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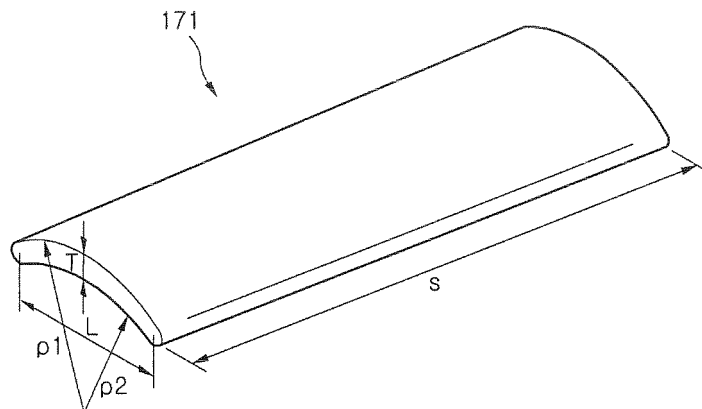
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(54) **Indoor unit for air conditioning apparatus**

(57) The present invention relates to an indoor unit for an air conditioning apparatus and relates to an optimized design of a fan that can reduce noise and flow resistance in an indoor unit to which a cross flow fan is

applied. As the cross flow fan according to the embodiment of the present invention is applied, fan noise can be reduced and flow resistance of air passing through a heat exchanger can be reduced.

Figure 5



Description

[0001] The present invention relates to an indoor unit for an air conditioning apparatus.

[0002] In general, an air conditioning apparatus is an apparatus that cools/heats a room using a compressor, a condenser, an expander, and an evaporator.

[0003] The air conditioning apparatus, which includes an indoor unit and an outdoor unit, may be a separated air conditioning apparatus in which an indoor unit is separated from an outdoor unit and an integrated air conditioner in which an indoor unit is integrated with an outdoor unit.

[0004] A fan that compulsorily flows air and a heat exchanger that performs a heat exchange with indoor air to be inhaled are received in the indoor unit.

[0005] Also, a method in which air flowed from a front surface and an upper part to be discharged downwardly to the front surface is commonly applied to a conventional air conditioning apparatus. And, a cross flow fan is commonly applied to a separated indoor unit that is installed on a wall surface.

[0006] In an indoor unit to which such a cross flow fan is applied, an indoor unit to which a high efficiency cross flow fan is applied that can reduce the burdens of electricity charges has increased demand by consumers.

[0007] More specifically, a heat exchanger that has an increased heat exchange area has been applied in order to accomplish high efficiency in a limited indoor unit standard. In order to meet such a demand, a heat exchanger in which coolant pipes are arranged in 3 rows forward and backward may also be used. However, if the 3 row heat exchanger is applied to the indoor unit to which cross flow fan is applied, the heat exchange area of the heat exchanger becomes high but the system resistance is increased. And, as the system resistance is increased, the noise level at the same wind volume is increased. For example, noise such as a surging noise is highly likely to be generated.

[0008] The present invention is proposed to solve the problem. An object of the present invention is to provide a fan structure where the fan can be normally operated without abnormal noise although air resistance by dust accumulated on a heat exchanger or a filter is increased due to a long time use, having a reduced noise level, when a 3 row heat exchanger is applied to an indoor unit to which a cross flow fan is applied.

[0009] In an embodiment, an indoor unit for an air conditioning apparatus, comprising: a chassis including a stabilizer that generates a flow of air, and a fan insertion groove; a cross flow fan that is mounted on a front surface of the chassis corresponding to an upper end of the stabilizer, to inhale indoor air; a heat exchanger that is provided on a front side of the fan to perform a heat exchange with the indoor air, wherein $0.088 \leq T/L \leq 0.132$ (T: thickness of fan, L: length of fan).

[0010] With the indoor unit for the air conditioning apparatus according to the embodiment of the present in-

vention constituted as described above, the system resistance can be reduced although the 3 row heat exchanger is applied in order to improve a heat exchange efficiency of the indoor unit.

