United States Patent

Kristiansen

[15] **3,635,589**

[45] **Jan. 18, 1972**

[54] **DOUBLE IMPELLER WHEEL**

[72] Inventor: **Svend Helge Kristiansen,** Naestved, Denmark

[73] Assignee: **Nordisk Ventilator Co. A/S,** Naestved, Denmark

[22] Filed: **Mar. 13, 1970**

[21] Appl. No.: **19,182**

[30] **Foreign Application Priority Data**

Mar. 31, 1969 Denmark 1790/69

[52] **U.S. Cl.** **416/193,** 415/77
[51] **Int. Cl.** **F04d 19/00**
[58] **Field of Search** 416/193, 203, 210, 194, 196; 415/79, 78, 77

[56] **References Cited**

UNITED STATES PATENTS

785,014	3/1905	Ludeman	415/79
2,007,408	7/1935	Schellens	415/79
2,790,596	4/1957	Stirling	415/77 X
3,186,166	6/1965	Grieb	415/79 UX

FOREIGN PATENTS OR APPLICATIONS

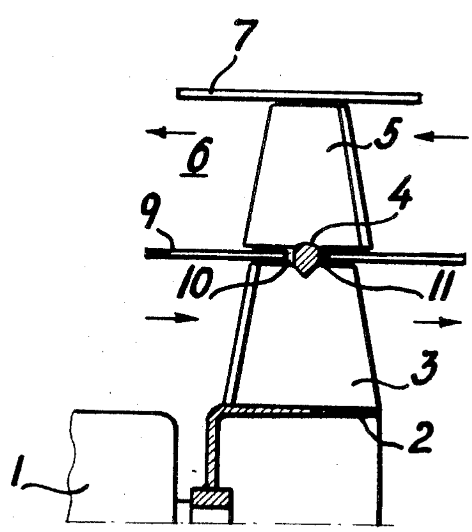
60,579	4/1954	France	416/242
327,058	4/1919	Germany	416/193

Primary Examiner—Everette A. Powell, Jr.
Attorney—Sughrue, Rothwell, Mion, Zinn & Macpeak

[57] **ABSTRACT**

A double impeller wheel for axial flow fans comprising a set of inner impeller blades surrounded by an intermediate ring, a set of outer impeller blades secured to the ring, the width of the ring in an axial direction being less than that of the impeller blades.

