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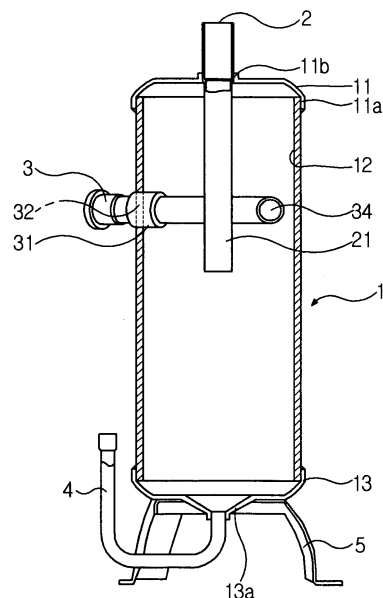
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**(54) Oil separator for air conditioner**

(57) An oil separator for an air conditioner includes a cylindrical housing (1); a refrigerant discharge pipe communicating with the housing for discharging refrigerant gas; an oil discharge pipe (4) for circulating oil collected in the lower portion of the housing; and a refrigerant inflow pipe (3) having one end facing the inner surface of a side wall of the housing in the tangential direction for supplying a refrigerant-oil mixture to the inside of the housing. An insertion hole (32), into which the refrigerant inflow pipe (3) is inserted, is easily formed, the efficiency of the oil separator is increased, and noise and vibration generated from the oil separator is reduced.

Fig.1



## Description

### BACKGROUND OF THE INVENTION

#### 1. Field of the Invention

**[0001]** The present invention relates to an air conditioner, and more particularly, to an oil separator for an air conditioner, in which the shape of a housing, the structure of a refrigerant inflow pipe, and the structure of a gas discharge pipe are improved, thereby increasing an oil separating efficiency and reducing the generation of noise and vibration.

#### 2. Description of the Related Art

**[0002]** Generally, air conditioners are divided into integration type air conditioners in which indoor and outdoor units are integrally formed and split type air conditioners in which indoor and outdoor units are separated from each other. A split type air conditioner includes an outdoor unit and an indoor unit. The outdoor unit has a compressor for compressing a refrigerant into a high-temperature and high-pressure state, an oil separator for separating oil from the compressed refrigerant discharged from the compressor, a condenser for condensing the compressed refrigerant by exchanging heat with outdoor air, and an expansion device for adiabatically expanding the refrigerant condensed by the condenser. The indoor unit has an evaporator for evaporating the refrigerant, having passed through the expansion device, by exchanging heat with indoor air.

**[0003]** The oil separator is an apparatus which allows oil from a refrigerant-oil mixture to flow along the inner wall of a cylinder and to be collected in a lower portion of the cylinder, and allows gas from the mixture to be discharged to the outside through a refrigerant discharge pipe formed through an upper portion of the cylinder, thereby separating the oil and the gas from each other. That is, the oil separator allows the mixture to rotate and flow down along the inner wall of the cylinder by centrifugal force so that the oil is collected in the lower portion of the cylinder and the gas is discharged to the outside through the refrigerant discharge pipe formed through the upper end of the cylinder by the rotating air current. The oil separator employs the principle of a cyclone. In order to separate the oil and the gas from each other using the above principle, the mixture must be initially supplied to the inner wall of the cylinder in the tangential direction.

**[0004]** For this reason, the conventional oil separator has a structure in which a hole for supplying the mixture in the tangential direction is formed through the side wall of the cylinder and a refrigerant inflow pipe for supplying the mixture into the cylinder therethrough is inserted into the hole formed through the side wall at a designated angle. In the above structure, since the hole is not formed perpendicularly through the side wall of the cylinder but

is formed through the side wall of the cylinder at the designated angle, it is difficult to form the hole through the oil separator and costs required to form the hole through the oil separator are high.

**[0005]** Another conventional oil separator having a structure in which a refrigerant inflow pipe for supplying a refrigerant-oil mixture into the oil separator passes through the side wall of a cylinder at a right angle and is inserted towards the central portion of the cylinder such that the end of the refrigerant inflow pipe is bent towards the side wall of the cylinder has been proposed.

**[0006]** Korean Patent Laid-open Publication No. 2004-0105264 discloses the above conventional oil separator. Such a conventional oil separator solves the problems, such as the difficulty in forming a hole through the oil separator and the increase in costs required to form the hole through the oil separator. However, since the mixture does not flow along the inner wall of the cylinder in the tangential direction but hits the inner wall of the cylinder, the above conventional oil separator causes increased noise and vibration. The reason is that a compressor discharges the mixture in a pulse mode.

### SUMMARY OF THE INVENTION

**[0007]** Therefore, one aspect of the invention is to provide an oil separator, in which a refrigerant inflow pipe for supplying a refrigerant-oil mixture into the oil separator is simply installed so that and noise and vibration can be reduced.

**[0008]** In accordance with one aspect, the present invention provides an oil separator for an air conditioner including: a cylindrical housing; a refrigerant inflow pipe for supplying a refrigerant-oil mixture to the inside of the housing; a refrigerant discharge pipe for discharging refrigerant separated from the mixture to the outside of the oil separator; and an oil discharge pipe for returning oil separated from the mixture to a compressor, wherein one end of the refrigerant inflow pipe faces the inner surface of a side wall of the housing in the tangential direction.

**[0009]** The refrigerant inflow pipe may be bent in a gentle curve at a portion thereof which is inserted into the housing.

**[0010]** The refrigerant inflow pipe may be bent again in the reverse direction to the bent portion so that the refrigerant inflow pipe has an approximately "S" shape.

**[0011]** The refrigerant inflow pipe may be inserted into a through hole, formed through the side wall of the housing, at a designated angle.

**[0012]** The refrigerant inflow pipe may be inserted perpendicularly into a through hole formed through the side wall of the housing.

**[0013]** The refrigerant inflow pipe may pass through the side wall of the housing and be divided into a plurality of branched pipes, and ends of the branched pipes may be bent in the tangential direction towards the side wall.

**[0014]** The refrigerant inflow pipe may be located at a position having a height corresponding to 70~85% of the

height of the housing.

**[0015]** The end of the refrigerant inflow pipe facing the inner surface of the side wall of the housing in the tangential direction may be cut at a designated angle.

**[0016]** A long side of the cut section of the end of the refrigerant inflow pipe may contact the inner surface of the side wall of the housing, and be fixed to the side wall.