[0011] Also, although the resistance by dust accumulated on a heat exchanger or a filter is increased due to a long time use, the fan can be normally operated without abnormal noise.

[0012] Also, although the 3 row heat exchanger is used, the noise level can be reduced.

[0013] The above and other objects, features and advantages of the present invention will become apparent from the following description of preferred embodiments given in conjunction with the accompanying drawings, in which:

FIG. 1 is a side cross-sectional view showing a structure of an indoor unit for an air conditioning apparatus according to an embodiment of the present invention;

FIG. 2 is a front perspective view of a chassis applied to an indoor unit according to an embodiment of the present invention;

FIG. 3 is a partial perspective view of a fan mounted on an indoor unit according to an embodiment of the present invention;

FIG. 4 is a side view of the fan;

FIG. 5 is a perspective view showing a blade of a fan corresponding to a portion A of FIG. 4;

FIG. 6 is a graph showing experimental results for the relation between an outer circumferential angle and noise in a fan of an indoor unit according to an embodiment of the present invention;

FIG. 7 is a graph showing experimental results for the relation between a ratio of inner diameter to outer diameter and noise in a fan of an indoor unit according to an embodiment of the present invention;

FIG. 8 is a graph showing experimental results for the relation between a ratio of thickness to length of a fan and noise in a fan of an indoor unit according to an embodiment of the present invention;

FIG. 9 is a graph showing experimental results for the relation between a ratio of an insertion depth to length of a fan and noise in a fan of an indoor unit according to an embodiment of the present invention; and

FIG. 10 is a graph showing a result of a noise performance improvement when an indoor unit on which an optimizngly designed fan is mounted is driven.

[0014] Hereinafter, embodiments of the present invention will be described in detail with reference to the accompanying drawings.

[0015] FIG. 1 is a side cross-sectional view showing a structure of an indoor unit for an air conditioning apparatus according to an embodiment of the present invention.

[0016] Referring to FIG. 1, the indoor unit 10 for the air

conditioning apparatus includes a chassis 11 that is closely adhered to a wall surface, a front frame 12 that is coupled to a front side of the chassis 11, a front panel 13 that is rotatably or elevatably provided on a front surface of the front frame 12, a fan 17 that is received in a space formed by the chassis 11 and the front frame 12 to inhale indoor air, and a heat exchanger 16 that surrounds the fan 17 to perform a heat exchange with indoor air to be inhaled.

[0017] More specifically, a stabilizer 112 is provided on a front surface of the chassis 11 to allow air flow to be generated as the fan 17 rotates. And, a heat exchanger seating part 111 that supports one end of the heat exchanger 16 is formed on an upper side of the stabilizer 112.

[0018] Also, an inlet grill that inhales indoor air is formed on an upper surface of the front frame 12 and a front surface inlet port 122 that inlets indoor air is also formed on a front surface thereof. And, a filter 15 is mounted on a front surface of the heat exchanger 16 to clean indoor air inhaled through the inlet grill 121 and the front surface inlet port 122.

[0019] Also, if the indoor unit 10 operates, an upper end or a lower end of the front panel 13 is rotated or is upwardly rotated to allow the front surface inlet port 122 to be opened. And, a discharge grill 14 is provided on a lower end of the indoor unit 10, wherein the other end of the heat exchanger 16 is seated on an upper side of the discharge grill 14 and an air outlet port 141 is formed on a lower side thereof. And, a lower end of the stabilizer 112 is extended to the air outlet port 141. And, a discharge louver 143 that controls a leftward and rightward flow of discharged air and a discharge vane 142 that not only selectively opens/closes the air outlet port 141 but also controls an upward and downward flow of the discharged air of the discharged air are provided on the air outlet port 141. And, the discharge vane 142 and the discharge louver 143 may be rotatably coupled to each other on a lower side of the discharge grill 14. And, the heat exchanger 16 may have a shape where coolant pipes are arranged in 3 rows forwardly and backwardly or are divided in plural to surround a front and an upper of the fan 17. And, the fan 17 may be a cross flow fan.