8 Claims, 6 Drawing Figures



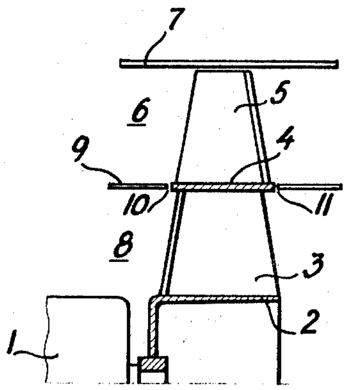


FIG. 1

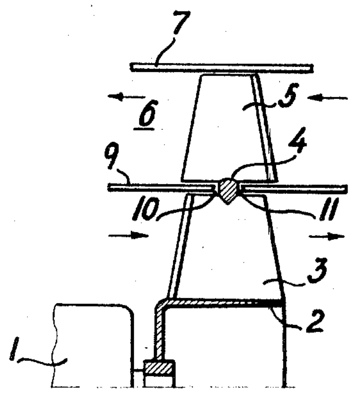


FIG. 2

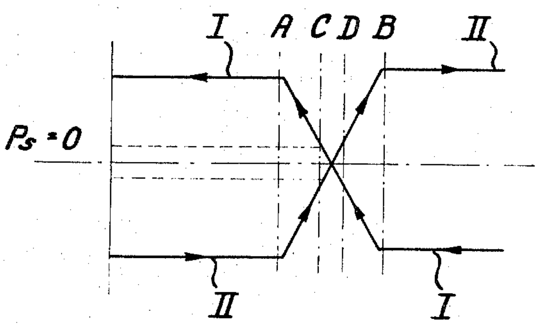


FIG. 3

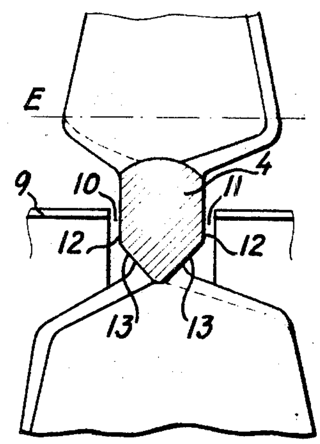


FIG. 4

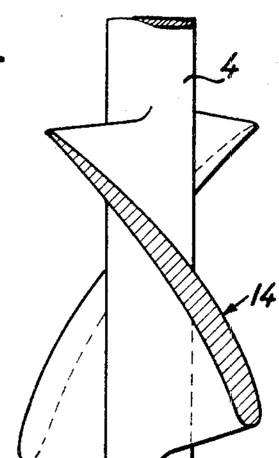


FIG. 5

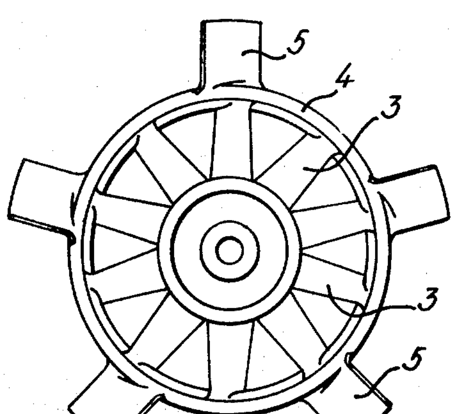


FIG. 6

DOUBLE IMPELLER WHEEL

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a double impeller wheel for axial flow fans with a set of inner impeller blades secured to a hub, an intermediate ring mounted around the extremities of these blades and a set of outer impeller blades mounted on this intermediate ring coaxially with the first set of outer impeller blades, and in which the two sets of blades are adapted to blow in opposite directions.

2. Description of the Prior Art

Such double impeller wheels are used, for instance, for the ventilation of rooms in buildings such as stables, in that they are mounted in two coaxial ducts with the inner blades together with the drive motor of the wheel in the innermost duct, and the outer blades in the outermost annular duct. Since the two sets of blades blow in opposite directions, it is thus possible for the extraction of air from the room through the one duct, and the injection of fresh air through the second duct to take place.

On the spot, where the impeller wheel is mounted, there must of course be a break in the partition between the two coaxial ducts.

In the two ducts, there is going to be a, taking it by and large, constant different in the pressure, but with opposite signs on the two sides of the impeller wheel. The change in sign takes place essentially across the width of the blades seen in the axial direction, and as the width of the intermediate ring usually corresponds to this blade width, it means that a significant difference in pressure exists between the two ducts on the spot where the edges of the partition between them faces the intermediate ring. Since there must be a certain gap between the edges of the partition and the intermediate ring, this difference in pressure gives rise to an air flow from the one duct to the other, so that a certain loss occurs. At the same time, an annoying deposition of dust takes place on the inside of the intermediate ring which, in the course of time, may reduce the efficiency and, moreover, may given rise to an imbalance.

SUMMARY OF THE INVENTION

According to the present invention, these disadvantages are obviated by the axial width of the intermediate ring being considerably smaller than the width of the blades measured in the axial direction from front edge to rear edge in the proximity of the points of the inner blades.

No difficulty is encountered in producing the intermediate ring having a width which is considerably smaller than the width of the blades, since it is only necessary to see to it that the cross section remains of a sufficient size in order to provide the necessary strength and that the connection between the blades and the intermediate ring remains sufficiently strong.

Owing to the narrow intermediate ring, the gaps between the partition and the ring are moved into an area where the difference in pressure is considerably smaller, so that the air flow between the two ducts is very significantly reduced.

According to the invention it is advantageous for the intermediate ring to be constructed with lateral surfaces of considerable width at right angles to the axis of the wheel, as it is possible thereby to reduce the requirements as to tolerance in the manufacture of the partition between the two ducts very considerably.

Furthermore, it is expedient according to the invention for the inside of the intermediate ring to be composed of surfaces sloping inwards towards the center as thereby the risk of dust deposition is reduced still further.

Finally, it may, according to the invention, be advantageous for the section of the blades in the proximity of their securing surfaces on the intermediate ring to be turned in such a way that the securing surfaces of the blades extend in a direction which, at the most, will form a small angle with a plane at right angles to the axis of the impeller wheel, by means of which a very strong securing of the blades even on a very narrow intermediate ring is made possible.

