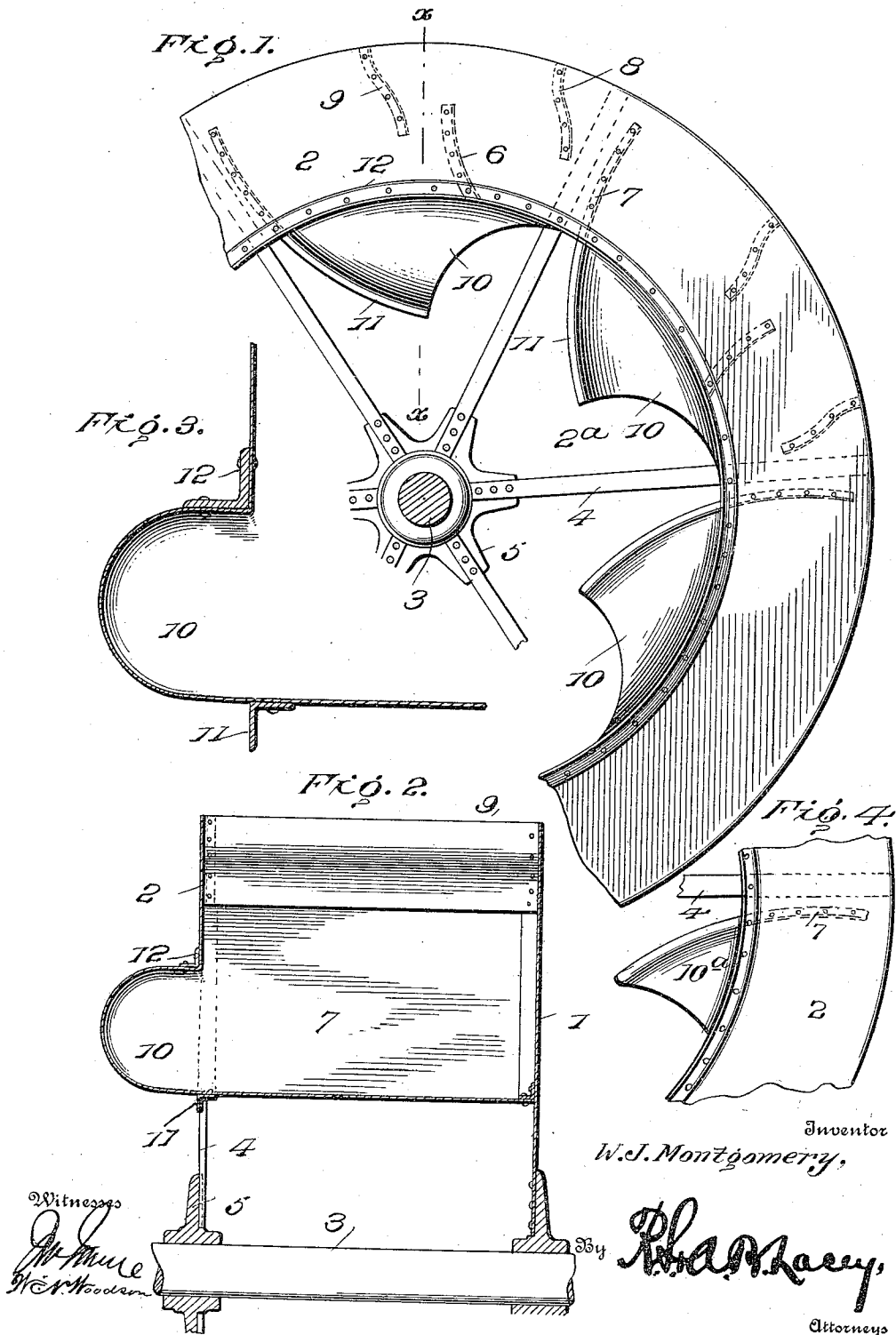


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CENTRIFUGAL FAN.

APPLICATION FILED APR. 2, 1907. RENEWED JULY 23, 1915.

