

W. CLIFFORD.  
VENTILATING APPARATUS.  
APPLICATION FILED MAR. 23, 1909.

963,278.

Patented July 5, 1910.

4 SHEETS—SHEET 1.

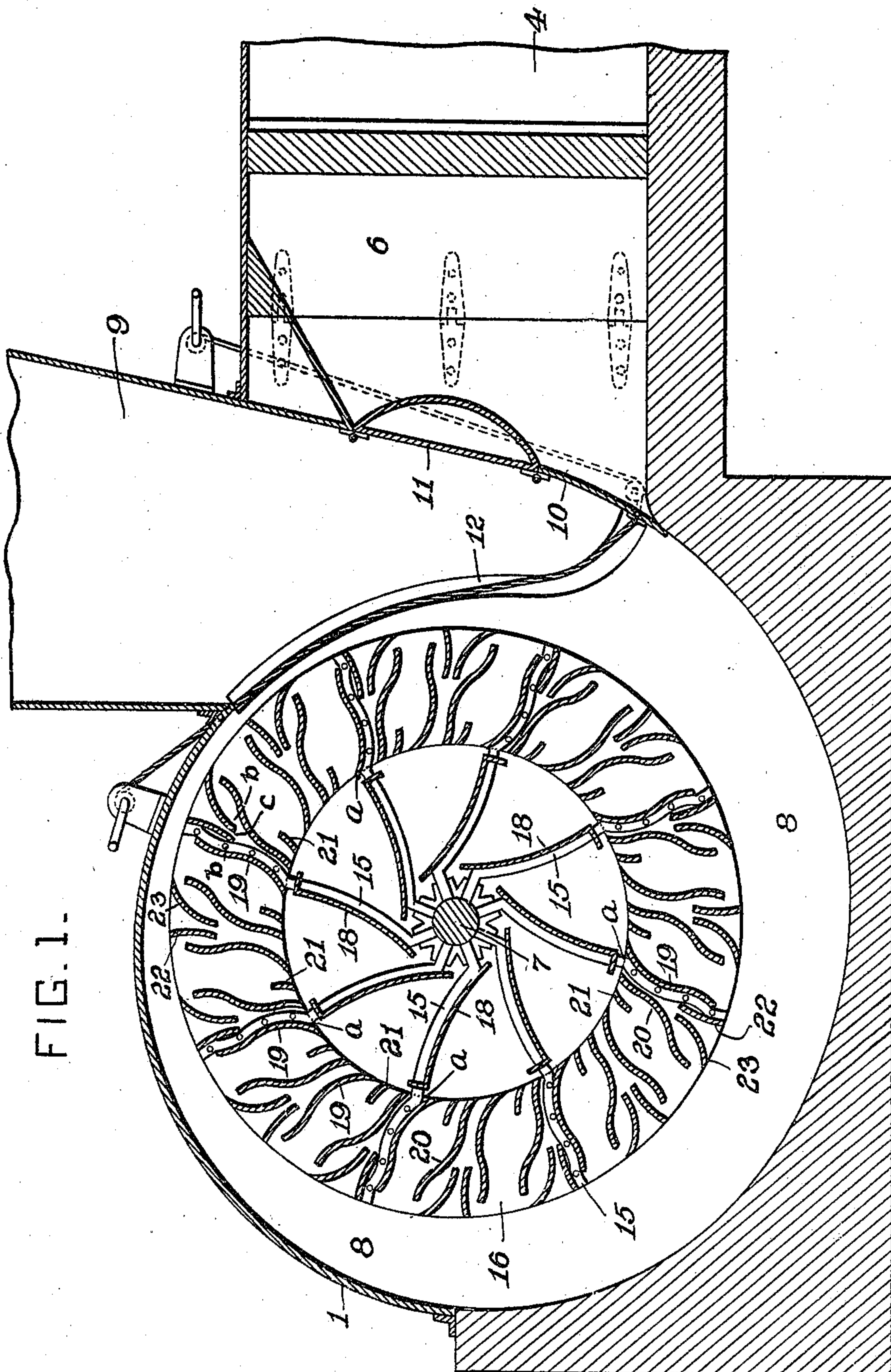


FIG. 1.

WITNESSES:

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*Charles Barnard*

INVENTOR

*William Clifford*  
*by Christy and Christy*  
Atty's



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4 SHEETS—SHEET 2.