BRIEF DESCRIPTION OF THE DRAWINGS

In the following, the invention is explained in greater detail with reference to the drawing, in which

FIG. 1 shows diagrammatically a part of a known double impeller wheel mounted in coaxial ducts,

FIG. 2 shows a diagrammatical illustration of a double impeller wheel according to the invention shown in the same way as the wheel in FIG. 1,

FIG. 3 shows a pressure diagram for explaining the effect of the invention,

FIG. 4 shows a part of an impeller wheel according to the invention on a larger scale in a special embodiment, and

FIG. 5 shows another part of an impeller wheel according to the invention.

FIG. 6 shows the wheel as seen in an axial direction.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 shows a motor 1, on the shaft of which a hub 2 is secured which carries a set of inner blades 3. Around the extremities of these blades, an intermediate ring 4 is mounted, which carries a set of outer blades 5. The motor 5 with the blade sets 3 and 5 is mounted in two coaxial ducts, of which the outer wall of the outermost duct 6 is denoted with 7, while the outer wall of the innermost duct 8, which, at the same time, forms the partition between the two ducts, is denoted with 9. The intermediate ring 4 is cylindrical and of the same radius as the partition 9 and fills in a break in same, the manufacturing tolerances rendering it necessary though that on each side of the intermediate ring 4 there appears a gap 10 and 11.

FIG. 1 represents the known construction of a double impeller wheel, while a double impeller wheel constructed according to the invention is shown diagrammatically in a corresponding manner in FIG. 2, in which the same designations are employed for the individual parts.

The difference between the constructions shown in FIGS. 1 and 2 lies in the fact that the intermediate ring 4 in FIG. 1, measured in the axial direction, is of a width that corresponds to the width of the outer blades in the proximity of the blade base or the width of the inner blades measured in the proximity of the points of the blades, while the width of the intermediate ring 4 in FIG. 2 according to the invention is considerably less and, as is seen, only constitutes a fraction of this width.

The effect of this difference is going to be explained in greater detail by means of the curves shown in FIG. 3.

In this figure, the curve I denotes the pressure condition in the duct 6, while the curve II denotes the pressure condition in duct 8.

The two curves lie in the figure symmetrically with respect to the zero line, but this will not always be the case, as the pressures in the two ducts, depending on the construction of the blade set, may possess different numerical values.

The curves in FIG. 3 apply both to the known construction shown in FIG. 1, as well as to the construction according to the invention shown in FIG. 2, provided that all dimensions in the two figures are identical apart from the dimensions of the intermediate ring and the location of the gaps 10 and 11.

It is seen that the pressures in the ducts change signs in a point 0 which approximately lies in a midplane through the blades at right angles to the axis, in that FIGS. 1, 2 and 3 are drawn in such a way in relation to each other that the abscissae from FIG. 3 can be directly transferred to FIGS. 1 and 2.

It is seen, furthermore, that the pressure in the ducts remains constant on both sides of the impeller wheel all the way to the two lines marked A and B in FIG. 3. From these spots the pressures decrease practically linearly towards 0.

It follows herefrom that the difference in pressure between the two ducts 6 and 8, taking it by and large, are constant outside of blades and here are of a very considerable magnitude, viz corresponding to the total of the numerical values of those pressures which are produced by the two sets of blades.

It is seen that the gaps **10** and **11** in FIG. **1** are in two places which correspond to the lines A and B in FIG. **3**, that is to say, in places where, to all intents and purposes, the maximum difference in pressure between the ducts exists. On the other hand, the gaps **10** and **11** in FIG. **2** have been moved considerably closer together and are on a place which in FIG. **2** is marked with lines C and D, i.e., on a place where the difference in pressure between the two ducts has come very close to 0.

Since theoretically it can be anticipated that the gaps in the two cases can be made equally narrow, this means that the airflow from the one duct to the other through these gaps is considerably less with the impeller wheel according to the invention as shown in FIG. **2** than with the known impeller wheel as shown in FIG. **1**.

It appears from FIG. **4** that the intermediate ring **4** in this embodiment is constructed with lateral surfaces **12** which are at right angles to the axis of the wheel and are of a considerable width. By means of this it is achieved that the width of the gaps **10** and **11** remain more or less the same, even if the partition **9** is not constructed precisely circular-cylindrically or is mounted slightly eccentrically. It is consequently not necessary to meet such exacting requirements as regards tolerance, as far as the construction and mounting of the ducts is concerned, as with the embodiment shown in FIG. **1**.

