DRUM MOTOR BLADE CONSTRUCTION

Original Filed Aug. 26, 1963

2 Sheets-Sheet 1

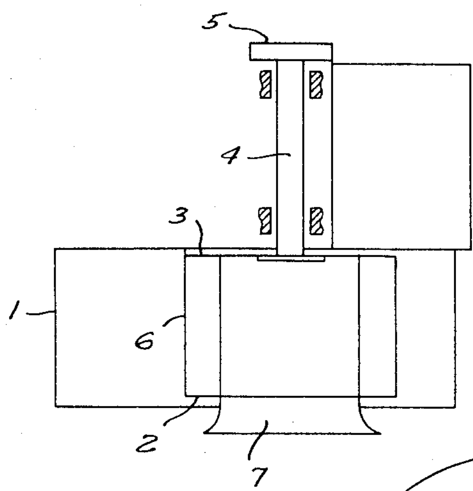

FIG. 2

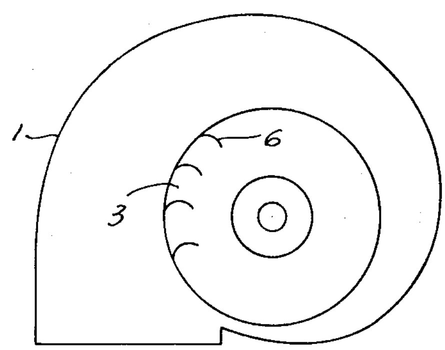

FIG. 1

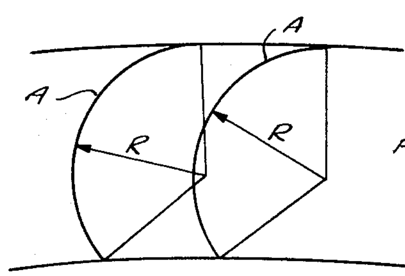

FIG. 3

PRIOR ART

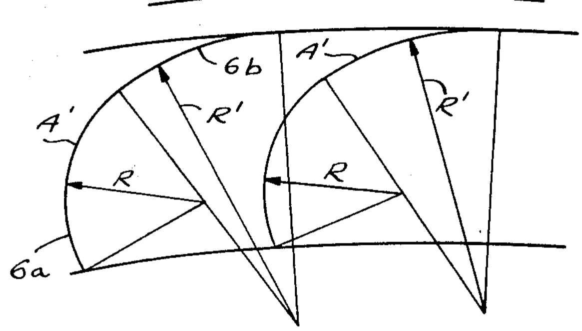

FIG. 4

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DRUM MOTOR BLADE CONSTRUCTION

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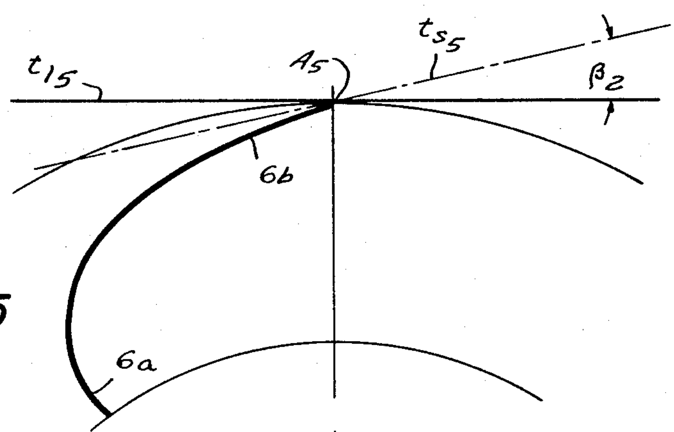

