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(54) **CENTRIFUGAL FAN, AND FAN EQUIPPED WITH SOUND-MUFFLING BOX AND USING CENTRIFUGAL FAN**

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CPC ***F04D 29/4233*** (2013.01); ***F04D 17/16*** (2013.01); ***F04D 29/422*** (2013.01); ***F04D 29/663*** (2013.01)

(57) **ABSTRACT**

Centrifugal fan includes casing and impeller, and discharge duct is connected to casing. At least one of tongue-part-side wall surface on tongue part side extending from casing outlet of casing and opposite tongue-part-side wall surface on side opposite to tongue part side extending from casing outlet protrudes into the inside of discharge duct, and outlet gas flow is bent at predetermined angle and is formed into discharge duct internal gas flow.

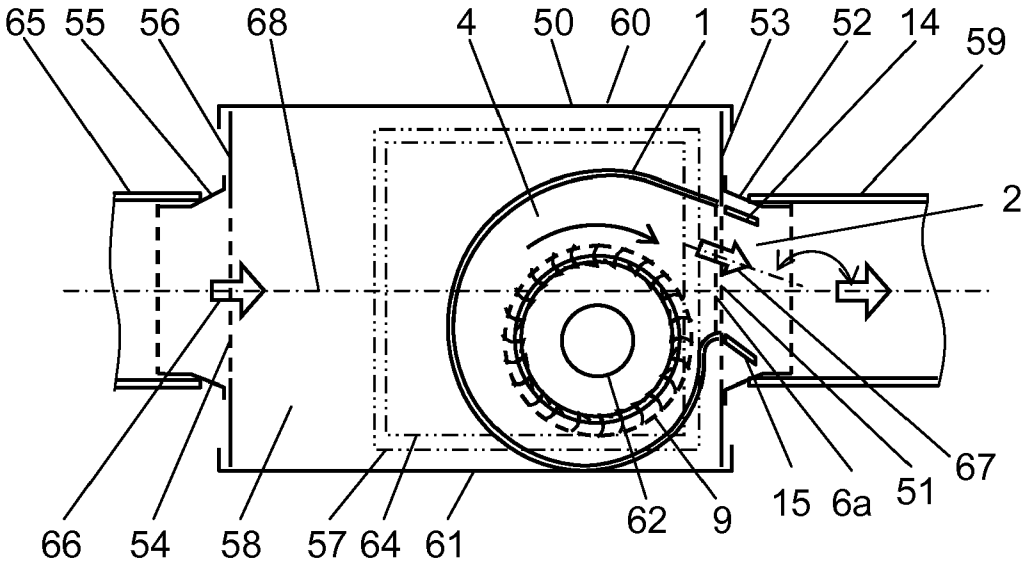


FIG. 1

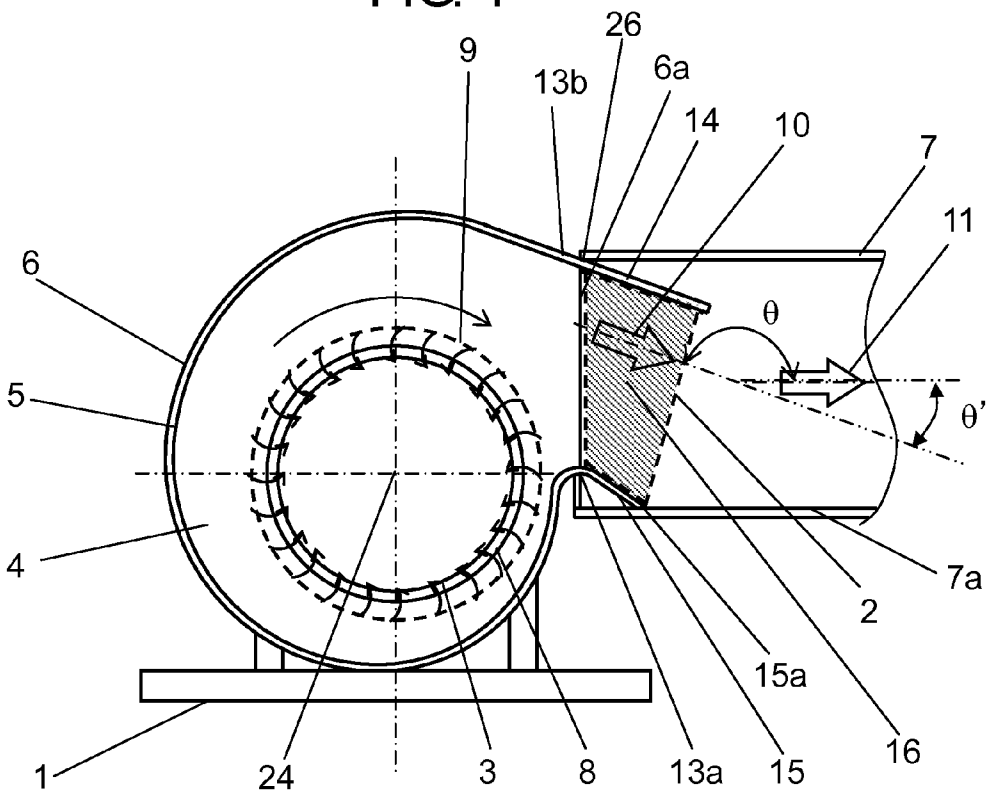


FIG. 2

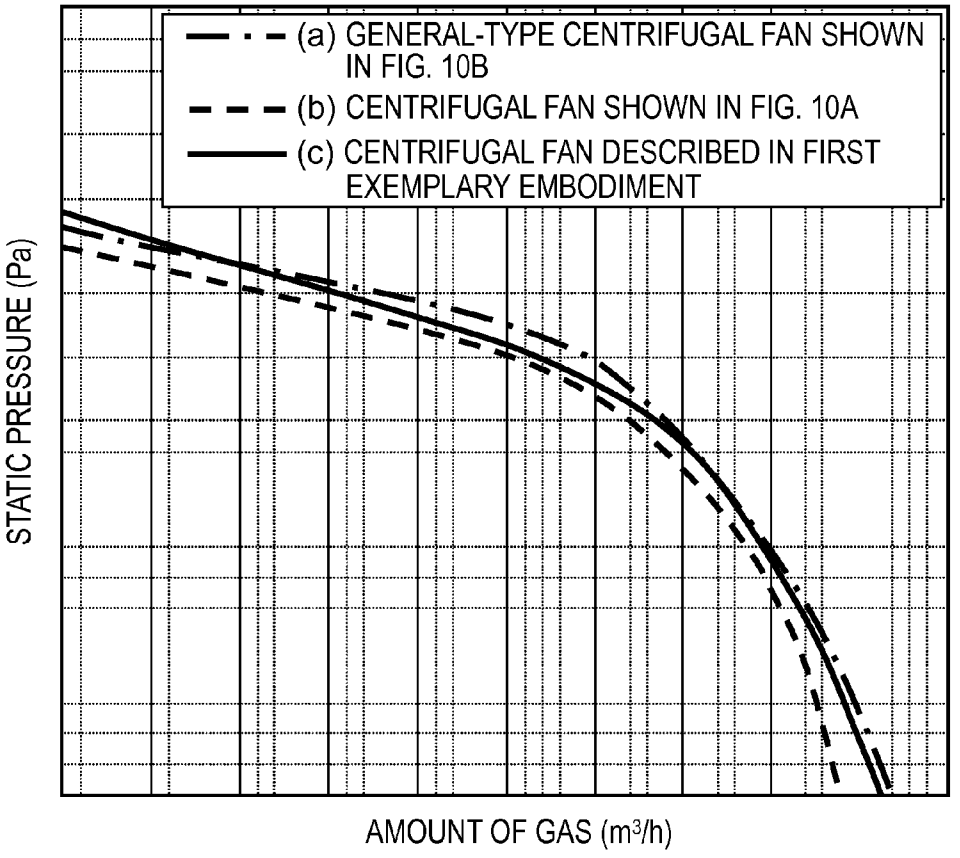

(a) GENERAL-TYPE CENTRIFUGAL FAN SHOWN IN FIG. 10B
(b) CENTRIFUGAL FAN SHOWN IN FIG. 10A
(c) CENTRIFUGAL FAN DESCRIBED IN FIRST EXEMPLARY EMBODIMENT
STATIC PRESSURE (Pa)
AMOUNT OF GAS (m3/h)