[0020] FIG. 2 is a front perspective view of a chassis applied to an indoor unit according to an embodiment of the present invention.

[0021] Referring to FIG. 2, as described above, the heat exchanger seating part and the stabilizer 112 are formed on the front surface of the chassis 11 that is applied to the indoor unit 10 of the present invention.

[0022] More specifically, a fan supporter 114 is formed on one side of the chassis 11 corresponding to a spot where the stabilizer 112 is formed. And, a motor seating part 113 where a motor that drives the fan 17 is seated is provided on a side of the fan supporter 114. And, a structure where a side end of the fan 17 is supported is also provided on the other side of the chassis 11. More specifically, a fan insertion groove 115 that is collapsed

at a predetermined depth t for supporting the side end of the fan 17 is formed on the other side of the chassis 11.

[0023] Here, fan noise is generated differently depending on the indented depth of the fan insertion groove 115.

Therefore, the depth of the fan insertion groove 115 becomes a main design factor for reducing noise of the indoor unit. Hereinafter, the relation between the depth of the fan insertion groove 115 and noise will be explained based on experimental results, and an optimal depth of the fan insertion groove 115 will be explained.

[0024] FIG. 3 is a partial perspective view of a fan mounted on an indoor unit according to an embodiment of the present invention, and FIG. 4 is a side view of the fan.

Referring to FIGS. 3 and 4, the fan 17 applied to the indoor unit according to the embodiment of the present invention may be a cross flow fan, and the cross flow fan has a plurality of blades 171 that are radially arranged along a circumferential direction. And, each blade is arranged slantly at a predetermined angle θ . In other words, a line extended along a width s (see FIG. 5) direction of each blade is mounted to the blade, not being parallel to a rotation shaft of the fan 17 but being slanted by the predetermined angle θ .

Also, the fan forms a mean camber line by means of an inner diameter $D1$ from a center to an inner end of the blade 171, an outer diameter $D2$ from a center to an outer end of the blade 171, an inner circumferential angle $\beta1$ and an outer circumferential angle $\beta2$.

[0027] Here, the mean camber line of the blade (hereinafter, referred to as a camber line) means a line that bisects a thickness T (see FIG. 5) of the blade 171.

Also, the inner circumferential angle means an angle that is made by a line connecting the inner end of the camber line to the center of the fan and a contact line passing the inner end of the camber line from a circle formed by the inner diameter $D1$, and hereinafter, the inner circumferential angle will be set to 90 degree.

Also, the outer circumferential angle means an angle that is made by an extended straight line extended from the outer end of the camber line and a contact line passing the outer end of the camber line from a circle formed by the outer diameter $D2$.

[0030] FIG. 5 is a perspective view showing a blade of a fan corresponding to portion A of FIG. 4.

[0031] Referring to FIG. 5, the blade 171 that constitutes the fan 17 has predetermined length L and width s and is rounded as going in a length direction.

More specifically, an inner curvature $p1$ of the blade 171 is set to be different from an outer curvature $p2$ thereof. Therefore, in the blade 171, a thickness of the edge portion is different from that of the central portion. In other words, the blade 171 has a shape that it becomes thick and then becomes thin from one end to the other end. And, the length L (Chord Length) of the blade 171 is defined based on a straight distance from the inner end of the blade to the outer end thereof.

[0033] In the indoor unit 10 on which the fan 17 con-

stituted as described above is mounted, it is confirmed the relation between a ratio of inner diameter to outer diameter of the fan 17 and noise, the relation between an outer circumferential angle and noise, the relation between a ratio of thickness to length of a fan and noise, the relation between a ratio of an insertion depth of a side end of a fan to a length of the fan and noise, through experiments repeated several times. And, through the experiments as described above, an optimal design condition that can minimize fan noise is found.

[0034] FIG. 6 is a graph showing experimental results for the relation between an outer circumferential angle and noise in a fan of an indoor unit according to an embodiment of the present invention.

[0035] Here, it is noted that an inner circumferential angle is set to 90 degree.

