possible to provide a compact Y-shaped branch pipe that can pass a pressure resistance test according to the household electrical appliance safety regulation "IEC 60335-2-40:2002 + A1:2005 + A2: 2005" of the international household electrical appliance safety standards "IEC 60335-1 Ed. 4" and therefore satisfies the pressure resistance standards.

[0021] Furthermore, because the air conditioner of the present invention can use the Y-shaped branch pipes, which are compact and satisfy the pressure resistance standards, without modification for the branch point where the refrigerant flow splits into the two channels, it is possible to provide a compact air conditioner that satisfies the pressure resistance standards without facing a problem such as the need to change the piping layout due to an increased branch pipe size for improved pressure resistance.

Brief Description of Drawings

[0022]

Fig. 1
Fig. 1 is a refrigerant circuit diagram of an air conditioner using a Y-shaped branch pipe according to the present invention.
Fig. 2A
Fig. 2A is a partially cutaway sectional view of an embodiment of the Y-shaped branch pipe used in the air conditioner shown in Fig. 1.
Fig. 2B
Fig. 2B is a sectional view taken along line a-a of Fig. 2A.
Fig. 2C
Fig. 2C is a right side view of Fig. 2A.
Fig. 3A
Fig. 3A is a partially cutaway sectional view of another embodiment of the Y-shaped branch pipe used in the air conditioner shown in Fig. 1.
Fig. 3B
Fig. 3B is a sectional view taken along line b-b of Fig. 3A.
Fig. 3C
Fig. 3C is a right side view of Fig. 3A.
Fig. 4A
Fig. 4A is a view, equivalent to a sectional view taken along line a-a, of another embodiment of the Y-shaped branch pipe shown in Figs. 2A to 2C.
Fig. 4B
Fig. 4B is a view, equivalent to a sectional view taken along line b-b, of another embodiment of the Y-shaped branch pipe shown in Figs. 3A to 3C.
Fig. 5
Fig. 5 is a table showing the results of a pressure resistance test on the Y-shaped branch pipes shown in Figs. 2A to 2C and Figs. 3A to 3C.

Description of Embodiments

[0023] Embodiments of the present invention will be described below with reference to the drawings.

First Embodiment

[0024] A first embodiment of the present invention will be described below using Figs. 1, 2A to 2C, and 5.

Fig. 1 shows a refrigerant circuit diagram of an air conditioner using a Y-shaped branch pipe according to the present invention, and Figs. 2A to 2C show an embodiment of the Y-shaped branch pipe used in the refrigerant circuit.

An air conditioner 1 includes a compressor 2, a four-way switch valve 3, an outdoor heat exchanger 4, an outdoor expansion valve 5, a receiver 6, a Y-shaped branch pipe 7, a plurality of indoor expansion valves 8A and 8B and indoor heat exchangers 9A and 9B connected in parallel with each other via the Y-shaped branch pipe 7, an accumulator 10, and so on, which are sequentially connected via refrigerant piping 11 to form a closed-cycle refrigerant circuit 12. The outdoor heat exchanger 4 is equipped with an outdoor fan 13, and the indoor heat exchangers 9A and 9B are equipped with indoor fans 14A and 14B, respectively.

[0025] The Y-shaped branch pipe 7 is installed at a branch point where a refrigerant splits into the plurality of indoor heat exchangers 9A and 9B in the refrigerant circuit 12 and, as shown in Figs. 2A to 2C, includes a cylindrical pipe 15 having a pipe-connecting portion 16 formed at one end thereof, with a main line 11A on the refrigerant supply side connected thereto, and a bifurcated portion 17 formed at the other end thereof, with a plurality of (two) branch lines 11B and 11C connected thereto. Here, for example, the cylindrical pipe 15 of the Y-shaped branch pipe 7 has a wall thickness of 1.2 mm and an outer diameter of 25.4 mm, the pipe-connecting portion 16 has an inner diameter of 9.52 mm, and the bifurcated portion 17 has an inner diameter of 12.7 mm.