FIG. 3A

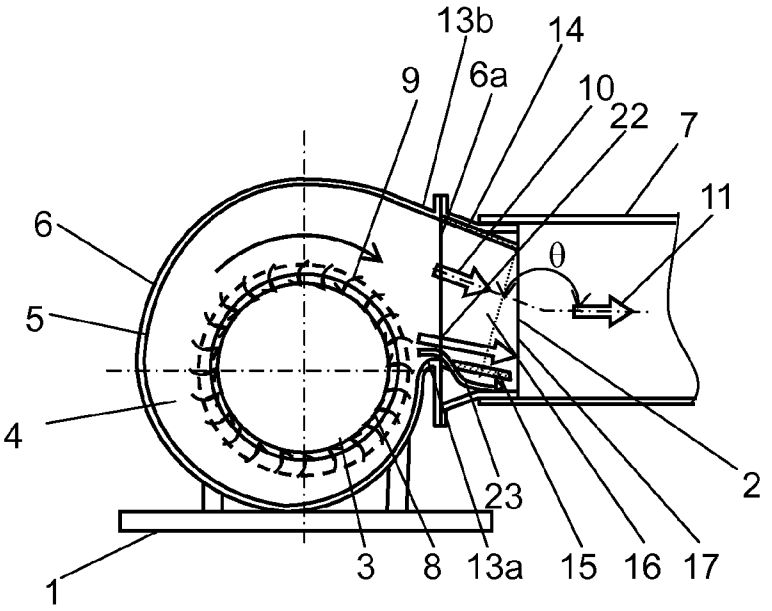

13b
14
9
6a
10
22
7
11
6
θ
5
4
2
23
1
3
8
13a
15
16
17

FIG. 3B

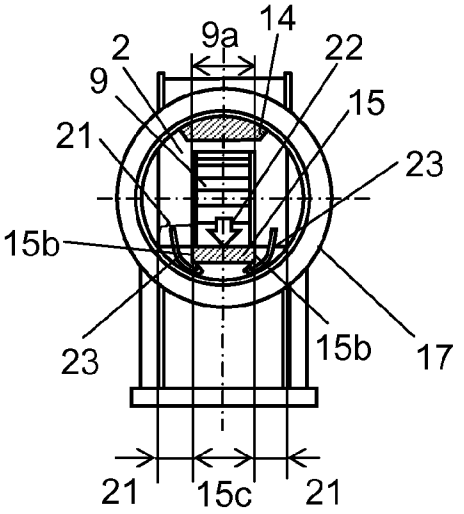

14
9a
2
22
9
15
21
23
15b
23
15b
17
21
15c
21

FIG. 4

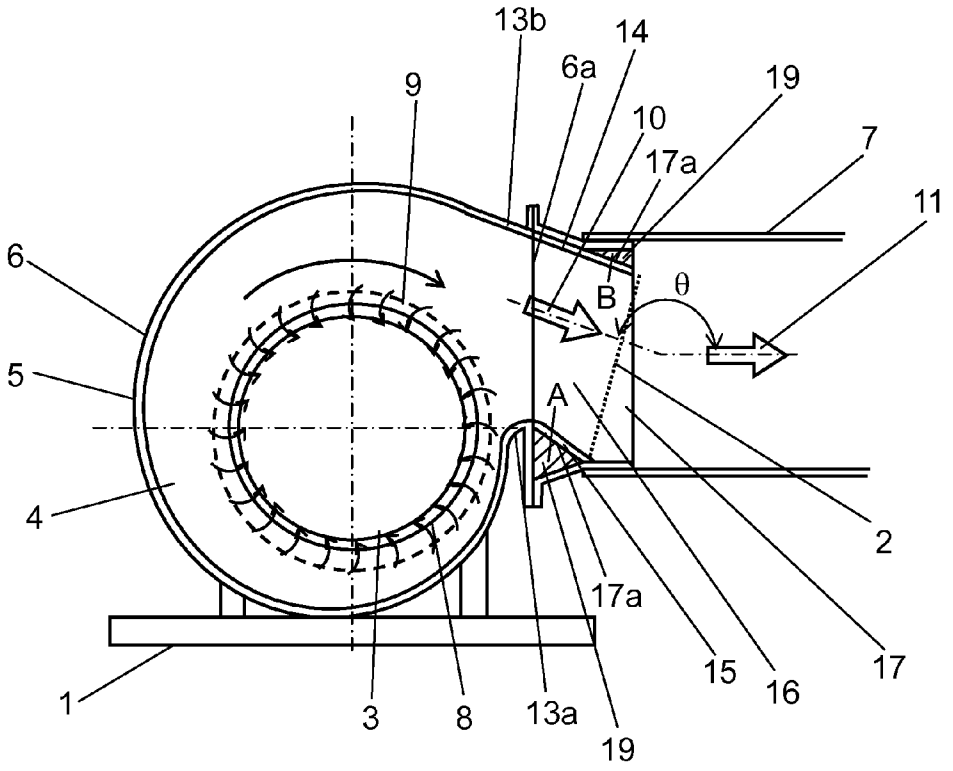


FIG. 5

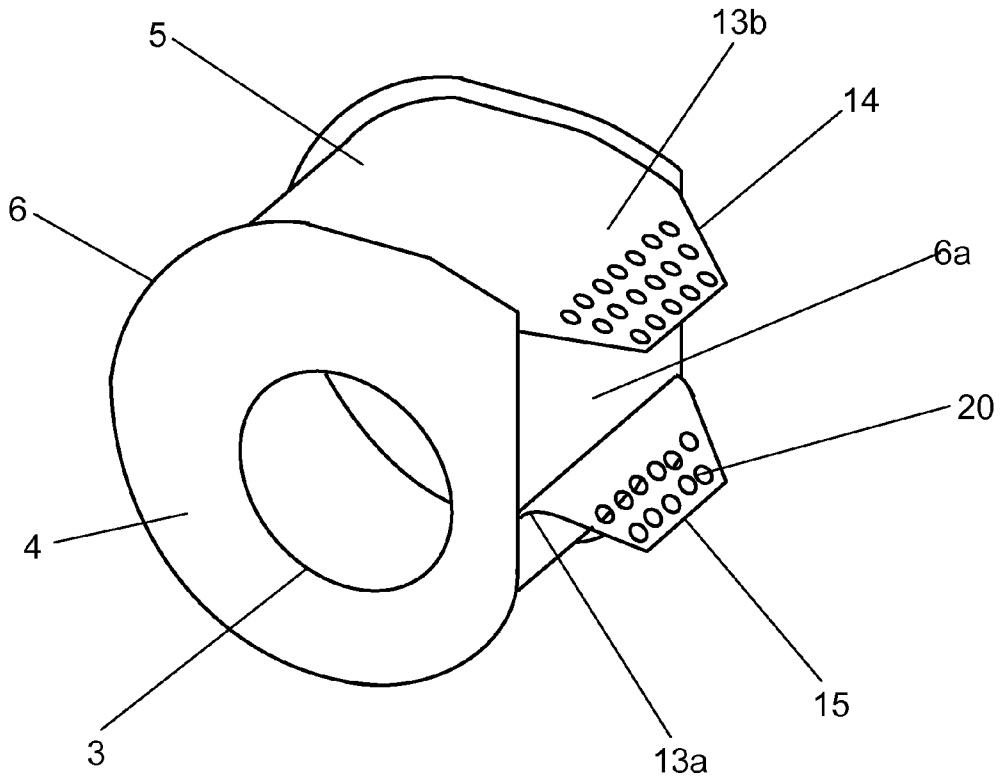


FIG. 6

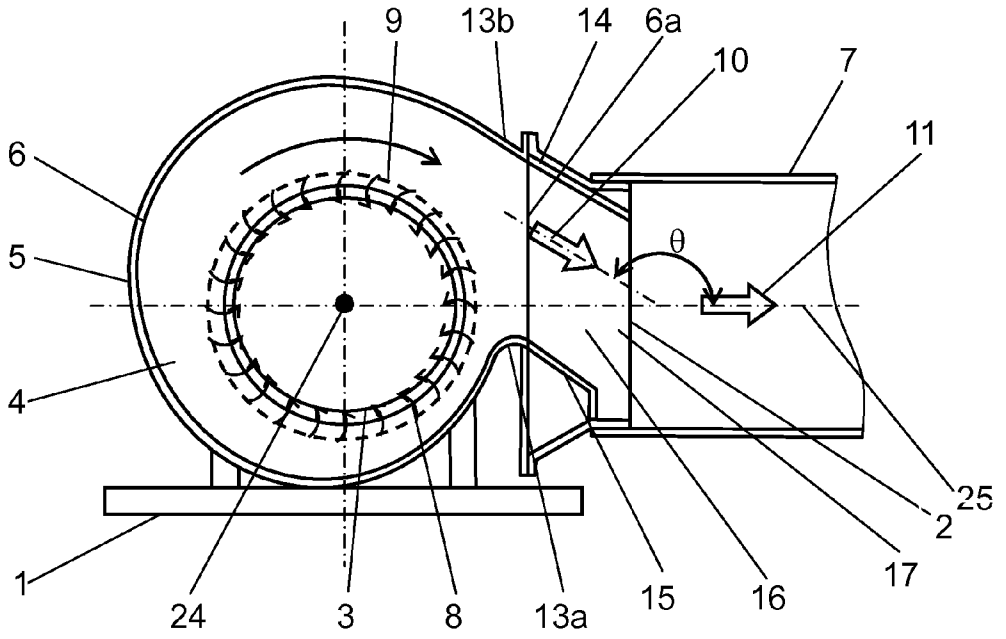


FIG. 7

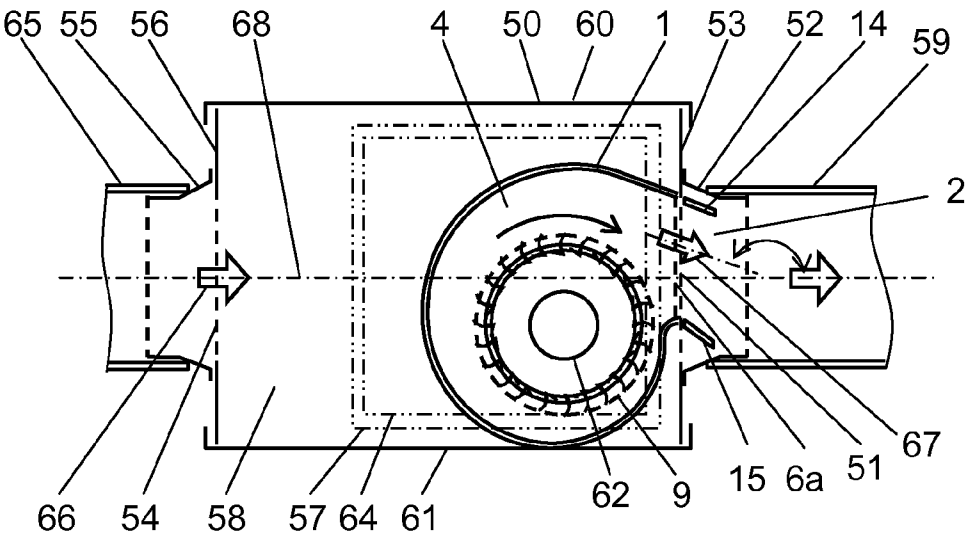


FIG. 8

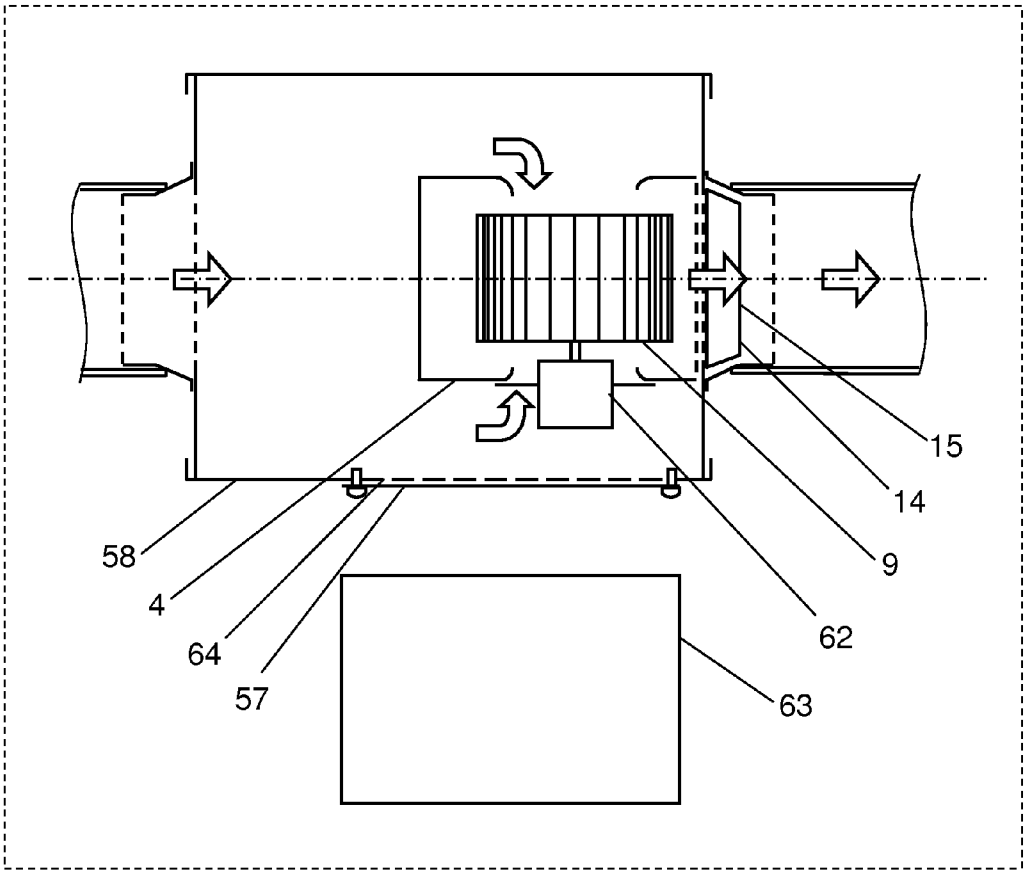


FIG. 9

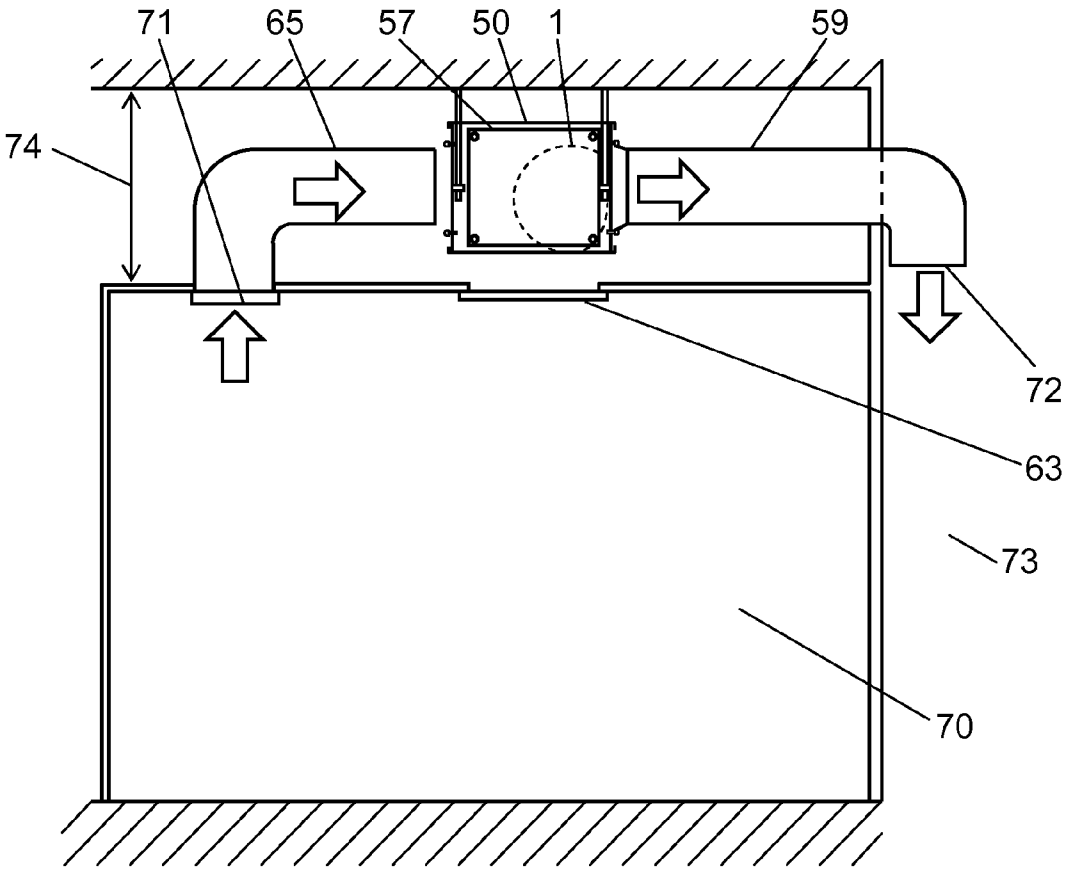


FIG. 10A

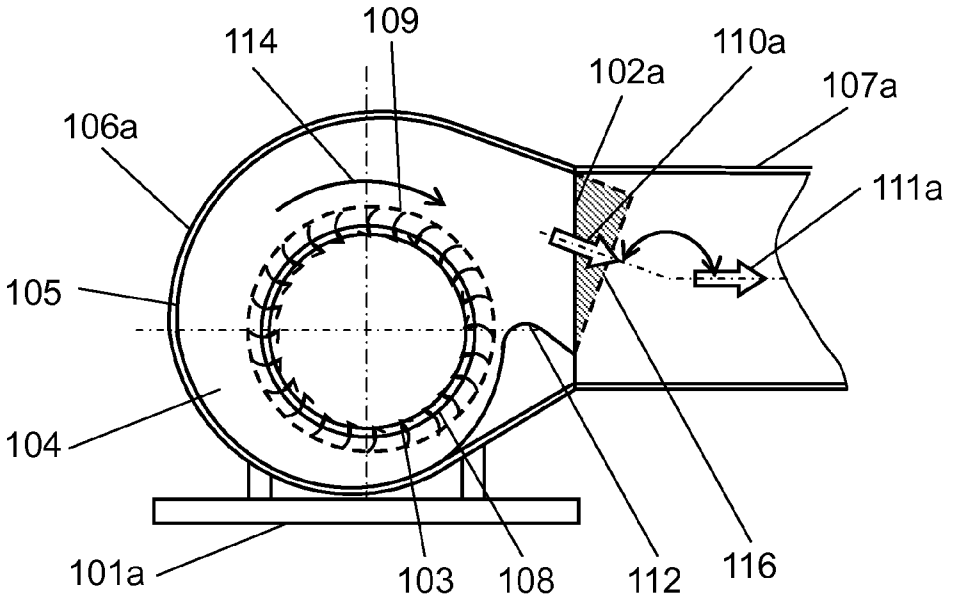
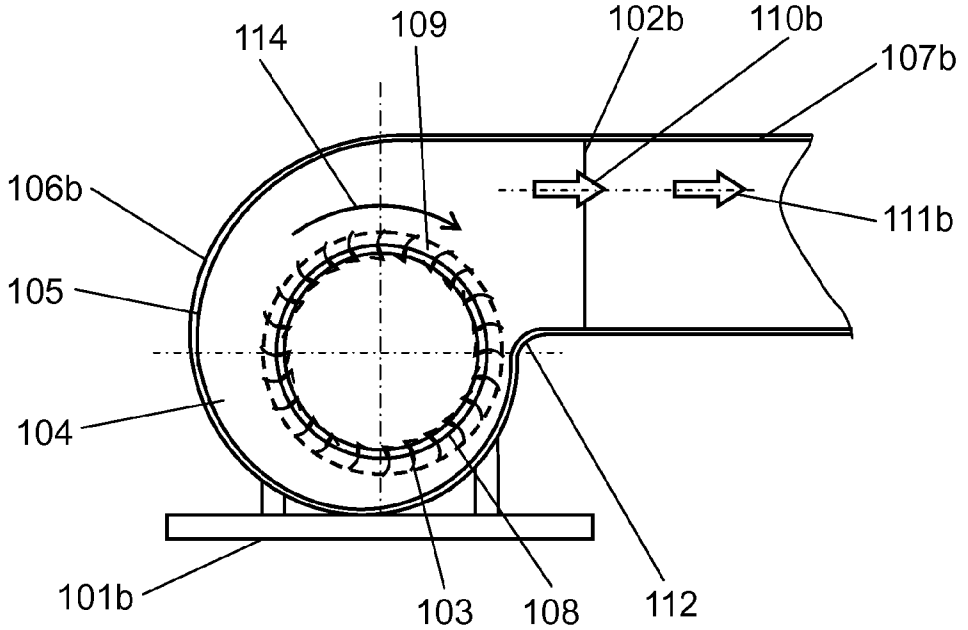


FIG. 10B



CENTRIFUGAL FAN, AND FAN EQUIPPED WITH SOUND-MUFFLING BOX AND USING CENTRIFUGAL FAN

TECHNICAL FIELD

[0001] The present invention relates to a centrifugal fan, and a fan equipped with a sound-muffling box and using the centrifugal fan.

BACKGROUND ART

[0002] At a casing outlet of a centrifugal fan with a scroll casing, velocity of gas blown out from an outer peripheral side (opposite tongue-part-side) of a casing is high. Further, a gas flow blown out from the casing outlet is liable to be bent in a rotational direction of an impeller. Accordingly, in the centrifugal fan with a scroll casing, a pressure loss is generated due to bending of a gas flow toward an discharge duct from the casing outlet. For the reduction of such a pressure loss, in a conventional centrifugal fan the blowout direction of a gas flow at an outer peripheral portion of the casing where gas velocity is high is directed toward an area in the vicinity of a center portion of the discharge duct.