[0036] Referring to FIG. 6, it can be appreciated that the noise is reduced until the outer circumferential angle of the blade 171 reaches 30 degree and then is increased again as it exceeds 30 degree. In other words, it can be appreciated that the noise is minimized when the outer circumferential angle is 30 degree through the experimental results.

[0037] More specifically, it can be appreciated that the outer circumferential angle of the blade 171 is preferably $28 \text{ degree} \leq \beta_2 \leq 32 \text{ degree}$, more preferably, $30 \text{ degree} \leq \beta_2 \leq 32 \text{ degree}$.

[0038] FIG. 7 is a graph showing experimental results for the relation between a ratio of inner diameter to outer diameter and noise in a fan of an indoor unit according to an embodiment of the present invention.

[0039] Referring to FIG. 7, it can be appreciated that the noise is first generated at a point where the ratio of inner diameter to outer diameter $D1/D2$ of the blade 171 is 0.79. In other words, the noise is reduced until the ratio of inner diameter to outer diameter becomes 0.79 and then is increased again as the ratio of inner diameter to outer diameter exceeds 0.79.

[0040] More specifically, it can be appreciated that the ratio of inner diameter to outer diameter of the blade 171 is preferably $0.77 \leq D1/D2 \leq 0.81$, more preferably, $0.77 \leq D1/D2 \leq 0.8$.

[0041] FIG. 8 is a graph showing experimental results for the relation between a ratio of thickness to length of a fan and noise in a fan of an indoor unit according to an embodiment of the present invention.

[0042] Referring to FIG. 8, it can be appreciated that the noise is reduced until the ratio of thickness to length of a fan T/L reaches 0.1 and then is increased again as the ratio of thickness to length of a fan T/L exceeds 0.1. In other words, it can be appreciated that the noise is minimize at a point where the ratio of thickness to length of a fan T/L is 0.1 through the experimental results.

[0043] More specifically, it can be appreciated that the ratio of thickness to length of a fan is preferably $0.088 \leq T/L \leq 0.132$.

[0044] FIG. 9 is a graph showing experimental results for the relation between a ratio of an insertion depth to

length of a fan and noise in a fan of an indoor unit according to an embodiment of the present invention.

[0045] Referring to FIG. 9, it can be appreciated that the noise is reduced until the ratio of an insertion depth to length of a fan t/L reaches 0.007 and then is increased again as the ratio of an insertion depth to length of a fan t/L exceeds 0.007. In other words, it can be appreciated that the noise is minimized at a point where the ratio of an insertion depth to length of a fan is 0.007 through the experimental results.

[0046] More specifically, it can be appreciated that the ratio of thickness to length of a fan is preferably $0.0044 \leq t/L \leq 0.0143$.

[0047] Also, it can be appreciated that a blowing function is maximized at a point of the optimal noise or in the range of the optimal noise according to the experimental results as shown in FIGS. 6 to 9.

[0048] Based on the experimental results as described above, it can be appreciated that the entire blowing function is improved and the noise is reduced when the fan 17 having the blade 171 structure corresponding to the optimal range is mounted on the indoor unit.

[0049] FIG. 10 is a graph showing a result of a noise performance improvement when an indoor unit on which an optimizngly designed fan is mounted is driven.

[0050] Referring to FIG. 10, it can be appreciated the entire noise is reduced by about 2.2dB after the structure of the fan is improved compared to before the structure of the fan is improved.

[0051] The optimized design of the fan as described above lead to the results that the blowing performance of the fan can be increased and the system resistance and the fan noise can be reduced. The results can be applied regardless of the size of the indoor unit or the size of the fan.

Claims

1. An indoor unit for an air conditioning apparatus, comprising:

a chassis including a stabilizer that generates a flow of air, and a fan insertion groove;
a cross flow fan that is mounted on a front surface of the chassis corresponding to an upper end of the stabilizer, to inhale indoor air;
a heat exchanger that is provided on a front side of the fan to perform a heat exchange with the indoor air,

wherein $0.088 \leq T/L \leq 0.132$ (T: thickness of fan, L: length of fan).

