W. CLIFFORD.

VENTILATING APPARATUS.

APPLICATION FILED JULY 27, 1906.

963,277.

Patented July 5, 1910.

2 SHEETS—SHEET 1.

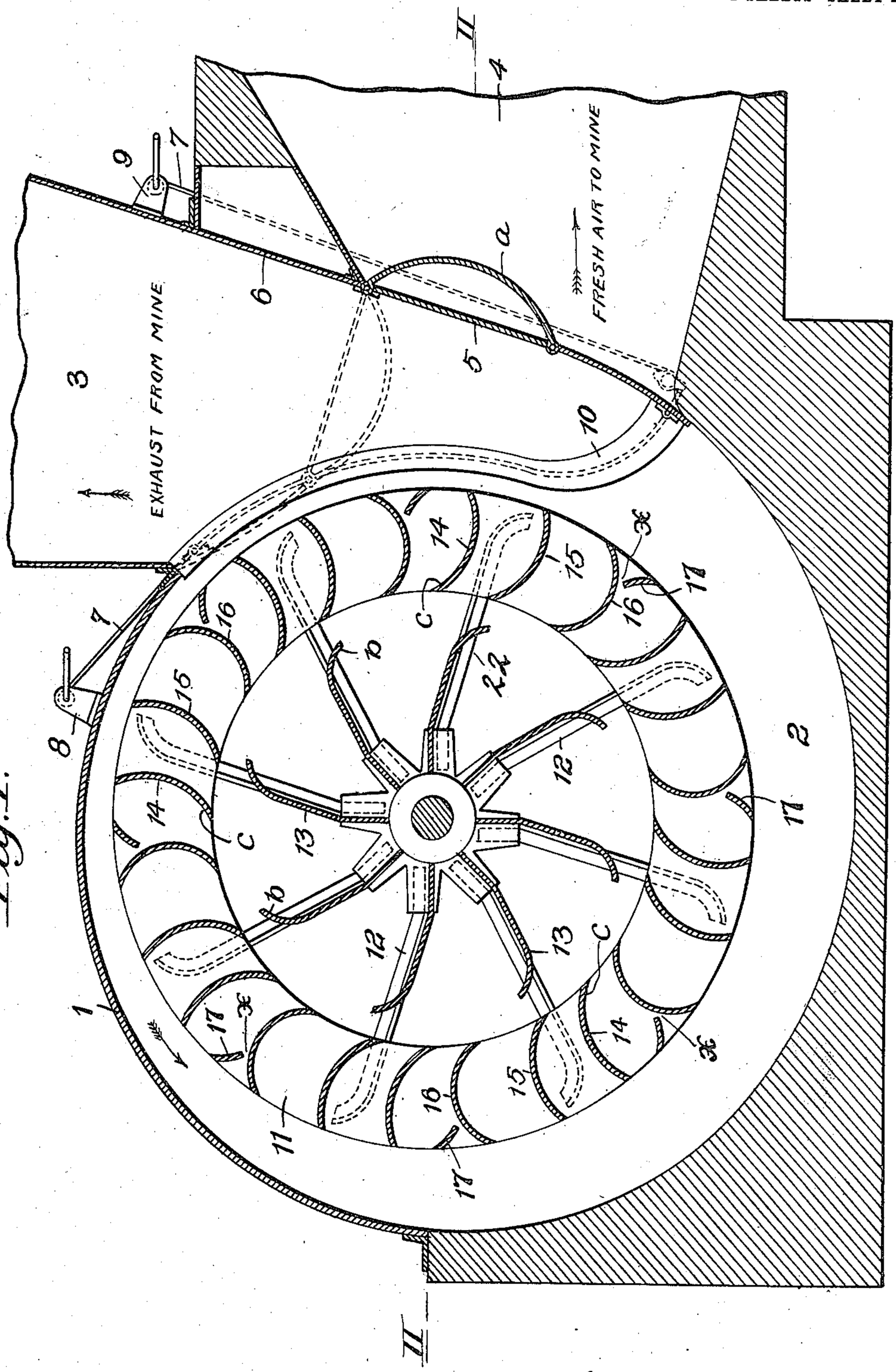

Fig. 1.

