US 20230033024A1

(19) United States
(12) Patent Application Publication
(10) Pub. No.: US 2023/0033024 A1
(43) Pub. Date: Feb. 2, 2023
Chiu et al.

(54) DIAGONAL FAN

(71) Applicant: **Delta Electronics, Inc.**, Taoyuan City (TW)

(72) Inventors: **Pei-Han Chiu**, Taoyuan City (TW); **Chien-Ming Lee**, Taoyuan City (TW); **Chung-Yuan Tsang**, Taoyuan City (TW)

(21) Appl. No.: **17/680,052**

(22) Filed: **Feb. 24, 2022**

Related U.S. Application Data

(60) Provisional application No. 63/153,868, filed on Jul. 29, 2021.

(30) **Foreign Application Priority Data**

Feb. 11, 2022 (CN) 202210128548.9

Publication Classification

(51) **Int. Cl.**

F04D 29/66	(2006.01)
F04D 19/00	(2006.01)
F04D 29/32	(2006.01)
F04D 29/54	(2006.01)
F04D 29/52	(2006.01)

(52) **U.S. Cl.**

CPC ***F04D 29/667*** (2013.01); ***F04D 19/002*** (2013.01); ***F04D 29/325*** (2013.01); ***F04D 29/542*** (2013.01); ***F04D 29/522*** (2013.01); ***F04D 29/666*** (2013.01)

(57) **ABSTRACT**

A diagonal fan is disclosed and includes a frame and an impeller. The frame includes an inlet, an outlet, an accommodation space and a guiding wall. The inlet and the outlet are communicated through the accommodation space. The guiding wall is extended along an axial direction to the accommodation space. The impeller is accommodated within the accommodation space and includes a conical section shell. When the impeller is rotated, an airflow flowing is generated. The outer diameter of the hub of the impeller is expended gradually in a direction from the inlet toward the outlet, so that the flowing direction of the airflow is expended gradually around the peripheral of the impeller. A gap having a spacing distance is substantially maintained to form a backflow channel. A backflow is transported through an intake section, a horizontal section and an exhaust section of the backflow channel, and converged with the airflow.

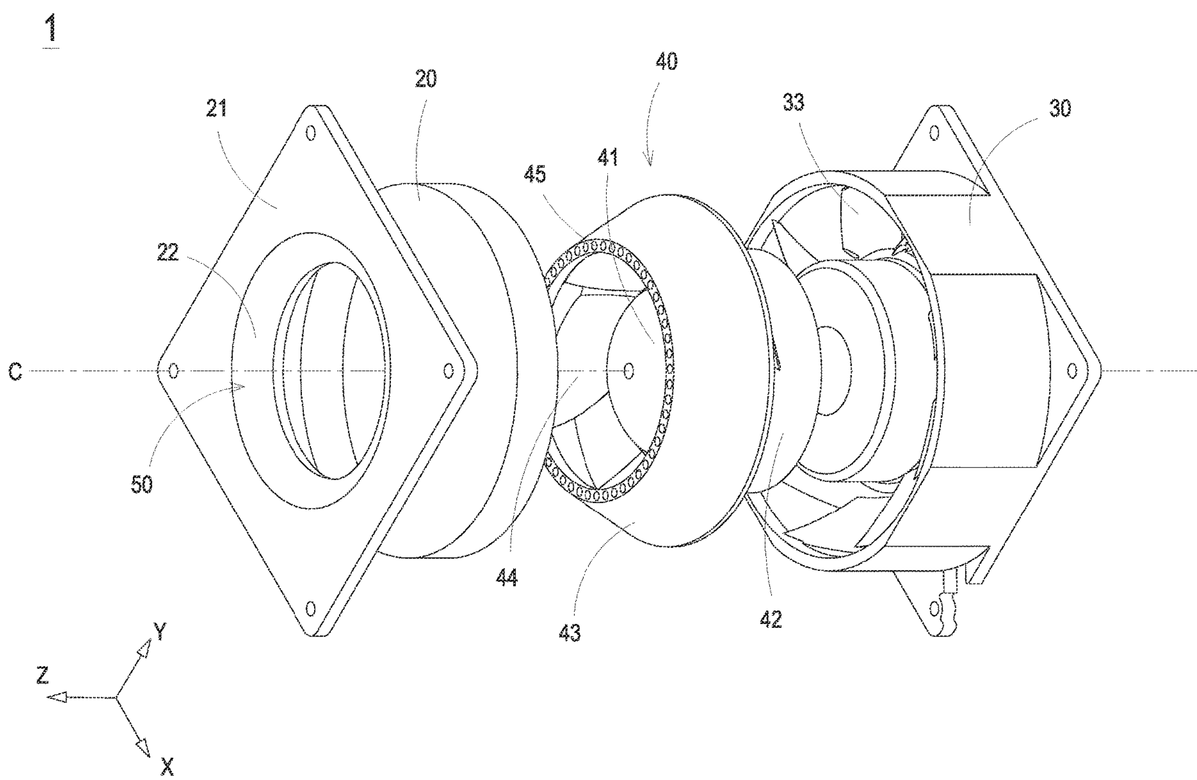


FIG. 1

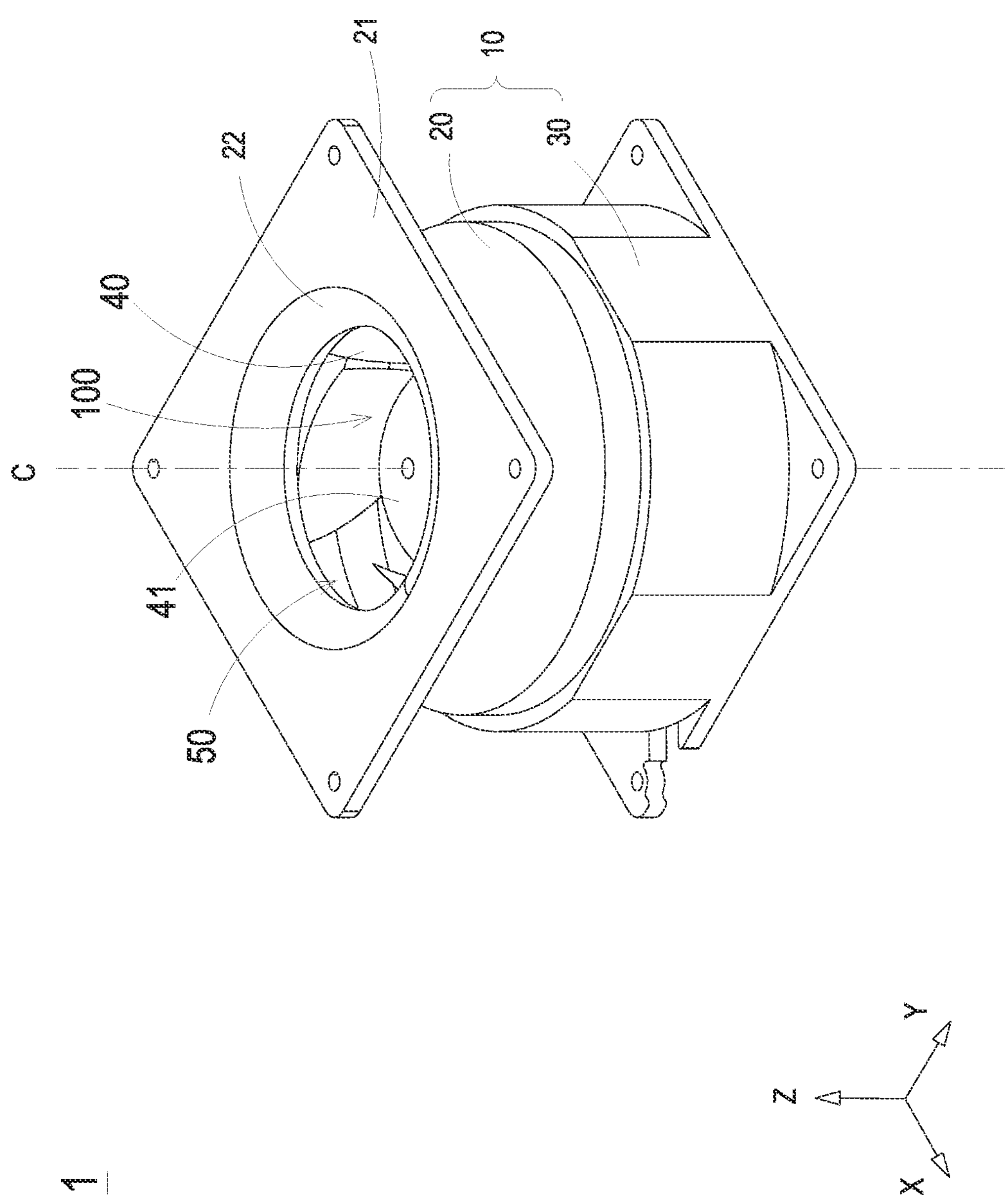
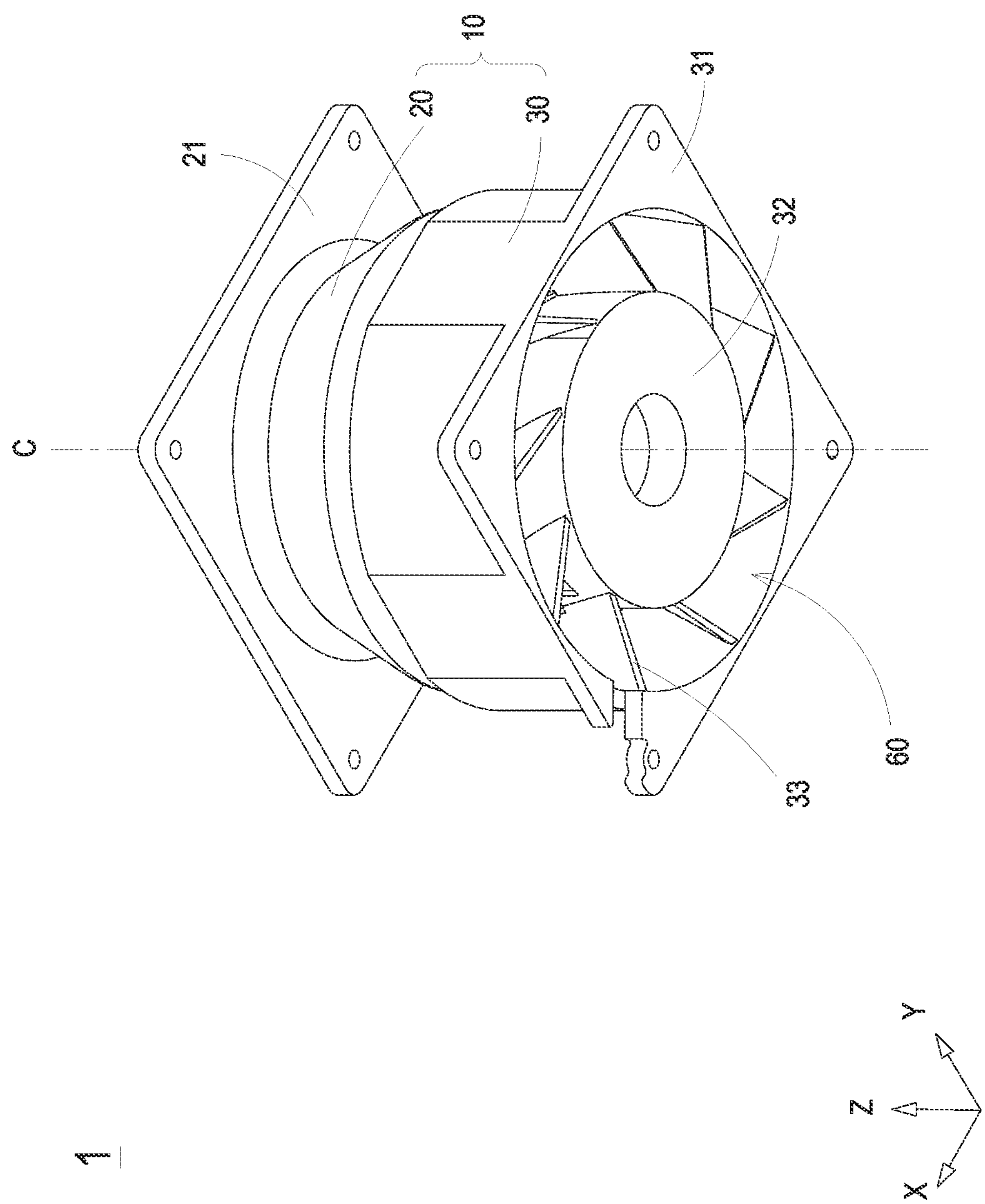