FIG. 5

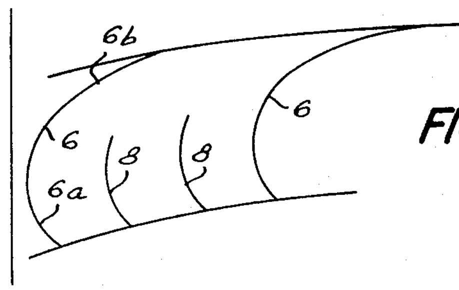

FIG. 7

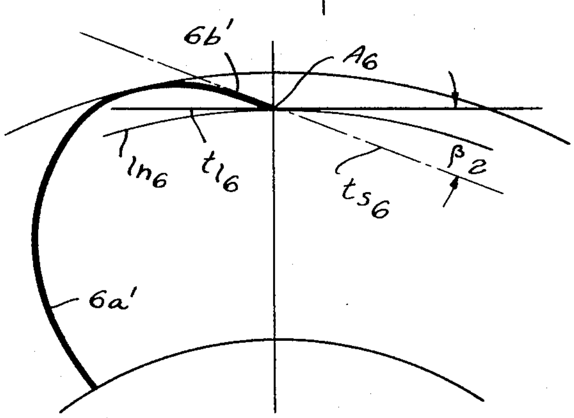

FIG. 6

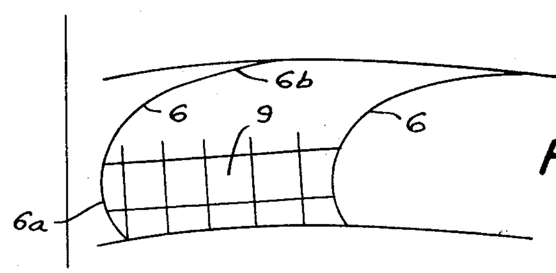

FIG. 8

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DRUM MOTOR BLADE CONSTRUCTION

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Continuation of application Ser. No. 304,418, Aug. 26, 1963. This application Sept. 2, 1966, Ser. No. 577,090
Claims priority, application Germany, July 24, 1959, E 18,014
7 Claims. (Cl. 230—134)

ABSTRACT OF THE DISCLOSURE

Rotor blades elongated in axial direction have inner portions with a small radius of curvature, and outer portions with a larger radius of curvature forming tangential angles of less than 15 degrees.

The present invention relates to a drum rotor blade construction, and more particularly to a drum impeller rotor of the type in which blades which are substantially longer in axial direction than in radial direction are disposed in a circular row between axially spaced end walls.

This application is a continuation of my copending application Ser. No. 304,418 filed Aug. 26, 1963, now abandoned, which was a continuation-in-part application of my application Ser. No. 42,862 filed July 14, 1960, now abandoned. Known drum impeller rotors of this type have blades curved in planes perpendicular to the axis of rotation to have a circular, or substantially circular curvature.

The prior art constructions have the disadvantage that they require a comparatively great number of blades for a desired given volume of fluid transported by the impeller rotor. Another disadvantage of prior art constructions is the great loss of efficiency of drum impeller rotors having small dimensions, as compared with corresponding drum impeller rotors having larger dimensions.

An important disadvantage of prior art constructions is the formation of zones of turbulence in the region of the outer edges of the blades. This turbulence is the cause of low efficiency and great pressure losses of the rotor.

It is one object of the invention to overcome these disadvantages of known drum impeller rotors, and to provide a blade construction for a drum impeller rotor resulting in high efficiency of the rotor.

Another object of the invention is to provide a drum impeller rotor with blades constructed and disposed in such a manner that no turbulence is created in the conveyed fluid.

Another object of the invention is to shape and dispose the outer discharge portions of the rotor blades in such a manner that the fluid passes the outer edges of the blades in a smooth laminar flow without any turbulence in this region.

With these objects in view, a drum impeller rotor according to one embodiment of the invention comprises two walls located in parallel planes perpendicular to the axis of rotation, and a set of spaced blades secured to the walls and disposed in a circular row equidistant from the axis.

Each blade is elongated in axial direction and has inner and outer edges parallel to the axis of rotation. The blades are curved in planes perpendicular to the axis, and preferably form passages which gradually narrow in outward direction. The fluid flows during rotation of the rotor parallel to the walls in the passages between the same and the blades, and leaves the passages at an increased pressure.