WITNESSES:

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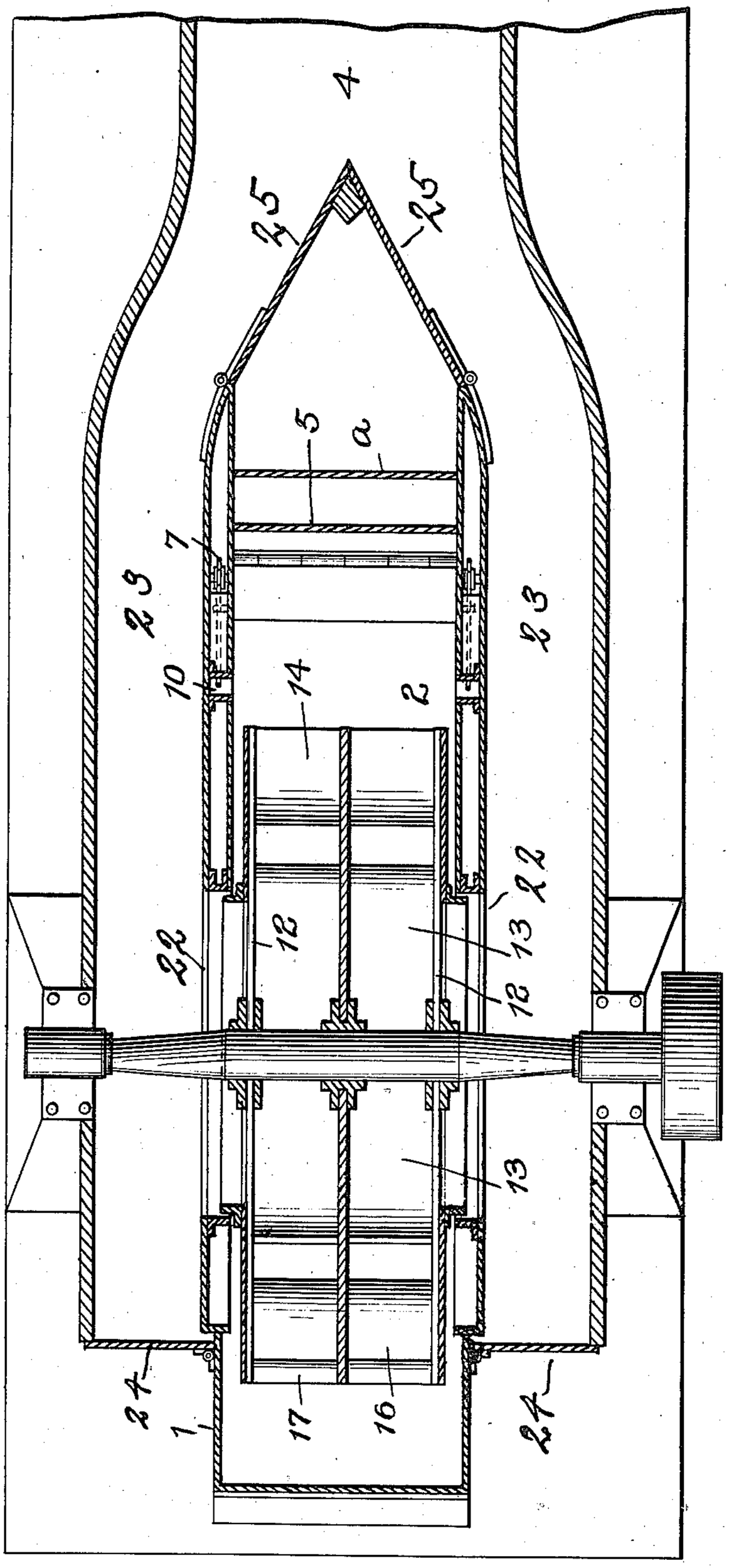
2 SHEETS—SHEET 2.

FIG. 2.



WITNESSES:

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UNITED STATES PATENT OFFICE.

WILLIAM CLIFFORD, OF JEANNETTE, PENNSYLVANIA.

VENTILATING APPARATUS.

963,277. Specification of Letters Patent. Patented July 5, 1910.

Application filed July 27, 1906. Serial No. 328,092.

To all whom it may concern:

Be it known that I, WILLIAM CLIFFORD, residing at Jeannette, in the county of Westmoreland and State of Pennsylvania, a citizen of the United States, have invented or discovered certain new and useful Improvements in Ventilating Apparatus, of which improvements the following is a specification.