[0026] The bifurcated portion 17 of the Y-shaped branch pipe 7 is formed by pinching middle portions at the end of the cylindrical pipe 15 to bring the portions into close contact with each other, thereby forming a pinch 18, and forming a pair of channels 19A and 19B into which a refrigerant flow is split in a shape like a pair of glasses on both sides of the pinch 18, at which the portions are brought into close contact with each other. In

this embodiment, L is set such that L/D = 0.3 to 0.5 is satisfied, where L is the distance between a pinch base 20, formed by the pinch 18, of the bifurcated portion 17 and the cylindrical portion of the cylindrical pipe 15, and D is the outer diameter of the cylindrical pipe 15.

[0027] Because the outer diameter D of the cylindrical pipe 15 is 25.4 mm, as described above, 0.3 to 0.5 times the outer diameter D is 7.62 to 12.7 mm; in this embodiment, the distance L is 12 mm. In this embodiment, additionally, the portion between the pinch base 20 and the cylindrical portion of the cylindrical pipe 15 has a deformed conical shape 21 that varies in shape linearly, as shown in Figs. 2A to 2C.

[0028] Furthermore, a metal mesh strainer 30 having a cap shape that opens at one end thereof is built into the cylindrical pipe 15 to remove foreign matter from the refrigerant and to rectify the refrigerant flow reaching the bifurcated portion 17 so that the refrigerant splits evenly into the two channels 19A and 19B.

[0029] With the configuration described above, this embodiment provides the following advantageous effects.

In the above air conditioner 1, the refrigerant supplied from the receiver 6 through the main line 11A to the Y-shaped branch pipe 7 has foreign matter removed therefrom by the strainer 30 in the Y-shaped branch pipe 7 while being rectified as it passes through the metal mesh, and flows into the bifurcated portion 17, through which the refrigerant is substantially evenly split into the two channels 19A and 19B separated by the pinch 18. The refrigerant then flows through the indoor expansion valves 8A and 8B into the indoor heat exchangers 9A and 9B, respectively, where the refrigerant is subjected to heat exchange with indoor air circulated by the indoor fans 14A and 14B for indoor air conditioning.

[0030] The Y-shaped branch pipe 7, which is a refrigerant system component, needs to satisfy the pressure resistance strength stipulated in the relevant standards. In this embodiment, the Y-shaped branch pipe 7 includes the pinch 18 formed by pinching middle portions at the end of the cylindrical pipe 15 to bring the portions into close contact with each other and the glasses-shaped bifurcated portion 17, formed on both sides of the pinch 18, that splits the refrigerant flow into the two channels 19A and 19B, and L/D is set in the range 0.3 to 0.5, where L is the distance between the pinch base 20, at which the portions are brought into close contact with each other by pinching the Y-shaped branch pipe 7, and the cylindrical portion of the cylindrical pipe 15, and D is the outer diameter of the cylindrical pipe 15.

[0031] When exposed to the internal pressure according to the pressure resistance standards, therefore, the portion between the pinch base 20 and the cylindrical portion of the cylindrical pipe 15, if it deforms and expands into a spherical shape, experiences a smaller displacement, which avoids cracking due to stretching and thinning of the pinch base 20. It is therefore possible to provide a compact Y-shaped branch pipe 7 that can pass a pressure resistance test according to the household electrical appliance safety regulation "IEC 60335-2-40:2002 + A1:2005 + A2:2005" of the international household electrical appliance safety standards "IEC 60335-1 Ed. 4" and therefore satisfies the pressure resistance standards.

[0032] If the distance L is set such that L/D = 0.3 to 0.5, the maximum displacement experienced by the portion between the pinch base 20 and the cylindrical portion of the cylindrical pipe 15 as it expands into a spherical shape can be reduced to about half that for the case where $L \approx D$ (if the maximum displacement for the case where $L \approx D$ is 6.56 mm, it can be reduced to about half the displacement, namely, to 3.72 mm). Fig. 5 shows the results of a pressure resistance test on them. The results show that the burst pressure, which was 12.9 MPa before the improvement, that is, for the case where $L \approx D$, increased to 19.93 MPa after the improvement, that is, for the case where L/D = 0.3 to 0.5 (specifically, the outer diameter D was 25.4 mm, the distance L was 12 mm, and L/D was about 0.47), which is about 65% higher than before the improvement, demonstrating that the burst pressure strength was four or more times the high-pressure-side design pressure for R410A refrigerants, namely, 4.15 MPa.