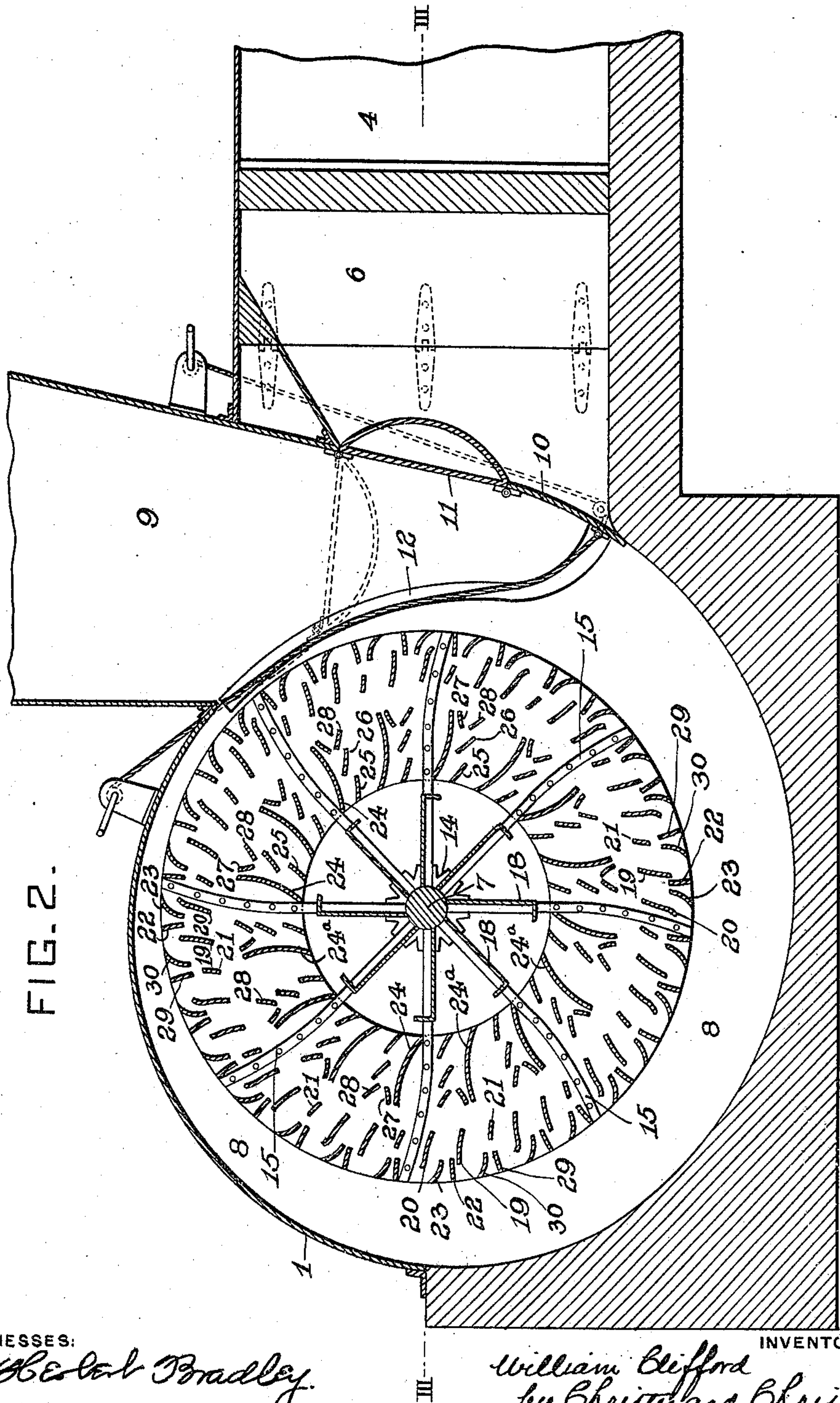


FIG. 2.