**[0017]** In accordance with another aspect, the present invention provides an oil separator for an air conditioner including: a cylindrical housing; a refrigerant inflow pipe for supplying a refrigerant-oil mixture to the inside of the housing; a refrigerant discharge pipe for discharging refrigerant separated from the mixture to the outside of the oil separator; and an oil discharge pipe for returning oil separated from the mixture to a compressor, wherein the housing has a conical shape so that the housing is broadened from the upper portion thereof to the lower portion thereof.

**[0018]** The side wall of the housing may meet the vertical line at an angle of 30° or less, and the refrigerant inflow pipe may be located at a position having a height corresponding to 70~85% of the height of the housing.

**[0019]** In accordance with yet another aspect, the present invention provides an oil separator for an air conditioner including: a cylindrical housing; a refrigerant inflow pipe for supplying a refrigerant-oil mixture to the inside of the housing; a refrigerant discharge pipe for discharging refrigerant separated from the mixture to the outside of the oil separator; and an oil discharge pipe for returning oil separated from the mixture to a compressor, wherein a plurality of fine pipes having a designated length are formed at one end of the refrigerant discharge pipe located in the housing and serve as a muffler for reducing noise in the housing.

**[0020]** The fine pipes may be formed by pressing a gas discharge pipe.

**[0021]** Additional aspects and/or advantages of the invention will be set forth in part in the description which follows and, in part, will be apparent from the description, or may be learned by practice of the invention.

#### BRIEF DESCRIPTION OF THE DRAWINGS

**[0022]** These and/or other aspects and advantages of the invention will become apparent and more readily appreciated from the following description of the embodiments, taken in conjunction with the accompanying drawings in which:

FIG. 1 is a longitudinal sectional view of an oil separator for an air conditioner in accordance with the present invention;

FIG. 2 is a transversal sectional view of a refrigerant inflow pipe of an oil separator of an air conditioner in accordance with a first embodiment of the present invention;

FIG. 3 is a transversal sectional view of a refrigerant inflow pipe of an oil separator of an air conditioner

in accordance with a second embodiment of the present invention;

FIG. 4 is a transversal sectional view of a refrigerant inflow pipe of an oil separator of an air conditioner in accordance with a third embodiment of the present invention;

FIG. 5 is a transversal sectional view of a refrigerant inflow pipe of an oil separator of an air conditioner in accordance with a fourth embodiment of the present invention;

FIG. 6 is a transversal sectional view of a refrigerant inflow pipe of an oil separator of an air conditioner in accordance with a fifth embodiment of the present invention;

FIG. 7 is a longitudinal sectional view illustrating the structure of a housing, which can be applied to the oil separators of the respective embodiments of the present invention;

FIG. 8 is a perspective view illustrating a gas discharge pipe, which can be applied to the oil separators of the respective embodiments of the present invention; and

FIG. 9 is a table for comparing noise generated from an oil separator, to which a conventional refrigerant inflow pipe is applied, and noise generated from the oil separator, to which the refrigerant inflow pipe in accordance with the second embodiment of the present invention is applied.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

**[0023]** Reference will now be made in detail to the embodiments of the present invention, an example of which is illustrated in the accompanying drawings, wherein like reference numerals refer to like elements throughout. The embodiments are described below to explain the present invention by referring to the annexed drawings.

**[0024]** FIG. 1 is a longitudinal sectional view of an oil separator for an air conditioner in accordance with the present invention.

**[0025]** The oil separator includes a housing 1 for forming the external appearance thereof. An opening formed through the upper surface of the housing 1 is sealed by an upper cap member 11. The upper cap member 11 has a plate shape, and has a connection portion 11 a, which is extended from the edge thereof and connected to a side wall 12 of the housing 1. The upper cap member 11 is connected to the side wall 12 of the housing 1 by various methods, such as interference fit and welding, as long as the connection withstands the high pressure of the inside of the housing 1. A first insertion hole 11 b is formed through the central portion of the upper cap member 11 such that the inner wall of the first insertion hole 11 b is not spaced from the outer circumferential surface of a refrigerant discharge pipe 2.

**[0026]** The refrigerant discharge pipe 2 is inserted into the first insertion hole 11 b. The refrigerant discharge

pipe 2 serves to discharge a refrigerant gas, separated from a refrigerant-oil mixture by the oil separator, to the outside of the oil separator. A suction terminal 21 of the refrigerant discharge pipe 2 may be positioned in the upper portion of the housing 1, in which the refrigerant gas is collected by an ascending air current.

**[0027]** The side wall 12 serves to form the housing 1, and a second insertion hole 32, into which a refrigerant inflow pipe 3 is inserted, is formed through a designated portion of the side wall 12. A bushing 31 is installed at the second insertion hole 32, thereby allowing the refrigerant inflow pipe 3 to be easily inserted into the housing 1 and supporting the refrigerant inflow pipe 3.

**[0028]** A lower cap member 13 is provided on the lower portion of the housing 1. Similar to the upper cap member 11, the lower cap member 13 is connected to the side wall 12 of the housing 1. The bottom surface of the lower cap member 13 may be concave so that oil separated from the refrigerant gas by the oil separator is stored in the concave bottom surface. A third insertion hole 13a, into which an oil discharge pipe 4 is inserted or connected, is formed through the bottom surface of the lower cap member 13. The oil discharge pipe 4 serves to supply the oil, collected in the bottom surface of the lower cap member 13, towards an inlet of a compressor (not shown).

**[0029]** A base portion 5 is provided under the lower end of the housing 1. The base portion 5 is approximately trivet-shaped so as to firmly fix the oil separator to a designated position separated from the ground and to reduce the generation of noise or vibration.

**[0030]** The above oil separator allows the mixture to rotate and flow down along the inner wall of the housing 1 by centrifugal force so that the oil is collected in the lower portion of the housing 1 and the gas is discharged to the outside through the refrigerant discharge pipe 2 formed through the upper end of the housing 1 by the rotating air current. The oil separator employs the principle of a cyclone. In order to separate the oil and the refrigerant gas from each other as described above, the mixture must be initially supplied to the inner wall of the housing 1 in the tangential direction. Hereinafter, oil separators in accordance with several embodiments of the present invention will be proposed.