In accordance with the present invention, each blade includes an inner intake portion bounded by the inner edge of the blade and having a first radius of curvature, and an outer discharge portion bounded by the outer edge and having a second different radius of curvature. The outer discharge portion of each blade is constructed and disposed in such a manner that a plane passing through the outer edge tangentially to the discharge portion is located within an angle of plus 20 degrees outwardly, and within an angle of minus 15 degrees inwardly of another plane passing through the outer edge perpendicularly to a radial plane through the same.

Due to the guidance of discharged fluid by the discharge portions in the region of the outer edges, any turbulence in this region is prevented, and the efficiency of the rotor of the invention as compared with prior art constructions, substantially improved. When the fluid is discharged within this angular zone, excellent flow conditions and new and unexpected results are achieved. The fluid streams between the blades are sharply deflected in the peripheral direction of the rotor. Particularly, if the blades are comparatively widely spaced in circumferential direction, a very great peripheral deflection can be obtained, which results in a substantial pressure increase without the necessity of providing very elongated blade discharge portions which due to the high centrifugal forces acting in this region, are particularly undesirable since they are subjected to very high bending moments.

The blade construction of the present invention produces very high pressures by a very simple, but unobvious improvement of the known blade constructions, and such pressure increase, and the corresponding greater efficiency of the present invention, is decisive for permitting the use of drum impeller rotors for certain tasks for which the prior art constructions have been considered unsuitable.

According to one embodiment of the invention, the tangential plane of the blade discharge portion defines a positive angle with a corresponding tangential plane on the periphery of the rotor. According to another embodiment of the invention, the tangential plane of the discharge portion forms a negative angle with a chord perpendicular to the radial plane passing through the outer edge of the blade, and this construction produces particularly high pressure.

Due to the fact that the fluid moves between the end walls of the rotor which are perpendicular to the axis of rotation, the streams of fluid between adjacent blades have no axial component, and all parts of the fluid within each passage move parallel to each other so that when the discharge angle of the fluid is selected in accordance with the present invention, no turbulence develops at the outer edges of the blades.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

FIG. 1 is a side elevation, partially in section, illustrating a blower provided with a drum impeller rotor according to one embodiment of the invention;

FIG. 2 is a sectional view illustrating the blower of FIG. 1;

FIG. 3 is a fragmentary schematic cross sectional view illustrating a blade construction according to the prior art;

FIG. 4 is a fragmentary schematic cross sectional view illustrating a blade construction according to one embodiment of the invention;

FIG. 5 is a fragmentary schematic cross sectional view illustrating on an enlarged scale the construction and position of the discharge portion of a blade according to the embodiment of FIG. 4;

FIG. 6 is a fragmentary schematic cross sectional view illustrating on an enlarged scale the construction and position of the discharge portion of the blade according to another embodiment of the invention;

FIG. 7 is a fragmentary schematic cross sectional view illustrating a modified arrangement according to the present invention; and

FIG. 8 is a fragmentary schematic cross sectional view illustrating another modified construction of the invention.

Referring now to the drawings, and more particularly to FIGS. 1 and 2, a drum impeller rotor according to the present invention is mounted within a spiral-shaped casing **1** and includes two circular walls **2** and **3**, and a set of blades **6** whose ends are secured to walls **2** and **3** in the region of the outer circular periphery of the same. The end wall **3** is secured to a drive shaft **4** which extends through an opening in one side wall of casing **1** and carries a pulley **5** which is driven by a belt from a suitable motor, not shown. The other end wall **2** has a central opening registering with a corresponding opening in the other side wall of casing **1**, and an inlet tube **7** is provided for guiding the fluid into the central cavity of the rotor. During rotation of the rotor with shaft **4**, a fluid supplied to inlet **7** will move outwardly due to the action of the centrifugal force, and pass through the passages defined by adjacent blades **6** between the outer peripheral portions of end walls **2** and **3**. The fluid discharged from the rotor will flow along the spiral-shaped cavity of casing **1**, and will be discharged through the outlet of the casing.