FIG. 2



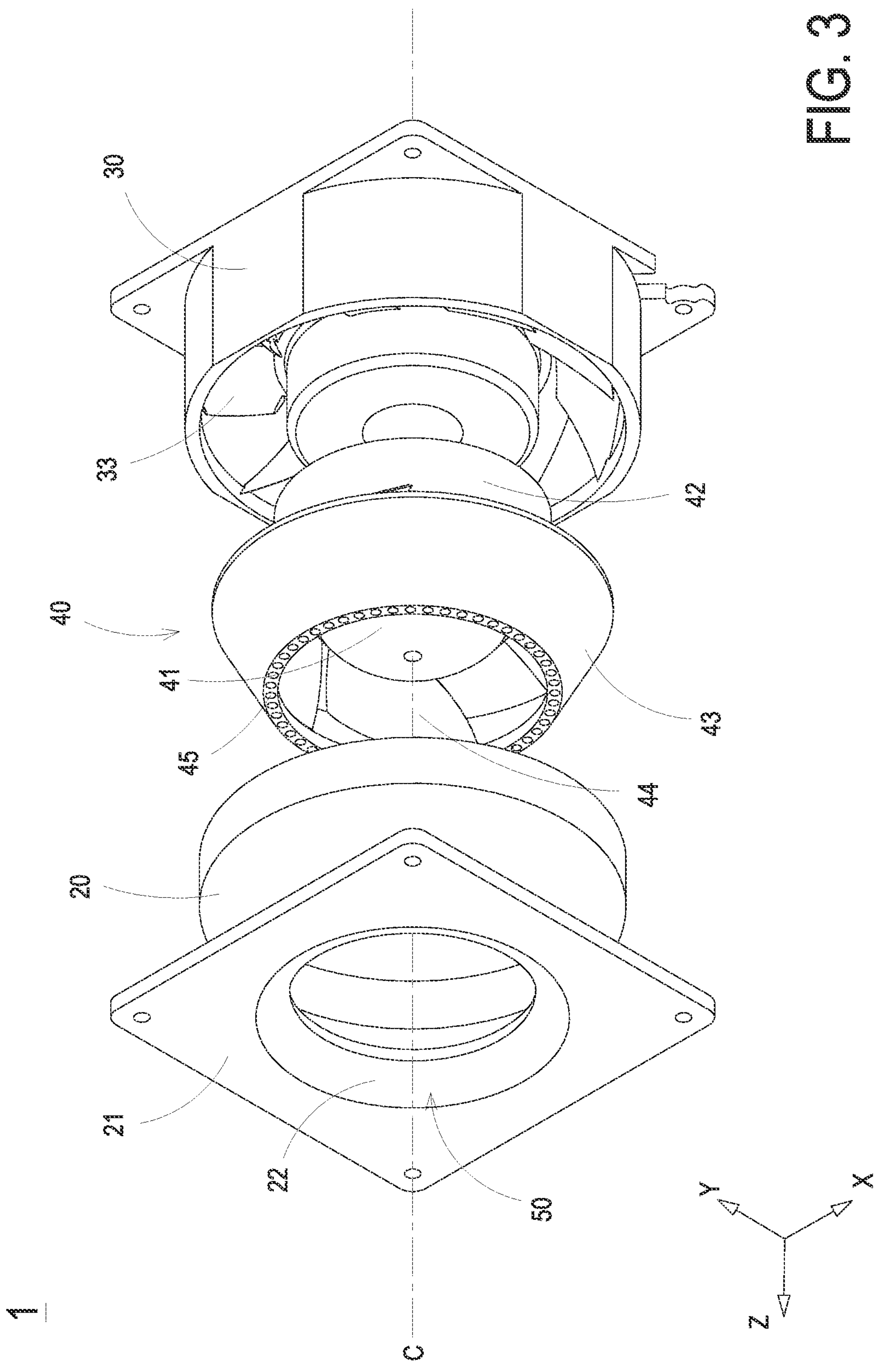


FIG. 3

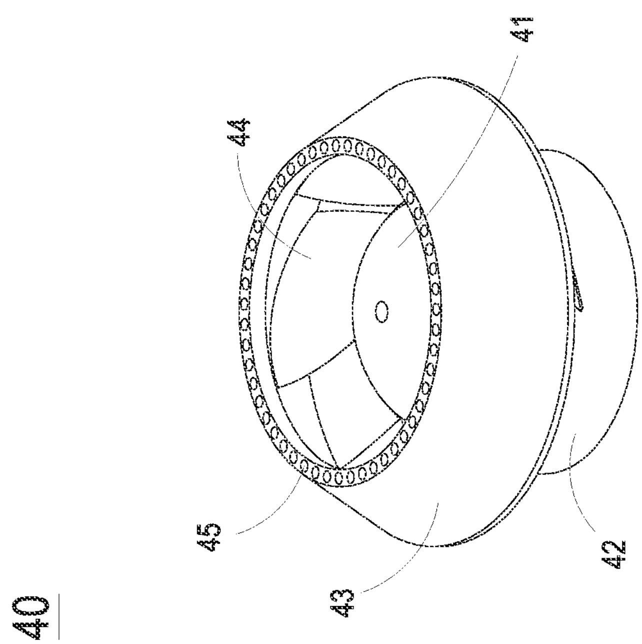


FIG. 4A

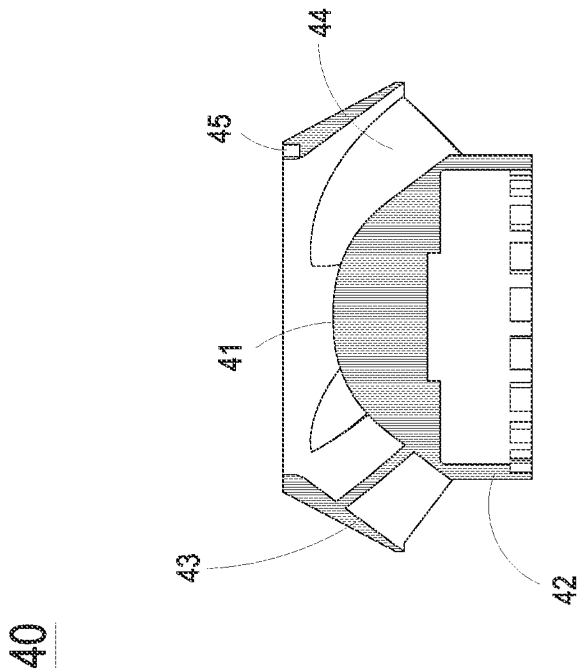


FIG. 4B

FIG. 5

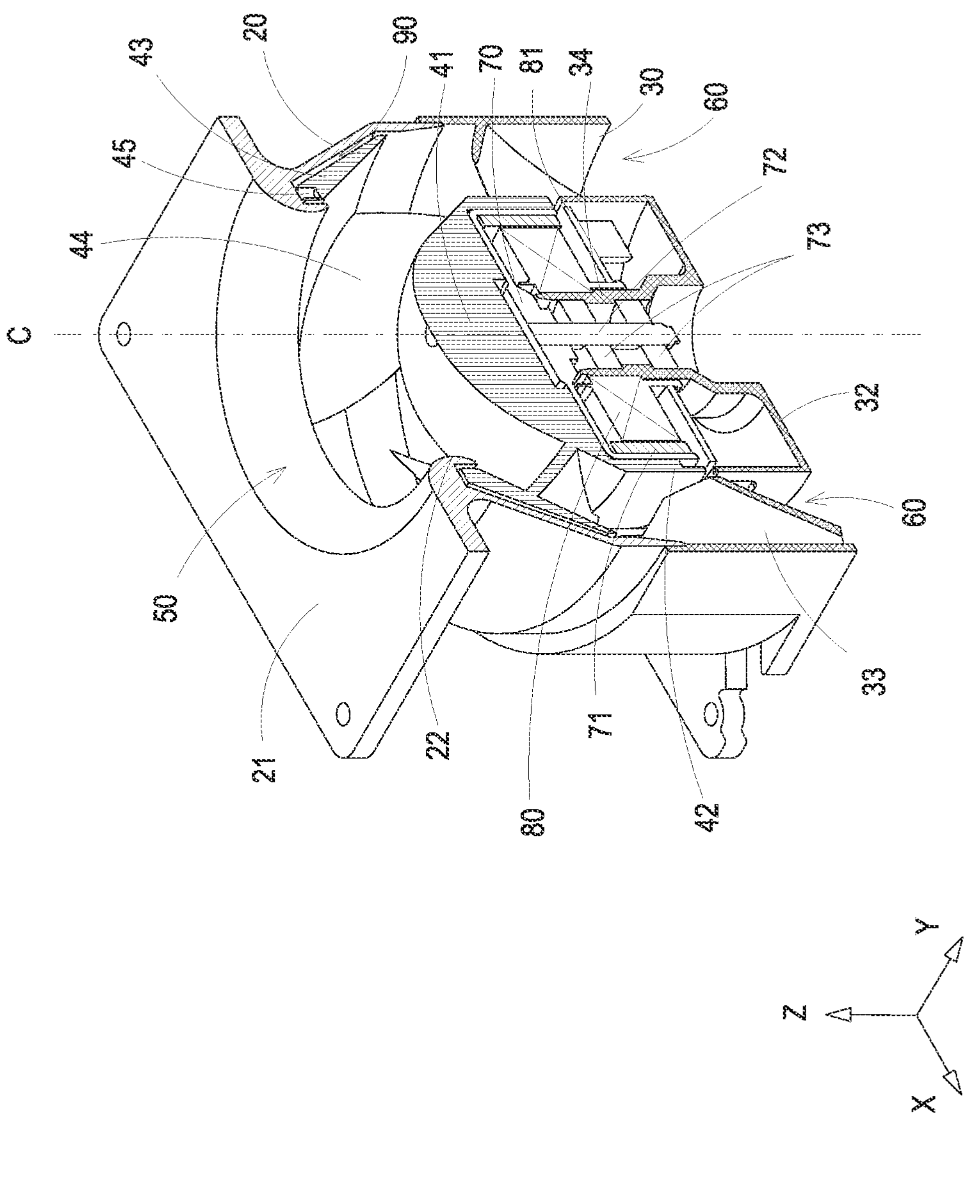
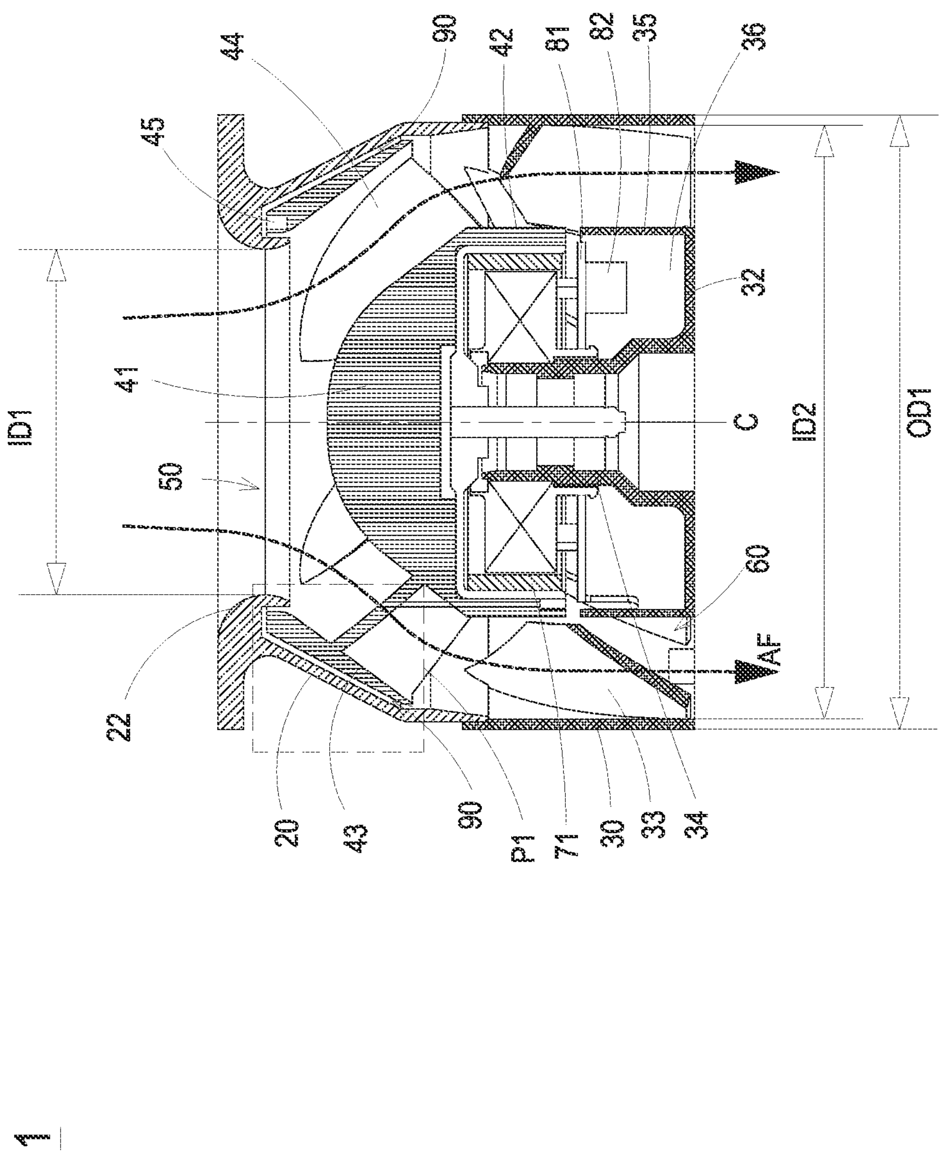


