June 17, 1930. F. A. PFEIFER 1,764,052

WINDMILL

Filed July 20, 1926 2 Sheets-Sheet 1

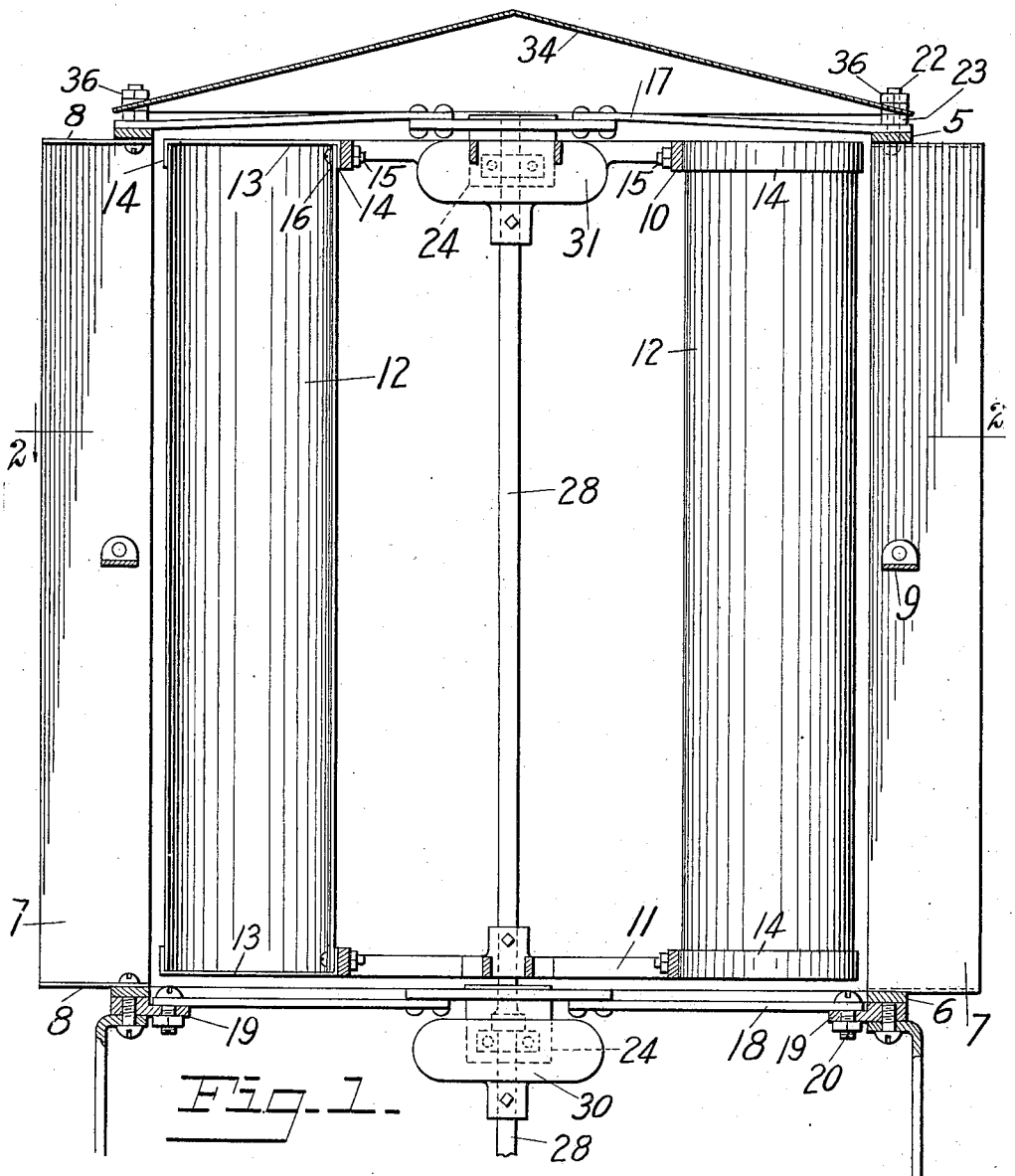


Fig. 1.

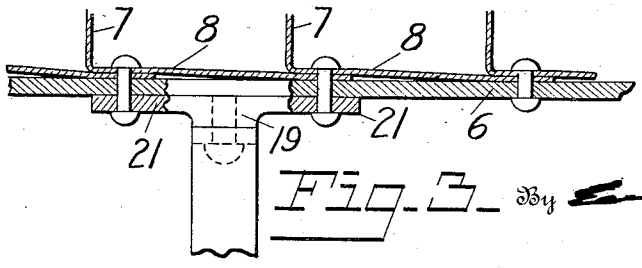


Fig. 3.

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Fig. 2.