[0033] In addition, because the strainer 30 is installed in the cylindrical portion of the cylindrical pipe 15, the strainer 30 installed in the cylindrical portion rectifies the refrigerant flow so that it can be evenly split into the two channels 19A and 19B through the bifurcated portion 17. Therefore, the strainer 30 can not only remove foreign matter from the refrigerant, but also enables the plurality of indoor heat exchangers 9A and 9B connected to the downstream side of the Y-shaped branch pipe 7 to exhibit equal performance.

[0034] Furthermore, because the air conditioner 1, which splits a refrigerant flow into two channels through a branch pipe, can use the Y-shaped branch pipe 7, which is compact and satisfies the pressure resistance standards, without modification, it is possible to provide a compact air conditioner 1 that satisfies the pressure resistance standards without facing a problem such as the need to change the piping layout due to an increased branch pipe size for improved pressure resistance.

Second Embodiment

[0035] Next, a second embodiment of the present invention will be described using Figs. 3A to 3C.

This embodiment differs from the first embodiment described above in the shape of the portion of the Y-shaped branch pipe 7 between the pinch base 20 and the cylindrical portion of the cylindrical pipe 15. For the other points, this embodiment is similar to the first embodiment, and therefore a description thereof is omitted.

In this embodiment, as shown in Figs. 3A to 3C, the portion of the Y-shaped branch pipe 7 between the pinch base 20 and the cylindrical portion of the cylindrical pipe

15 has a spherical shape 22 with a radius R. In this case, the radius R is 12.7 mm for the cylindrical pipe 15, which has an outer diameter D of 25.4 mm.

[0036] If the portion of the Y-shaped branch pipe 7 between the pinch base 20 and the cylindrical portion of the cylindrical pipe 15 has the spherical shape 22 with the radius R, as above, the pressure resistance strength can be further increased as compared with the first embodiment, although that portion is slightly more difficult to form. This embodiment can therefore provide the same advantages as the first embodiment, including the ability to provide a compact Y-shaped branch pipe 7 that can pass a pressure resistance test according to the household electrical appliance safety regulation "IEC 60335-2-40:2002 + A1:2005 + A2:2005" of the international household electrical appliance safety standards "IEC 60335-1 Ed. 4" and therefore satisfies the pressure resistance standards.

Third Embodiment

[0037] Next, a third embodiment of the present invention will be described using Figs. 4A and 4B.

This embodiment differs from the first and second embodiments described above in that the Y-shaped branch pipe 7 has through-holes formed in the pinch base 20. For the other points, this embodiment is similar to the first and second embodiments, and therefore a description thereof is omitted.

In this embodiment, as shown in Figs. 4A and 4B, the Y-shaped branch pipes 7 of the first and second embodiments have through-holes 23A and 23B formed in the pinch base 20.

[0038] If the through-holes 23A and 23B are formed in the pinch base 20, as above, when the branch lines 11A and 11B are connected and brazed to the bifurcated portion 17, the brazing alloy overflows from inside through the through-holes 23A and 23B to form fillets 24A and 24B in the through-holes 23A and 23B, respectively. This makes it possible to determine that the brazing alloy has reached the pinch base 20 and to further improve the pressure resistance strength by joining the through-holes 23A and 23B to each other with the brazing alloy. It is therefore possible to provide a compact Y-shaped branch pipe 7 that satisfies the pressure resistance standards and that can be easily inspected for its quality.

[0039] Fig. 5 shows the results of a pressure resistance test on the Y-shaped branch pipe 7, as shown in the first embodiment, to which the through-hole 23A was added (with hole; plan B). In this case, the burst pressure was 20.07 MPa, demonstrating that it increased slightly as compared with the one without the through-hole 23A (plan A).