[0003] Hereinafter, the conventional centrifugal fan is described with reference to FIG. **10**A and FIG. **10**B. FIG. **10**A is a side view of the centrifugal fan described in PTL 1, and FIG. **10**B is a side view of a conventional centrifugal fan of a general type.

[0004] As shown in FIG. **10**A, centrifugal fan **101***a* is constituted of casing **106***a*; and impeller **109** incorporated in casing **106***a*. Casing **106***a* is formed of side plate **104** provided with suction port **103**, and scroll **105**. Discharge duct **107***a* is provided at outlet **102***a* of casing **106***a*. Suction duct **108** is provided at suction port **103**. When impeller **109** is rotated, a gas which passes through suction duct **108** flows into casing **106***a* from suction port **103** by way of impeller **109**. Then, pressure of the gas is boosted in casing **106***a*, and the gas is blown out to discharge duct **107***a* from outlet **102***a*.

[0005] As shown in FIG. **10**A, in centrifugal fan **101***a*, the gas supply direction (discharge duct internal gas flow **111***a*) of discharge duct **107***a* is parallel to a plane orthogonal to a rotation axis of impeller **109**. A gas flow blown out from outlet **102***a* (outlet gas flow **110***a*) is bent toward an opposite tongue-part-side in an area in the vicinity of tongue part **112** by discharge duct **107***a* so that outlet gas flow **110***a* is formed into discharge duct internal gas flow **111***a*.

[0006] That is, a gas flow blown out from the opposite tongue-part-side of casing **106***a* does not flow along a wall surface of discharge duct **107***a*. The blowout direction of the gas flow is directed to a center portion between an upper side and a lower side of discharge duct **107***a* in FIG. **10**A.

[0007] FIG. **10**B shows a connection mode between centrifugal fan **101***b* of general type and discharge duct **107***b*. In FIG. **10**B, symbols equal to symbols used in FIG. **10**A indicate identical constitutional elements. As shown in FIG. **10**B, a terminal end of casing **106***b* and discharge duct **107***b* are substantially horizontal. In such centrifugal fan **101***b* of a general type, discharge duct **107***b* is fixed such that the direction of outlet gas flow **110***b* at outlet **102***b* and the direction of discharge duct internal gas flow **111***b* are directed in the same direction. In other words, outlet gas flow **110***b* blown out from casing **106***b* advances into discharge duct **107***b* by keeping the straight linear movement.