**[0031]** FIG. 2 is a transversal sectional view of a refrigerant inflow pipe of an oil separator of an air conditioner in accordance with a first embodiment of the present invention. The refrigerant pipe 3 of the oil separator in accordance with the first embodiment is inserted into the second insertion hole 32, formed through the housing 1 towards the central portion of the housing 1, at a designated angle. That is, the second insertion hole 32 has a diameter larger than that of the refrigerant inflow pipe 3 so that the refrigerant inflow pipe 3 is horizontally inserted into the second insertion hole 32 at the designated angle. Then, the bushing 31 fixes the refrigerant inflow pipe 3 inserted into the second insertion hole 32.

**[0032]** The bushing 31 of the oil separator of the first

embodiment is a disk-shaped member, through which a through hole 31a is obliquely formed, so that the refrigerant inflow pipe 3 is inserted into the through hole 31a at a designated angle. The bushing 31 fixes the refrigerant inflow pipe 3 such that an end 34 of the refrigerant inflow pipe 3 approaches the inner surface of the side wall 12, thereby allowing the refrigerant inflow pipe 3 to discharge the refrigerant-oil mixture in the tangential direction. The end 34 of the refrigerant inflow pipe 3 is bent in a gentle curve and is located close to the side wall 12 so that the mixture flows down in a spiral shape along the inner surface of the side wall 12.

**[0033]** Accordingly, in the oil separator in accordance with the first embodiment, since the refrigerant inflow pipe 3 is slantingly inserted into the second insertion hole 32 at a designated angle although the second insertion hole 32 is formed perpendicularly through the side wall 12 of the housing 1, the end 34 of the refrigerant inflow pipe 3 is located close to the side wall 12 and guides the mixture in the tangential direction. Here, the shape of the bushing 31 is important. Compared to the formation of the second insertion hole 32 through the side wall 12 of the housing 1 in the tangential direction, the bushing 31 is easily formed. Thus, compared to the above-described conventional oil separator, the oil separator of the first embodiment is advantageous in terms of a manufacturing process and costs.

**[0034]** Further, the refrigerant inflow pipe 3 has a structure in which the distance with the side wall 12 is gradually decreased from a portion of the refrigerant inflow pipe 3 away from the end 34 to the end 34, thereby guiding the mixture in the tangential direction of the side wall 12.

**[0035]** FIG. 3 is a transversal sectional view of a refrigerant inflow pipe of an oil separator of an air conditioner in accordance with the second embodiment of the present invention. A second insertion hole 62 passes perpendicularly through the side wall 12, and faces the center of the housing 1. A bushing 61 for supporting a refrigerant inflow pipe 6 is installed at the second insertion hole 62. The bushing 61 of the oil separator of the second embodiment has a simple ring shape, different from the bushing 31 of the oil separator of the first embodiment. That is, the refrigerant inflow pipe 6 is inserted into the bushing 61 towards the center of the housing 1.

**[0036]** In order to cause the refrigerant inflow pipe 6, inserted perpendicularly into the side wall 12, to discharge the mixture to the inner surface of the side wall 12 in the tangential direction, the refrigerant inflow pipe 6 is bent in an approximately S-shaped gentle curve. The above gently curved structure of the refrigerant inflow pipe 6 allows an end 64 of the refrigerant inflow pipe 6 to be located close to the inner surface of the side wall 12 although the refrigerant inflow pipe 6 is inserted perpendicularly into the side wall 12, and does not hinder the flow of the mixture so that the mixture is discharged to the inner surface of the side wall 12 in the tangential direction. Identical to the refrigerant inflow pipe 3 of the oil separator of the first embodiment, the refrigerant in-

flow pipe 6 has a structure in which the distance with the side wall 12 is gradually decreased from a portion of the refrigerant inflow pipe 6 away from the end 64 to the end 64, thereby guiding the mixture, discharged through the refrigerant inflow pipe 6, in the tangential direction of the side wall 12.

**[0037]** FIG. 4 is a transversal sectional view of a refrigerant inflow pipe of an oil separator of an air conditioner in accordance with a third embodiment of the present invention. A second insertion hole 72, which is formed through the side wall 12 of the housing 1, faces the center of the housing 1, identical to the second insertion hole 62 of the oil separator of the second embodiment. A ring-shaped bushing 71 is inserted into the second insertion hole 72, thus supporting a refrigerant inflow pipe 7.

**[0038]** The refrigerant inflow pipe 7 is inserted into the second insertion hole 72 towards the center of the housing 1, and has at least one branched pipe 74 at its end. In the third embodiment, the refrigerant inflow pipe 7 has two branched pipes 74, which are parallel with each other. The diameter and number of the branched pipes 74 are determined by the capacity of the oil separator required by the air conditioner.

**[0039]** Ends 74a of the branched pipes 74 are oriented so that a refrigerant-oil mixture is discharged from the ends 74a in any one tangential direction, and are bent at a designated angle. The mixture flows from a compressor (not shown) of the air conditioner to the refrigerant inflow pipe 7 through an inlet 73 of the refrigerant inflow pipe 7, and is then divided into the branched pipes 74. The mixture flows in the tangential direction through the bent ends 74a of the branched pipes 74, thereby being effectively separated into oil and refrigerant gas.

**[0040]** FIG. 5 is a transversal sectional view of a refrigerant inflow pipe of an oil separator of an air conditioner in accordance with a fourth embodiment of the present invention. In the oil separator of the fourth embodiment, the refrigerant inflow pipe 8 is supported by a bushing 81 that is inserted into a second insertion hole 82 perpendicularly to the side wall 12 of the housing. The refrigerant inflow pipe 8 is rectilinearly extended, and is bent at a designated angle at a bent portion 83 so that a refrigerant-oil mixture is supplied towards the side wall 12 of the housing.

**[0041]** However, the bent portion 83 may disturb the flow of the mixture. In order to minimize the disturbance of the flow of the mixture, the refrigerant inflow pipe 8 is rectilinearly extended from the bent portion 83 to a designated length, thereby producing a rectilinearly-extended end 84. The length of the rectilinearly-extended end 84 of the refrigerant inflow pipe 8 is at least larger than the inner diameter of the refrigerant inflow pipe 8.