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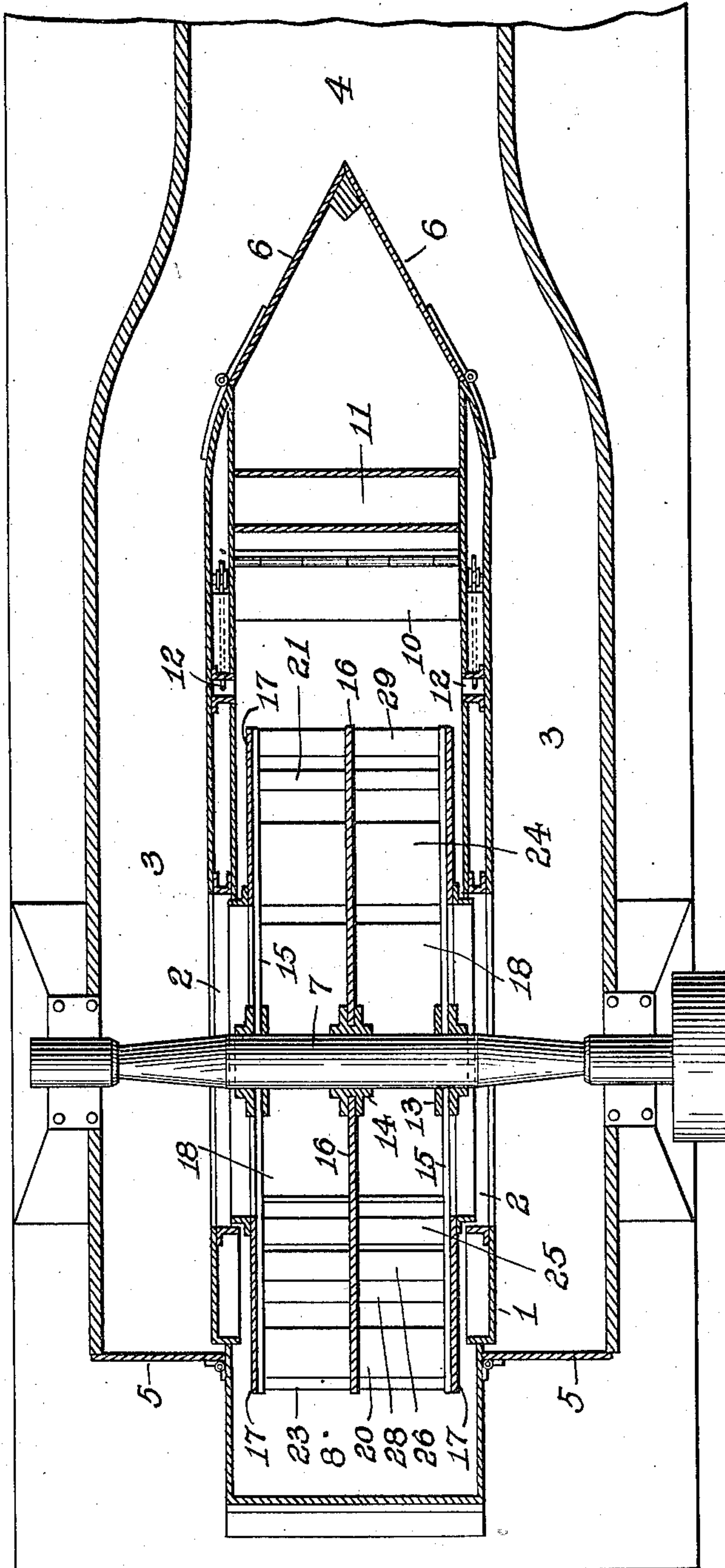
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4 SHEETS—SHEET 3.

FIG. 3.



