June 8, 1937. H. F. HAGEN 2,082,955

FAN

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Fig. 1.

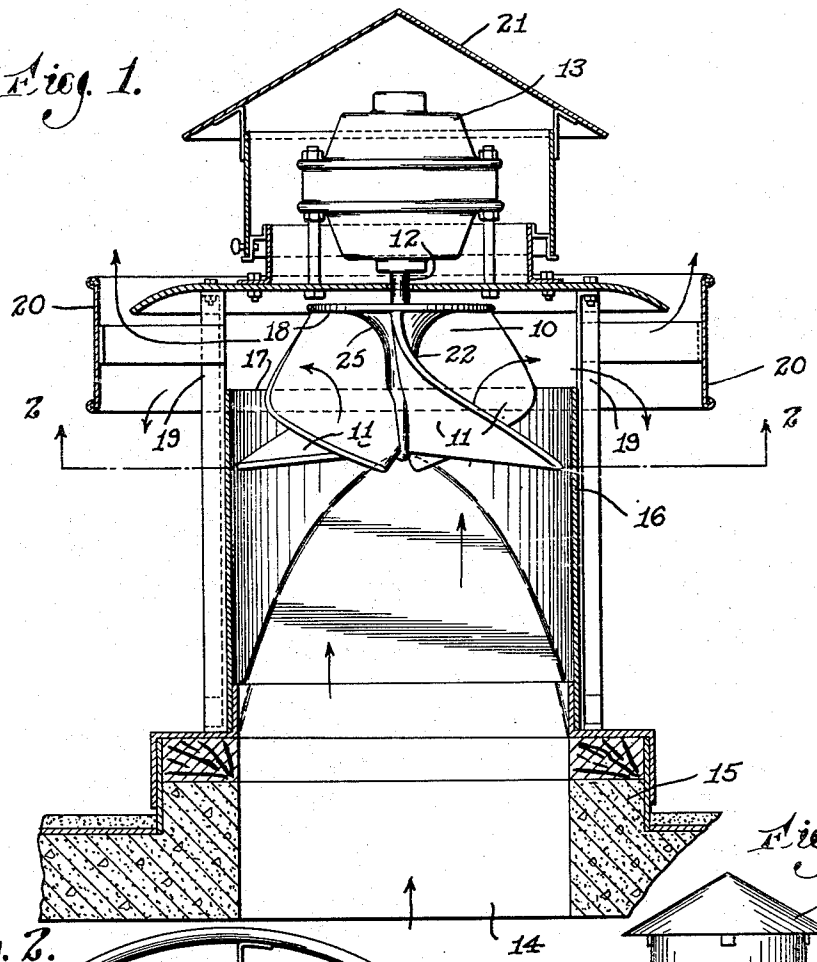


Fig. 2.

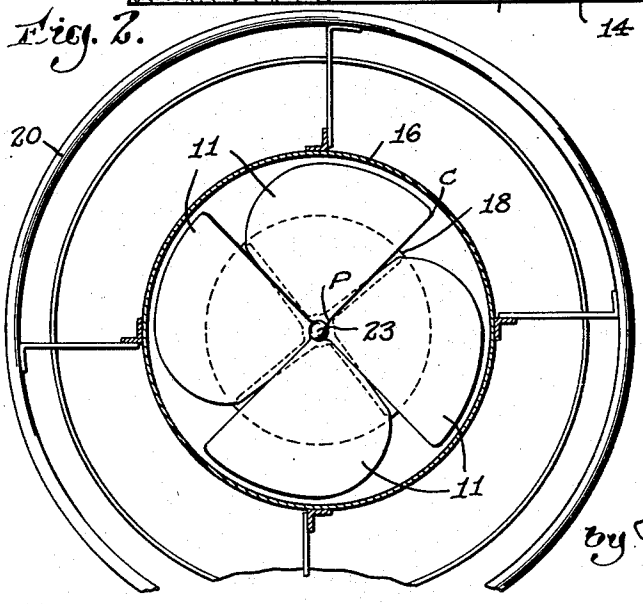
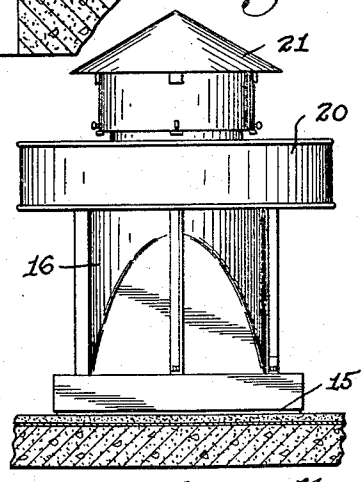


Fig. 3.