The invention described herein relates to certain improvements in mechanism for ventilating mines, etc., and has for its object a construction and combination of fan blades whereby internal resistance to the movement of the air through and out of the fan is so reduced that the movement from the fan is practically as free as the inflow.

It is a further object of the invention to so construct the delivery passages and their controlling door as to facilitate the movement of the air therethrough.

The invention is hereinafter more fully described and claimed.

In the accompanying drawings, forming a part of this specification, Figure 1 is a sectional elevation of my improved ventilating mechanism, showing the fan, casing and passages leading therefrom and Fig. 2 is a sectional plan view on the plane indicated by the line II—II Fig. 1.

In the practice of my invention the casing 1 is provided with openings 22 in its sides adapted to be connected by chambers or channels 23 either with the atmosphere or with the entrance 4 to mine or other space to be ventilated as the operator may desire, so that fresh air may be forced into the mine or foul air drawn therefrom. The flow of fresh air into these chambers is controlled by doors 24 and the flow of foul air from the mine into the same chambers is controlled by doors 25. The fan which is of the centrifugal type is so arranged in the casing that a tapering spiral passage is formed between the periphery of the fan and the casing. This spiral delivery chamber 2 is adapted to be connected either with the passage 3, usually termed the chimney, for receiving and conducting away the foul air from the mine, or with the delivery passage 4, whereby fresh air may be conducted to the mine. These passages 3 and 4 are arranged at or nearly at right angles to each other, and each has a wall which is tangential or approximately tangential to the wall of the casing. The flow of air from the fan to one or the other of these passages is controlled by a door or valve 5, so arranged as to be capable of being moved from a position across the throat of one passage to a position across the other passage.

In order to provide a restricted throat for the fresh air passage 4, a curtain wall 6 extends down from the upper wall of said passage forming a part of outer wall of the chimney 3. A further restriction of the passage 4 is formed by a swell or upward projection *a* on the lower wall of the passage 4, at or near the junction of said passage with the casing. The door or valve 5 is hinged to the lower end of the curtain wall 6 and when in position across the throat of the fresh air passage 4, forms a continuation of the wall of the casing. In order that this door may be swung to position to close the chimney, the door is made flexible or in two or more sections hinged together so that it may be bent or partially folded so that it can swing past the fan. The lower section of the door is connected to a rope 7 having its ends secured to the drums of winches 8 and 9, whereby the door can be shifted from one position to the other. The lower section is provided at its free end with arms projecting into reversely curved guide grooves 10, which extend from the lower wall of the fresh air passage to the inner wall of the chimney. In shifting the door from the position shown to the position indicated by dotted lines, the free end of the lower section is moved along the guides and after it has reached a position at right angles to the upper portion of the door, the latter begins to swing. When the door 5 stands in the position shown in full lines in Fig. 1, it will be understood that doors 24 and 25 stand closed, as indicated in Fig. 2. The fan is then in position to operate as an exhaust fan, drawing air from the mine or other place to be ventilated and expelling it through the chimney. When door 5 is shifted to the position indicated by dotted lines in Fig. 1, and doors 24 and 25 are opened, the fan is in position to operate as a blowing fan, receiving air from the atmosphere and forcing it to the mine or other place to be ventilated.

It will be observed that the projection of

the curtain wall 6 into the passage 4 forms in the rear of said wall a recess or pocket opposite or nearly opposite, the swell or projection *a* in the lower wall of the passage. By this construction of the walls the formation of eddy currents is prevented.

The annular plates 11 of the fan are secured to the radial arms 12 extending from the hub. Inner wings 13 are secured to the arms and extend from the hub to or nearly to the inner peripheries of the annular plates. In order to facilitate the radial delivery of the air, the radial arms 12 and the wings 13 carried thereby are bent back from the direction of rotation of the fan.

Outer wings 14, 15, 16 are arranged between the annular plates 11 and have a radial length equal or approximately equal to the width of said plates.

In addition to the general backward inclination of the wings 13 the outer edges thereof are given a further backward inclination forming lips *b* of openings for the backward flow of the air, the other lips *c* of said openings being formed by the lower edges of the opposite outer wings 14, said lips being approximately parallel, and so shaped as to direct air passing between them into the openings in front of the wings 15 and 16. The wings 14, 15 and 16 extend in curved planes from the inner to the outer perimeters of the annular plates. These wings may have the same curvature, or may vary in curvature, the curvature of the wings 16 being the greatest.