[0040] The present invention is not limited to the invention according to the above embodiments; it can be appropriately modified without departing from the spirit thereof. For example, while the above embodiments have been illustrated with the example in which the Y-shaped branch pipe 7 is installed at the branch point where the refrigerant splits into the plurality of indoor heat exchangers 9A and 9B, they can also be applied to a Y-shaped branch pipe for installation at a branch point where a refrigerant splits into refrigerant lines of a plurality of heat exchanger circuits. Reference Signs List

[0041]

1 air conditioner
7 Y-shaped branch pipe
15 cylindrical pipe
17 bifurcated portion
18 pinch
19A, 19B two channels
20 pinch base
22 spherical shape
23A, 23B through-hole
30 strainer
D outer diameter of cylindrical pipe
L distance between pinch base and cylindrical portion of cylindrical pipe
R radius of spherical portion

Claims

1. A Y-shaped branch pipe comprising a pinch formed by pinching middle portions at an end of a cylindrical pipe to bring the portions into close contact with each other and a glasses-shaped bifurcated portion, formed on both sides of the pinch, that splits a refrigerant flow into two channels,
wherein L/D is 0.3 to 0.5, wherein L is the distance between a pinch base at which the portions are brought into close contact with each other by pinching and a cylindrical portion of the cylindrical pipe, and D is the outer diameter of the cylindrical pipe.

2. A Y-shaped branch pipe comprising a pinch formed by pinching middle portions at an end of a cylindrical pipe to bring the portions into close contact with each other and a glasses-shaped bifurcated portion, formed on both sides of the pinch, that splits a refrigerant flow into two channels,
wherein a portion between a pinch base at which the portions are brought into close contact with each other by pinching and a cylindrical portion of the cylindrical pipe has a spherical shape.

3. The Y-shaped branch pipe according to Claim 1 or 2, wherein through-holes are provided in the pinch base.

4. The Y-shaped branch pipe according to one of Claims 1 to 3, wherein a strainer is installed in the cylindrical portion of the cylindrical pipe.

5. An air conditioner comprising a Y-shaped branch

pipe disposed at a branch point where a refrigerant flow splits into two channels in a refrigerant circuit, wherein the Y-shaped branch pipe is the Y-shaped branch pipe according to one of Claims 1 to 4.