2. The indoor unit for the air conditioning apparatus according to claim 1, wherein $0.77 \leq D1/D2 \leq 0.81$ ($D1/D2$: ratio of inner diameter to outer diameter).

3. The indoor unit for the air conditioning apparatus according to claim 1 or 2, wherein $0.77 \leq D1/D2 \leq 0.81$.
4. The indoor unit for the air conditioning apparatus according to claim 1, wherein $28 \text{ degree} \leq \beta_2 \leq 32 \text{ degree}$ (β_2 : outer circumferential angle). 5
5. The indoor unit for the air conditioning apparatus according to claim 1 or 4, wherein $28 \text{ degree} \leq \beta_2 \leq 32 \text{ degree}$. 10
6. The indoor unit for the air conditioning apparatus according to claim 1, wherein $0.0044 \leq t/L \leq 0.0143$ (t: insertion depth of fan, L: length of fan). 15

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Figure 1

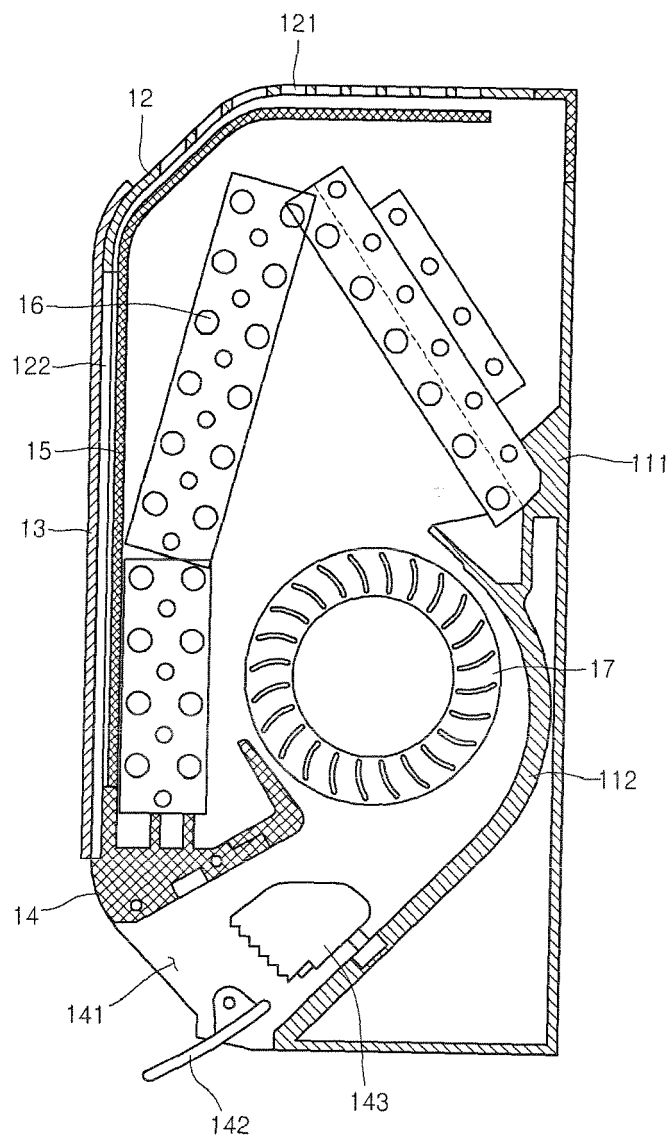


Figure 2

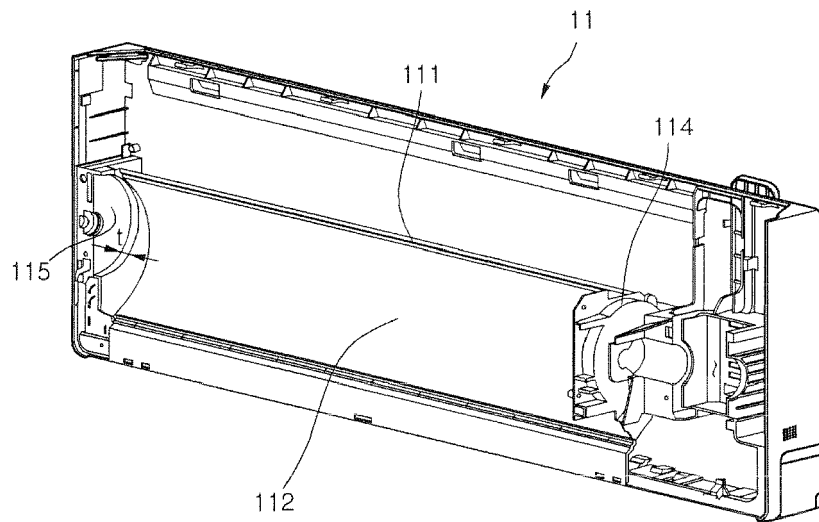


Figure 3.