FIG. 6


44
90
42
81
82
35
36
45
ID1
41
C
ID2
OD1
50
32
60
AF
22
20
43
90
P1
71
30
33
34
1

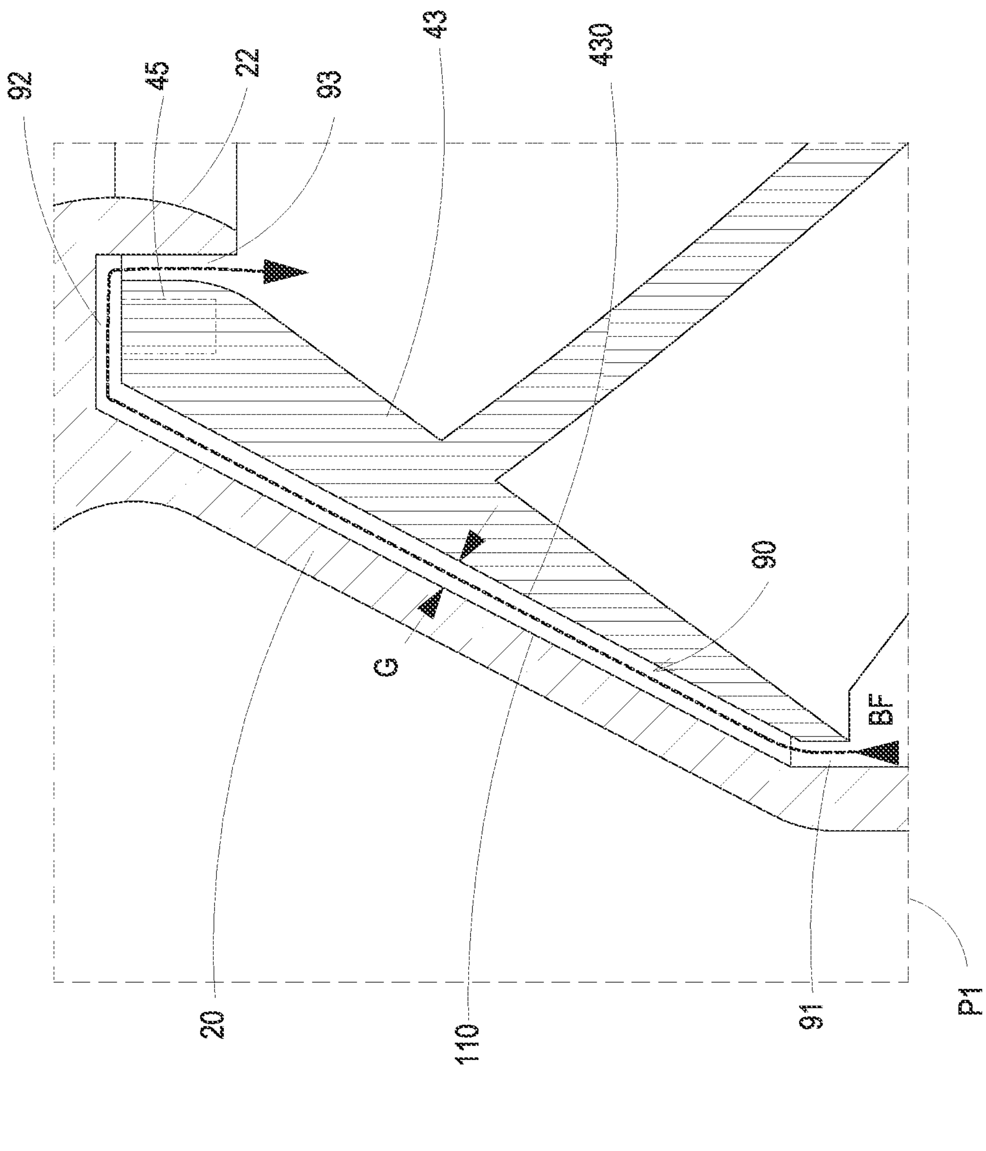


FIG. 7

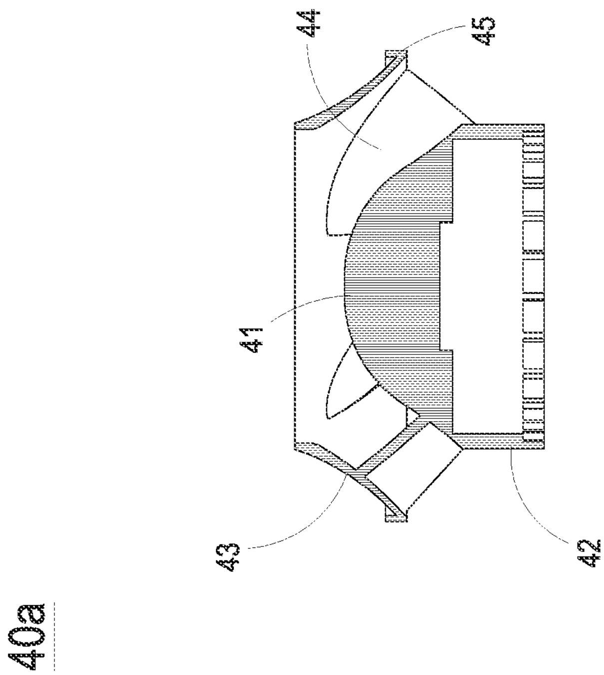


FIG. 8B

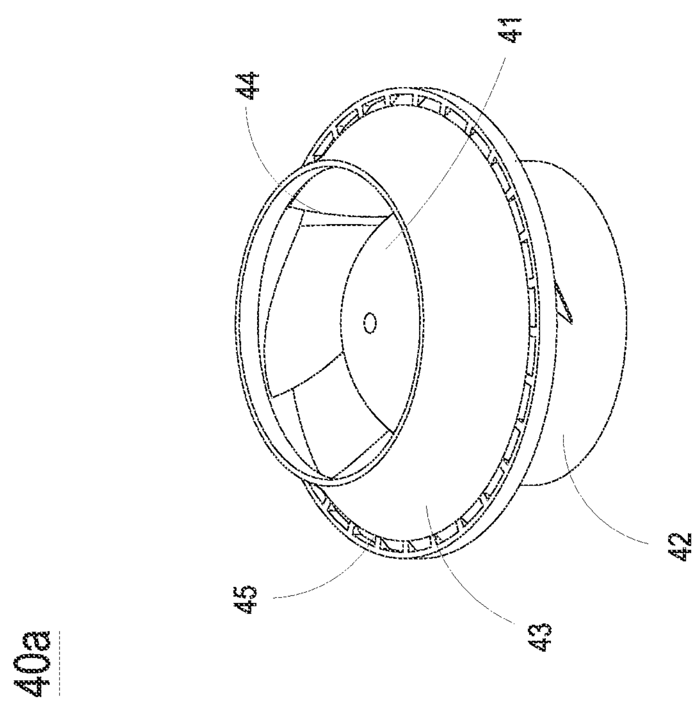
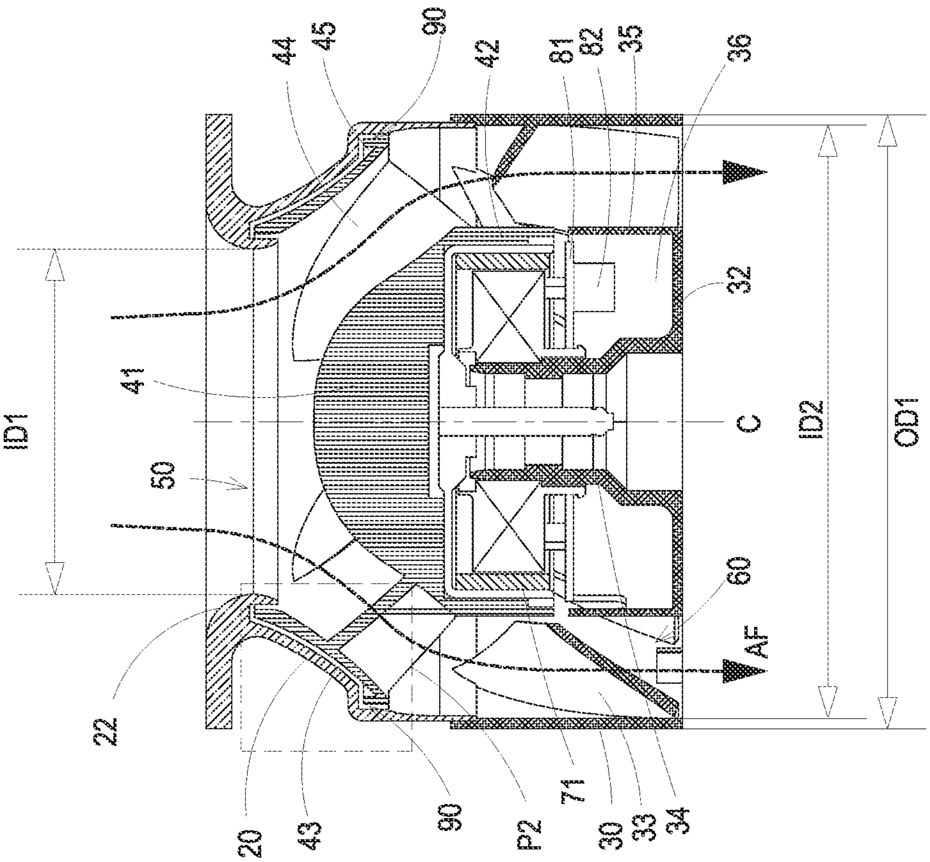