A known drum rotor construction provides circular blades having a single radius of curvature R, as shown in FIG. 3. This construction causes cavitation in the region A, and great turbulence in the region of the outer axially extending edges of the blades.

In the embodiment according to FIGS. 4 and 5 of the present invention, the inner intake portion *6a* has a smaller radius of curvature R than the outer discharge portion *6b* which has a greater radius of curvature R'.

In the embodiment of FIG. 6, the inner intake portion *6a'* has a greater radius of curvature than the outer discharge portion *6b'*.

In the embodiment illustrated in FIG. 5, the angle β_2 is characteristic of the shape and position of the discharge portion *6b*. This angle is defined by a tangential plane t_{15} on the periphery of the rotor and passing through the outer edge A_5 of the blade, and the tangential plane t_{s5} on the discharge portion *6b* of the blade passing through the outer edge A_5. The outer edges A5 of all blades are located along an imaginary cylinder 1_{n5}, and it is evident that the tangential plane t_{15} on this cylinder is perpendicular to a radial plane r_{15} passing through the axis of the rotor and through the outer edge A_5 of the respective blade.

In accordance with the present invention, the angle β_2 is not greater than 20°, and since this angle is located outwardly of the tangential plane t_{15}, it will be referred to hereinafter as a positive angle.

In the embodiment of FIG. 6, the angle β'_2 is characteristic for the shape and position of the outer discharge portion *6b'*. This angle is formed between a tangential plane t_{s6} on the discharge portion *6b'* through the outer edge A6, and a plane t_{16} passing through the outer edge A_6 perpendicularly to the radial plane r_{16} which extends through the axis of the rotor and the outer edge A_6. The plane t_{16} extends along a chord of the imaginary cylinder along which the outermost portions of the blades move, and is at the same time a tangential plane on an imaginary cylinder 1_{n6} along which the outer edge A_6 of each blade moves during rotation of the rotor. Since the angle β'_2 is located inwardly of plane t_{16}, it will be referred to hereinafter as a negative angle. The angle β'_2 is not greater than 15°.

In the embodiment of the invention according to FIG. 5, fluid discharge from the passages between adjacent blades, will move without any turbulence in the regions of the outer edges A_5. In the embodiment of the invention according FIG. 6, the passages between adjacent blades are wider at the inner ends of the passages, and gradually narrow in the region between the outer discharge portions of the blades to that the pressure of the discharge fluid is increased. The embodiment of FIG. 6 results in particularly high pressure.

The super-curvature of the blades causes a high diversion of the fluid in circumferential direction so that a high pressure for a rotor with a very small number of blades is achieved in a very simple manner and with very moderate expenses. The efficiency is indeed a little smaller, but there are many uses where this is not important while the high pressure is very desirable.

FIG. 7 illustrates a modified embodiment according to which auxiliary blades **8** are provided between two adjacent blades **6** of the type described with reference to FIG. 5. Each auxiliary blade **8** has an inner edge spaced the same distance from the axis as the inner edges of the blades **6**, and an outer edge which is located in the region where the inner intake portions *6a* join the outer discharge portions *6b* of blades **6**. The curvature of the auxiliary blades **8** corresponds to the curvature of the inner intake portion *6a* of the blades **6**. While the auxiliary blades **8** are shown in combination with the blades **6** of the embodiment of FIG. 5, the embodiment of FIG. 6 is preferably provided with correspondingly arranged auxiliary blades **8** whose shape and curvature corresponds to the shape and curvature of the inner intake portions *6a'*.

Another modified embodiment is illustrated in FIG. 8, and includes a preferably honey-comb mesh **9** bent to the shape of the inner intake portions of the blades, and guiding the fluid in the inner passage portions between the blades **6**.