[0008] On the other hand, velocity of outlet gas flow **110***b* is high at an outer peripheral side of casing **106***b*. Accordingly, in the inside of discharge duct **107***b*, gas velocity at an upper side is higher than gas velocity at the center portion between the upper side and a lower side of discharge duct **107***b*. As a result, when discharge duct **107***b* is bent in the same direction as rotational direction **114** at a downstream portion thereof, a gas flow having a high gas velocity passes at an outer peripheral side of a bent portion, and the gas flow smoothly flows along bending of discharge duct **107***b*. On the other hand, when discharge duct **107***b* is bent in the direction opposite to rotational direction **114** at the downstream portion thereof, a gas flow having high gas velocity passes an inner side of the bent portion and hence, the turbulence of gas flow is generated at the bent portion of discharge duct **107***b*. Thus, a pressure loss is increased.

[0009] In PTL 1, casing **106***a* is rotated in rotational direction **114** of impeller **109**. Accordingly, in outlet gas flow **110***a*, outlet gas flow **110***a* having high gas velocity at an outer peripheral side of casing **106***a* flows into an area in the vicinity of a center portion between the upper side and the lower side of discharge duct **107***a*. Then, in the area in the vicinity of the center of discharge duct **107***a*, outlet gas flow **110***a* spreads over the whole discharge duct **107***a*, and flows in discharge duct **107***a*.

[0010] Outlet gas flow **110***a* having high velocity is collected to the center portion of discharge duct **107***a* and hence, whichever direction discharge duct **107***a* is bent, a pressure loss generated by bending discharge duct **107***a* is reduced. Accordingly, it is possible to provide centrifugal fan **101***a* having a small pressure loss irrelevant to the bending direction of discharge duct **107***a*.

[0011] However, when discharge duct **107***a* is bent in the direction opposite to the rotational direction of impeller **109** on a downstream side of discharge duct **107***a*, it is necessary to increase a distance between the bent portion and the outlet **102***a*.

CITATION LIST

Patent Literature

[0012] PTL 1: Unexamined Japanese Patent Publication No. 11-294393

SUMMARY OF THE INVENTION

[0013] In such a conventional centrifugal fan, a gas flow having high velocity can be collected to the center portion between the upper side and the lower side of discharge duct **107***a* shown in FIG. **10**A. However, scroll **105** is formed into a shape where hatched portion **116** in the vicinity of outlet **102***a* is cut away, that is scroll **105** is formed into a shape where scroll **105** terminates half way. In scroll gas passage enlarging portion from an area in the vicinity of tongue part **112** of scroll **105** to outlet **102***a*, a velocity of a gas whose pressure is boosted by impeller **109** is lowered due to the enlargement of scroll gas passage. That is, the scroll gas passage enlarging portion is a portion which converts a gas into a static pressure from a dynamic pressure and makes the gas flow out into the inside of discharge duct **107***a*. However, in centrifugal fan **101***a* described in PTL 1, the scroll gas passage enlarging portion is short and hence, a velocity of the gas cannot be sufficiently dropped in the scroll gas passage enlarging portion. Accordingly, the centrifugal fan **101***a*

described in PTL 1 has a drawback that performance (static pressure) of the centrifugal fan is lowered.

[0014] The centrifugal fan of the present invention includes: a casing having a scroll; and an impeller disposed inside the casing. The casing includes a side plate having a suction port. The scroll includes an outlet. An discharge duct is connected to the casing. An outlet gas flow blown out from the outlet is parallel to a plane orthogonal to a rotational axis of the impeller. At least one of a tongue-part-side wall surface on a tongue-part-side extending from a casing outlet of the casing and an opposite tongue-part-side wall surface on a side opposite to the tongue-part-side extending from the casing outlet protrudes into the inside of the discharge duct. As viewed from the direction orthogonal to the suction port, the outlet gas flow is bent toward the side opposite to the tongue-part-side from the tongue-part-side at a predetermined angle and the outlet gas flow is formed into an discharge duct internal gas flow.

[0015] The scroll gas passage enlarging portion is increased by the tongue-part-side wall surface, the opposite tongue-part-side wall surface or both the tongue-part-side wall surface and the opposite tongue-part-side wall surface and hence, a velocity of an outlet gas flow is sufficiently dropped so that the outlet gas flow is smoothly introduced into the discharge duct. Accordingly, in the outlet gas flow, the conversion into a static pressure from a dynamic pressure can be sufficiently performed and hence, a pressure loss is prevented whereby lowering of performance of the centrifugal fan can be prevented.

BRIEF DESCRIPTION OF DRAWINGS

[0016] FIG. **1** is a side view of a centrifugal fan according to a first exemplary embodiment of the present invention.

[0017] FIG. **2** is a graph comparing performance of the centrifugal fan of the present invention and performance of a conventional centrifugal fan.

[0018] FIG. **3**A is a side view of a centrifugal fan according to a second exemplary embodiment of the present invention.

[0019] FIG. **3**B is a front view of the centrifugal fan.

[0020] FIG. **4** is a side view of the centrifugal fan where a sound absorbing member is disposed inside an discharge adapter.

[0021] FIG. **5** is a perspective view of a casing when small holes are formed in a tongue-part-side wall surface and an opposite tongue-part-side wall surface of the centrifugal fan.

[0022] FIG. **6** is a side view for describing the duct connection of the centrifugal fan.

[0023] FIG. **7** is a side view of a fan equipped with a sound-muffling box which uses a centrifugal fan according to a third exemplary embodiment of the present invention.

[0024] FIG. **8** is a top plan view of the fan equipped with a sound-muffling box which uses the centrifugal fan.

[0025] FIG. **9** is an installation view of the fan equipped with a sound-muffling box.

[0026] FIG. **10**A is a side view of a centrifugal fan described in PTL 1.

[0027] FIG. **10**B is a side view of a conventional centrifugal fan of a general type.

DESCRIPTION OF EMBODIMENTS

[0028] Hereinafter, exemplary embodiments of the present invention are described with reference to drawings.

First Exemplary Embodiment

[0029] FIG. **1** is a side view of a centrifugal fan according to the first exemplary embodiment of the present invention. As shown in FIG.**1**, centrifugal fan **1** is constituted of casing **6**; and impeller **9** incorporated in casing **6**. Casing **6** is formed of side plate **4** having suction port **3**, and scroll **5** having outlet **2**. Discharge duct **7** is connected to casing outlet **6***a* of casing **6**, and suction duct **8** is connected to suction port **3**.

[0030] Opposite tongue-part-side wall surface **14** of scroll **5** on an opposite tongue part **13***b* side and tongue-part-side wall surface **15** of scroll **5** on a tongue part **13***a* side protrude into the inside of discharge duct **7**. Opposite tongue-part-side wall surface **14** does not reach the center of discharge duct **7**, and an end portion of opposite tongue-part-side wall surface **14** is disposed at a position in an upper half of discharge duct **7** in FIG. **1**. Open end of tongue-part-side wall surface **15***a* of tongue-part-side wall surface **15** is in contact with discharge duct wall surface **7***a*. Opposite tongue-part-side wall surface **14** and tongue-part-side wall surface **15** extend from casing outlet **6***a*.

[0031] Discharge duct **7** is connected to outlet **2** such that outlet gas flow **10** which flows in outlet **2** is bent parallel to a plane orthogonal to rotation axis **24** of impeller **9** and toward an opposite tongue part **13***b* side on a side opposite to tongue part **13***a* of scroll **5**. That is, as viewed from the direction orthogonal to suction port **3**, outlet gas flow **10** is bent at a predetermined angle θ' toward the opposite tongue part **13***b* side from a tongue part **13***a* side, and forms discharge duct internal gas flow **11** which flows in discharge duct **7**. Predetermined angle θ' is larger than 0 degree and smaller than 45 degrees, and preferably more than or equal to 20 degrees and less than or equal to 30 degrees.

[0032] Since θ is expressed as θ=180−θ' in FIG. **1**, angle θ is a value exceeding 135 degrees and less than 180 degrees, and preferably more than or equal to 150 degrees and less than or equal to 160 degrees.

[0033] Discharge duct internal gas flow **11** is also parallel to a plane orthogonal to rotation axis **24** of impeller **9**.