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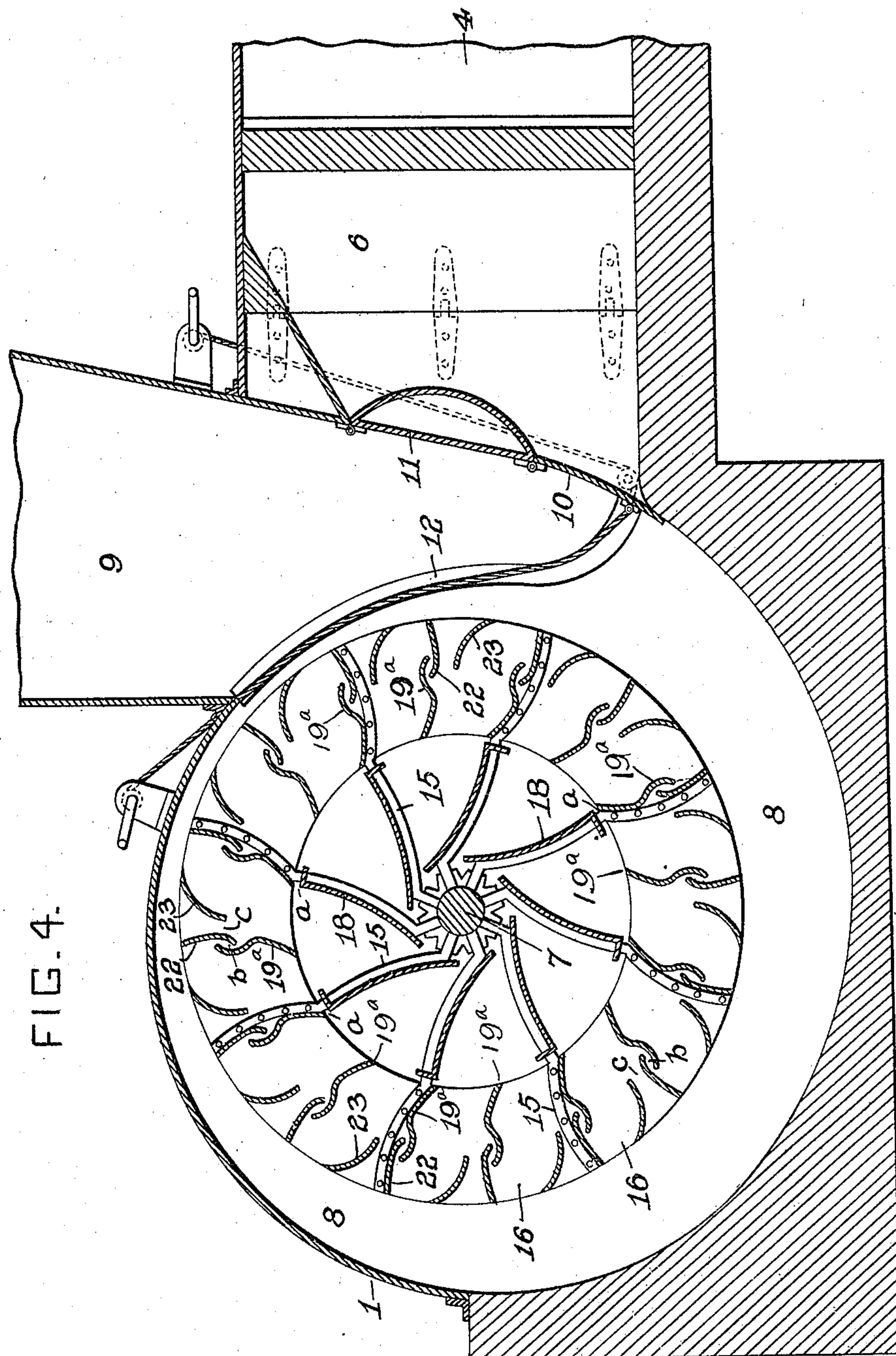


FIG. 4.

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# UNITED STATES PATENT OFFICE.

WILLIAM CLIFFORD, OF JEANNETTE, PENNSYLVANIA.

VENTILATING APPARATUS.

Specification of Letters Patent.

Patented July 5, 1910.

963,278.

Application filed March 23, 1909. Serial No. 485,230.

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 fans for ventilating mines, etc., and has for its object a construction and arrangement of vanes whereby the formation of eddies is prevented and the general efficiency of the fan increased.

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 fan arranged in a suitable casing with doors, etc., whereby the fan may be employed for forcing air into a mine or withdrawing it therefrom; Fig. 2 is a similar view of a double or high service fan embodying my improvements; Fig. 3 is a sectional plan view on a plane indicated by the line III—III Fig. 2, and Fig. 4 is a view similar to Fig. 1 illustrating a modification of the construction shown in said figure.

In the practice of my invention the fan is arranged in a casing 1 having openings 2 into side chambers or channels 3 which communicate at their respective ends with the mine entrance 4 and with the air. The flow of fresh air into these chambers is controlled by doors 5, and the flow of foul air from the mine into the same chambers is controlled by doors 6. The fan is mounted on a shaft 7 mounted concentrically with the openings 2 through which air is drawn from the chambers into the center of the fan, and peripherally discharged into the spiral passage 8 between the periphery of the fan and casing 1. This spiral passage communicates with the mine and with a chimney 9. The flow of air from the chamber is controlled by a sectional valve or door 10, 11, fully described and claimed in an application Serial No. 328,092, filed by me July 27, 1906. This door, which is arranged in the casing, is adapted to be shifted from a position transverse of the chimney to a position transverse of the connection of the spiral passage 8 with the mine entrance 4. The flow of air

from the passage 8 into the mine is also controlled by the doors 6 as will be seen by reference to Figs. 1, 2 and 3. As shown in said application the sections 10, 11 of the door or valve are hinged together and the section 10 moves in guide ways 12.