FIG. 1

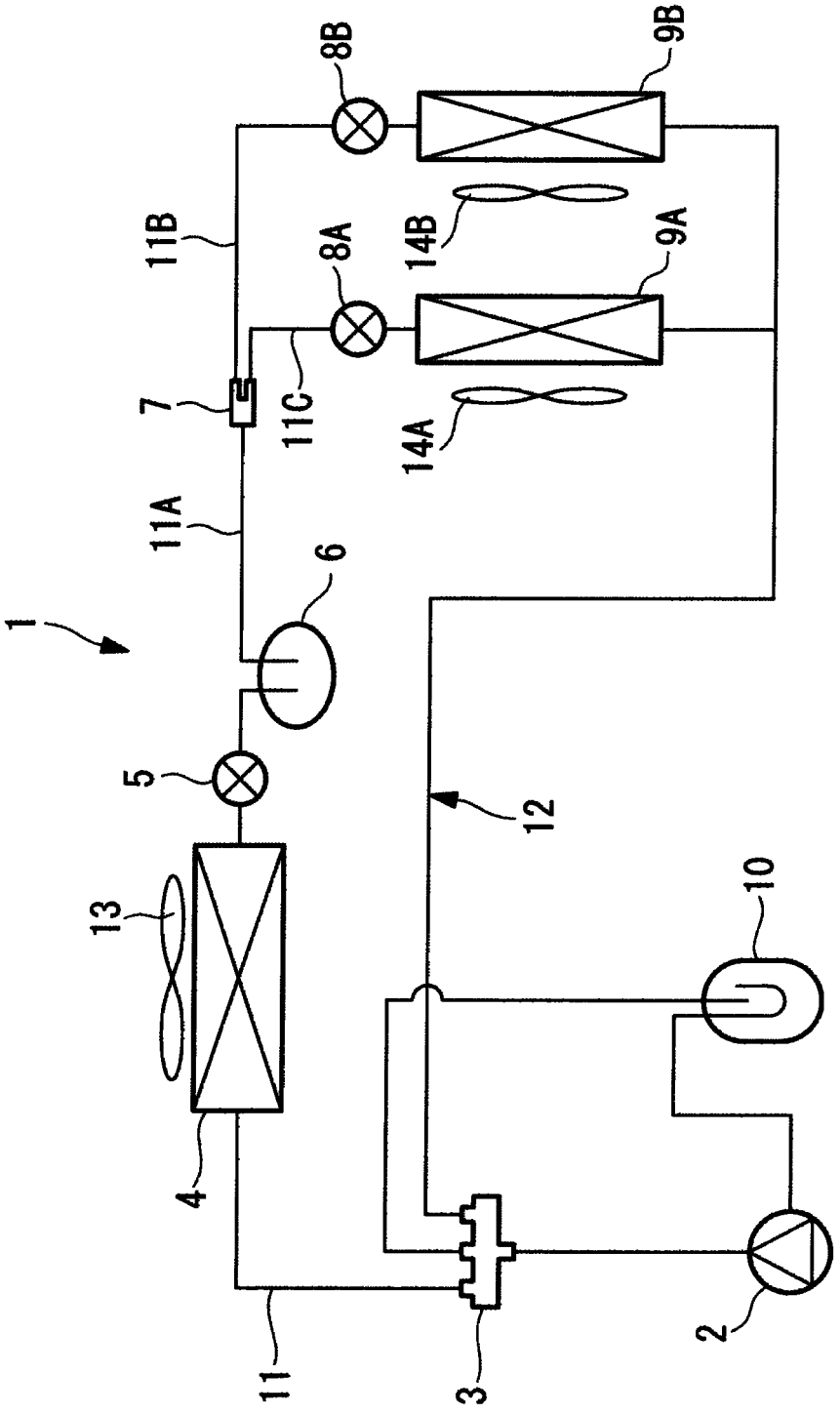


FIG. 2A

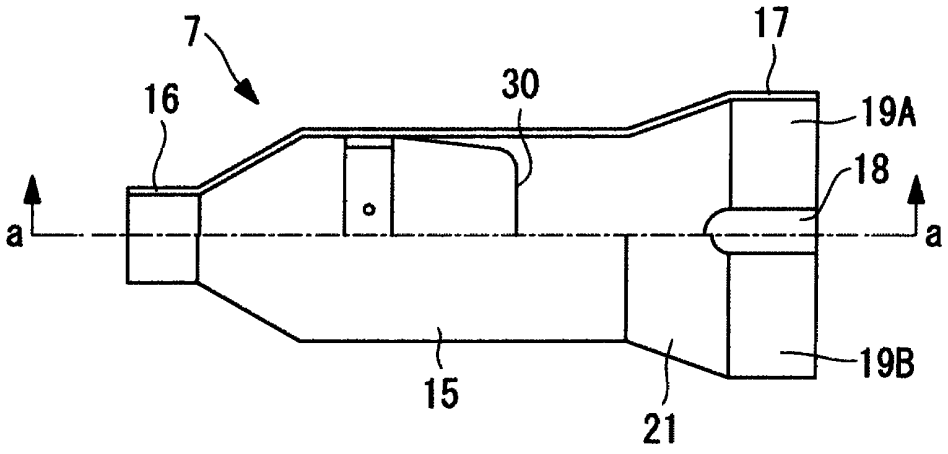


FIG. 2B

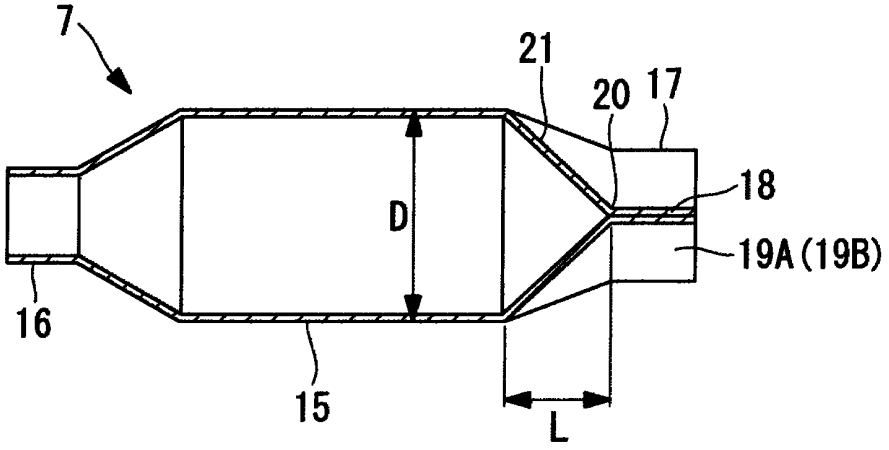


FIG. 2C

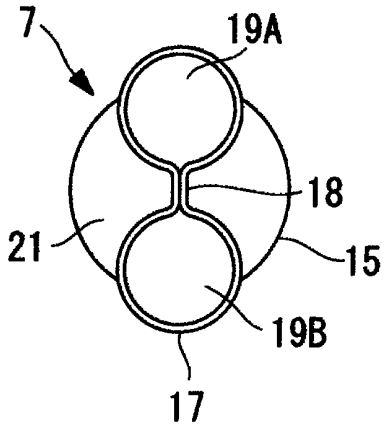


FIG. 3A

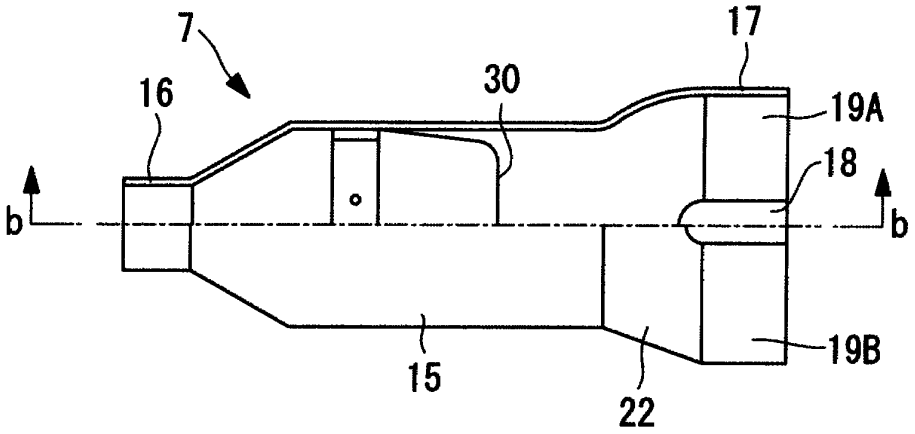


FIG. 3B

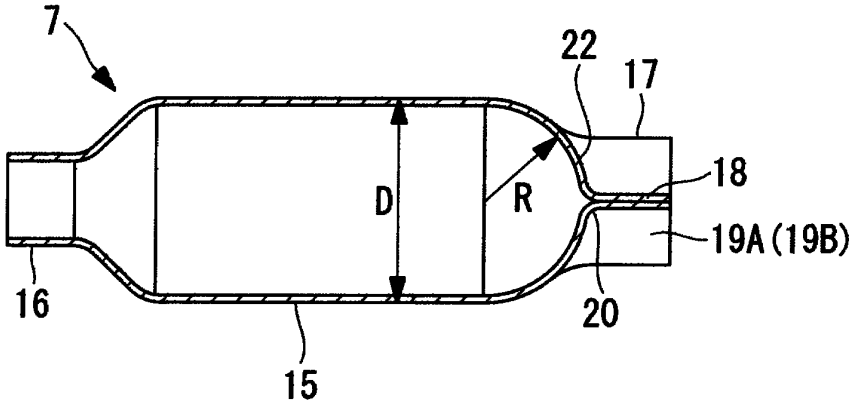


FIG. 3C

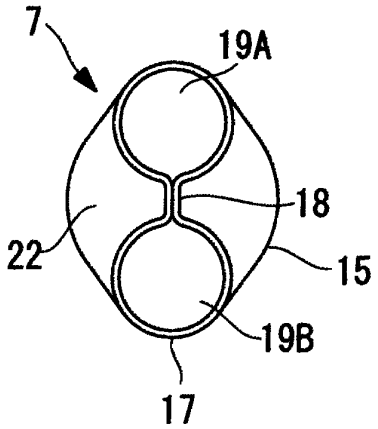


FIG. 4A

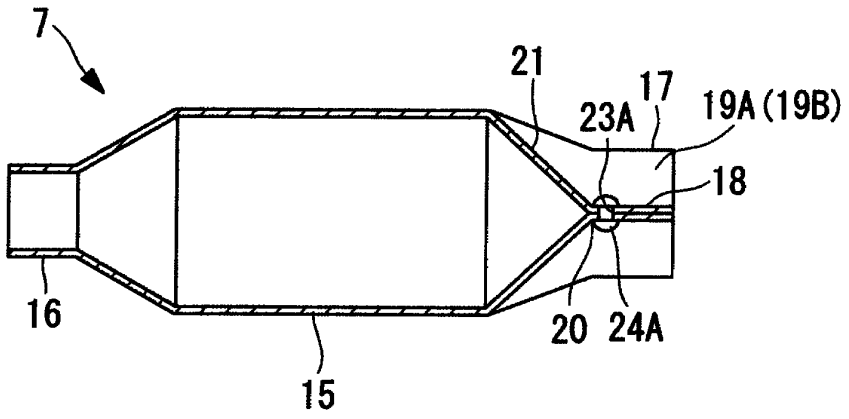

7
21
17
23A
19A (19B)
18
16
20
24A
15

FIG. 4B

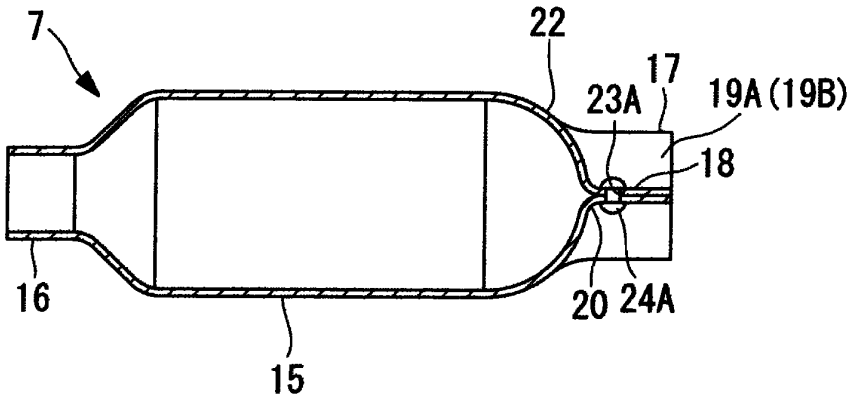

7
22
17
23A
19A (19B)
18
16
20
24A
15

FIG. 5

RESULTS OF PRESSURE RESISTANCE TEST (MPa)

	BEFORE IMPROVEMENT	AFTER IMPROVEMENT
WITHOUT HOLE (PLAN A)	12.9	19.93
WITH HOLE (PLAN B)		20.07

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2011/058413