Inventor
HAROLD F. HAGEN
by Robert J. Palmer
Attorney

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Fig. 4.

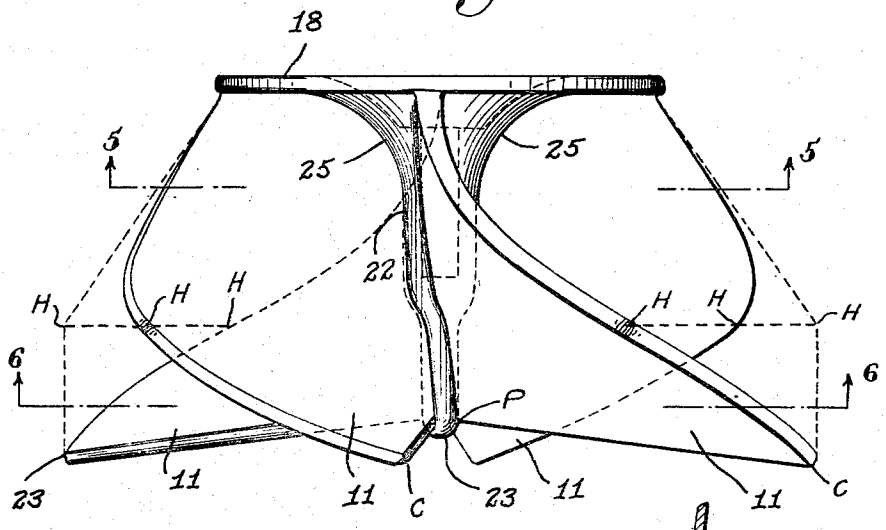
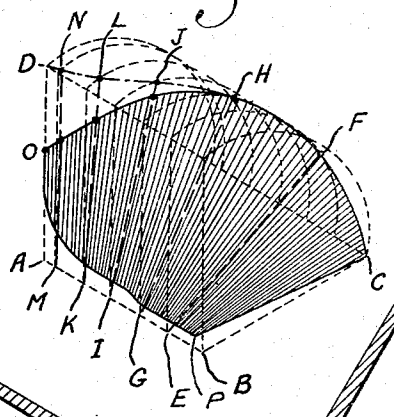


Fig. 7



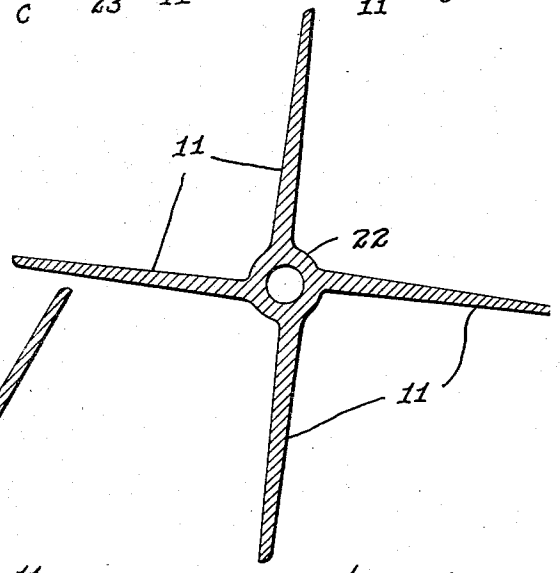


Fig. 5.

Fig. 6.

Inventor
HAROLD F. HAGEN
by Robert J. Palmer
attorney

Patented June 8, 1937 2,082,955

UNITED STATES PATENT OFFICE

2,082,955

FAN

Harold F. Hagen, Dedham, Mass., assignor to B. F. Sturtevant Company, Boston, Mass.

Application July 21, 1936, Serial No. 91,686

16 Claims. (Cl. 170—159)

This invention relates to fans or blowers and relates more particularly to an efficient fan adapted for high speed operation.

In my Patent No. 2,004,516, issued June 11, 1935, there is described a fan wheel provided with blades having flat, radial, main working portions and conoidal inlet portions. The advantages of such blades are that centrifugal forces during rotation are a minimum on all portions of the blades, and the curved inlet portions direct the air entering the blades in smooth flow upon the radial main working portions, providing high efficiency in operation.

The fan or blower of the present invention, represents an improvement over that disclosed by my said patent in that it may be operated at higher speeds for the same head. For a given head, electric motors for driving a fan or blower, are cheaper when designed for high speed operation. Furthermore, steam turbines which are often used for driving fans or blowers, as on ships, are more efficient at high speeds of rotation.