The shaft 7 has hubs 13—14 and a disk 16, secured thereto, the disk 16 being intermediate of the hub. Annular plates or disks 17 are attached to the arms 15 which have their inner ends secured to the hubs, the internal diameter of said plates 17 being equal or approximately equal to the diameters of the openings 2 in the casing. The arms 15 may be radial as shown in Fig. 2 or curved backward from the direction of rotation as shown in Figs. 1 and 4. The inner wings 18 which are secured to the arms 15 and intermediate disk 16 may be radial, but preferably curve backward from the direction of rotation to facilitate the radial delivery of the air drawn into the fan. Outer wings 19 and 20 are arranged between the annular plates 17 and the intermediate disk 16. The wings are preferably formed with opposite curvatures, the wing 19 having its inner portion concave and outer portion convex in the direction of rotation, while the wing 20 forming the other member of the pair, as these wings may be conveniently termed, has its inner portion convex and its outer portion concave in direction of rotation of the fan. It will be observed that these are not strictly radial but incline from their inner ends back from the direction of rotation of the fan. The amount of inclination may be varied as can also the curvature of the wings, which can be made straight. The wings comprising a pair are preferably arranged more nearly adjacent to each other than the pairs of wings, and these pairs are so spaced relative to the inner wings 18 that air is mainly directed by the latter between the members of alternate pairs of outer wings. The pair of outer wings in the rear of the inner wings should be preferably arranged in such relation to the inner wings that air flowing back over the outer ends of these wings 18 will be delivered into the spaces between pairs of wings 19, 20 and between adjacent pairs of wings. It will be observed that the inner wings do not extend to the circle passing through the inner ends of wings 19, 20, but have their outer ends bent back to form passages or



openings *a* through which air can pass to the spaces between wings in the rear of wings 19.

As shown in Fig. 4 one member of each pair of the outer wings may be omitted, preferably the rear wing 20. In this construction, the inner wings 18 are arranged in such relation to alternate outer wings 19<sup>a</sup>, that the greater volume of air delivered by the inner wings 18 will flow along the front face of the wings 19<sup>a</sup>. A part of the air will however pass through the spaces between adjacent wings 19<sup>a</sup>. Pilot wings 21 may be arranged between adjacent wings 19<sup>a</sup> or adjacent pairs of wings 19, 20.

In order to avoid the formation of eddies in the rear of wings 19, the spaces between adjacent wings 19<sup>a</sup>, and between the wings 19—20 of the pairs, two vanes 22—23 are arranged in the rear of wings 19<sup>a</sup>, as shown in Fig. 4, and extend into the spaces between pair of wings 19—20, as shown in Figs. 1 and 2. The vanes are arranged in V-shaped relation to each other having their inner ends most closely adjacent but not contacting, thus affording openings for the outward flow of air. The vanes are also arranged in such relation to the outer portions of the wings 19 and 20, that air passing along the rear faces of the wings 19<sup>a</sup> and the front faces of the wings 20, will flow rapidly through the passages *c*. The passages or gullets *b* and *c* will create radial blasts or currents flowing out radially, thus preventing the formation of retarding eddies.

For high pressures, the fans are constructed with two or more series of wings one outside of the other as shown in Fig. 3. The outer series of wings and vanes and also the inner wings are preferably constructed and arranged as in the construction shown in Fig. 2. The main wings 24, 24<sup>a</sup> of the intermediate series are so arranged that alternate wings 24 have their inner ends in or approximately in line radially with the outer ends of the wings 18 while the other wings 24<sup>a</sup> are arranged approximately half way between the wings 24. Pilot wings 25 and 26 are arranged between the wings 24 and 24<sup>a</sup> and provision is made for breaking up eddies by vanes 27 and 28 arranged in V-shape relation to each other in the rear of wings 24, 24<sup>a</sup> and have spaces or openings between their inner ends to permit a blast of air through between them. The vanes 27 adjacent to and in the rear of wings 24 and 24<sup>a</sup>, are arranged in such relation to the latter, as to form therewith outwardly contracting passages through which air will flow as a blast or jet preventing the formation of eddies.

As shown in Fig. 2 vanes 29 and 30 may be arranged in V-shaped relation to each other between adjacent pairs of wings 19

and 20, openings or gullets being provided at their inner ends to permit of the formation of a blast of air which will prevent the formation of eddies between the pairs of wings. It will be observed that this gullet between the vanes 29, 30 is in line or approximately in line radially with the pilot wing 21, which is adapted to direct a portion of the air flowing outwardly between the pairs of wings 19, 20, forward toward the gullet between vanes 29 and 30.