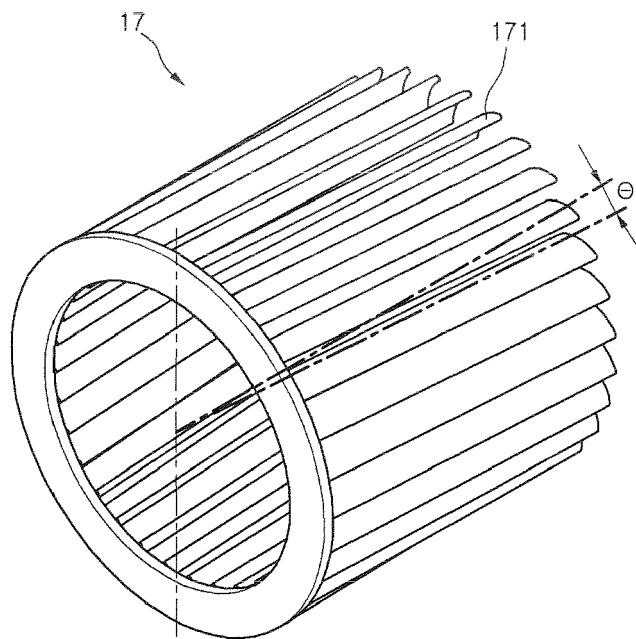


Figure 4

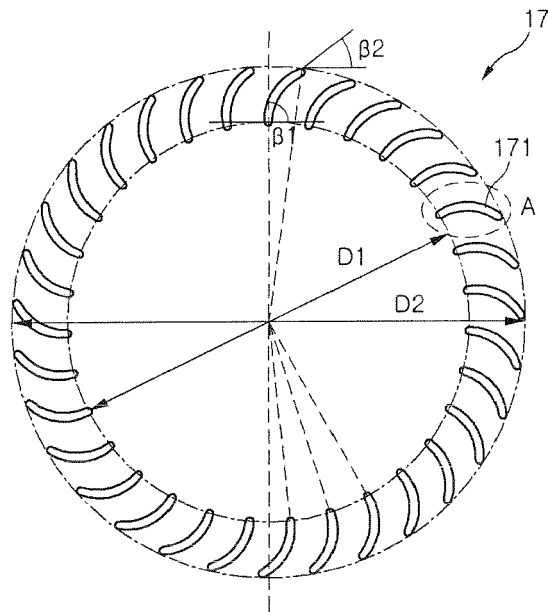


Figure 5

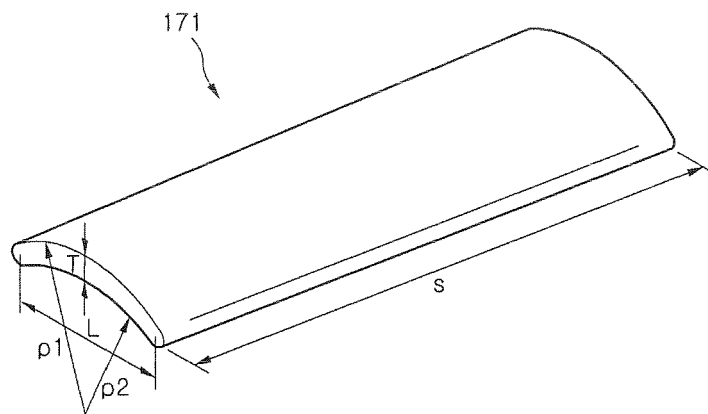


Figure 6

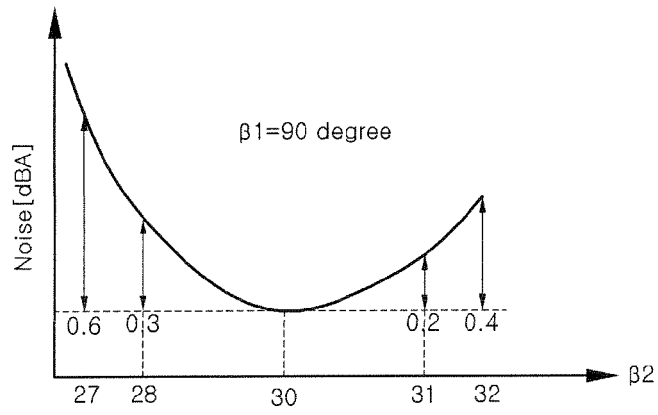