FIG. 8A

FIG. 9


ID1
50
41
22
20
43
90
P2
71
30
33
34
AF
60
C
ID2
OD1
32
36
35
82
81
42
90
45
44

1a

FIG. 10

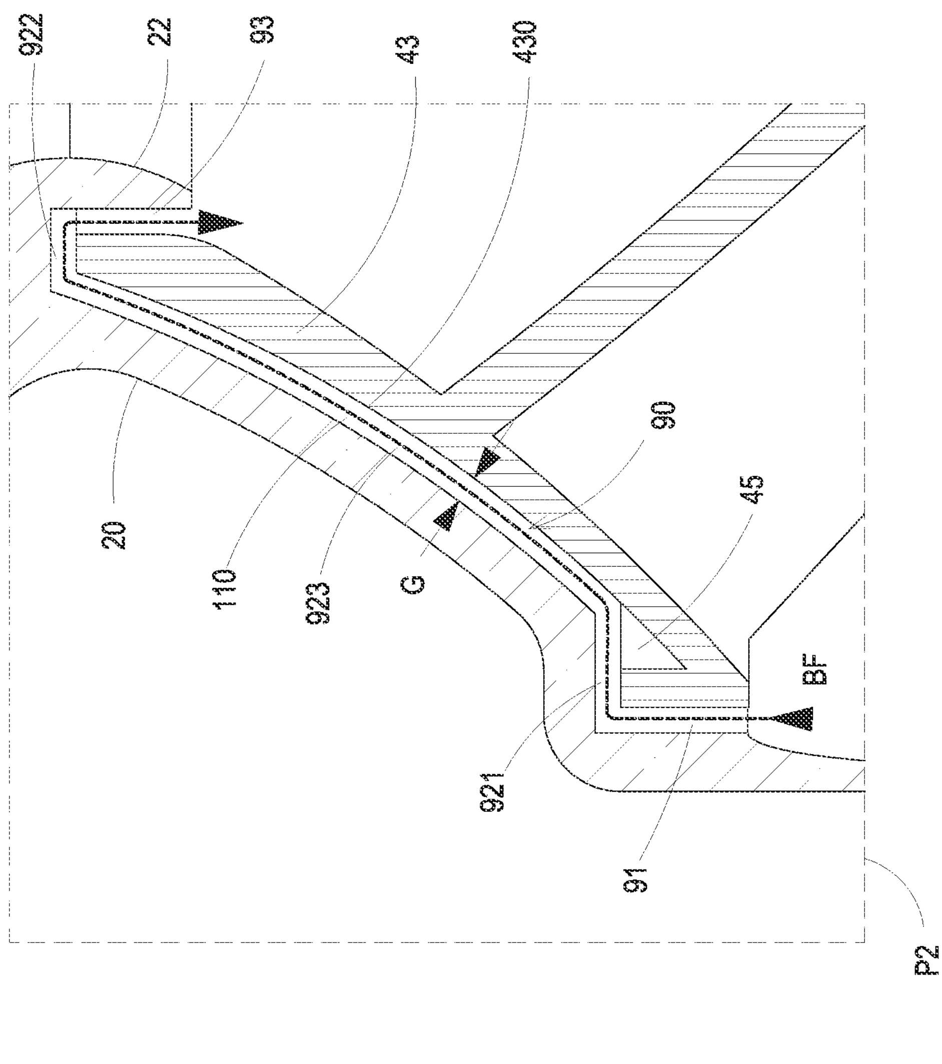


FIG. 11

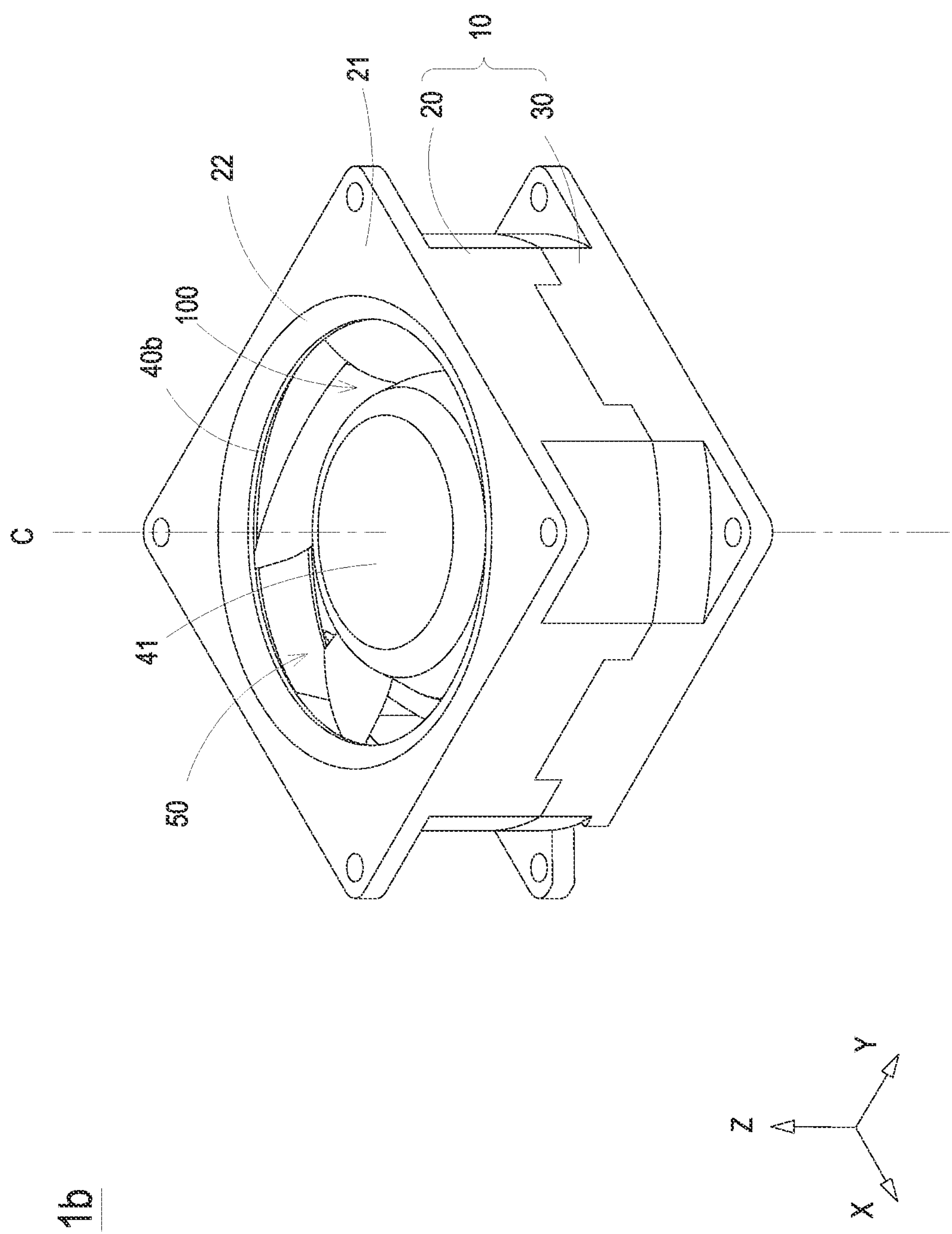
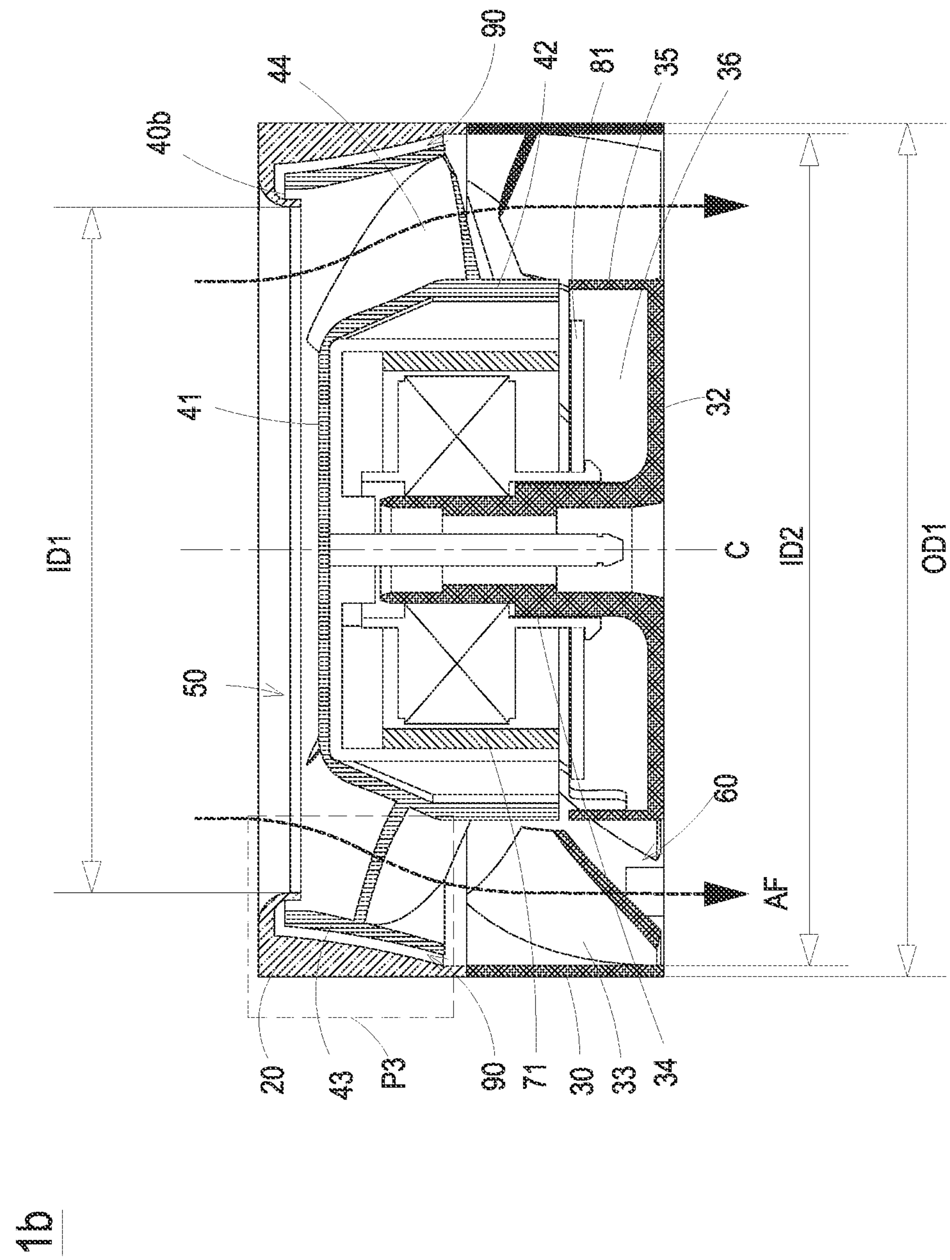