[0034] Tongue part opposedly facing position **13***c* is a position where a perpendicular extending downwardly to opposite tongue-part-side wall surface **14** from tongue part **13***a* intersects with opposite tongue-part-side wall surface **14**. Connection portion **26** on an opposite tongue part **13***b* side between casing **6** and discharge duct **7** is provided closer to impeller **9** side than to tongue part opposedly facing position **13***c*.

[0035] The manner of operation and advantageous effects brought about by the above-mentioned constitution of centrifugal fan **1** are described. When impeller **9** is rotated, a gas which passes through suction duct **8** flows into the inside of casing **6** from suction port **3** by way of impeller **9**, and a pressure of the gas is boosted inside casing **6**, and the gas flows out into discharge duct **7** from outlet **2**.

[0036] Here, the most characterizing part of the first exemplary embodiment is described. In the first exemplary embodiment, opposite tongue-part-side wall surface **14** and tongue-part-side wall surface **15** are formed inside discharge duct **7** such that scroll **5** protrudes into the inside of discharge duct **7**, thus ensuring scroll gas passage enlarging portion **16**. Accordingly, a gas which reaches casing outlet **6***a* lowers a velocity thereof sufficiently in scroll gas passage enlarging potion **16** and hence, the conversion into a static pressure from a dynamic pressure is accelerated, and the gas flows out into discharge duct **7**.

[0037] Further, due to the formation of tongue-part-side wall surface **15**, outlet gas flow **10** which impinges on tongue part **13***a* is guided to the inside of discharge duct **7** along tongue-part-side wall surface **15**. Since outlet gas flow **10** is smoothly guided into discharge duct **7** by tongue-part-side wall surface **15** in this manner, a pressure loss caused by the sudden enlargement of the gas passage from tongue part **13***a* to discharge duct **7** can be prevented.

[0038] Accordingly, it is desirable that tongue-part-side wall surface **15** protruding into the inside of discharge duct **7** is configured such that open end of tongue-part-side wall surface **15***a* is brought into contact with discharge duct wall surface **7***a*. However, open end of tongue-part-side wall surface **15***a* is not necessarily brought into contact with discharge duct wall surface **7***a*.

[0039] A velocity of outlet gas flow **10** is higher on an outer peripheral side of casing **6**, that is, on an opposite tongue part **13***b* side. Outlet gas flow **10** on the opposite tongue part **13***b* side is bent by opposite tongue-part-side wall surface **14** in the direction of discharge duct internal gas flow **11** at a center portion of discharge duct **7**. In this manner, in centrifugal fan **1** of the first exemplary embodiment, the velocity of outlet gas flow **10** at the center portion in the inside of discharge duct **7** becomes high. Accordingly, whichever direction discharge duct **7** is bent at a bent portion thereof on a downstream side, the increase of a pressure loss can be suppressed. That is, compared with the case where outlet gas flow **10** flows straightly and forms discharge duct internal gas flow **11**, a distance from outlet **2** to the bent portion of discharge duct **7** in the first exemplary embodiment can be made small.

[0040] Discharge duct **7** is connected to casing **6** such that discharge duct **7** is arranged closer to an impeller **9** side than tongue part facing position **13***c* is and hence, centrifugal fan **1** can be miniaturized.

[0041] Further, discharge duct **7** is connected to casing **6** such that a central axis of discharge duct **7** is arranged close to impeller **9** and hence, centrifugal fan **1** can be miniaturized.

[0042] From a viewpoint of miniaturizing centrifugal fan **1**, it is desirable that discharge duct **7** is connected to casing **6** such that the central axis of discharge duct **7** passes rotation axis **24** (or a position in the vicinity of rotation axis **24**) of impeller **9**.

[0043] FIG. **2** is a graph comparing performance of the centrifugal fan according to the first exemplary embodiment of the present invention and performance of a conventional centrifugal fan. FIG. **2** is a graph comparing an amount of gas blown out from the centrifugal fan of the first exemplary embodiment which is indicated by graph (c), an amount of gas blown out from the centrifugal fan shown in FIG. **10**A which is indicated by graph (b), and an amount of gas blown out from the centrifugal fan shown in FIG. **10**B which is indicated by graph (a). An amount of gas is taken on an axis of abscissas, and a static pressure is taken on an axis of ordinates. Graph (a) indicates a case where an outlet gas flow from the centrifugal fan shown in FIG. **10**B flows straightly and forms an discharge duct internal gas flow. Graph (b) indicates a case where an outlet gas flow from the centrifugal fan shown in FIG. **10**A is bent to an opposite tongue part side and forms an discharge duct internal gas flow. Graph (c) indicates a case where opposite tongue-part-side wall surface **14** and tongue-part-side wall surface **15** protrude into the inside of discharge duct **7** in centrifugal fan **1** of the first exemplary embodiment, and outlet gas flow **10** is bent to the opposite tongue part **13***b* side and forms discharge duct internal gas flow **11**.

[0044] Compared to the centrifugal fan shown in FIG. **10**B, the centrifugal fan shown in FIG. **10**A has a smaller scroll gas passage enlarging potion. Further, a gas passage leading to an discharge duct is suddenly enlarged at the tongue part in the centrifugal fan shown in FIG. **10**A and hence, a static pressure is lowered as a whole. On the other hand, it is confirmed that centrifugal fan **1** according to the first exemplary embodiment has the substantially same performance as the general-type centrifugal fan shown in FIG. **10**B.

[0045] As described above, according to the centrifugal fan **1** of first exemplary embodiment of the present invention, whichever direction discharge duct **7** is bent, the pressure loss caused by bending of discharge duct **7** can be reduced and, at the same time, casing **6** can be miniaturized while suppressing the lowering of performance (static pressure). Further, it is unnecessary to prepare two kinds of parts that is, a part for the rightward rotation and a part for the leftward rotation in conformity with the bending direction of discharge duct **7** with respect to the parts of centrifugal fan **1** such as casing **6**. Accordingly, the lowering of the pressure loss can be suppressed irrespective of the bending direction of discharge duct **7**.

[0046] In the first exemplary embodiment, both of opposite tongue-part-side wall surface **14** on an opposite tongue part **13***b* side and tongue-part-side wall surface **15** on a tongue part **13***a* side protrude into the inside of discharge duct **7** in casing **6**. However, it is sufficient that either one of opposite tongue-part-side wall surface **14** on the opposite tongue part **13***b* side and tongue-part-side wall surface **15** on tongue part **13***a* side protrudes into the inside of discharge duct **7**. In this case, the first exemplary embodiment can acquire advantageous effects brought about only either one of opposite tongue-part-side wall surface **14** on the opposite tongue part **13***b* side and tongue-part-side wall surface **15** on tongue part **13***a* side.

Second Exemplary Embodiment

[0047] In the second exemplary embodiment of the present invention, constitutional elements having the same constitution as the corresponding constitutional elements of the first exemplary embodiment are given the same symbols, and the detailed description of these constitutional elements is omitted and only different parts are described. FIG. **3**A is a side view of a centrifugal fan according to the second exemplary embodiment of the present invention, and FIG. **3**B is a front view of the centrifugal fan.

[0048] Centrifugal fan **1** shown in FIG. **3**A and FIG. **3**B is installed such that discharge adapter **17** having a circular shape covers an outer periphery of casing outlet **6***a* in connecting discharge duct **7** having a circular shape to casing outlet **6***a*. Discharge duct **7** having a circular shape is connected to discharge adapter **17**. Opposite tongue-part-side wall surface **14** and tongue-part-side wall surface **15** protrude into the inside of discharge adapter **17**. In this exemplary embodiment, tongue-part-side wall surface width **15***c* has the same size as impeller width **9***a*. Further, gaps **21** are formed between tongue-part-side wall surface sides **15***b* and both left and right sides of discharge adapter **17**.

[0049] The manner of operation and advantageous effects brought about by the above-mentioned constitution of centrifugal fan **1** are described.