It will be observed that the inner and outer wings 13 and 14 are so shaped and arranged in such relation to each other, the wings 14 being somewhat in advance of the wings 13, that the streams of air flowing through the openings between the wings will form an acute angle with radii of the fan. In case the wings 13 and 14 were made continuous, the air delivered by the portions of such continuous wings within the eye of the fan, would have the greatest compression immediately in front of the outer portions of such continuous wings, the compression decreasing rapidly toward the next forward outer wing and becoming very attenuated immediately in the rear of the outer portion of the next anterior continuous wing. By forming an opening between the inner and outer wings, a portion of the air caught by each inner wing 13 will be delivered in the rear of the corresponding outer wing 14, and the delivery of air from the spaces between adjacent outer wings will be approximately uniform at all points.

It will be observed that in one position the door or valve forms a continuation of one wall of the chimney, and when in its alternate position the inner or upper section forms a continuation of the upper wall of the passage 4, the other section forming an extension of the peripheral wall of the casing. The upper section of the door is provided with a swell or enlargement which can be varied in height to suit the duty required of the fan.

In order to prevent the formation of a partial vacuum in the rear of the outer wings whereby an inward pull would be exerted on the air in the spiral passage between the casing and the fan, plates 17 are arranged in rear of the outer wings and in such relation thereto as to form passages *x* through which air will flow outwardly along the back of the preceding wing preventing the formation of a vacuum. Jets of air will pass under pressure through the openings *x* along the backs of the outer wings and thereby prevent the formation of a vacuum and a consequent eddying of the air in the rear of the outer ends of the wings.

By reason of the greater flow of air out along the rear faces of the wings 14, resulting from the openings between inner and outer wings 13 and 14, the blast of air produced by the arrangement of the blade 17 is more efficient to prevent the formation of eddies in the rear of wings 14.

I claim herein as my invention:

1. A centrifugal wheel for circulating fluids, having a series of vanes extending inwardly from the periphery and blades back of the vanes, each such blade extending inwardly toward its vane and at a greater angle from the radius than such vane, said wheel having an opening at or near the inner end of the blade leading into the space between the blade and vane.

2. A centrifugal wheel for circulating fluids, having a series of vanes extending inwardly from the periphery, and blades back of the vanes, each such blade extending inwardly toward its vane and at a greater angle from the radius than such vane to a point between the inlet and the periphery, said wheel having an opening at or near the inner end of the blade leading into the space between the vane and blade.

3. A centrifugal wheel for circulating fluids, having a series of vanes extending inwardly from the periphery, and blades back of the vanes, each such blade extending inwardly toward its vane and at a greater angle from the radius than such vane, said wheel having an opening at the inner end of said blade communicating with the space between the vane and blade.

4. A centrifugal wheel for circulating fluids, having a series of vanes extending inwardly from the periphery, and blades back of the vanes, each blade extending from the periphery inwardly toward its vane and at a greater angle from the radius than such vane to a point between the inlet and the periphery, said wheel having an opening at the

inner end of said blade communicating with the space formed between the vane and the blade.

5. A centrifugal wheel for circulating fluids, having a tail-blade fitted at the back of a vane, which blade diverges from the vane as reckoned from the inner to the outer edge, a space interval being provided between the inner edge of the blade and the adjacent portion of the surface of the vane.

6. A centrifugal wheel for circulating fluids, having a series of vanes extending inwardly from the periphery, and blades back of said vanes, each such blade extending inwardly toward its vane and at a greater angle from the radius than such vane and terminating short of the inner end of the vane and leaving an opening between the inner end of the blade and the vane.

7. A centrifugal wheel for circulating fluids, having a series of vanes extending inwardly from the periphery and concave in the direction of rotation, and blades back of the vanes, each such blade extending inwardly toward its vane and at a greater angle from the radius than such vane and terminating short of the inner end of the vane and leaving an opening between the inner end of the blade and the vane.

8. A fan having in combination two plates, one having a central opening or eye, a series of inner wings extending from the hub of the fan toward and terminating short of the inner periphery of the eye or opening in said plate, and a corresponding series of radial outer wings each having its inner end at a greater distance from the center of the fan than the outer end of the corresponding inner wing, thereby providing openings for the rearward discharge of air between adjacent ends of the inner and outer series of wings.