It does, moreover, appear from FIG. **4** that the intermediate ring **4** is constructed with an inside that is constituted of surfaces **13** which are sloping inwards towards the center. Already as a consequence of the smaller surface area, the deposition of dust is substantially reduced and the use of these sloping surfaces **13** results in an additional reduction of the risk of dust deposition.

FIG. **5** shows a particularly expedient embodiment of the connection of the blades with the intermediate ring.

In FIG. **5** is seen a blade **14** which is shown according to its normal section. The blade has this section with essentially the same pitch throughout, possibly with a outwardly diminishing width of blade, but within a line in the proximity of the intermediate ring **4** as indicated with the line E in FIG. **4**, the section is twisted acutely towards the plane of the intermediate ring, as seen in FIG. **5**. Thereby, on the one hand, a longer connecting surface to the intermediate ring, and on the other hand, a closing of the blade at the end facing the intermediate ring is obtained, such as is obtained in the known construction according to FIG. **1** by means of the intermediate ring, but which is impossible to obtain without twisting, when the intermediate ring is narrowed.

The axial width of the intermediate ring should be less than half, preferably less than a third of the largest width of the inner vanes as measured in an axial direction from their front edges to their rear edges.

The radial width of the intermediate ring should be at least 1½ times the axial width thereof.

What is claimed is:

1. A double impeller wheel for an axial flow fan comprising a hub;

a set of inner impeller blades each secured at its radially inner end to said hub and having an outwardly decreasing axial width;

a connecting ring secured to the radially outer ends of said impeller blades coaxially with said hub; and

a set of outer impeller blades each secured at its radially inner end to said ring and having an outwardly decreasing axial width, said inner and outer impeller blades being inclined in opposite directions with respect to the impeller axis, the dimension of said connecting ring in the radial direction being more than 1½ times the axial width of said ring between opposed end surfaces thereof, said axial width being smaller than one-half of the minimum axial width of said inner blades.

2. A double impeller wheel as claimed in claim **1** in which said axial width of said connecting ring is smaller than one-third of the minimum axial width of said inner blades.

3. A double impeller wheel as claimed in claim **2** in which the surface of said connecting ring facing against said hub is composed of two oppositely tapering surface portions each sloping inwardly towards a midplane of said ring perpendicular to the axis thereof.

4. A double impeller wheel as claimed in claim **1** in which the portions of said inner and outer impeller blades adjacent to said connecting ring are twisted relative to the respective blade profiles remote from said ring so as to merge with said ring at a small angle to a plane perpendicular to the axis of said ring.

5. A double axial flow fan comprising an inner tubular member defining a first air duct and having a circumferential slot intermediate to its ends;

an outer tubular member surrounding said inner tubular member and defining therewith an annular second air duct;

an impeller wheel having a hub rotatably supported within said first tubular member;

a plurality of inner impeller blades secured at their radially inner ends to said hub;

a connecting ring secured to the radially outer ends of said inner blades and located in said circumferential slot with its opposed axial end faces spaced from the axial faces of said slot;

the dimension of said connecting ring in the radial direction being more than 1½ times the axial width of said ring between opposed end faces thereof, said axial width being smaller than one-half of the minimum axial width of said inner blades;

a plurality of outer impeller blades secured at their radially inner ends to said ring and extending across said second annular duct, said inner and outer blades being inclined in opposite directions with respect to the wheel axis and having outwardly decreasing axial widths, said end faces of said connecting ring being located on opposite sides of a plane normal to said wheel axis in which the difference between the pressures in said first and second air ducts is substantially zero during rotation of said impeller wheel and so close to said normal plane that he differential pressure at each of said axial end faces is smaller than one-half of the maximum differential pressure between said ducts.

6. A double axial flow fan as claimed in claim **5** in which said end faces of said connecting ring are located in planes in which the differential pressure between said inner and outer ducts is smaller than one-third of the maximum differential pressure between said ducts.

7. A double axial flow fan as claimed in claim **5** in which the surface of said connecting ring facing against said hub is composed of two oppositely tapering surface portions each sloping inwardly towards a midplane of the ring normal to the axis thereof.

8. A double axial flow fan as claimed in claim **5** in which the portions of said inner and outer impeller blades adjacent to said connecting ring are twisted relative to the respective blade profiles remote from said ring so as to merge with said ring at a small angle to a plane perpendicular to the axis of said ring.

* * * * *