FIG. 12


1b
40b
44
90
42
81
35
36
41
32
ID1
C
ID2
OD1
50
60
AF
20
43
P3
90
71
30
33
34

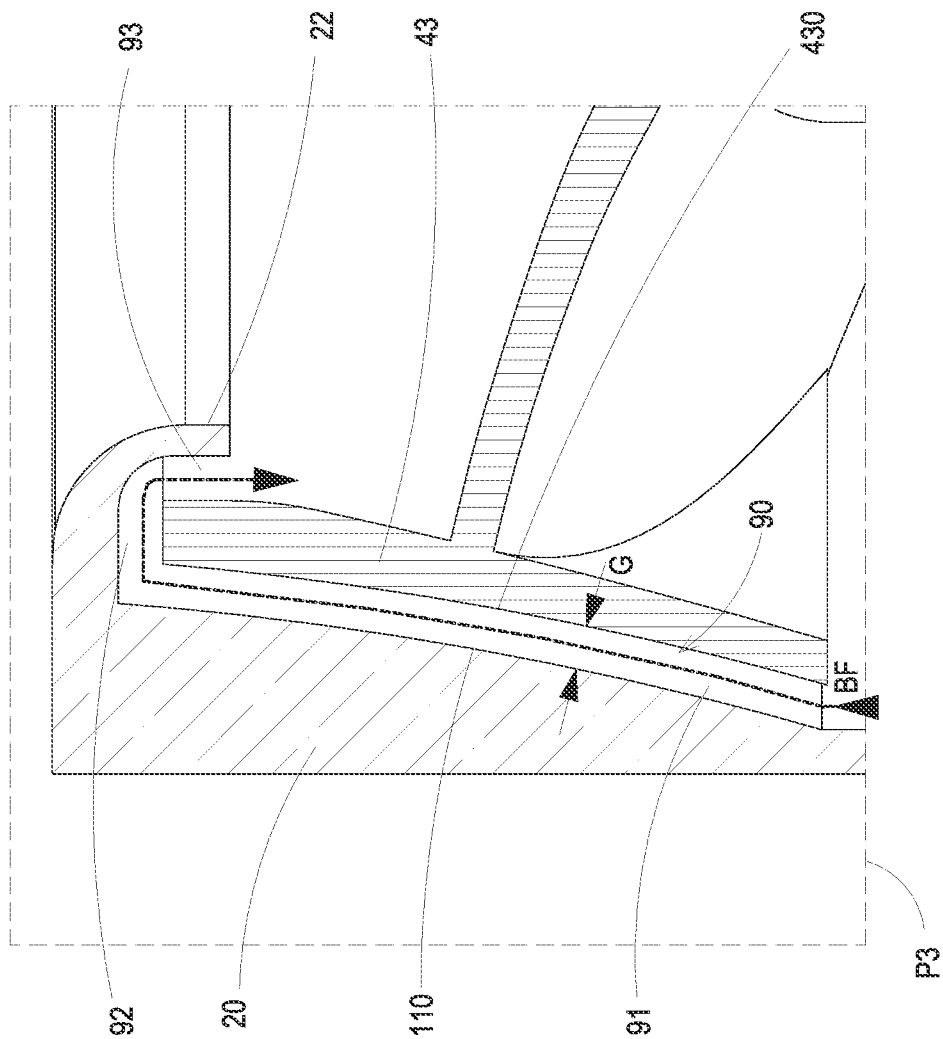


FIG. 13

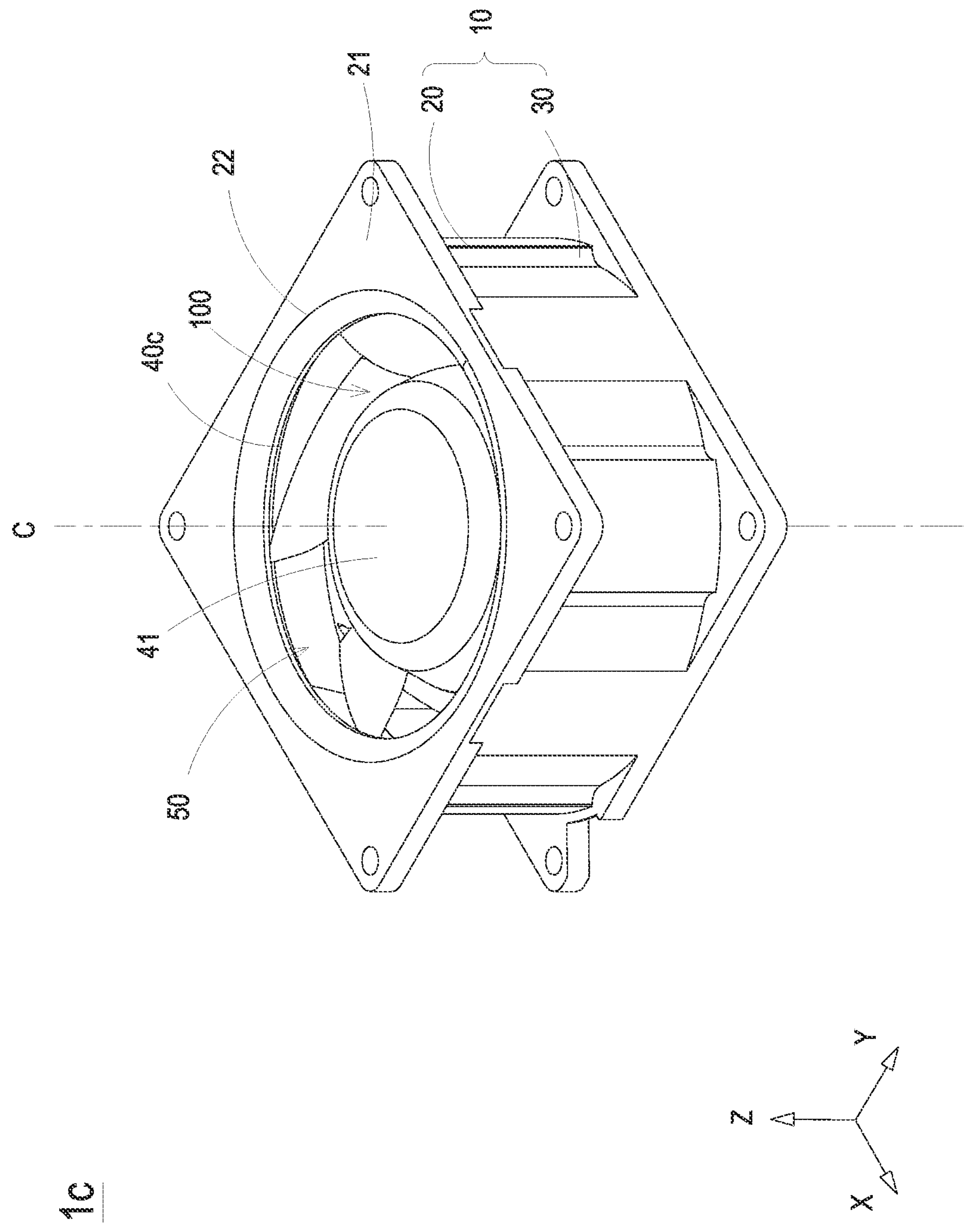


FIG. 14

FIG. 15

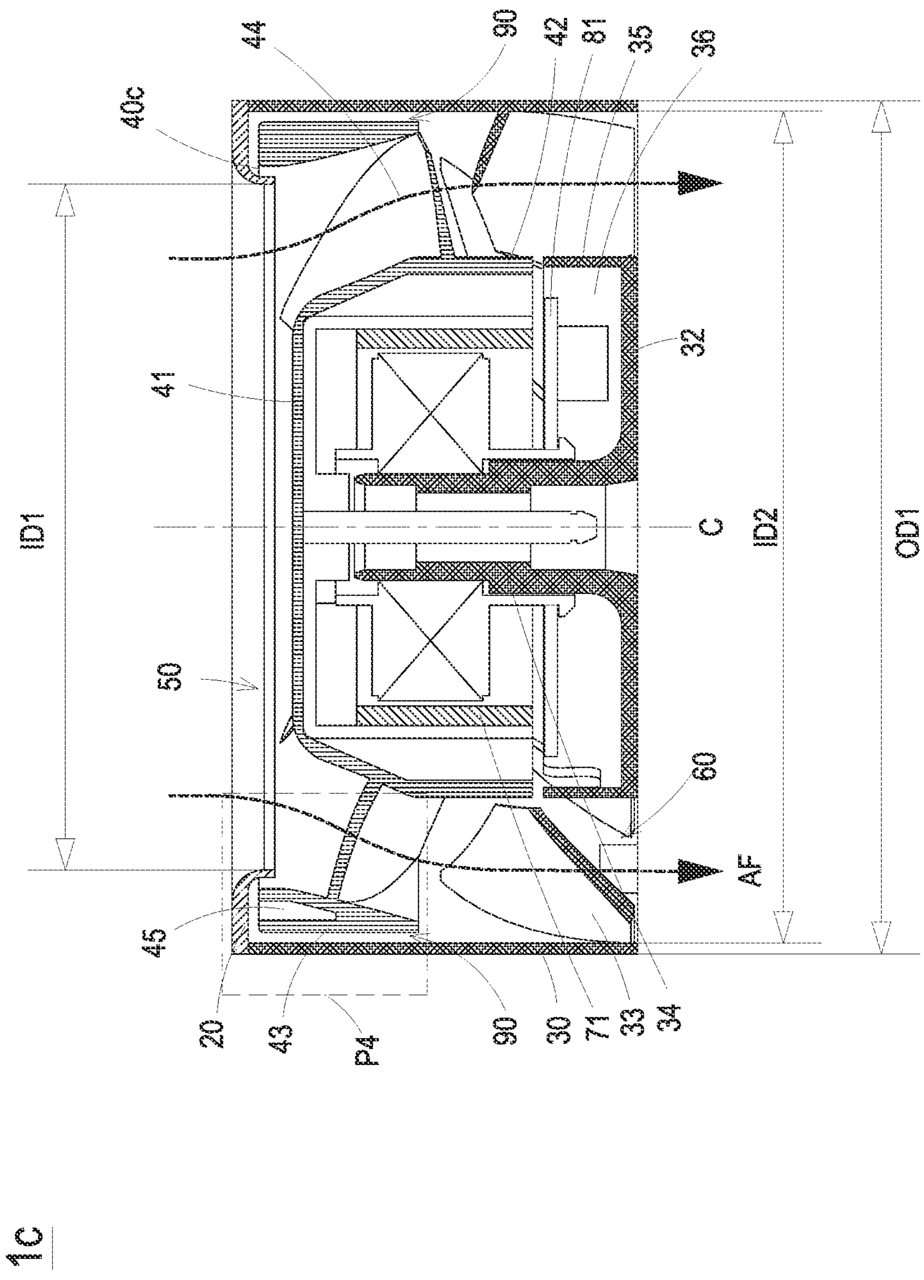
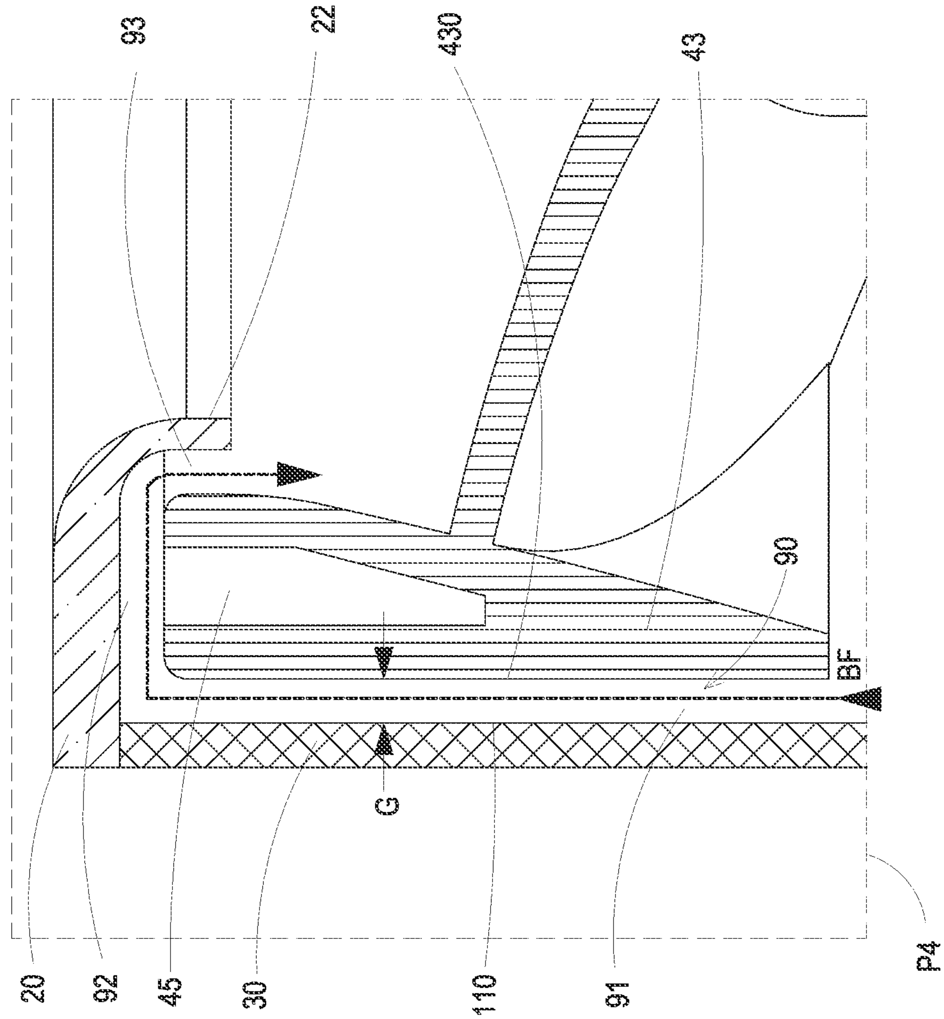

1C
40c
44
90
42
81
35
36
32
41
ID1
C
ID2
OD1
50
60
AF
45
20
43
P4
90
30
71
33
34

FIG. 16



DIAGONAL FAN

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit of U.S. Provisional Application No. 63/153,868 filed on Jul. 29, 2021, and entitled "DIAGONAL FAN". This application also claims priority to China Patent Application No. 202210128548.9, filed on Feb. 11, 2022. The entireties of the above-mentioned patent application are incorporated herein by reference for all purposes.

FIELD OF THE INVENTION

[0002] The present disclosure relates to a diagonal fan, and more particularly to a diagonal fan having an optimized chamber to reduce the backflow flowing into the chamber and eliminate the turbulence area in the chamber, thereby achieving the purpose of improving the fan characteristics and reducing the noise.

BACKGROUND OF THE INVENTION

[0003] With the increasing amount of calculation and transmission required by the communication systems, the efficiency and power consumption of electronic components in the system need to be improved to cope with huge data calculations continuously. In order to maintain the normal operation of the equipment, it is necessary to remove the internal heat of the system effectively. In a conventional communication equipment on the current market, the fan is mainly used to perform the forced convection on the system to achieve the purpose of heat dissipation. However, under increasingly severe system conditions, how to improve the efficiency of the fan effectively and maintain the same noise level has always been the goal of the industry's efforts.

[0004] Therefore, there is a need of providing a diagonal fan having an optimized chamber to reduce the backflow flowing into the chamber and eliminate the turbulence area in the chamber, thereby achieving the purpose of improving the fan characteristics and reducing the noise, so as to obviate the drawbacks encountered by the prior arts.

SUMMARY OF THE INVENTION

[0005] An object of the present disclosure is to provide a diagonal fan having an optimized chamber to reduce the backflow flowing into the chamber and eliminate the turbulence area in the chamber, thereby achieving the purpose of improving the fan characteristics and reducing the noise.

[0006] Another object of the present disclosure is to provide a diagonal fan. The outer diameter of the hub of the impeller is expended gradually in a direction from the inlet toward the outlet so that the flowing direction of the airflow is expended gradually around a periphery of the impeller, thereby forming the main feature of the diagonal fan. The guiding wall disposed on the frame is staggered and overlapped with the upper end of the conical section shell of the impeller, the inlet diameter is less than the outlet diameter, and the upper end of the conical section shell is extended upwardly from the tips of the blades, so that the diagonal fan is allowed to achieve the characteristic of slowing down the stall region as a centrifugal fan. The inner wall surface of the frame and the outer wall and the upper end of the conical section shell are designed to be parallel to each other, and a spacing distance is substantially maintained between the inner wall surface of the frame, and the outer wall and the upper end of the conical section shell to form a backflow channel, so that as a backflow is sucked into the backflow channel through an intake section, the flow velocity and the kinetic energy of the flow field are reduced gradually. Therefore, the wind resistance between the inner wall surface of the frame, and the outer wall and the upper end of the conical section shell is increased, the backflow sucked into the backflow channel is reduced, and the turbulent flow intensity of the backflow channel is eliminated simultaneously. Furthermore, the balance holes on the impeller are arranged and corresponding to the horizontal section of the backflow channel. On the other hand, when the impeller is rotated, the backflow flows in the exhaust section along a direction identical to that of the airflow flowing. In this way, when the backflow is converged into the airflow, the collision of flowing field is less likely to occur.