**[0042]** The end 84 of the refrigerant inflow pipe 8 is cut at a designated angle so as to supply the mixture to the inside of the housing in the tangential direction. A long side 84a of the cut section of the end 84 is close to the side wall 12 of the housing. The cutting angle of the end

84 is approximately larger than  $25^\circ$  and is approximately smaller than  $90^\circ$ . When the cutting angle of the end 84 is  $90^\circ$ , the cutting angle of the end 84 of the refrigerant inflow pipe 8 is equal to that of the conventional refrigerant inflow pipe, and when the cutting angle of the end 84 is smaller than  $25^\circ$ , the mixture cannot be guided in the tangential direction but instead flows down vertically.

**[0043]** FIG. 6 is a transversal sectional view of a refrigerant inflow pipe of an oil separator of an air conditioner in accordance with a fifth embodiment of the present invention. The refrigerant inflow pipe 9 of the fifth embodiment is similar to the refrigerant inflow pipe 8 of the fourth embodiment, but differs from the refrigerant inflow pipe 8 in that an end 94 of the refrigerant inflow pipe 9 fixedly contacts the side wall 12 of the housing.

**[0044]** That is, since the refrigerant inflow pipe 9 is fixed to the side wall 12 by a bushing 91 in the same state as a beam fixed to a clamp, the refrigerant inflow pipe 9 may be excessively vibrated. In order to solve such a problem, a long side 94a of the cut section of the end 94 contacts the side wall 12 of the housing, and is fixed to the side wall 12 by soldering or welding. Thus, the refrigerant inflow pipe 9 is fixed once to the side wall 12 by the bushing 91 and is fixed again to the side wall 12 at the end 94, thereby having two contact points with the side wall 12. Accordingly, the vibration of the refrigerant inflow pipe 9 is reduced.

**[0045]** The above fixation of the refrigerant inflow pipe 9 does not require an additional process. After the refrigerant inflow pipe 9 is inserted into a second insertion hole 92, the refrigerant inflow pipe 9 is pulled to the inner surface of the side wall 12 of the housing until the refrigerant inflow pipe 9 contacts the inner surface of the side wall 12, and the end of the refrigerant inflow pipe 9 is fixed to the side wall 12, as described above. Accordingly, compared to the conventional refrigerant inflow pipe, it is possible to simply and firmly install the refrigerant inflow pipe 9 without any additional part or process.

**[0046]** FIG. 7 is a longitudinal sectional view illustrating the structure of a housing, which can be applied to the oil separators of the respective embodiments of the present invention. As shown in FIG. 7, the housing 1 has a conical shape so that the housing 1 is broadened from the upper portion of the housing 1 to the lower portion of the housing 1. As described above, the refrigerant-oil mixture, which is supplied to the inside of the housing 1, flows into the housing 1 in the tangential direction and forms a vortex moving downwards. In order to continuously maintain such a vortex, the side wall 12 of the housing 1 meets the vertical line at an angle of  $30^\circ$  or less.

**[0047]** The above structure of the housing 1 depends on the Helmholtz vortex theorem. According to the Helmholtz vortex theorem, the rotating flow of the vortex is proportional to the multiplication of an angular velocity by twice a radius of the vortex. When the housing 1 has a conical shape, the radius of the vortex is gradually increased and the angular velocity is decreased. Thereby, kinetic energy of oil particles is decreased, and the oil

flows along the inner surface of the side wall 12 of the housing 1 and is collected in the lower cap member 13.

**[0048]** When the lower portion of the housing 1 is excessively broader than the upper portion of the housing 1, the vortex cannot be maintained, and the oil cannot flow along the side wall 12 of the housing 1 but instead flows down vertically. Accordingly, the tilt angle of the side wall 12 of the housing 1 meeting the vertical line is limited thereto.

**[0049]** The housing 1 of the oil separator, which has a conical shape, has a vortex effect as well as a cyclone effect, thus increasing the efficiency of the oil separator.

**[0050]** In the above-described oil separator of the present invention, a compressor (not shown) of an air conditioner discharges a refrigerant-oil mixture containing refrigerant gas and oil in a pulse mode into the housing 1 through the refrigerant inflow pipe. The refrigerant inflow pipes of each the embodiments of the present invention are located close to the inner surface of the side wall 12 of the housing 1 such that the ends of the refrigerant inflow pipes are bent in the tangential direction.

**[0051]** Accordingly, the mixture, supplied into the oil separator at a high pressure, does not hit the inner surface of the side wall 12, but flows down along the inner surface of the side wall 12 in the tangential direction. During this process, the oil having a high specific gravity is attached to the inner surface of the side wall 12 by the centrifugal force, and is collected in the lower cap member 13 provided on the lower portion of the housing 1. The collected oil is supplied again into the inlet of the compressor through the oil discharge pipe 4.

**[0052]** The refrigerant gas, separated from the oil, moves to the upper portion of the housing 1 by the rotating current generated from the inside of the housing 1, and is discharged to the outside of the oil separator through the refrigerant discharge pipe 2 (FIG 1). In order to assure sufficient time and distance to move the oil downwardly and collect the oil, and to efficiently discharge the refrigerant gas by means of the rotating current, the refrigerant inflow pipe may be installed at a height corresponding to 70~85% of the height of the housing 1.

**[0053]** When the refrigerant inflow pipe is installed at a height below 70% of the height of the housing 1, an efficiency of the oil separator due to the principle of the cyclone forming a spiral vortex of the mixture supplied in the tangential is reduced. Further, the refrigerant inflow pipe is installed at a height above 85% of the height of the housing 1, the ascending air current disturbs the discharge of the refrigerant gas, thereby reducing the efficiency of the oil separator. Accordingly, the proper height of the refrigerant inflow pipe is in the range of 70~85% of the height of the housing 1.

**[0054]** FIG 8 is a perspective view illustrating a gas discharge pipe, which can be applied to the oil separators of the respective embodiments of the present invention. As shown in FIG. 8, the gas discharge pipe 2 having a designated diameter is extended, and a plurality of fine pipes 21 a are formed at a portion of the gas discharge

pipe 2 away from a lower end 21 thereof by a designated length. The fine pipes 21 a are formed by pressing one end of a conventional gas discharge pipe using a press.

**[0055]** The fine pipes 21 exhibit the same effect as a muffler of a vehicle, and serves to reduce noise, generated when the mixture is supplied from a compressor to an oil separator under the condition that the mixture has a designated pulse, and noise, generated when an oil component is separated from the mixture supplied to the oil separator through the refrigerant inflow pipe. That is, the refrigerant gas, which is introduced into the fine pipes 21 a, is diffused into the inside of the gas discharge pipe 2 having a relatively large area by an ascending air current in the housing, thereby offsetting the noise. The number and length of the fine pipes 21 a are determined in consideration of the volume of the oil separator and various factors in the housing.