The fan of this invention differs from the fan of said patent in that the radial depth of the working portion of each fan blade decreases, along its delivery portion, towards the back plate of the wheel. The delivery edge of each blade lies along a curve of decreasing radii towards the back plate, the radius at any point on the curve being determined from the formula:

$$\text{Head (constant)} = \frac{w W_n r}{g}$$

Where w=angular velocity.
W_n=rotative velocity component imparted.
r=radius at any given point.
g=acceleration due to gravity.

Every element of each blade lies on a curved surface which is a conoid. A conoid is a surface formed by a straight line generatrix constantly touching two line directrices, one of which is straight and the other curved, and moving parallel to a given plane. In the present case, the generatrix preferably touches a base line which coincides with the axis of the fan wheel, and a curve which is so chosen that the blade is formed as a helix with increasing pitch towards the back plate.

Each blade is provided with a curved inlet portion with substantially a constant radial depth, which serves to pick up the air entering the fan and to deliver it equally upon all portions of the delivery portion of the blade. The delivery portion of each blade is given however, a decreasing radial depth so that the blade works the same amount on each particle of air going through the fan. Thus, a particle of air leaving the delivery edge of the blade at the back plate, is worked upon by the blade the same amount as a particle of air leaving the blade at the opposite extremity of the delivery edge.

The invention will now be described with reference to the drawings of which:

Fig. 1 is a section along a vertical plane through a fan or blower according to this invention, in the form of a roof ventilator;

Fig. 2 is a sectional view along the lines 2—2 of Fig. 1;

Fig. 3 is an exterior view in profile, of the complete roof ventilator;

Fig. 4 is an enlarged profile view of the fan wheel;

Fig. 5 is a sectional view along the lines 5—5 of Fig. 4;

Fig. 6 is a sectional view along the lines 6—6 of Fig. 4, and

Fig. 7 is a geometrical projection illustrating the development of the blades of Fig. 4 as conoidal surfaces.

Figs. 1, 2 and 3 illustrate the general assembly of a fan or blower utilizing the improved fan wheel of this invention. The wheel illustrated generally by 10 has the four curved blades 11. The wheel 10 is mounted on the shaft 12 of the motor 13.

The roof ventilator illustrated is designed for mounting upon the roof of a building and receives air from the interior of the building through the opening 14 in the roof 15 thereof. The casing 16 serves as the fan inlet, and the inlet portions of the blades 11 extend into the casing 16. The casing 16 has a square base and a cylindrical upper portion. The parabolic curves of Figs. 1 and 3 are the lines of transformation. Above the upper edge 17 of the casing 16 and between it and the back plate 18 of the fan wheel, the delivery edges of the blades extend. The back plate 18 turns the air and delivers it as shown by the arrows indicating air flow, of Fig. 1, through an opening 19 in the housing to be deflected by the annular member 20, from the ventilator. The shield 21 serves to protect the motor 13 from the elements.

In the embodiment of the fan wheel illustrated, the hub 22 and blades 11 are cast as an integral unit. The hub 22 tapers from the back plate 18 to its extreme inner portion 23, as illustrated more clearly by Fig. 4. The hub 22 increases rapidly

in diameter as it closely approaches the back plate 18 and its curved outer surface at 25 cooperates in turning the air from the wheel in quiet, efficient flow.

Fig. 7 illustrates the development of one of the blades upon the cylindrical surface of a quadrant of a cylinder. The line AB is the line, along which the lower end of the generatrix line moves while the upper end moves along the curve CD. The successive positions of the generatrix are shown at BC, EF, GH, IJ, and MN. The curve followed by the generatrix is so chosen that the generatrix forms the blade as a helix with increasing pitch towards the back plate.

The line CD of Fig. 7 since lying on the surface of a cylinder, is spaced the same distance from the line AB, at all points. The outer curve of the inlet portion of the blade coincides with the curve along the line CH, but departs from it to follow the line HO along the delivery edge, so as to provide a delivery portion having decreasing depth towards the back plate as determined by the formula.

The lower or base portion of the blade is sloped to fit along the hub 22 of the wheel.

The shaded portion of Fig. 7 illustrates the surface of the blade after it has been shaped to provide a delivery portion having decreasing depth towards the back plate, and to fit along the hub of the wheel. Other characteristics of the blade are: It has a constant radial depth in the entry portions CH; it lies along a surface of a helix having increasing pitch towards the back plate; its delivery edge terminates in a plane transverse to the fan wheel; its inlet edge PC (Figs. 2, 4 and 7) lies along a line passing through the axis of the fan wheel; its delivery edge (Fig. 2) at the back plate terminates in a plane in which the axis of the wheel lies.