[0007] In accordance with an aspect of the present disclosure, a diagonal fan is provided and includes a frame and an impeller. The frame includes an inlet, an outlet, an accommodation space and a guiding wall. The inlet and the outlet are disposed at two opposite sides of the frame, and in fluid communication with each other through the accommodation space. The impeller is accommodated within the accommodation space of the frame. When the impeller is rotated, an airflow flowing from the inlet to the outlet is generated. The outer diameter of a hub of the impeller is expended gradually in a direction from the inlet toward the outlet so that the flowing direction of the airflow is expended gradually around a periphery of the impeller. The impeller includes a conical section shell, and a spacing distance is substantially maintained between the inner wall surface of the frame, and an outer wall and an upper end of the conical section shell to form a backflow channel. The backflow channel includes an intake section, a horizontal section and an exhaust section, the intake section is located adjacent to a lower end of the conical section shell and in fluid communication with the exhaust section through the horizontal section, and the upper end of the conical section shell is at least partially shielded by the guiding wall to form the exhaust section. When the airflow flows from the inlet to the outlet, a backflow is transported from the intake section, flows through the horizontal section, is exhausted out through the exhaust section, and is converged with the airflow.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] The above contents of the present disclosure will become more readily apparent to those ordinarily skilled in the art after reviewing the following detailed description and accompanying drawings, in which:

[0009] FIG. **1** is a perspective view illustrating a diagonal fan according to a first embodiment of the present disclosure from an upper perspective;

[0010] FIG. **2** is a perspective view illustrating the diagonal fan according to the first embodiment of the present disclosure from a lower perspective;

[0011] FIG. **3** is an exploded view illustrating the diagonal fan according to the first embodiment of the present disclosure;

[0012] FIG. **4**A is a perspective view illustrating the impeller according to the first embodiment of the present disclosure;

[0013] FIG. **4**B is a cross-section view illustrating the impeller according to the first embodiment of the present disclosure;

[0014] FIG. **5** is a cross-section structural view illustrating the diagonal fan according to the first embodiment of the present disclosure;

[0015] FIG. **6** is a cross-section view illustrating the diagonal fan according to the first embodiment of the present disclosure;

[0016] FIG. **7** is an enlarged view showing the region P**1** in FIG. **6**;

[0017] FIG. **8**A is a perspective view illustrating an impeller according to a second embodiment of the present disclosure;

[0018] FIG. **8**B is a cross-section view illustrating the impeller according to the second embodiment of the present disclosure;

[0019] FIG. **9** is a cross-section view illustrating the diagonal fan according to the second embodiment of the present disclosure;

[0020] FIG. **10** is an enlarged view showing the region P**2** in FIG. **9**;

[0021] FIG. **11** is a perspective view illustrating a diagonal fan according to a third embodiment of the present disclosure;

[0022] FIG. **12** is a cross-section view illustrating the diagonal fan according to the third embodiment of the present disclosure;

[0023] FIG. **13** is an enlarged view showing the region P**3** in FIG. **12**;

[0024] FIG. **14** is a perspective view illustrating a diagonal fan according to a fourth embodiment of the present disclosure;

[0025] FIG. **15** is a cross-section view illustrating the diagonal fan according to the fourth embodiment of the present disclosure; and

[0026] FIG. **16** is an enlarged view showing the region P**4** in FIG. **15**.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0027] The present disclosure will now be described more specifically with reference to the following embodiments. It is to be noted that the following descriptions of preferred embodiments of this disclosure are presented herein for purpose of illustration and description only. It is not intended to be exhaustive or to be limited to the precise form disclosed. For example, the formation of a first feature over or on a second feature in the description that follows may include embodiments in which the first and second features are formed in direct contact, and may also include embodiments in which additional features may be formed between the first and second features, such that the first and second features may not be in direct contact. In addition, the present disclosure may repeat reference numerals and/or letters in the various examples. This repetition is for the purpose of simplicity and clarity and does not in itself dictate a relationship between the various embodiments and/or configurations discussed. Further, spatially relative terms, such as "downwardly", "upwardly", "lower", "upper" and the like, may be used herein for ease of description to describe one element or feature's relationship to another element(s) or feature(s) as illustrated in the figures. The spatially relative terms are intended to encompass different orientations of the device in use or operation in addition to the orientation depicted in the figures. The apparatus may be otherwise oriented (rotated 90 degrees or at other orientations) and the spatially relative descriptors used herein may likewise be interpreted accordingly. When an element is referred to as being "connected," or "coupled," to another element, it can be directly connected or coupled to the other element or intervening elements may be present. Although the wide numerical ranges and parameters of the present disclosure are approximations, numerical values are set forth in the specific examples as precisely as possible. In addition, although the "first," "second," "third," and the like terms in the claims be used to describe the various elements can be appreciated, these elements should not be limited by these terms, and these elements are described in the respective embodiments are used to express the different reference numerals, these terms are only used to distinguish one element from another element. For example, a first element could be termed a second element, and, similarly, a second element could be termed a first element, without departing from the scope of example embodiments.

[0028] FIG. **1** is a perspective view illustrating a diagonal fan according to a first embodiment of the present disclosure from an upper perspective. In the embodiment, the diagonal fan **1** includes a frame **10** and impeller **40**. The frame **10** includes an upper frame **20** and a lower frame **30** assembled with each other to form an accommodation space **100** for accommodating the impeller **40**. In the embodiment, the upper frame **20** includes an inlet **50** and a guiding wall **22** disposed thereon. The guiding wall **22** is extended downwardly from a periphery of the inlet **50** along an axial direction C into the accommodation space **100**. The impeller **40** include a hub **41** exposed through the inlet **50** under the axial direction C. In the embodiment, the upper frame **20** includes an upper frame plate **21**, for example in a square shape, disposed on an upper end of the upper frame **20**. The inlet **50** is located on the upper frame **20**. Preferably but not exclusively, the inlet **50** is circular and runs through the upper frame plate **21**. Preferably but not exclusively, the guiding wall **22** is an annular curved surface in appearance and connected to the upper frame plate **21**. The guiding wall **22** is extended downwardly from the periphery of the inlet **50** into the accommodation space **100** so that the air is introduced into the accommodation space **100** when the impeller **40** is rotated.

[0029] FIG. **2** is a perspective view illustrating the diagonal fan according to the first embodiment of the present disclosure from a lower perspective. In the embodiment, the lower frame **30** includes a lower frame plate **31**, a base **32** and a plurality of static blades **33**. The lower frame plate **31** is spatially corresponding to the upper frame plate **21**. Preferably but not exclusively, the upper frame plate **21** and the lower frame plate **31** are approximately parallel to each other. The plurality of static blades **33** are disposed between the base **32** and the lower frame plate **31**, and two ends of each of the static blades **33** are connected to the base **32** and the lower frame plate **31**, respectively, so as to form an outlet **60**. In that, the outlet **60** is located between the lower frame plate **31** and the base **32**. When the impeller **40** is rotated, the air in the accommodation space **100** is allowed to flow through the plurality of static blades **33**, between the base **32** and the lower frame plate **31**, and be discharged out through the outlet **60**.

[0030] FIG. **3** is an exploded view illustrating the diagonal fan according to the first embodiment of the present disclosure. In the embodiment, the frame **10** is formed by assembling the upper frame **20** and the lower frame **30**. Preferably but not exclusively, the upper frame **20**, the impeller **40** and the lower frame **30** are arranged along the axial direction C so that the impeller **40** is allowed to be placed in the accommodation space **100** when the upper frame **20** and the lower frame **30** are assembled together. In the embodiment, the impeller **40** includes a hub **41**, a cylindrical part **42**, a conical section shell **43**, a plurality of blades **44** and a plurality of balance holes **45**. The plurality of blades **44** of the impeller **40** are connected between the hub **41** and the conical section shell **43**. The plurality of balance holes **45** are disposed on a flat annular plane of the upper end of the conical section shell **43**. In other embodiments, the number, the shape and the size of the balance holes **45** are adjustable according to the practical requirements. The present disclosure is not limited thereto.

[0031] FIG. **4**A is a perspective view illustrating the impeller according to the first embodiment of the present disclosure. In the embodiment, the hub **41**, the cylindrical part **42**, the conical section shell **43**, the plurality of blades **44** and the plurality of balance holes **45** are integrally formed as a one piece by injection molding. The cylindrical part **42** is extended axially from a lower end of the hub **41**. The conical section shell **43** and the hub **41** are arranged concentrically with each other, and the conical section shell **43** is connected to the periphery of the hub **41** through the plurality of blades **44**. In the embodiment, each of the plurality of blades **44** is three-dimensionally curved. Preferably but not exclusively, each of the blades **44** includes an inner end connected to the hub **41** and an outer end connected to the inner annular wall of the conical section shell **43**. As the cylindrical part **42** drives the hub **41**, the plurality of blades **44** and the conical section shell **43** to rotate, the air is driven to flow among the hub **41**, the plurality of blades **44** and the conical section shell **43**.

[0032] FIG. **4**B is a cross-section view illustrating the impeller according to the first embodiment of the present disclosure. In the embodiment, the plurality of blades **44** are disposed around the periphery of the hub **41**, and the upper end of the conical section shell **43** is extended upwardly from the upper tips of the blades **44** so that the upper end of the conical section shell **43** is higher than the upper end of the hub **41** and the tips of the plurality of blades **44** connected with the conical section shell **43**. The upper end of the hub **41** is lower than the upper end of the conical section shell **43**. The outer diameter of the hub **41** of the impeller **40** is expended gradually in a direction from the inlet **50** toward the outlet **60**.

[0033] FIG. **5** is a cross-section structural view illustrating the diagonal fan according to the first embodiment of the present disclosure. In the embodiment, the base **32** of the lower frame **30** further includes a tube **34**. Preferably but not exclusively, the stator includes a winding **80** and a printed circuit board **81**. The winding **80** and the printed circuit board **81** are disposed on a periphery of the tube **34**. The rotator includes a magnetic shell **70**, a magnet **71** and a shaft **72**. The magnetic shell **70** is disposed within the cylindrical part **42** of the impeller **40** and connected to the shaft **72**. In the embodiment, the magnet **71** is disposed on a radially inner wall of the magnetic shell **70** and spatially corresponding to the winding **80**. The shaft **72** is disposed at the center of the magnetic shell **70**, and is disposed in the tube **34** through at least one bearing **73**. On the other hand, in the embodiment, the guiding wall **22** is extended downwardly from the periphery of the inlet **50**, and the upper end of the conical section shell **43** is extended upwardly from the outer ends of the blades **44**, so that the upper frame **20** of the frame **10**, the upper end of the conical section shell **43** and the guiding wall **22** are at least partially overlapped in view of the radial direction. The integrally formed upper frame body **20** and the guiding wall **22** are substantially parallel to the outer wall of the conical section shell **43** adjacent to the inlet **50** so that a backflow channel **90** is formed among the upper frame **20** of the frame **10**, the outer side of the conical section shell **43** and the inner side of the guiding wall **22**. Preferably but not exclusively, the backflow channel **90** is curved in multiple sections, so as to change the flow direction thereof.

[0034] FIG. **6** is a cross-section view illustrating the diagonal fan according to the first embodiment of the present disclosure. In the embodiment, the rotor and the stator are accommodated between the impeller **40** and lower frame **30**. A chamber **36** is formed between a base wall **35** of the base **32** and tube **34**, and configured to accommodate an electronic component **82** on the printed circuit board **81**. The upper end of the base **32** is spatially corresponding to a periphery of the cylindrical part **42**. In the embodiment, the impeller **40** is rotated to form the airflow AF from the inlet **50** to the outlet **60**. The inlet **50** and the outlet **60** are arranged substantially along the axial direction C. The airflow AF is inhaled through the inlet **50**, flowing among the plurality of blades **44**, the hub **41** and the conical section shell **43**, transported among the static blades **33**, the base **32** and the lower frame plate **31**, and discharged out through the outlet **60**. Since the outer diameter of the hub **41** of the impeller **40** is expended gradually in the direction from the inlet **50** toward the outlet **60**, the airflow AF is expanded gradually around the periphery of the impeller **40**. In the embodiment, the frame **10** has a frame diameter OD**1**, the inlet **50** has an inlet diameter ID**1**, and the outlet **60** has an outlet diameter ID**2**. Preferably but not exclusively, the inlet diameter ID**1** is less than the outlet diameter ID**2**. In the embodiment, a ratio of the inlet diameter ID**1** to the frame diameter OD**1** is ranged from 0.5 to 0.7. Preferably but not exclusively, the ratio of the inlet diameter ID**1** to the frame diameter OD**1** is 0.56. In the embodiment, a ratio of the outlet diameter ID**2** to the frame diameter OD**1** is ranged from 0.8 to 0.98. Preferably but not exclusively, the ratio of the outlet diameter ID**2** to the frame diameter OD**1** is 0.97. The inlet diameter ID**1** is less than the outlet diameter ID**2**, and the upper end of the conical section shell **43** is extended upwardly from the tips of the blades **44**.