1,174,938.

Patented Mar. 7, 1916.



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UNITED STATES PATENT OFFICE.

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CENTRIFUGAL FAN.

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Specification of Letters Patent.

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To all whom it may concern:

Be it known that I, WILLIAM J. MONTGOMERY, citizen of the United States, residing at Jeannette, in the county of Westmoreland and State of Pennsylvania, have invented certain new and useful Improvements in Centrifugal Fans, of which the following is a specification.

This invention contemplates certain new and useful improvements in centrifugal fans and relates particularly to the construction of the fan wheel.

The primary object of the invention is a fan wheel in which the shape and position of the blades or vanes will impart to the fan a maximum degree of volumetric and manometric efficiency, while, at the same time maintaining a high mechanical efficiency, requiring a minimum of power to rotate it. And a further object of the invention is a fan wheel in which the space provided by the eye of the fan wheel may be decreased according to the requirements of different installations without changing the original diameter of the eye and at the same time provide the wheel with a series of air ducts which will lead the air into the fan in the direction which it passes out between the vanes.

With these and other objects in view as will more fully appear as the description proceeds, the invention consists in certain constructions, arrangements and combinations of the parts which I shall hereinafter fully describe and then point out the novel features and combinations thereof in the appended claims.

For a full understanding of the invention and the merits thereof and also to acquire a knowledge of the details of construction of the means for effecting the result, reference is to be had to the following description and accompanying drawings, in which:

Figure 1 is a side elevation of a portion of a centrifugal fan embodying the improvements of my invention; Fig. 2 is a transverse sectional view thereof on the line $x-x$ of Fig. 1; Fig. 3 is an enlarged detail sectional view of one of the air ducts, and, Fig. 4 is a detail view illustrating a modification.

Corresponding and like parts are referred to in the following description and indicated in all the views of the drawings by the same reference characters.

Referring to the drawings, the numeral 1 designates the drive disk of the fan wheel, 2 its annular complementary disk, and 3 the drive shaft on which said disks are mounted, the annular disk 2 being connected to the shaft by radial braces 4 secured to a spider hub 5. The outer circumferences of the disks 1 and 2 constitute the outermost circles of rotation of the fan wheel. The above named parts are selected for the purpose of illustration only, as my invention does not reside in any shape, construction, or arrangement thereof, and for the same reason I have omitted to show the housing or casing of the fan wheel. The circular opening within the annular disk 2 constitutes the eye 2^a of the wheel.

As above stated, one of the main features of my invention resides in the construction and arrangement of the vanes or blades. I have discovered by repeated tests that in order to obtain the highest degree of volumetric, mechanical, and manometric efficiency, the vanes must be arranged tangential with the radius of the wheel at their extremities, and it will, therefore be seen, with reference to the accompanying drawing, that one set of blades 6 has its outer extremity disposed in such position and curves forwardly or in the direction in which the wheel is intended to rotate and that its inner extremity is set at an acute angle with the radius of the wheel, the angle in the present instance being about fifty degrees. Each blade or vane 6 extends from one disk across to the other and terminates at its inner extremity flush with the circumference of the eye 2^a, and each vane or blade 6 is of an expanse or length approximating two-thirds of the distance between the circumference of the eye and the periphery of the wheel, and terminates inside of the outermost circles of rotation of the wheel. Between every two blades or vanes 6, blades 7 are positioned, such blades, like the blades 6 having their outer extremities set tangentially with respect to the radius of the wheel, but it is to be noted that the

blades 7 project inwardly past the outer circumference of the eye, the inner portions of such blades 7 maintaining substantially the same angular relation or set to the wheel radius as the blades 6. The blades 7 are of such length that they project at their outer ends beyond the outer ends of the blades 6, but terminate short of the periphery of the wheel, *i. e.*, inside of the outermost circles of rotation of the wheel. It will be evident then that the outer edge of each blade 7 is outside of the outer circles of rotation of the blades 6, and that the inner edge of each blade 7 is inside of the inner circles of rotation of the blades 6.