A. CLASSIFICATION OF SUBJECT MATTER
F25B41/00(2006.01)i, *F25B43/00*(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F25B41/00, F25B43/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2011
Kokai Jitsuyo Shinan Koho 1971-2011 Toroku Jitsuyo Shinan Koho 1994-2011

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	JP 10-300277 A (Goh Shoji Co., Inc.), 13 November 1998 (13.11.1998), paragraphs [0002], [0003], [0010] to [0012]; fig. 7 (Family: none)	1-3 4,5
X Y	JP 10-339521 A (Goh Shoji Co., Inc.), 22 December 1998 (22.12.1998), paragraphs [0002], [0003]; fig. 11 (Family: none)	1,2 4,5
Y	JP 11-304297 A (Aisin Seiki Co., Ltd.), 05 November 1999 (05.11.1999), paragraphs [0010] to [0012]; fig. 1 to 5 (Family: none)	4,5

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
02 June, 2011 (02.06.11)	14 June, 2011 (14.06.11)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2011/058413

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2007-64489 A (Sanyo Electric Co., Ltd.), 15 March 2007 (15.03.2007), fig. 5, 6 (Family: none)	1-5
A	JP 2006-266563 A (Matsushita Electric Industrial Co., Ltd.), 05 October 2006 (05.10.2006), entire text; all drawings (Family: none)	1-5
A	JP 2007-32921 A (Kakinuma Kinzoku Seiki Co., Ltd.), 08 February 2007 (08.02.2007), entire text; all drawings (Family: none)	1-5
A	JP 11-125379 A (Mitsubishi Electric Corp.), 11 May 1999 (11.05.1999), entire text; all drawings (Family: none)	1-5

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP HEI11304297 B **[0004]**
- JP 3606732 B **[0004]**