[0035] FIG. **7** is an enlarged view showing the region P**1** shown in FIG. **6**. In the embodiment, a gap having a spacing distance G is substantially maintained between an inner wall surface **110** of the upper frame **20** and an outer wall **430** of the upper end of the conical section shell **43** to form the aforementioned backflow channel **90**. In the embodiment, a ratio of the spacing distance G to the frame diameter OD**1** (referring to FIG. **6**) is ranged from 0.01 to 0.02. Preferably but not exclusively, the ratio of the spacing distance G to the frame diameter OD**1** is ranged from 0.0125. In the embodiment, the backflow channel **90** includes an intake section **91**, a horizontal section **92** and an exhaust section **93**. The intake section **91** is located adjacent to a lower end of the conical section shell **43** and in fluid communication with the exhaust section **93** through the horizontal section **92**, and the upper end of the conical section shell **43** is at least partially shielded by the guiding wall **22** to form the exhaust section **93**. Notably, the backflow BF flows in the intake section **91** along a direction reversed to that of the backflow BF flowing in the exhaust section **93**. The backflow BF flows in the horizontal section **92** along a direction perpendicular to the axial direction C. The backflow BF flows in the exhaust section **93** along a direction identical to that of the airflow AF flowing. Since the inner wall surface **110** of the frame **10** and the outer wall **430** and the upper end of the conical section shell **43** are designed to be parallel to each other, and the gap having the spacing distance G is substantially maintained between the inner wall surface **110** of the frame **10**, and the outer wall **430** and the upper end of the conical section shell **43** to form the backflow channel **90** curved in multiple sections, as the backflow BF is sucked into the backflow channel **90** through the intake section **91**, the flow velocity and the kinetic energy of the flow field are reduced gradually. Therefore, the wind resistance between the inner wall surface **110** of the frame **10**, and the outer wall **430** and the upper end of the conical section shell **43** is increased, the backflow BF sucked into the backflow channel **90** is reduced, and the turbulent flow intensity of the backflow channel **90** is eliminated simultaneously. In the embodiment, the conical section shell **43** includes the plurality of balance holes **45** disposed around the upper end of the conical section shell **43**, and the horizontal section **92** is spatially corresponding to the plurality of balance holes **45**. In the embodiment, the corresponding lengths of the intake section **91**, the horizontal section **92** and the exhaust section **93** are varied and bent by adjusting the frame **10**, the impeller **40** and the guiding wall **22**. In other embodiments, the corresponding lengths and the relative bending angles of the intake section **91**, the horizontal section **92** and the exhaust section **93** are adjustable according to the practical requirements. The present disclosure is not limited thereto.

[0036] FIG. **8**A is a perspective view illustrating an impeller according to a second embodiment of the present disclosure. In the embodiment, the impeller **40*a*** includes a hub **41**, a cylindrical part **42**, a conical section shell **43**, a plurality of blades **44** and a plurality of balance holes **45**. The lower end of the hub **41** is connected to the cylindrical part **42**, and the hub **41** and the cylindrical part **42** are integrally formed as a single piece by injection molding. Preferably but not exclusively, the conical section shell **43** and the hub **41** are arranged concentrically with each other, and the conical section shell **43** is connected to the outer part of the hub **41** through the plurality of blades **44**. In the embodiment, each of the plurality of blades **44** is three-dimensionally curved. Preferably but not exclusively, each of the blades **44** includes an inner end connected to the hub **41** and an outer end connected to the inner ring wall of the conical section shell **43**. As the cylindrical part **42** drives the hub **41**, the plurality of blades **44** and the conical section shell **43** to rotate, the air is driven to flow among the hub **41**, the plurality of blades **44** and the conical section shell **43**. The lower end of the conical section shell **43** is protruded outwardly in the radial direction so as to form an annular plane. Preferably but not exclusively, the plurality of balance holes **45** are annularly arranged at the lower end of the conical section shell **43** and located at the annular plane protruded outwardly from the lower end of the conical section shell **43**. Moreover, the opening of each of balance holes **45** is faced upwardly.

[0037] FIG. **8**B is a cross-section view illustrating the impeller according to the second embodiment of the present disclosure. In the embodiment, the plurality of blades **44** are disposed around the periphery of the hub **41**, and the upper end of the conical section shell **43** is extended upwardly from the tips of the blades **44**. In addition, a flat annular plane is formed on the upper end of the conical section shell **43**. Preferably but not exclusively, the flat annular plane is higher than the tips of the plurality of blades **44** connected to the conical section shell **43**, and is also higher than the upper end of the hub **41**. Preferably but not exclusively, in the embodiment, the cylindrical par **42** is annular and includes a hollow portion, which is configured to accommodate the rotor and the stator, so that the impeller **40*a*** is driven by the rotor and the stator to rotate. In conjunction with the change in the design of the balance holes **45**, it helps to increase the varied applications of the impeller **40*a***.

[0038] FIG. **9** is a cross-section view illustrating the diagonal fan according to the second embodiment of the present disclosure. In the embodiment, when the impeller **40*a*** is rotated, an airflow AF is formed to flow from the inlet **50** to the outlet **60**. The inlet **50** and the outlet **60** are substantially arranged along the axial direction C. The airflow AF is inhaled through the inlet **50**, flowing among the plurality of blades **44**, the hub **41** and the conical section shell **43**, transported among the static blade **33**, the base **32** and the lower frame plate **31**, and discharged out through the outlet **60**. Since the outer diameter of the hub **41** of the impeller **40*a*** is expended gradually in the direction from the inlet **50** toward the outlet **60**, the airflow AF is expanded gradually around the periphery of the impeller **40*a***. In the embodiment, the frame **10** has a frame diameter OD**1**, the inlet **50** has an inlet diameter ID**1**, and the outlet **60** has an outlet diameter ID**2**. Preferably but not exclusively, the inlet diameter ID**1** is less than the outlet diameter ID**2**. In the embodiment, a ratio of the inlet diameter ID**1** to the frame diameter OD**1** is ranged from 0.5 to 0.7. Preferably but not exclusively, the ratio of the inlet diameter IDI to the frame diameter OD**1** is 0.56. In the embodiment, a ratio of the outlet diameter ID**2** to the frame diameter OD**1** is ranged from 0.8 to 0.98. Preferably but not exclusively, the ratio of the outlet diameter ID**2** to the frame diameter OD**1** is 0.97.

[0039] FIG. **10** is an enlarged view showing the region P**2** in FIG. **9**. In the embodiment, a gap having a spacing distance G is substantially maintained between an inner wall surface **110** of the upper frame **20** and an outer wall **430** of the upper end of the conical section shell **43** to form the aforementioned backflow channel **90**. In the embodiment, a ratio of the spacing distance G to the frame diameter OD**1** (referring to FIG. **9**) is ranged from 0.01 to 0.02. Preferably but not exclusively, the ratio of the spacing distance G to the frame diameter OD**1** is ranged from 0.0125. In the embodiment, the backflow channel **90** includes an intake section **91**, a first horizontal section **921**, a second horizontal section **922**, a communication section **923** and an exhaust section **93**. The intake section **91** is located adjacent to the lower end of the conical section shell **43**, and in fluid communication with the exhaust section **93** through the first horizontal section **921**, the communication section **923** and the second horizontal section **922**, sequentially. Moreover, the upper end of the conical section shell **43** is at least partially shielded by the guiding wall **22** to form the exhaust section **93**. Notably, the backflow BF flows in the intake section **91** along a direction, which is reversed to the direction of the backflow BF flowing in the exhaust section **93** and parallel to the axial direction C. The backflow BF flows in the first horizontal section **921** along a direction, which is perpendicular to the axial direction C and perpendicular to the intake section **91**. The backflow BF flows in the second horizontal section **922** along a direction, which is perpendicular to the axial direction C and perpendicular to the exhaust section **93**. The backflow BF flows in the exhaust section **93** along a direction identical to that of the airflow AF flowing. In the embodiment, the conical section shell **43** includes a plurality of balance holes **45** disposed around the lower end of the conical section shell **43**. The first horizontal section **921** is spatially corresponding to the plurality of balance holes **45**, and the backflow BF flows in the first horizontal section **921** along the direction perpendicular to the axial direction C. In the embodiment, the inner wall surface **110** of the frame **10** and the outer wall **430** and the upper end of the conical section shell **43** are designed to be parallel to each other, and a gap having a spacing distance G is substantially maintained between the inner wall surface **110** of the frame **10**, and the outer wall **430** and the upper end of the conical section shell **43** to form the backflow channel **90** curved in multiple sections. Preferably but not exclusively, the backflow channel **90** includes at least two vertical bending portions. As the backflow BF is sucked into the backflow channel **90** through the intake section **91**, the flow velocity and the kinetic energy of the flow field are reduced gradually. Therefore, the wind resistance between the inner wall surface **110** of the frame **10**, and the outer wall **430** and the upper end of the conical section shell **43** is increased, the backflow BF sucked into the backflow channel **90** is reduced, and the turbulent flow intensity of the backflow channel **90** is eliminated simultaneously.

[0040] FIG. **11** is a perspective view illustrating a diagonal fan according to a third embodiment of the present disclosure. In the embodiment, the structures, elements and functions of the diagonal fan **1***b* are similar to those of the diagonal fan **1** of FIGS. **1** to **3**, and are not redundantly described herein. In the embodiment, the diagonal fan **1***b* is of a flat design, and the frame **10** is formed by assembling an upper frame **20** and a lower frame **30**. The accommodation space **100** is configured to accommodate the impeller **40***b*. In the embodiment, the inlet **50** and the guiding wall **22** are disposed on the upper frame **20**. Preferably but not exclusively, the upper frame **20** includes a square upper frame plate **21** disposed at the upper end of the upper frame **20**. The inlet **50** is located on the upper frame **20**. Preferably but not exclusively, the inlet **50** is circular and runs through the upper frame plate **21**. The guiding wall **22** is connected to the upper frame plate **21** and extended downwardly from the periphery of the inlet **50** into the accommodation space **100**, so that the air is introduced into the accommodation space **100** when the impeller **40***b* is rotated. In addition, the upper end of the hub **41** includes a flat plane.

[0041] FIG. **12** is a cross-section view illustrating the diagonal fan according to the third embodiment of the present disclosure. In the embodiment, when the impeller **40***b* is rotated, an airflow AF is formed to flow from the inlet **50** to the outlet **60**. The inlet **50** and the outlet **60** are arranged along the axial direction C. The airflow AF is inhaled through the inlet **50**, flowing among the plurality of blades **44**, the hub **41** and the conical section shell **43**, transported among the static blade **33**, the base **32** and the lower frame plate **31**, and discharged out through the outlet **60**. Since the outer diameter of the hub **41** of the impeller **40***b* is expended gradually in the direction from the inlet **50** toward the outlet **60**, the airflow AF is expanded gradually around the periphery of the impeller **40***b*. In the embodiment, the frame **10** has a frame diameter OD**1**, the inlet **50** has an inlet diameter ID**1**, and the outlet **60** has an outlet diameter ID**2**. Preferably but not exclusively, the inlet diameter ID**1** is less than the outlet diameter ID**2**. In the embodiment, a ratio of the inlet diameter ID**1** to the frame diameter OD**1** is ranged from 0.6 to 0.8. Preferably but not exclusively, the ratio of the inlet diameter ID**1** to the frame diameter OD**1** is 0.74. In the embodiment, a ratio of the outlet diameter ID**2** to the frame diameter OD**1** is ranged from 0.8 to 0.98. Preferably but not exclusively, the ratio of the outlet diameter ID**2** to the frame diameter OD**1** is 0.975.

[0042] FIG. **13** is an enlarged view showing the region P**3** in FIG. **12**. In the embodiment, a gap having a spacing distance G is substantially maintained between an inner wall surface **110** of the upper frame **20** and an outer wall **430** and the upper end of the conical section shell **43** to form the aforementioned backflow channel **90**. In the embodiment, a ratio of the spacing distance G to the frame diameter OD**1** (referring to FIG. **12**) is ranged from 0.01 to 0.02. Preferably but not exclusively, the ratio of the spacing distance G to the frame diameter OD**1** is ranged from 0.0125. In the embodiment, the backflow channel **90** includes an intake section **91**, a horizontal section **92** and an exhaust section **93**. The intake section **91** is located adjacent to a lower end of the conical section shell **43** and in fluid communication with the exhaust section **93** through the horizontal section **92**, and the upper end of the conical section shell **43** is at least partially shielded by the guiding wall **22** to form the exhaust section **93**. Notably, the backflow BF flows in the intake section **91** along a direction reversed to that of the backflow BF flowing in the exhaust section **93**. The backflow BF flows in the horizontal section **92** along a direction perpendicular to the axial direction C. The backflow BF flows in the exhaust section **93** along a direction identical to that of the airflow AF flowing. Since the inner wall surface **110** of the frame **10** and the outer wall **430** and the upper end of the conical section shell **43** are designed to be parallel to each other, and the gap having the spacing distance G is substantially maintained between the inner wall surface **110** of the frame **10**, and the outer wall **430** and the upper end of the conical section shell **43** to form the backflow channel **90**, as the backflow BF is sucked into the backflow channel **90** through the intake section **91**, the flow velocity and the kinetic energy of the flow field are reduced gradually. Therefore, the wind resistance between the inner wall surface **110** of the frame **10**, and the outer wall **430** and the upper end of the conical section shell **43** is increased, the backflow BF sucked into the backflow channel **90** is reduced, and the turbulent flow intensity of the backflow channel **90** is eliminated simultaneously. Preferably but not exclusively, in the embodiment, the arrangement of the aforementioned balance holes **45** is omitted in the impeller **40***b*, and the horizontal section **92** is spatially corresponding to the annular plane of the upper end of the conical section shell **43**. On the other hand, when the impeller **40***b* is rotated, the backflow BF flows in the exhaust section **93** of the backflow channel **90** along a direction identical to that of the airflow

AF flowing. In this way, when the backflow BF is converged into the airflow AF, the collision of flowing field is less likely to occur and the noise during operation is reduced.