[0050] With respect to ensuring of scroll gas passage enlarging potion **16**, the prevention of the sudden enlargement of the gas passage from tongue part **13***a* to discharge duct **7**, and blowing of outlet gas flow **10** having high velocity at the outer peripheral portion of casing **6** into a center portion between an upper side and a lower side of discharge duct **7**, the second exemplary embodiment has the constitution exactly same as the constitution explained in conjunction with the first exemplary embodiment. Impeller outlet gas flow **22** which is directly blown out from impeller **9** and has high velocity is liable to be influenced by the sudden enlargement of the gas passage. However, tongue-part-side wall surface width **15***c* and impeller width **9***a* have the same size and hence, impeller outlet gas flow **22** flows along tongue-part-side wall surface **15**. Accordingly, impeller outlet gas flow **22** is smoothly guided to the inside of discharge duct **7** through discharge adapter **17**.

[0051] On the other hand, velocity of side-plate-side outlet gas flow **23** on a side plate **4** side of impeller **9** is low. That is, side-plate-side outlet gas flow **23** is minimally influenced by a sudden enlarging portion of the gas passage formed in gap **21** portions so that side-plate-side outlet gas flow **23** flows into a lower side of discharge adapter **17** and is guided to discharge duct **7**. In this manner, due to the formation of gaps **21**, impeller outlet gas flow **22** having high velocity and side-plate-side outlet gas flow **23** having low velocity are smoothly guided into the inside of discharge duct **7** without colliding with each other and hence, the pressure loss of impeller outlet gas flow **22** and the pressure loss of side-plate-side outlet gas flow **23** can be prevented.

[0052] Discharge adapter **17** connects casing outlet **6***a* having a quadrangular shape following a shape of the extension of scroll **5** and discharge duct **7** having a circular shape. Discharge adapter **17** is configured such that discharge adapter **17** has a circular shape on a scroll **5** side, and a circular cross-sectional area of discharge adapter **17** is gradually decreased toward an discharge duct **7** side. Outlet gas flow **10** flows into the inside of casing **6** through impeller **9**, pressure of outlet gas flow **10** is boosted inside casing **6**, and outlet gas flow **10** reaches casing outlet **6***a*. Outlet gas flow **10** is smoothly guided to discharge duct **7** from casing outlet **6***a* by discharge adapter **17**. At the same time, outlet gas flow **10** is directed to a center portion of discharge duct **7**. Accordingly, a diameter of discharge duct **7** can be reduced. Discharge duct **7** is installed by being inserted into discharge adapter **17**. A portion of casing **6** is inserted into discharge adapter **17** and hence, centrifugal fan **1** can be miniaturized.

[0053] In this manner, in centrifugal fan **1** according to the second exemplary embodiment of the present invention, casing **6** can be miniaturized, discharge duct **7** can be also miniaturized, and the installation workability can be also improved while suppressing the lowering of performance (static pressure).

[0054] In the second exemplary embodiment, tongue-part-side wall surface **15** has a flat planar shape. However, tongue-part-side wall surface sides **15***b* may be raised toward the opposite tongue part **13***b* side with respect to the gas supply direction or may be bent in the direction toward the tongue part **13***a* side.

[0055] FIG. **4** is a side view of the centrifugal fan according to the second exemplary embodiment of the present invention where a sound absorbing member is disposed inside an discharge adapter. In centrifugal fan **1** shown in FIG. **4**, sound absorbing member **19** is disposed between discharge adapter inner surface **17***a* and opposite tongue-part-side wall surface **14** as well as between discharge adapter inner surface **17***a* and tongue-part-side wall surface **15**.

[0056] The manner of operation and advantageous effects of centrifugal fan **1** shown in FIG. **4** are described. A gas flow whose pressure is boosted inside casing **6** is flown out into discharge duct **7** from casing outlet **6***a*. At this time, outlet gas flow **10** impinges on discharge adapter **17** so that gas flow noises are generated. Such gas flow noises are absorbed by sound absorbing members **19** disposed between discharge adapter **17** and casing outlet **6***a* of scroll **5**.

[0057] FIG. **5** is a perspective view of a casing when small holes are formed in a tongue-part-side wall surface and an opposite tongue-part-side wall surface of the centrifugal fan according to the second exemplary embodiment of the present invention. As shown in FIG. **5**, a plurality of small holes **20** are formed in opposite tongue-part-side wall surface **14** and tongue-part-side wall surface **15**.

[0058] By forming the plurality of small holes **20** in opposite tongue-part-side wall surface **14** and tongue-part-side wall surface **15**, an energy of gas flow noises passes through small holes **20** so that the energy propagates to spaces A, B shown in FIG. **4** disposed between scroll **5** and discharge adapter **17** or to sound absorbing members **19** whereby gas flow noises are absorbed. As a result, a sound absorbing rate in the inside of discharge adapter **17** is increased.

[0059] FIG. **6** is a side view for describing the duct connection of the centrifugal fan according to the second exemplary embodiment of the present invention. As shown in FIG. **6**, central axis **25** of an opening of discharge adapter **17** passes rotation axis **24** of impeller **9** which constitutes the center of suction port **3**.

[0060] As a result, a height of discharge duct **7** and a height of suction duct **8** can be set equal to each other. Accordingly, when discharge duct **7** and suction duct **8** are fixed to a floor or ceiling using members, a length of the members can be unified.

[0061] In the second exemplary embodiment, gaps **21** are disposed between tongue-part-side wall surface sides **15***b* and discharge adapter **17**. However, gaps **21** may be disposed between tongue-part-side wall surface sides **15***b* and discharge duct **7**.

Third Exemplary Embodiment

[0062] In a third exemplary embodiment of the present invention, constitutional elements having the same constitution as the corresponding constitutional elements of the first and second exemplary embodiments are given the same symbols, and the description of these constitutional elements is omitted and only different parts are described. FIG. **7** is a side view of a fan equipped with a sound-muffling box which uses a centrifugal fan according to a third exemplary embodiment of the present invention. FIG. **8** is a top plan view of the fan equipped with a sound-muffling box which uses the centrifugal fan.

[0063] The fan equipped with a sound-muffling box according to the third exemplary embodiment includes: either one of centrifugal fans **1** described in the first and second exemplary embodiments; and box-shaped body **50** which incorporates centrifugal fan **1** therein. As shown in FIG. **7** and FIG. **8**, body **50** is constituted of: outlet panel **53**; suction panel **56**; and side panels **58**. Body blowout port **51** and discharge adapter **52** are provided to outlet panel **53**. Body

suction port **54** and suction adapter **55** are provided to suction panel **56**. Checkup panel **57** is fixed to side panel **58**.

[0064] Casing outlet **6***a* is connected to discharge duct **59** by connecting discharge adapter **52** to discharge duct **59**. Further, discharge adapter **52** is disposed at the center of outlet panel **53**, and suction adapter **55** is disposed at the center of suction panel **56**. Although opposite tongue-part-side wall surface **14** and tongue-part-side wall surface **15** are disposed inside discharge adapter **52** in the third exemplary embodiment, in the same manner as the first exemplary embodiment or the second exemplary embodiment, either one of opposite tongue-part-side wall surface **14** and tongue-part-side wall surface **15** may be disposed inside discharge adapter **52**.

[0065] Top panel **60**, bottom panel **61** and side panels **58** are positioned between outlet panel **53** and suction panel **56**. Top panel **60** and bottom panel **61** are panels of body **50** which cover a top surface and a bottom surface of centrifugal fan **1**, respectively. Checkup panel **57** detachably fixed to side panel **58** faces side plate **4** of centrifugal fan **1**. Accordingly, after removing checkup panel **57** from side panel **58**, an operator who enters from wall surface checkup opening **63** can observe impeller **9** and motor **62** fixed to side plate **4** through checkup panel opening **64**.

[0066] Body blowout port **51** is formed at the center of outlet panel **53**, and outlet panel **53** faces casing outlet **6***a* of centrifugal fan **1**. In the third exemplary embodiment, outlet panel **53** and centrifugal fan **1** are connected and fixed to each other in a state where outlet panel **53** and centrifugal fan **1** are arranged close to each other. However, outlet panel **53** and centrifugal fan **1** may be connected and fixed to each other by way of an intermediate member.

[0067] Body suction port gas flow **66** supplied through body suction port **54** passes centrifugal fan **1** and flows out as body blowout port gas flow **67** through discharge duct **59** connected to discharge adapter **52** and suction duct **65** connected to suction adapter **55**. Discharge adapter **52** is disposed at the center of outlet panel **53** and suction adapter **55** is disposed at the center of suction panel **56**, and discharge adapter **52** faces suction adapter **55**. Accordingly, discharge duct **59** and suction duct **65** are installed on the same central axis **68**. By providing body suction port **54** at the center of suction panel **56**, body suction port gas flow **66** from suction duct **65** smoothly flows into body suction port **54**. For this reason, it is desirable that body suction port **54** be provided at the center of suction panel **56**.