The vanes 8 are set behind the respective blades 7 and extend from the periphery of the wheel inwardly, but terminate short of the circumference of the eye, and said vanes 8 have a compound curve formation, curving toward the blades 7 and producing therewith contracted passages behind every one of such blades.

9 designates similar vanes that are located in spaced relation to the respective blades 6.

From the drawing and the description up to this point, it will be evident that the vanes 7 will carry a much greater volume of air than the vanes 6. Hence I carry the vanes 7 closer to the periphery of the wheel before terminating them. In the operation of the wheel, the discharge of the air over the outer edge of the vanes 7 and the peculiar construction and arrangement of the vanes 8 as above noted cause a contraction of the space between the vanes 7 and 8, and hence the radial flow of air due from the centrifugal action will produce a higher velocity between the vanes 7 and 8 than is obtainable in other positions. Furthermore I have found that the compound curvature of the vanes 8 results in discharging the air in a true radial direction and without any dragging effect upon the wheel. It is evident that the vanes 6 will have a less volume of air to carry and consequently the pressure will be less and I can release the air earlier. For this reason I extend the vanes 6 outwardly from the circumference of the eye a distance of only about two-thirds the distance between said circumference and the periphery of the wheel. By such arrangement, I am enabled to terminate both sets of vanes 7 and 6 before they reach the periphery of the wheel and thereby greatly reduce the weight of the wheel at the periphery and consequently reduce the strain on the supporting parts, as well as effect a reduction of the air travel over the vanes and the consequent reduction of the air friction and in the power required to drive the fan wheel. It is to be distinctly noted that the vanes 8 and 9 will not take up the air

pressure released from the vanes 7 and 6, as I have found by actual tests that the air after being released from the pressure on the vanes will, when unobstructed, travel at a greater velocity than the vanes themselves.

It is well recognized as a fundamental principle of pneumatics that a desideratum in the construction of a centrifugal fan is to form perfect vortexes. The more perfect the vortexes, the more efficient will be the fan. Conversely, if the vanes are pitched forward at their extremities, a diminution in the volumetric and mechanical efficiency will result, while, on the other hand, if the vanes are pitched back at their extremities, the manometric efficiency will be decreased. I believe that the highest efficiency in all of these respects that is capable of being produced results from the arrangement and construction of vanes in my fan wheel, as herein illustrated and hereinbefore specifically described.

My invention is designed particularly for use in connection with mines for forcing air into or out of a mine opening, although it is to be understood that it is also applicable for general ventilating purposes.

Different mines have different mine resistances and in recognition of this fact, it has been the aim of fan builders to meet the different conditions of different mines, and in so doing they are continually compelled to change the diameter of the eye of the fan wheels in order to prevent the air from gushing from the eye at that point of the wheel which is close to the "cut-off", that is, at the point where the air is separated from the fan wheel and its housing.

In order to obviate the necessity of changing the diameter of the eye and, at the same time to increase the efficiency of the fan wheel, I have invented an air duct or funnel which forms another important feature of my invention and which I shall now describe.

A series of cones 10 is secured to the wheel, said cones projecting into the eye and facing in a direction in which the wheel is intended to revolve. In the present instance, these cones are secured in alinement with the inwardly projecting portions of the relatively long blades 7 and are fastened to the curved angle supports 11 for the ends of the blades and to the angle hoop 12 which is secured to the inner circumference of the disk 2. As the fan revolves (in the direction of the dart shown in Fig. 1) these conical air ducts 10 will obviously serve as a means for drawing the air into the fan and in the same direction by which it passes through or between the vanes. Hence, not only do these air ducts assist in the efficiency of the fan, but as they project into the eye, they serve to decrease the area of the eye and