**[0056]** FIG. 9 is a table for comparing noise generated from an oil separator, to which a conventional refrigerant inflow pipe is applied, and noise generated from the oil separator, to which the refrigerant inflow pipe in accordance with the second embodiment of the present invention is applied. The table illustrates values of noise generated from the oil separator installed in a multi air conditioner, which has a plurality of indoor units and outdoor units connected to each other and a digital scroll compressor. The conventional refrigerant inflow pipe has a structure, as shown in FIG. 3 of Korean Patent Laid-open Publication No. 2004-0105264.

**[0057]** As shown in FIG. 9, compared to when the conventional refrigerant inflow pipe is applied to the oil separator, when the refrigerant inflow pipe in accordance with the second embodiment is applied to the oil separator, the noise generated from the oil separator is drastically reduced, as follows.

**[0058]** First, at a 1/3 octave band of a center frequency of 2,500Hz, where a large difference of noises is generated according to operating conditions of the compressor (for example, loading and unloading states), in a full load state in which all indoor units are operated, the oil separator having the conventional refrigerant inflow pipe generates noise of 60.5dBA, and the oil separator having the refrigerant inflow pipe of the second embodiment generates noise of 53.3dBA, which is reduced from the noise generated from the oil separator having the conventional refrigerant inflow pipe by 7.2dBA.

**[0059]** In a part load in which some of the indoor units are operated, the oil separator having the conventional refrigerant inflow pipe generates noise of 57.5dBA, and the oil separator having the refrigerant inflow pipe of the second embodiment generates noise of 51.2dBA, which is reduced from the noise generated from the oil separator having the conventional refrigerant inflow pipe by 6.3dBA.

**[0060]** Further, a difference of noises is generated according to operating conditions of the compressor (for example, loading and unloading states). Since the oil separator having the conventional refrigerant inflow pipe

generates noise of 57.5dBA in the loading state, and generates noise of 49.9dBA in the unloading state, a difference of noises of the oil separator having the conventional refrigerant inflow pipe is 7.6dBA. On the other hand, since the oil separator having the refrigerant inflow pipe of the second embodiment generates noise of 51.2dBA in the loading state, and generates noise of 49.2dBA in the unloading state, a difference of noises of the oil separator having the refrigerant inflow pipe of the second embodiment 2dBA, which is reduced from the difference of noises generated from the oil separator having the conventional refrigerant inflow pipe by 5.6dBA.

**[0061]** Second, overall noise of the indoor units is described as below. In the full load state in which all indoor units are operated, the oil separator having the conventional refrigerant inflow pipe generates noise of 65.1dBA, and the oil separator having the refrigerant inflow pipe of the second embodiment generates noise of 62.9dBA, which is reduced from the noise generated from the oil separator having the conventional refrigerant inflow pipe by 2.2dBA.

**[0062]** In the part load in which some of the indoor units are operated, the oil separator having the conventional refrigerant inflow pipe generates noise of 64.5dBA, and the oil separator having the refrigerant inflow pipe of the second embodiment generates noise of 63.0dBA, which is reduced from the noise generated from the oil separator having the conventional refrigerant inflow pipe by 1.5dBA.

**[0063]** Further, a difference of noises in the part load is generated according to operating conditions of the compressor (for example, loading and unloading states). Since the oil separator having the conventional refrigerant inflow pipe generates noise of 64.5dBA in the loading state, and generates noise of 63.3dBA in the unloading state, a difference of noises of the oil separator having the conventional refrigerant inflow pipe is 1.2dBA. On the other hand, since the oil separator having the refrigerant inflow pipe of the second embodiment generates noise of 63.0dBA in the loading state, and generates noise of 62.6dBA in the unloading state, a difference of noises of the oil separator having the refrigerant inflow pipe of the second embodiment 0.4dBA, which is reduced from the difference of noises generated from the oil separator having the conventional refrigerant inflow pipe by 0.8dBA.

**[0064]** As apparent from the above description, the present invention provides an oil separator for an air conditioner, in which an insertion hole is formed through a side wall of a housing of the oil separator so that a refrigerant inflow pipe is inserted into the insertion hole perpendicularly to the side wall, thereby being easily manufactured compared to the conventional oil separator.

**[0065]** Further, since the refrigerant inflow pipe discharges a refrigerant-oil mixture to the inner surface of the side wall of the housing in the tangential direction, and the mixture does not hit the inner surface of the side wall of the housing but instead flows down along the side wall of the housing, noise and vibration generated from

the oil separator are drastically reduced.

**[0066]** Although embodiments of the invention have been shown and described, it would be appreciated by those skilled in the art that changes may be made in these embodiments without departing from the principles and spirit of the invention, the scope of which is defined in the claims and their equivalents.

## 10 Claims

1. An oil separator for an air conditioner comprising:
  - a cylindrical housing;
  - a refrigerant inflow pipe for supplying a refrigerant-oil mixture to the inside of the housing;
  - a refrigerant discharge pipe for discharging refrigerant separated from the mixture to the outside of the oil separator; and
  - an oil discharge pipe for returning oil separated from the mixture to a compressor,
 wherein one end of the refrigerant inflow pipe faces the inner surface of a side wall of the housing in the tangential direction.
2. The oil separator as set forth in claim 1, wherein the refrigerant inflow pipe is bent in a gentle curve at a portion thereof which is inserted into the housing.
3. The oil separator as set forth in claim 2, wherein the refrigerant inflow pipe is bent again in the reverse direction to the bent portion so that the refrigerant inflow pipe has an approximately "S" shape.
4. The oil separator as set forth in claim 1, wherein the refrigerant inflow pipe is inserted into a through hole, formed through the side wall of the housing, at a designated angle.
5. The oil separator as set forth in claim 1, wherein the refrigerant inflow pipe is inserted perpendicularly into a through hole formed through the side wall of the housing.
6. The oil separator as set forth in claim 1, wherein the refrigerant inflow pipe passes through the side wall of the housing and is divided into a plurality of branched pipes, and ends of the branched pipes are bent in the tangential direction towards the side wall.
7. The oil separator as set forth in claim 1, wherein the refrigerant inflow pipe is located at a position having a height corresponding to 70~85% of the height of the housing.
8. The oil separator as set forth in claim 1, wherein the end of the refrigerant inflow pipe facing the inner surface of the side wall of the housing in the tangential

direction is cut at a designated angle.