Characteristics of the embodiment of the fan wheel illustrated are: The entering edges of opposite blades lies substantially in a plane transverse to the axis of the wheel (Fig. 2). The entering edge of each blade lies in a plane in which the delivery edge of the adjacent blade terminates.

Since all elements of each blade extend in lines radiating from the center line of the shaft, centrifugal forces are a minimum and the fan may be rotated at very high speeds without fear of mechanical failure. The fan is not only very quiet and efficient in operation, but may be easily and economically manufactured.

Whereas one embodiment of the invention has been described for the purpose of illustration, it should be understood that the invention is not to be limited to the exact arrangement described, as many departures may be made by those skilled in the art, after having had access to this disclosure.

What is claimed is:

1. A fan wheel for a centrifugal fan, comprising a back plate, and a plurality of blades having curved delivery portions extending to said back plate and having curved inlet portions, said blades having substantially conoidal surfaces.

2. A fan wheel for a centrifugal fan comprising a back plate, and a plurality of blades having curved delivery portions extending to said back plate and having curved inlet portions, said blades having their surfaces formed substantially as conoids and as helices.

3. A fan wheel for a centrifugal fan, comprising a plurality of blades with inlet portions having substantially constant depths and delivery portions with decreasing depths, and a back plate for turning the air delivered by said blades, said blades joining said back plate at their points of minimum depth.

4. A blade for a centrifugal fan having substantially its entire surface formed as a conoid and with an inlet portion having a substantially constant depth, and with a delivery portion with decreasing depth.

5. A fan wheel for a centrifugal fan, comprising a plurality of blades having their surfaces formed as helices of varying pitch and with inlet portions having substantially constant depths and delivery portions with decreasing depths, and a back plate for turning the air delivered by said blades, said blades joining said back plate at their points of minimum depth.

6. A blade for a centrifugal fan having substantially its entire surface formed as a conoid, as a helix of varying pitch and with an inlet portion having a substantially constant depth and a delivery portion with decreasing depth.

7. A wheel for a centrifugal fan, comprising a back plate, a plurality of helical blades having curved inlet portions for directing air axially into said wheel and having curved delivery portions for delivering air from said wheel at right angles to the axis thereof, attached to said back plate, said blades tapering in radial depth throughout their delivery portions towards said back plate.

8. A wheel for a centrifugal fan, comprising a back plate, a plurality of helical blades having curved inlet and delivery portions attached to said back plate, said blades tapering in radial depth throughout their delivery portions toward said back plate but having inlet portions with substantially constant radial depth.

9. A wheel for a centrifugal fan, comprising a back plate, a plurality of helical blades having curved inlet and delivery portions attached to said back plate, said blades tapering in radial depth throughout their delivery portions towards said back plate but having inlet portions with substantially constant radial depth, all elements of said blades lying in lines extending substantially radial to the center line of the axis of said wheel, said back plate acting to turn the air delivered by said blades.

10. A fan wheel for a centrifugal fan, comprising a pair of oppositely disposed curved blades, the inlet edges of said blades lying in a plane extending substantially transverse the axis of said wheel.

11. A fan wheel for a centrifugal fan, comprising a pair of curved blades, the inlet edge of one of said blades lying substantially in a plane in which the delivery edge of the other of said blades terminates.

12. A fan wheel for a centrifugal fan, comprising a back plate, a plurality of curved blades attached to said back plate, each of said blades having a delivery portion shaped as a helix with decreasing area towards the back plate, said back plate acting to turn the air delivered by said blades.

13. A fan wheel for a centrifugal fan, comprising a plurality of curved blades formed substantially as surfaces of conoids, and as helices, having entry and delivery portions, each delivery portion being so shaped as to act upon the air passing same to provide a constant head across its width.

14. A fan wheel for a centrifugal fan, compris-

ing a plurality of curved blades formed substantially as surfaces of conoids, and as helices of increasing pitch from front to back, having entry and delivery portions, each delivery portion being so shaped as to act upon the air passing same to provide a constant head across its width.

15. A fan wheel for a centrifugal fan, comprising a back plate, a hub, a plurality of blades having curved delivery portions attached to said hub and back plate, said hub being shaped to cooperate with the delivery portions of said blades and with said back plate in turning the air from said wheel.

16. A fan wheel for a centrifugal fan, comprising a back plate, a hub, a plurality of blades having curved delivery portions attached to said hub and back plate, said hub being curved and thickened towards said back plate, so as to cooperate with the delivery portions of said blades and with said back plate in turning the air from said wheel.

HAROLD F. HAGEN.