accordingly such area may be decreased to a greater or less extent by the number or size of the air ducts. It is, of course, to be understood that my invention is not limited to any number or size of these ducts, as this will depend upon the predetermined mine resistance to be compensated for or overcome. Hence, these air ducts serve a two fold purpose, to wit, the diminution of the air space in the eye by extending the ducts well around the angle hook 12, thereby preventing a backward flow of air through the eye when encountering a high mine resistance, and second, as a means for grasping the air and conveying it to the vanes in the direction by which it passes through or between them. As illustrated in Fig. 4, the air ducts will obviously be modified at lower mine resistances, as indicated at 10^a, but any modification of the air duct will serve as a means for drawing in and conveying the air to the vanes in the proper direction. Preferably the conical air ducts are formed by the continuation of the vanes 7 laterally, the ducts being sheared off to the proper form and then curved up and around, and riveted to the angle hoop 12 so that their forward portions extend farthest laterally from the disk 2 and then slope backwardly in conical form to the position where the supporting angle strips 11 and angle hoop 12 meet. At this point the vertex of the cone should be flush with the plate or disk 2.

While I have shown my invention as embodied in a fan wheel of the single admission type, it is evident that the single unit may be duplicated whenever desired by mounting a second fan wheel on the same shaft, the two being placed back to back with the drive disk 1 as a partition between them, or, if desired, two units may be so mounted without the intermediate drive disk 1.

While the words "fan" and "fan wheel" have been used throughout the specification, it is to be understood that these words must be taken in their broader significance so as to include a pump.

Having thus described the invention, what is claimed as new is:

1. A fan wheel provided with an eye and two series of blades, the blades of one series being curved so that their outer extremities are tangential to the radius of the wheel and their inner are at an acute angle to such radius, the blades of the other series being similarly curved and projecting into the eye, while the blades of the first named series terminate at the circumference of the eye.
2. A fan wheel provided with an eye and two series of blades, the blades of one series extending from the circumference of the eye outwardly, but terminating short of the periphery of the wheel, the blades of the other

series projecting into the eye and extending outwardly beyond the outer edges of the blades of the first named series, the blades of both series being curved so that their outer extremities are tangential with the radii of the wheel extending through such extremities and their inner extremities are at acute angles to the radii of the wheel extending through such inner extremities.

3. A fan wheel provided with an eye and with two series of curved blades, the blades of one series being longer than the blades of the other series and projecting into the eye, and vanes having a compound curve formation set behind the blades of both series and extending inwardly from the periphery of the wheel and forming contracted passages behind each blade.

4. A fan wheel, provided with an eye and two series of blades, the blades of both series being mounted with their outer extremities tangential to the radius of the wheel and with their inner extremities at an acute angle to the radius of the wheel, the blades of one series extending from the circumference of the eye outwardly and terminating short of the periphery of the wheel, the blades of the other series projecting into the eye and having their outer edges terminating short of the circumference of the wheel, but beyond the edges of the first named series of the blades, and a series of vanes of compound curve formation projecting inwardly from the periphery of the wheel and forming contracted passages behind the respective blades of both series.

5. A fan wheel provided with an eye and with two series of curved blades, the blades of one series being longer than the blades of the other series and projecting into the eye, the blades of the said other series terminating at the eye at their inner ends and short of the outer ends of the first named series, and vanes having a compound curve formation set behind the blades of both series and extending inwardly from the periphery of the wheel and forming a contracted passage behind each blade.

6. A fan wheel provided with an eye and with two series of curved blades, the blades of one series being longer than the blades of the other series and projecting into the eye, the blades of the said other series terminating at the eye at their inner ends and short of the outer ends of the first named series, and vanes having a compound curve formation set behind the blades of both series and forming a contracted passage behind each blade.

7. A fan wheel provided with an eye and with two series of blades, the blades of one series extending from the circumference of the eye outwardly and the blades of the

other series projecting into the eye, said last named blades being provided with lateral cone shaped extensions in registry with the ends of such blades and extending laterally from the wheel at the circumference of the eye.

8. A centrifugal wheel for circulating fluids having a series of principal or main vanes extending inwardly from the peripheral region of the wheel, an intermediate vane located between said main vanes, and a tail-blade back of each of said intermediate vanes, each such blade extending inwardly toward its vane and at a greater angle than such vane, said wheel having an opening at or near the base of the blade leading into the space between the blade and vane.