9. The oil separator as set forth in claim 8, wherein a long side of the cut section of the end of the refrigerant inflow pipe contacts the inner surface of the side wall of the housing, and is fixed to the side wall. 5
10. An oil separator for an air conditioner comprising:
  - a cylindrical housing; 10
  - a refrigerant inflow pipe for supplying a refrigerant-oil mixture to the inside of the housing;
  - a refrigerant discharge pipe for discharging refrigerant separated from the mixture to the outside of the oil separator; and 15
  - an oil discharge pipe for returning oil separated from the mixture to a compressor, wherein the housing has a conical shape so that the housing is broadened from the upper portion thereof to the lower portion thereof. 20
11. The oil separator as set forth in claim 10, wherein the side wall of the housing meets the vertical line at an angle of 30° or less. 25
12. The oil separator as set forth in claim 10, wherein the refrigerant inflow pipe is located at a position having a height corresponding to 70~85% of the height of the housing. 30
13. An oil separator for an air conditioner comprising:
  - a cylindrical housing;
  - a refrigerant inflow pipe for supplying a refrigerant-oil mixture to the inside of the housing; 35
  - a refrigerant discharge pipe for discharging refrigerant separated from the mixture to the outside of the oil separator; and
  - an oil discharge pipe for returning oil separated from the mixture to a compressor, 40
  - wherein a plurality of fine pipes having a designated length are formed at one end of the refrigerant discharge pipe located in the housing and serve as a muffler for reducing noise in the housing. 45
14. The oil separator as set forth in claim 13, wherein the fine pipes are formed by pressing a gas discharge pipe. 50
15. The oil separator as set forth in claim 8, wherein the designated angle is larger than 25° and smaller than 90°. 55