9. A fan having in combination two plates, one having a central opening or eye, a series of inner wings extending from the hub of the fan toward the periphery of the annular plate, a series of outer radially arranged wings extending from the inner periphery of the annular plate outwardly, the outer wings being in advance of the inner wings, and each of the outer wings having its inner end at a greater distance from the center of the fan than the outer end of the corresponding inner wing, thereby providing openings between adjacent ends of the inner and outer wings for the backward discharge of air at an angle to the radii of the fan.

10. A fan having in combination a series of wings extending outward from the eye or inlet of the fan toward the periphery of the fan, and plates in the rear of said wings, and so arranged relative to adjacent wings that the opening between such plates and the next forward wing is materially less than the spaces between such plates and the next wing in the rear, whereby an eddy-destroying flow of air may be formed in the rear of such wings.

11. In a fan a wing construction including a wing extending outward from the eye of the fan toward the periphery and a plate arranged rearward of said wing and so arranged relative to adjacent wings that the opening between such plate and the next forward wing is materially less than the spaces between such plate and the next wing in the rear, whereby an eddy-destroying flow of air is produced in the rear of such wings.

12. In a fan a wing construction including a wing extending outward from the eye of the fan toward the periphery and a plate so arranged rearward of the wing as to diverge therefrom outwardly and in such relation to the wing as to form an opening between the blade and wing in the rear of the latter, whereby an eddy-destroying flow of air is produced in the rear of the wing.

13. In a fan a wing construction including a curved wing extending outward from the eye of the fan toward the periphery, and presenting its concave face toward the direction of rotation and a plate arranged rearward of the wing and in such relation to the wing as to form an opening between the wing and the blade in the rear of the latter whereby an eddy-destroying current or flow of air will be produced along the rear face of such wing.

14. A fan having in combination a shaft provided with radial arms, an annular plate carried by said arms, a series of wings extending from the shaft toward the inner periphery of the annular plate and a corresponding series of outer radial wings, each having its inner end at a greater distance from the center of the fan than the outer end of the corresponding inner wing, thereby providing openings for the rearward discharge of air between adjacent ends of the inner and outer wings.

15. A fan having in combination a series of inner wings arranged at an angle to the radii of the fan and a corresponding series of substantially radial concavo convex outer wings arranged with their concavity in the direction of rotation of the fan, said wings being so arranged relative to each other as to provide openings between them, adapted to discharge air backwardly at an acute angle to the radii of the fan to permit of a free radial discharge of air in front of the outer wings from the front faces of the corresponding inner wings.

16. A fan having in combination a series of backwardly-inclined inner wings, a corresponding series of concavo convex outer wings arranged in such relation to the inner wings as to form openings for the backward discharge of air at an angle to the radii of

the fan, the main series of inner and outer wings having such relative positions that the outer wings will permit a free radial flow of air in front of them from the front faces of the corresponding inner wings.

17. In a fan two series of radially arranged wings, the wings of one series being in line or approximately in line with the wings of the other series, in combination with a series of wings arranged between adjacent wings of the outer series and plates arranged in the rear of and in such relation to adjacent outer wings that openings between such plates and the adjacent forward wings are materially less than the spaces between such plates and wings in the rear, whereby eddy destroying currents of air are produced in the rear of such wings.

18. A centrifugal fan apparatus having in combination two passages extending in tangential directions from the frame or casing, and a flexible door conforming when in one position to a wall of one of the passages, and when in its other position to a wall of the other passage, said doors being provided with a swell extending into one passage when the door is in position to close the other passage, substantially as set forth.

19. A cylindrical fan including in its construction a cylindrical wheel open at its periphery and provided with a centrally arranged inlet or eye, a wing construction including a wing extending from the eye of the fan outward toward the periphery, and a wing extending from the hub outward toward the first-named wing, said wings being arranged to form a space between their adjacent ends for the backward escape of air.

20. In a centrifugal wheel for propelling fluids, the combination with a wing extending inward in substantially radial direction from the periphery to the eye of the wheel, of a plate arranged rearward of the tip of said wing and extending inward from the periphery of the wheel to a point intermediate the periphery and eye, and separating from the main flow of fluid rearward of said wing the space at the tip of the wing in which an eddy would otherwise be formed, said plate being separate from and spaced at an interval from the rear surface of the wing and forming therewith a passage for an eddy-preventing jet of fluid, substantially as described.

In testimony whereof, I have hereunto set my hand.

WILLIAM CLIFFORD.

Witnesses:

CHARLES BARNETT,

J. HERBERT BRADLEY.