The auxiliary blades **8** of FIG. 7, and the mesh of FIG. 8 have the effect of initially deflecting the fluid entering between the blades, and thereby relieve the blades **6** of a considerable part of the load which tends to bend the blades. The efficiency of the blade construction is improved, and a number of blades **6** may be reduced without causing any speed differences between fluid streams discharged by the rotor.

In the construction explained with reference to FIG. 6, the streams of discharged fluid have a substantially smaller circumferential width than in the embodiment of FIG. 5, since the discharged streams are bounded by the edges A_6, and by the outermost peripheral portions of the next leading blade, whereas in the embodiments of FIG. 5, the streams are bounded by the outer edge A_5 and the outer edge of the next leading blade. The circumferential spacing of the blades can be selected to produce the optimal turbulence free flow conditions. Streams of the width of the streams in the embodiment of FIG. 5 can be obtained in the embodiment of FIG. 6 by blades which are farther spaced from each other, so that a lesser number of blades need be provided in the embodiment of FIG. 6 than in the embodiment of FIG. 5, assuming that the same pressure is to be produced by the two constructions.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of impeller blade constructions differing from the types described above.

While the invention has been illustrated and described as embodied in a blade construction for a drum impeller rotor including curved blades having discharge portions extending at selected angles to a periphery of the rotor, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. A drum impeller rotor having an axis of rotation and comprising two supports spaced along said axis; and a set of spaced blades secured to said supports and disposed in a circular row equidistant from said axis, each blade being elongated in axial direction and having inner and outer edges, each blade being curved in planes perpendicular to said axis whereby a fluid flows during rotation of said rotor between said blades in outward direction, each blade including a curved inner intake portion bounded by said inner edge and having a first smaller radius of curvature, a curved outer discharge portion bounded by said outer edge and having a second greater radius of curvature, and between said inner intake portion and said outer discharge portion a portion having a radius of curvature greater than said first radius but not greater than said second radius, said discharge portion being disposed in such a position that a plane passing through said outer edge tangentially to said discharge portion defines an angle of less than 15 degrees with another plane passing through said outer edge perpendicularly to a radial plane through said axis and said outer edge whereby turbulence in said fluid in the region of said outer edges is prevented.

2. A drum impeller rotor according to claim **1** wherein said inner edges of said blades are parallel to said axis.

3. A drum impeller rotor according to claim **1** wherein said intake portion merges gradually into said discharge portion.

4. A drum impeller rotor having an axis of rotation and comprising two walls located in parallel planes perpendicular to said axis; a set of spaced blades secured to said walls and disposed in a circular row equidistant from said axis, each blade being elongated in axial direction and having inner and outer edges parallel to said axis, each blade being curved in planes perpendicular to said axis whereby a fluid flows during rotation of said rotor parallel to said walls between the same and said blades in outward direction, each blade including an inner intake portion bounded by said inner edge and having a first smaller

radius of curvature, an outer discharge portion bounded by said outer edge and having a second greater radius of curvature, and between said inner intake portion and said outer discharge portion a portion having a radius of curvature greater than said first radius but not greater than said second radius, said discharge portion being disposed in such a manner that a plane passing through said outer edge tangentially to said discharge portion defines an angle less than 15 degrees with another plane passing through said outer edge perpendicularly to a radial plane through said outer edge; and guide means having circumferentially aligned ends and located between said inner intake portions of said blades for guiding a fluid into free passages formed between said outer discharge portions whereby turbulence in said fluid in the region of said outer edges is prevented.

5. A drum impeller rotor according to claim **4** wherein said guide means includes at least one auxiliary blade disposed between each pair of adjacent blades of said blades, each auxiliary blade having an outer edge located in the region where said inner intake portion and said outer discharge portions of said adjacent blades join, each auxiliary blade being curved and substantially parallel with said inner intake portions of said adjacent blades.

6. A drum impeller rotor according to claim **5** wherein said second radius of curvature of said outer discharge portions is greater than said first radius of curvature of said inner intake portions.

7. A drum impeller rotor according to claim **4** wherein said guide means is a mesh guide means curved substantially parallel with said inner intake portion.

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