Fig.1

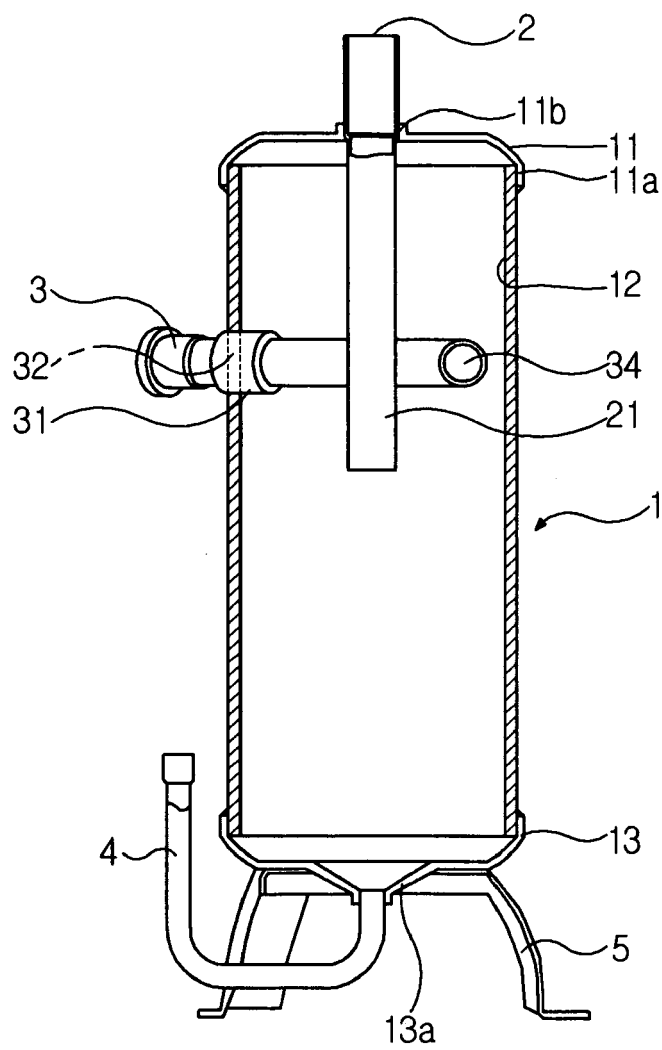


Fig.2

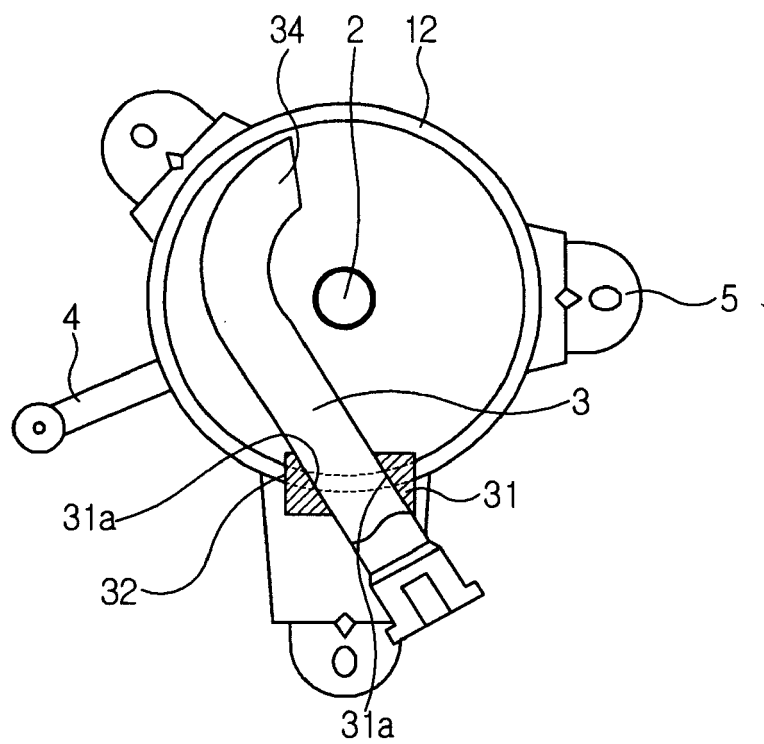


Fig.3

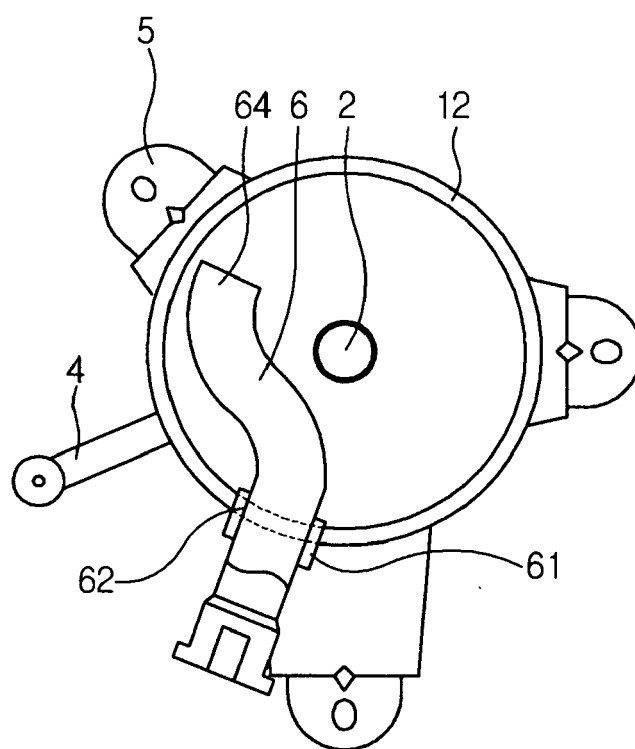


Fig.4

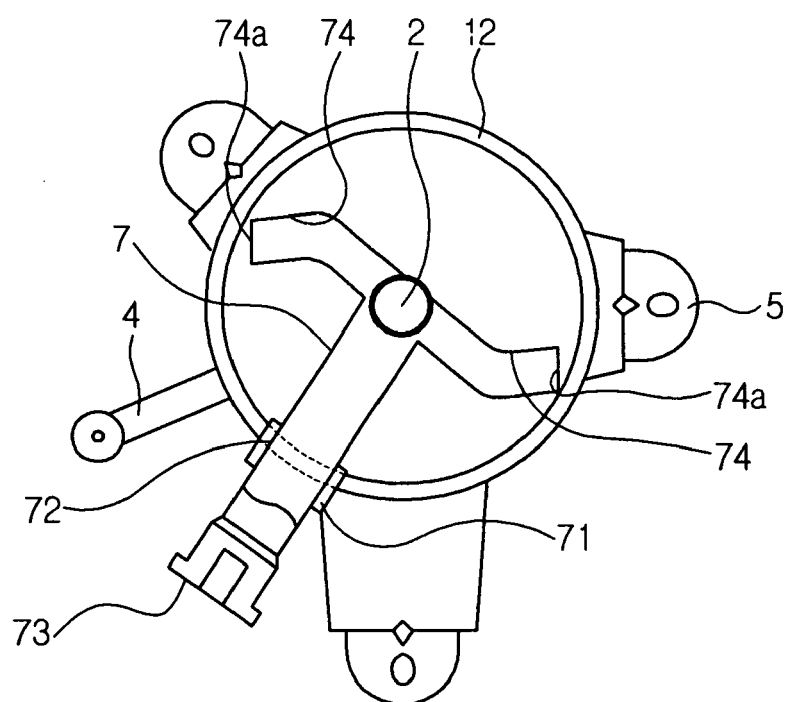


Fig.5

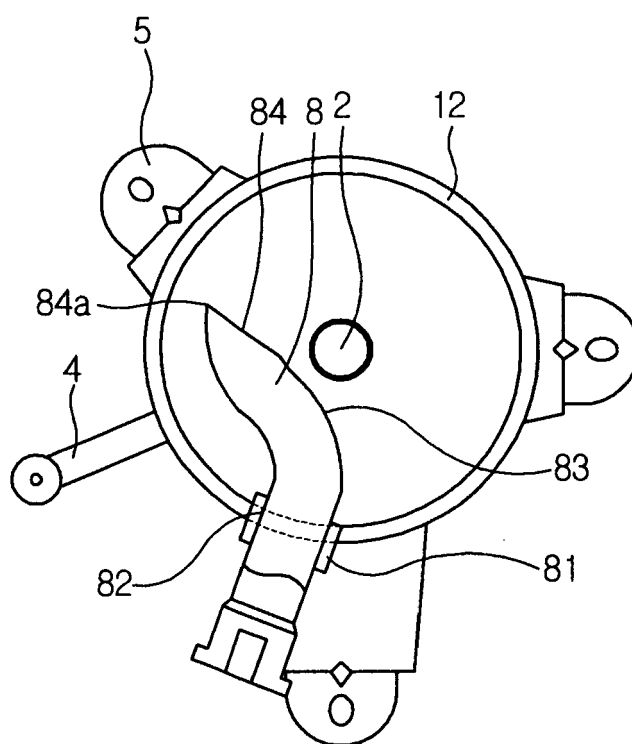


Fig.6

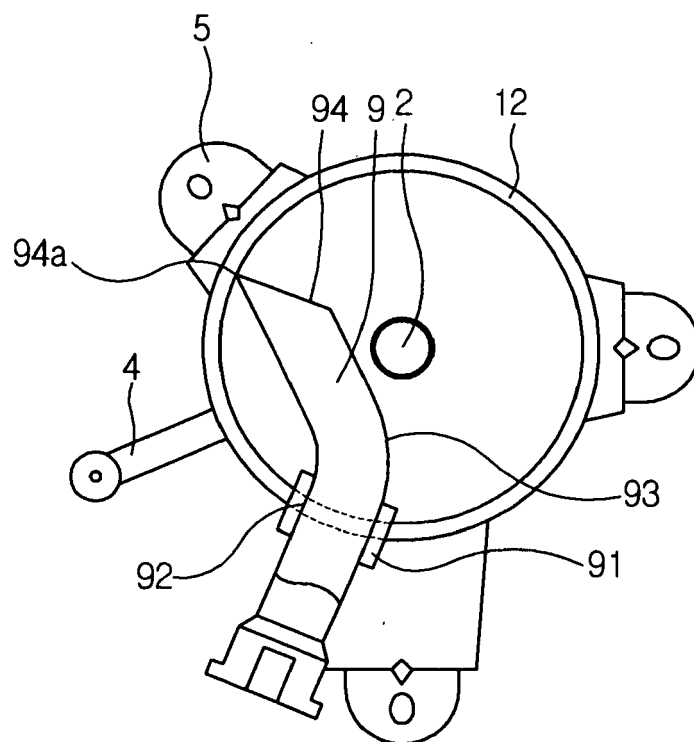


Fig.7

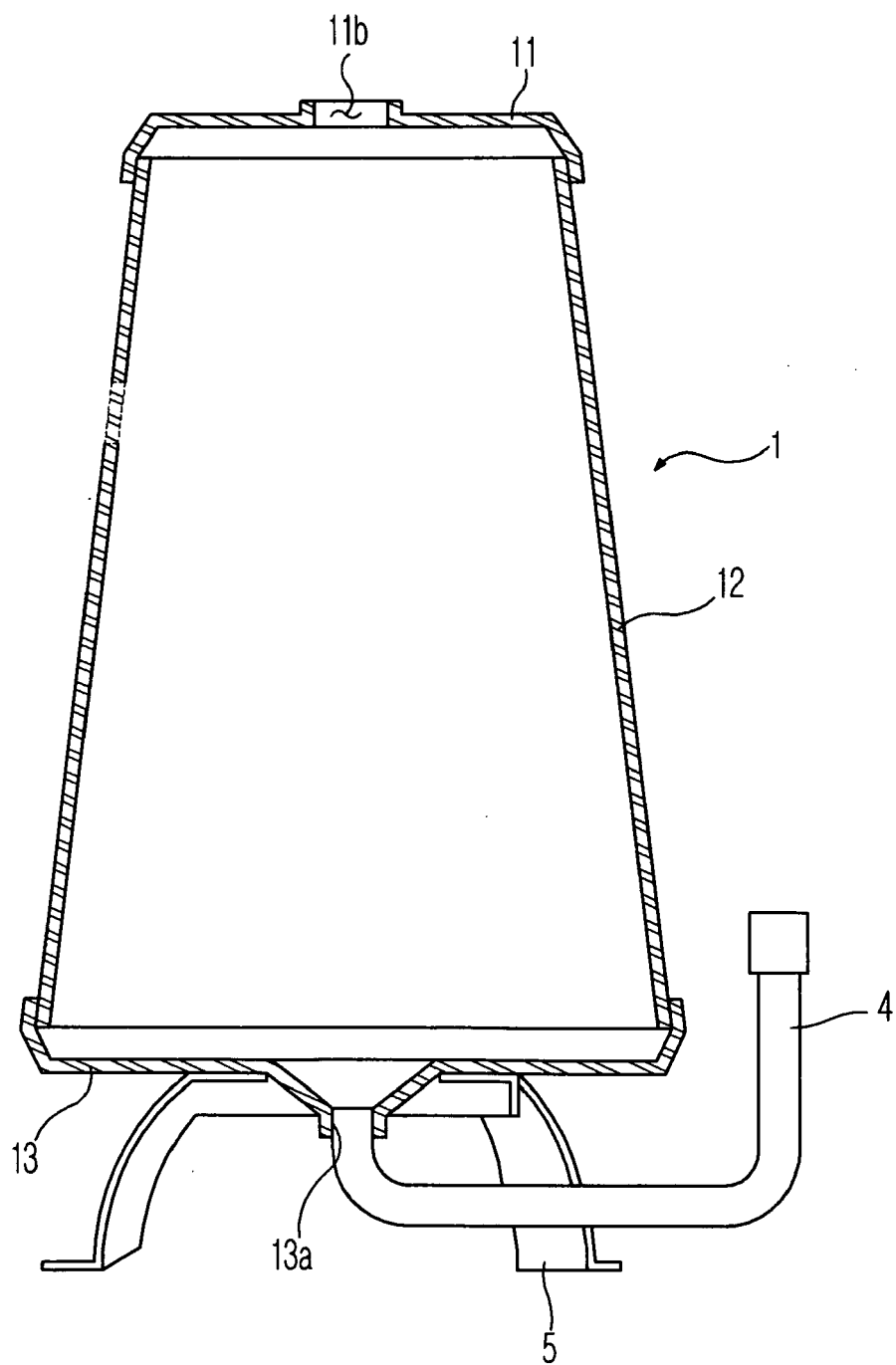


Fig.8

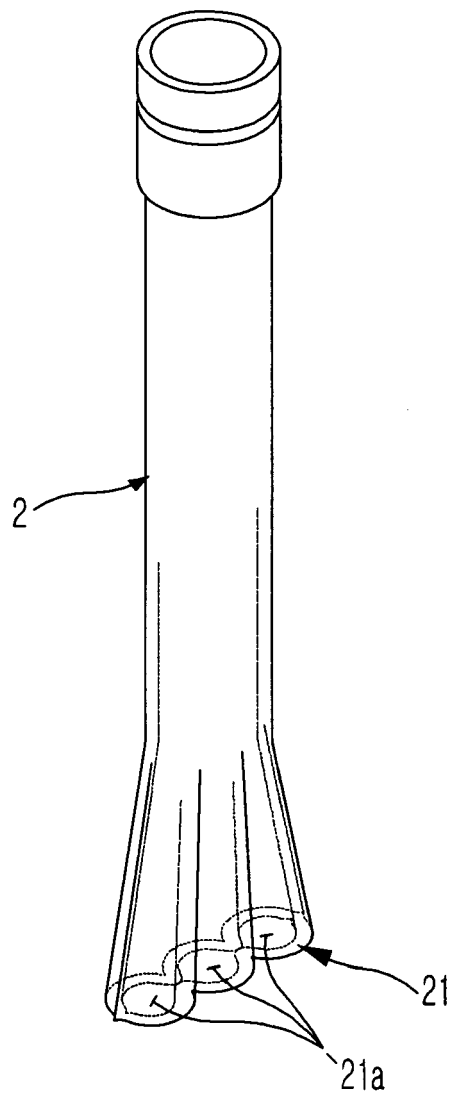




Fig.9

	operating load	conventional oil separator		oil separator in accordance with second embodiment	
		Loading	Unloading	Loading	Unloading
center frequency 2500Hz, 1/3 Octave band noise(dBA)	Full load	60.5	-	53.3	-
	Part load	57.5	49.9	51.2	49.2
Overall Noise (dBA)	Full load	65.1	-	62.9	-
	Part load	64.5	63.3	63.0	62.6

**REFERENCES CITED IN THE DESCRIPTION**

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**Patent documents cited in the description**

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