9. A centrifugal wheel for circulating fluids having a series of principal or main vanes extending inwardly from the peripheral region of the wheel, an intermediate vane located between said main vanes, and a tail-blade back of each of said main vanes and each of said intermediate vanes, each such blade extending inwardly toward its vane and at a greater angle than such vane, said wheel having an opening at or near the base of the blade leading into the space between the blade and vane.

10. A centrifugal wheel for circulating fluids having a series of principal or main vanes extending inwardly from the peripheral region of the wheel, an intermediate vane located between said main vanes and extending from the air-inlet circle toward the periphery, and a tail-blade back of each of said main vanes and each of said intermediate vanes, each such blade extending inwardly toward its vane and at a greater angle than such vane, said wheel having an opening at or near the base of the blade leading into the space between the blade and vane.

11. A centrifugal wheel for circulating fluids having a series of principal or main vanes extending inwardly from the peripheral region of the wheel, an intermediate vane located between said main vanes and extending from the inlet circle toward the periphery, and a tail-blade back of each of said main vanes and each of said intermediate vanes, each such blade extending inwardly toward its vane and at a greater angle than such vane, said wheel having an opening at or near the base of the blade leading into the space between the blade and vane.

12. The combination in a fan wheel having a circular eye, of a series of scoops projecting laterally from the wheel at the eye, a series of air-throwing blades each extending backward from a scoop and terminating at a point a short distance from the wheel periphery, and a series of air-throwing blades,

each situated between two of the aforesaid blades and extending radially outward from a circle of rotation between the circles of rotation of the inner and outer edges, respectively, of the aforesaid blades, to the wheel periphery the spaces between the blades of the first series being unobstructed along the circle of rotation of the outer edges of the blades except for the respective blades of the said second series.

13. A fan wheel having a series of rotating blades each of which has its outer edge situated inside of the outermost circles of rotation of the wheel and a second series of blades each of which has its outer edge in the outer circles of rotation of the wheel and its inner edge inside of the outer circles of rotation of the blades of the aforesaid series, and situated relatively nearer to one of the blades of the first mentioned series mounted next ahead of it in the direction of rotation, than to the one behind it the spaces between the blades of the first series being unobstructed along the circle of rotation of the outer edges of the blades except for the respective blades of the said second series.

14. A fan wheel having a series of rotating blades each of which has its outer edge situated inside of the outermost circles of rotation of the fan wheel and a second series of blades set behind the blades of the first mentioned series, each blade of said second series having its outer edge in the outer circles of rotation of the wheel and having an ogee curve formation.

15. A fan wheel having a series of rotating blades each of which has its outer edge situated inside of the outermost circles of rotation of the fan wheel and a second series of blades set behind the blades of the first mentioned series, each of said second series having its outer edge in the outer circles of rotation of the wheel and so shaped and situated as to form an inwardly tapering passage behind each blade of the first mentioned series the spaces between the blades of the first series being unobstructed along the circle of rotation of the outer edges of the blades except for the blades of the said second series.

16. A fan wheel having a series of rotating blades each of which has its outer edge situated inside of the outermost circles of rotation of the fan wheel and a second series of blades each of which has its outer edge in the outer circles of rotation of the wheel and approximately tangential to the radial plane of the wheel and its inner edge inside of the outer circles of rotation of the blades of the aforesaid series, and approximately tangential to a radial plane of the wheel in front of the aforesaid radial plane.

17. A fan wheel having a series of rotat-

ing blades included between two planes
transverse to the axis of the wheel, and a se-
ries of rotating conical air duct casings
mounted laterally outside of the aforesaid
transverse planes, each being so shaped that
it merges tangentially with a cylindrical sur-
face of rotation containing its apex.

In testimony whereof I affix my signature
in presence of two witnesses.

WILLIAM J. MONTGOMERY. [L. S.]

Witnesses:

A. B. MULL,
FRANK F. MULL.

Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents,
Washington, D. C."