Figure 7

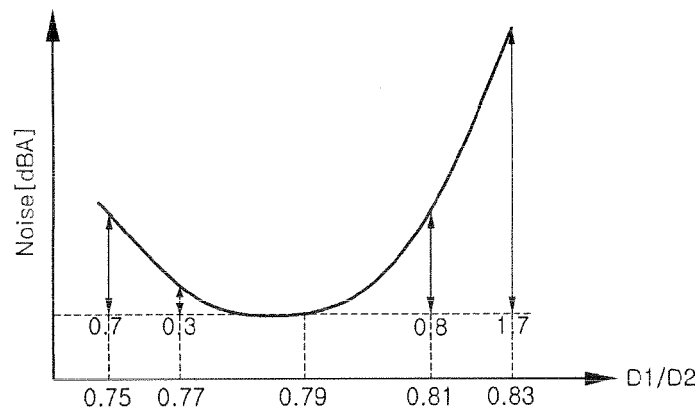


Figure 8

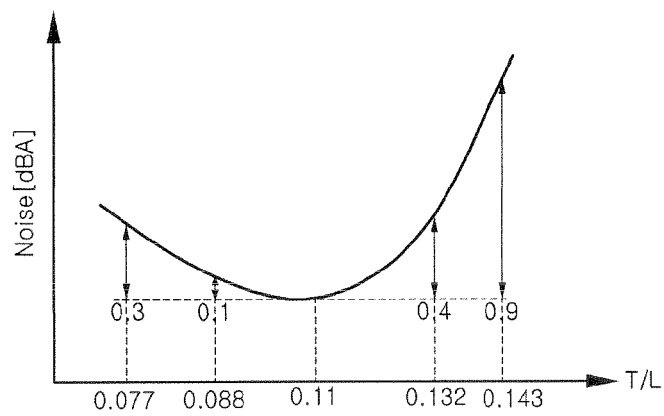


Figure 9

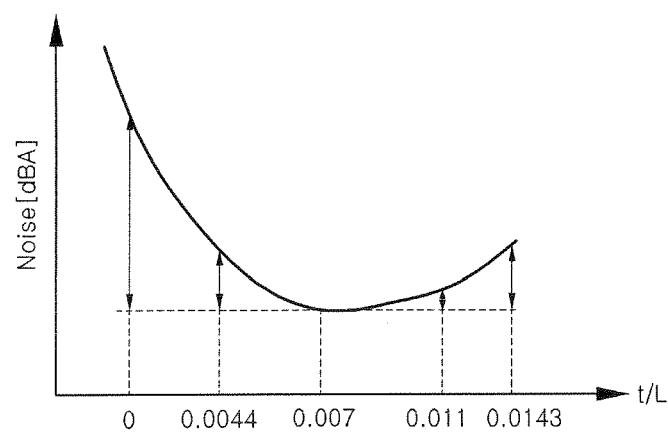


Figure 10