[0043] FIG. **14** is a perspective view illustrating a diagonal fan according to a fourth embodiment of the present disclosure. In the embodiment, the structures, elements and functions of the diagonal fan **1***c* are similar to those of the diagonal fan **1***b* of FIGS. **11** to **12**, and are not redundantly described herein. In the embodiment, the diagonal fan **1***c* is of a flat design, and the frame **10** is formed by assembling an upper frame **20** and a lower frame **30**. Preferably but not exclusively, the upper frame **20** is a plate-like structure, and covered on the lateral walls of the lower frame **30** to form an accommodation space **100** configured to accommodate the impeller **40***c*. In the embodiment, the inlet **50** and the guiding wall **22** are disposed on the upper frame **20**. Preferably but not exclusively, the upper frame **20** is a square upper frame plate **21** disposed on the upper end of the lower frame **30**. The guiding wall **22** is connected to the upper frame plate **21** and extended downwardly from the periphery of the inlet **50** into the accommodation space **100**, so that the air is introduced into the accommodation space **100** when the impeller **40***c* is rotated. Preferably but not exclusively, the upper end of the hub **41** includes a flat plane.

[0044] FIG. **15** is a cross-section view illustrating the diagonal fan according to the fourth embodiment of the present disclosure. In the embodiment, when the impeller **40***c* is rotated, an airflow AF is formed to flow from the inlet **50** to the outlet **60**. The inlet **50** and the outlet **60** are arranged along the axial direction C. The airflow AF is inhaled through the inlet **50**, flowing among the plurality of blades **44**, the hub **41** and the conical section shell **43**, transported among the static blade **33**, the base **32** and the lower frame plate **31**, and discharged out through the outlet **60**. Since the outer diameter of the hub **41** of the impeller **40***c* is expended gradually in the direction from the inlet **50** toward the outlet **60**, the airflow AF is expanded gradually around the periphery of the impeller **40***c*. In the embodiment, the frame **10** has a frame diameter OD**1**, the inlet **50** has an inlet diameter ID**1**, and the outlet **60** has an outlet diameter ID**2**. Preferably but not exclusively, the inlet diameter ID**1** is less than the outlet diameter ID**2**. In the embodiment, a ratio of the inlet diameter ID**1** to the frame diameter OD**1** is ranged from 0.6 to 0.8. Preferably but not exclusively, the ratio of the inlet diameter ID**1** to the frame diameter OD**1** is 0.74. In the embodiment, a ratio of the outlet diameter ID**2** to the frame diameter OD**1** is ranged from 0.8 to 0.98. Preferably but not exclusively, the ratio of the outlet diameter ID**2** to the frame diameter OD**1** is 0.975.

[0045] FIG. **16** is an enlarged view showing the region P**4** in FIG. **15**. In the embodiment, a gap having a spacing distance G is substantially maintained between an inner wall surface **110** of the lower frame **30** and an outer wall **430** and the upper end of the conical section shell **43** to form the aforementioned backflow channel **90**. In the embodiment, a ratio of the spacing distance G to the frame diameter OD1 (referring to FIG. **15**) is ranged from 0.01 to 0.02. Preferably but not exclusively, the ratio of the spacing distance G to the frame diameter OD**1** is ranged from 0.0125. In the embodiment, the backflow channel **90** includes an intake section **91**, a horizontal section **92** and an exhaust section **93**. The intake section **91** is located adjacent to a lower end of the conical section shell **43** and in fluid communication with the exhaust section **93** through the horizontal section **92**, and the upper end of the conical section shell **43** is at least partially shielded by the guiding wall **22** to form the exhaust section **93**. Preferably but not exclusively, in the embodiment, the inner wall surface **110** of the lower frame **30** and the outer wall **430** of the conical section shell **43** are parallel to the axial direction C. Notably, the backflow BF flows in the intake section **91** along a direction reversed to that of the backflow BF flowing in the exhaust section **93**. The backflow BF flows in the horizontal section **92** along a direction, which is perpendicular to the axial direction C and also perpendicular to the intake section **91** and the exhaust section **93**. The backflow BF flows in the exhaust section **93** along a direction identical to that of the airflow AF flowing. In the embodiment, the conical section shell **43** includes a plurality of balance holes **45** disposed around the upper end of the conical section shell **43**. The horizontal section **92** is spatially corresponding to the plurality of balance holes **45**, and the backflow BF flows in the horizontal section **92** along the direction perpendicular to the axial direction C. Since the inner wall surface **110** of the frame **10** and the outer wall **430** and the upper end of the conical section shell **43** are designed to be parallel to each other, and the gap having the spacing distance G is substantially maintained between the inner wall surface **110** of the frame **10**, and the outer wall **430** and the upper end of the conical section shell **43** to form the backflow channel **90** including at least two vertical bending portions, as the backflow BF is sucked into the backflow channel **90** through the intake section **91**, the flow velocity and the kinetic energy of the flow field are reduced gradually. Therefore, the wind resistance between the inner wall surface **110** of the frame **10**, and the outer wall **430** and the upper end of the conical section shell **43** is increased, the backflow BF sucked into the backflow channel **90** is reduced, and the turbulent flow intensity of the backflow channel **90** is eliminated simultaneously. In the embodiment, the conical section shell **43** includes the plurality of balance holes **45** disposed around the upper end of the conical section shell **43**, and the horizontal section **92** is spatially corresponding to the plurality of balance holes **45**. Moreover, the horizontal section **92** is perpendicular to the intake section **91** and the exhaust section **93**, and in communication between the intake section **91** and the exhaust section **93**. In other words, the balance holes **45** on the impeller **40***c* are arranged and corresponding to the horizontal section **92** of the backflow channel **90**. On the other hand, when the impeller **40***c* is rotated, the backflow BF flows in the exhaust section **93** of the backflow channel **90** along a direction identical to that of the airflow AF flowing. In this way, when the backflow BF is converged into the airflow AF, the collision of flowing field is less likely to occur and the noise during operation is reduced. Certainly, the diagonal fan **1***c* in the present disclosure is allowed to be combined and adjusted with the aforementioned technical features according to the practical requirements. In addition, the detailed structure of the backflow channel **90** in the present disclosure is adjustable according to the practical requirements. The present disclosure is not limited thereto.

[0046] In summary, the present disclosure provides a diagonal fan having an optimized chamber to reduce the backflow flowing into the chamber and eliminate the turbulence area in the chamber, thereby achieving the purpose of improving the fan characteristics and reducing the noise. The guiding wall disposed on the frame is staggered and overlapped with the upper end of the conical section shell of the impeller, the inlet diameter is less than the outlet diameter, and the upper end of the conical section shell is extended upwardly from the tips of the blades, so that the diagonal fan is allowed to achieve the characteristic of slowing down the stall region as a centrifugal fan. The inner wall surface of the frame and the outer wall and the upper end of the conical section shell are designed to be parallel to each other, and a gap having a spacing distance is substantially maintained between the inner wall surface of the frame, and the outer wall and the upper end of the conical section shell to form a backflow channel, so that as a backflow is sucked into the backflow channel through an intake section, the flow velocity and the kinetic energy of the flow field are reduced gradually. Therefore, the wind resistance between the inner wall surface of the frame, and the outer wall and the upper end of the conical section shell is increased, the backflow sucked into the backflow channel is reduced, and the turbulent flow intensity of the backflow channel is eliminated simultaneously. On the other hand, when the impeller is rotated, the backflow flows in the exhaust section along a direction identical to that of the airflow flowing. In this way, when the backflow is converged into the airflow, the collision of flowing field is less likely to occur and the noise during operation is reduced.

[0047] While the disclosure has been described in terms of what is presently considered to be the most practical and preferred embodiments, it is to be understood that the disclosure needs not be limited to the disclosed embodiment. On the contrary, it is intended to cover various modifications and similar arrangements included within the spirit and scope of the appended claims which are to be accorded with the broadest interpretation so as to encompass all such modifications and similar structures.

What is claimed is:

1. A diagonal fan, comprising:

a frame comprising an inlet, an outlet, an accommodation space and a guiding wall, wherein the inlet and the outlet are disposed at two opposite sides of the frame, respectively, and in fluid communication with each other through the accommodation space, wherein the guiding wall is connected to an inner wall surface of the frame, and the guiding wall is extended from a periphery of the inlet along an axial direction into the accommodation space; and

an impeller accommodated within the accommodation space of the frame, wherein when the impeller is rotated, an airflow flowing from the inlet to the outlet is generated, wherein the impeller comprises a conical section shell, and a gap having a spacing distance is substantially maintained between the inner wall surface of the frame, and an outer wall and an upper end of the conical section shell to form a backflow channel, wherein the impeller comprises a hub, and the outer diameter of the hub of the impeller is expended gradually in a direction from the inlet toward the outlet so that the flowing direction of the airflow is expended gradually around a periphery of the impeller.

2. The diagonal fan according to claim **1**, wherein the backflow channel comprises an intake section, a horizontal section and an exhaust section, the intake section is located adjacent to a lower end of the conical section shell and in fluid communication with the exhaust section through the horizontal section, and the upper end of the conical section shell is at least partially shielded by the guiding wall to form the exhaust section, wherein when the airflow flows from the inlet to the outlet, a backflow is transported from the intake section, flows through the horizontal section, is exhausted out through the exhaust section, and is converged with the airflow.

3. The diagonal fan according to claim **2**, wherein the conical section shell comprises a plurality of balance holes disposed around the upper end of the conical section shell, and the horizontal section is spatially corresponding to the plurality of balance holes.

4. The diagonal fan according to claim **2**, wherein the conical section shell comprises a plurality of balance holes disposed around the lower end of the conical section shell, the horizontal section is spatially corresponding to the plurality of balance holes, and the backflow channel further comprises a second horizontal section spatially corresponding to the upper end of the conical section shell.

5. The diagonal fan according to claim **2**, wherein the backflow flows in the intake section along a direction reversed to that of the backflow flowing in the exhaust section.

6. The diagonal fan according to claim **2**, wherein the backflow flows in the horizontal section along a direction perpendicular to the axial direction.

7. The diagonal fan according to claim **2**, wherein the backflow flows in the exhaust section along a direction identical to that of the airflow flowing.

8. The diagonal fan according to claim **1**, wherein the impeller comprises the hub, a cylindrical part and a plurality of blades, wherein the cylindrical part is configured to accommodate a rotor and a stator, the hub is disposed on the cylindrical part, the plurality of blade are spaced apart and disposed on the hub, and the plurality of blades are connected between the hub and the conical section shell, wherein when the impeller is rotated, the airflow is formed to flow through the plurality of blades and between the hub and the conical section shell.

9. The diagonal fan according to claim **8**, wherein the frame comprises an upper frame and a lower frame assembled with each other to form the inlet, the outlet and the accommodation space, wherein the inlet and the guiding wall are disposed on the upper frame.

10. The diagonal fan according to claim **9**, wherein the upper frame comprises an upper frame plate disposed on an upper end of the upper frame, the inlet is located at the upper frame, and the guiding wall is connected to the upper frame plate and extended downwardly from the periphery of the inlet into the accommodation space.

11. The diagonal fan according to claim **10**, wherein the lower frame comprises a lower frame plate, a base and a plurality of static blades, the lower frame plate is spatially corresponding to the upper frame plate, and the plurality of static blades are disposed between the base and the lower frame plate to form the outlet between the lower frame plate and base.

12. The diagonal fan according to claim **11**, wherein the base further comprises a tube, the stator comprises a winding and a printed circuit board disposed on a periphery of the tube, and the rotor comprises a magnetic shell, a magnet and a shaft, wherein the magnetic shell is disposed within the cylindrical part of the impeller and configured to accommodate the magnet, the shaft, the winding and a part of the tube, the magnet is disposed on an inner wall of the magnetic shell and spatially corresponding to the winding, the shaft is disposed at a center of the magnetic shell, and the shaft is disposed in the tube through a bearing.

13. The diagonal fan according to claim **12**, wherein a chamber is formed between the base and the tube, and configured to accommodate an electronic component on the printed circuit board.

14. The diagonal fan according to claim **1**, wherein the inlet has an inlet diameter, the outlet has an outlet diameter, and the inlet diameter is less than the outlet diameter.

15. The diagonal fan according to claim **1**, wherein the frame has a frame diameter, the inlet has an inlet diameter, the outlet has an outlet diameter, a ratio of the inlet diameter to the frame diameter is ranged from 0.5 to 0.7, and a ratio of the outlet diameter to the frame diameter is ranged from 0.8 to 0.98.

16. The diagonal fan according to claim **1**, wherein the frame has a frame diameter, the inlet has an inlet diameter, the outlet has an outlet diameter, a ratio of the inlet diameter to the frame diameter is ranged from 0.6 to 0.8, and a ratio of the outlet diameter to the frame diameter is ranged from 0.8 to 0.98.

17. The diagonal fan according to claim **1**, wherein the frame has a frame diameter, and a ratio of the spacing distance to the frame diameter is ranged from 0.01 to 0.02.

18. The diagonal fan according to claim **1**, wherein the frame, the upper end of the conical section shell and the guiding wall are at least partially overlapped in view of a radial direction.

* * * * *