In application Serial No. 328,092 is shown and described a construction in which a space is provided between the inner and outer wings for the backward flow of air across the outer end of the inner wing and also a construction in which a vane or auxiliary wing is arranged in such relation to the main outer wing as to form a passage in the rear of the main wing to cause the formation of a blast or jet to prevent the formation of or entirely destroy when formed any eddies produced by the wing.

I claim herein as my invention:

1. A fan having in combination an inner series of wings, two series of outer wings having an inclination away from the direction of rotation; the inner and outer series of wings being so constructed and arranged as to provide openings between adjacent ends of the inner and outer series; the wings of the inner series arranged with their outer ends in or approximately in line radially with the inner ends of alternate wings of one of the outer series.

2. A fan having in combination an inner series of wings, two series of outer wings having an inclination away from the direction of rotation, and vanes in the rear of the outer series arranged adjacent to the periphery of the fan and adapted in connection with adjacent wings to produce blasts or streams of air whereby the formation of eddies in the rear of the main wings is prevented.

3. A fan having in combination a series of inner wings, a series of pairs of outer wings, the inner wings having their outer ends in line or approximately in line radially with the inner ends of a portion of the outer wings.

4. A fan having in combination a series of inner wings, a series of pairs of outer wings, the inner wings having their outer ends in or approximately in line radially with the inner ends of a portion of the outer wings, and having their outer ends separated a distance from the inner ends of the outer wings, thereby forming openings for the backward flow of air between the inner and outer series of wings.

5. A fan having in combination a series of inner wings, a series of pairs of outer wings and pairs of vanes arranged between and at an angle to the pairs of outer wings,



and having openings or spaces between the inner ends of each pair.

6. A fan having in combination a series of inner wings, and two series of outer wings, the adjacent wings of the two series being so arranged relative to each other that the passage between them gradually increases in width toward the periphery of the fan, and vanes arranged between said adjacent wings and oppositely inclined relatively to such wings and to each other.

7. A fan having in combination a series of inner wings, a series of outer wings, vanes arranged between the outer wings and at an angle to the outer wings and to each other, thereby forming V-shaped spaces and pilot wings arranged in or approximately in line radially with the apices of the spaces formed by the vanes.

8. A fan having in combination a series of inner wings, two series of reversely curved wings extending from the inlet the wings of the two series being oppositely arranged and vanes arranged in V-shaped relation to each other between the two series of outer wings so that the wider portion of the space between the vanes will be toward the periphery of the fan.

9. In a centrifugal fan, a wing construction including a wing extending outward from the eye of the fan toward the periphery and a vane arranged rearward of said wing adjacent to the outer end of the latter and forming with said wing, a passageway for air along the rear surface of said wing, said passageway contacting outwardly with substantial uniformity, substantially as described.

10. In a centrifugal fan, a wing construction including a wing extending outward from the eye of the fan toward the periphery, a vane arranged rearward of said wing adjacent to its outer end and spaced therefrom to form a passageway for air along the rear surface of said wing, and a second wing arranged rearward of the first and ex-

tending outward from the eye of the fan and arranged to form with the first wing a passageway through which air is fed to the passageway formed by the vane and first wing, substantially as described.

11. In a centrifugal fan, a wing construction including a wing extending outward from the eye of the fan toward the periphery and inwardly converging vanes arranged rearward of said wing and adjacent to its outer end, one of the vanes forming with said wing a passageway for air flowing over the rear surface of said wing, substantially as described.

12. In a centrifugal fan, a wing construction including a wing extending outward from the eye of the fan toward the periphery, and vanes arranged rearward of said wing and adjacent to its outer end, said vanes diverging outwardly, and the inner ends of said vanes being separated to form a passage for the outward flow of air, substantially as described.

13. In a centrifugal fan, a wing construction including a pair of wings extending outward from the eye of the fan toward the periphery and forming between them a passageway for air, and outwardly diverging vanes arranged adjacent to the outer ends of said wings, the inner ends of the vanes lying in the passageway between said wings, substantially as described.

14. In a ventilating fan the combination with a wing extending outward from the eye or inlet of the fan toward the periphery, but not reaching the periphery, two converging vanes extending inward from the periphery and arranged rearward of said first named wing with a space between, substantially as described.

In testimony whereof, I have hereunto set my hand.

WILLIAM CLIFFORD.

Witnesses:

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