[0068] FIG. **9** is an installation view of the fan equipped with a sound-muffling box according to the third exemplary embodiment of the present invention. When centrifugal fan **1** shown in FIG. **9** is operated, air in room **70** is sucked through wall surface suction port **71**, and is discharged to outdoors **73** from wall surface outlet **72** through suction duct **65**, body **50** and discharge duct **59**.

[0069] Wall surface checkup opening **63** is provided in the vicinity of checkup panel **57** so that centrifugal fan **1** can be checked up. Body **50** is disposed in attic **74** and hence, the miniaturization of centrifugal fan **1** leads to the miniaturization of body **50**. Accordingly, even when attic **74** is narrow, body **50** can be easily installed.

[0070] The manner of operation and advantageous effects brought about by the fan equipped with a sound-muffling box which uses centrifugal fan **1** according to the third exemplary embodiment of the present invention are described.

[0071] As shown in FIG. **7**, discharge adapter **52** is provided at the center of outlet panel **53**, and suction adapter **55** is provided at the center of suction panel **56**. Accordingly, when body **50** is installed upside down, that is, a top surface of body **50** is disposed on a lower side and a bottom surface of body **50** is disposed on an upper side, positions of discharge adapter **52** and suction adapter **55** relative to body **50** are not changed so that installation workability is improved.

[0072] The upside-down installation of body **50** is effectively applicable to a case where the inside of attic **74** shown in FIG. **9** is narrow so that the position of checkup panel **57** with respect to body **50** is set upside down, that is, a case where body **50** is installed with wall surface checkup opening **63** disposed upside down.

[0073] As shown in FIG. **7**, body blowout port **51** is provided at the center of outlet panel **53**. Accordingly, body blowout port gas flow **67** from body blowout port **51** is directed to discharge adapter **52** disposed at the center of outlet panel **53** so that body blowout port gas flow **67** is smoothly guided without collision. Thus, a pressure loss can be suppressed.

[0074] Further, a distance between outlet panel **53** and centrifugal fan **1** is minimized so that body **50** can be miniaturized. Accordingly, it is desirable that outlet panel **53** be in contact with casing outlet **6***a* of centrifugal fan **1**. However, it is not always necessary to bring outlet panel **53** into contact with casing outlet **6***a*.

[0075] In this manner, according to the fan equipped with a sound-muffling box which uses centrifugal fan **1** according to the third exemplary embodiment of the present invention, the installation workability is improved and body **50** is miniaturized while suppressing the lowering of the performance (static pressure).

INDUSTRIAL APPLICABILITY

[0076] The present invention is applicable to a ventilation blower such as a duct fan and to a centrifugal fan used in an air conditioner or the like. The present invention is also applicable to cooling of installation equipment by using a gas flow from a body blowout port besides the conveyance of air by a ventilation blower or the like.

REFERENCE MARKS IN THE DRAWINGS

[0077] **1** centrifugal fan
[0078] **2** outlet
[0079] **3** suction port
[0080] **4** side plate
[0081] **5** scroll
[0082] **6** casing
[0083] **6***a* casing outlet
[0084] **7** discharge duct
[0085] **7***a* discharge duct wall surface
[0086] **8** suction duct
[0087] **9** impeller
[0088] **9***a* impeller width
[0089] **10** outlet gas flow
[0090] **11** discharge duct internal gas flow
[0091] **13***a* tongue part
[0092] **13***b* opposite tongue part
[0093] **13***c* tongue part facing position
[0094] **14** opposite tongue-part-side wall surface
[0095] **15** tongue-part-side wall surface
[0096] **15***a* open end of tongue-part-side wall surface

[0097] **15***b* tongue-part-side wall surface side
[0098] **15***c* tongue-part-side wall surface width
[0099] **16** scroll gas passage enlarging potion
[0100] **17**, **52** discharge adapter
[0101] **17***a* discharge adapter inner surface
[0102] **19** sound absorbing member
[0103] **20** small hole
[0104] **21** gap
[0105] **22** impeller outlet gas flow
[0106] **23** side-plate-side outlet gas flow
[0107] **24** rotation axis
[0108] **25** central axis
[0109] **26** connection portion
[0110] **50** body
[0111] **51** body blowout port
[0112] **53** outlet panel
[0113] **54** body suction port
[0114] **55** suction adapter
[0115] **56** suction panel
[0116] **57** checkup panel
[0117] **58** side panel
[0118] **59** discharge duct
[0119] **60** top panel
[0120] **61** bottom panel
[0121] **62** motor
[0122] **63** wall surface checkup opening
[0123] **64** checkup panel opening
[0124] **65** suction duct
[0125] **66** body suction port gas flow
[0126] **67** body blowout port gas flow
[0127] **68** same central axis
[0128] **70** room
[0129] **71** wall surface suction port
[0130] **72** wall surface outlet
[0131] **73** outdoor
[0132] **74** attic

1. A centrifugal fan comprising:
a casing having a scroll; and
an impeller disposed inside the casing,
wherein
the casing includes a side plate having a suction port,
the scroll includes an outlet; and
the casing is connected to an discharge duct,
an outlet gas flow which flows through the outlet is parallel to a plane orthogonal to a rotation axis of the impeller,
at least one of a tongue-part-side wall surface on a tongue part side and an opposite tongue-part-side wall surface on another side opposite to the tongue part side extending from the casing outlet of the casing protrudes into the discharge duct, and
as viewed from a direction orthogonal to the suction port, the outlet gas flow is bent from the tongue part side toward the side opposite to the tongue part side at a predetermined angle, and formed into an internal gas flow which flows through the discharge duct.

2. The centrifugal fan according to claim **1**, wherein the predetermined angle is larger than 0 degree and smaller than 45 degrees.

3. The centrifugal fan according to claim **1**, wherein an open end of the tongue-part-side wall surface is in contact with a wall surface of the discharge duct when the tongue-part-side wall surface protrudes into the discharge duct.

4. The centrifugal fan according to claim **1**, wherein a gap is formed between a tongue-part-side wall surface side and the discharge duct when the tongue-part-side wall surface protrudes into the discharge duct.

5. The centrifugal fan according to claim **4**, wherein a width of the tongue-part-side wall surface is equal to a width of the impeller.

6. The centrifugal fan according to claim **1**, wherein a connection portion on the side opposite to the tongue part side between the casing and the discharge duct is closer to the impeller than a tongue part facing position at which a perpendicular extending downwardly to the opposite tongue-part-side wall surface from the tongue part intersects.

7. The centrifugal fan according to claim **1** further comprising an discharge adapter which covers the casing outlet,
wherein the discharge duct and the discharge adapter are connected to each other, and the tongue-part-side wall surface and the opposite tongue-part-side wall surface protrude into the discharge adapter.

8. The centrifugal fan according to the claim **7**, wherein a sound absorbing member is interposed between an discharge adapter inner surface and the tongue-part-side wall surface and between the discharge adapter inner surface and the opposite tongue-part-side wall surface.

9. The centrifugal fan according to the claim **8**, wherein a plurality of small holes are formed in the tongue-part-side wall surface and the opposite tongue-part-side wall surface.

10. The centrifugal fan according to the claim **7**, wherein a center axis of an opening of the discharge adapter passes the rotation axis.

11. A fan equipped with a sound-muffling box, the fan comprising:
the centrifugal fan described in claim **1**; and
a body in which the centrifugal fan is incorporated,
wherein
the body includes:
an outlet panel provided with a body blowout port and an discharge adapter;
a suction panel provided with a body suction port and a suction adapter; and
a side panel to which a checkup panel is fixed,
the discharge adapter is connected to the discharge duct such that the casing outlet is in communication with the discharge duct,
the discharge adapter is disposed at a center of the outlet panel, and
the suction adapter is disposed at a center of the suction panel.

12. The fan equipped with a sound-muffling box according to claim **11**, wherein the body blowout port is disposed at the center of the outlet panel.

13. The fan equipped with a sound-muffling box according to the claim **11**, wherein the outlet panel is in contact with the casing outlet.

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