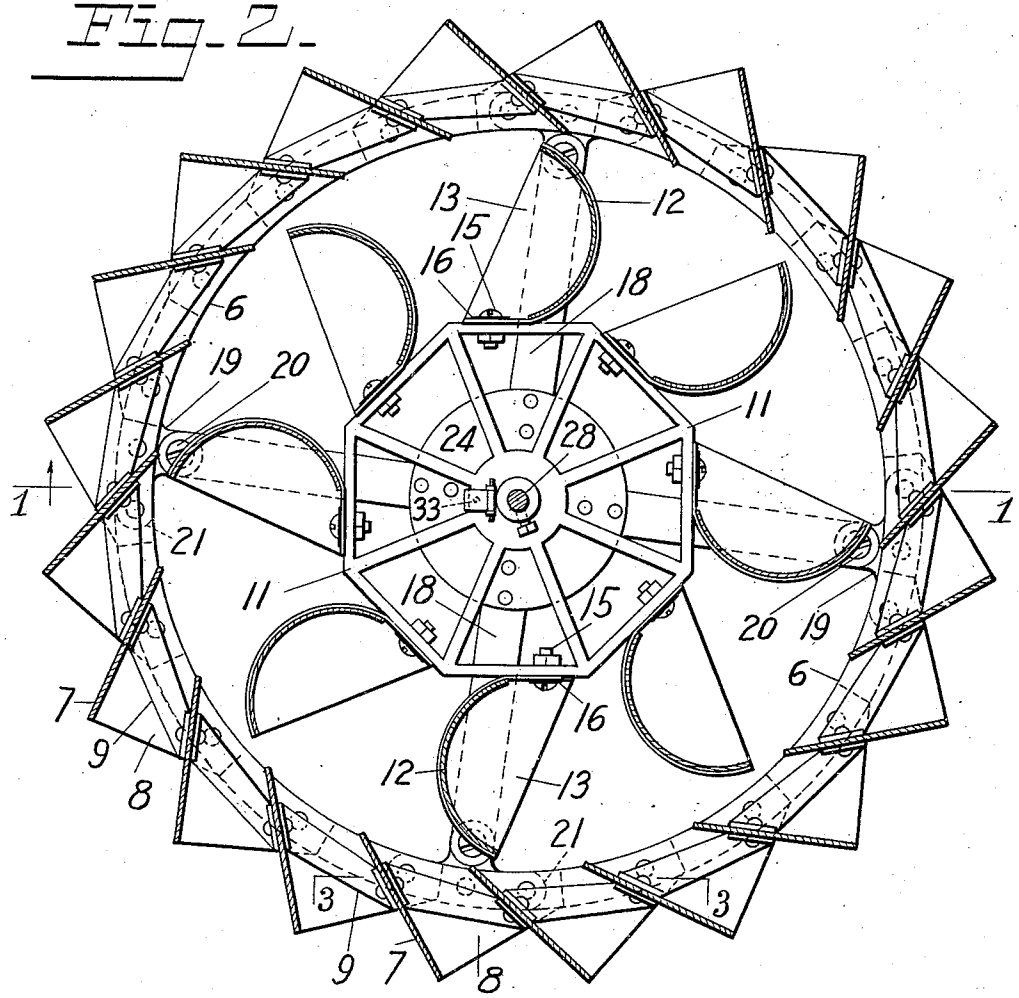


Fig. 4.

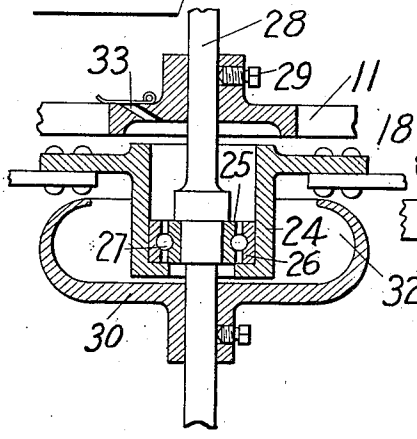
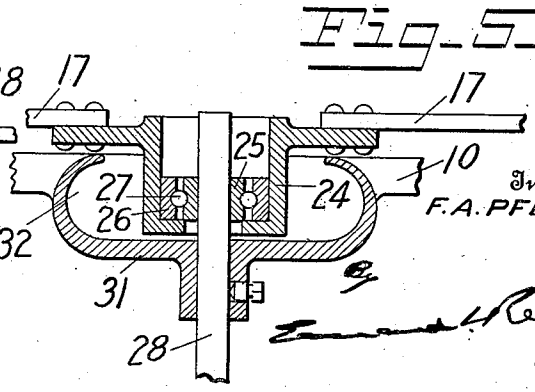


Fig. 5.



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UNITED STATES PATENT OFFICE

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WINDMILL

Application filed July 20, 1926. Serial No. 123,754.

This invention relates to windmills and more particularly to that type of windmill comprising an outer structure or cylindrical cage having an annular series of vanes, and an inner structure or rotor having a series of vanes so arranged that the air currents will be directed against them by the outer vanes.

One object of the invention is to provide such a windmill which will develop a large amount of power in proportion to the strength of the air currents.

A further object of the invention is to provide such a windmill which will be of such a character that it will not be destroyed or damaged by high winds and in which the vanes will be so arranged as to automatically control the speed at which the rotor moves.

A further object of the invention is to provide such a windmill with vanes so constructed and arranged as to impart thereto a high degree of efficiency.

A further object of the invention is to provide a windmill of this type which will be so constructed that the inner structure or rotor and its associated parts may be removed as a unit.

A further object of the invention is to provide such a windmill with improved means for maintaining a constant lubrication of the bearings.

A further object of the invention is to provide such a windmill which will be very simple in its construction and which can be manufactured at a relatively low cost.

Other objects of the invention will appear as the mechanism is described in detail.

In the accompanying drawings Fig. 1 is a vertical sectional view taken on the line 1—1 of Fig. 2 showing a windmill embodying my invention; Fig. 2 is a transverse section taken on the line 2—2 of Fig. 1; Fig. 3 is a section taken on the line 3—3 of Fig. 2, showing the supporting lug partially in elevation; Fig. 4 is a sectional view of the lower bearing and its associated devices; Fig. 5 is a sectional view of the upper bearing and its associated parts.

In these drawings I have illustrated one embodiment of my invention and have shown the same as comprising an outer structure or cage, substantially cylindrical in form, and comprising a series of vanes arranged to form passageways which will direct air currents into the cylindrical structure at angles to the respective radii thereof. Mounted within this outer structure is an inner structure or rotor having a plurality of trough shaped vanes so arranged that they will be actuated by the air currents entering through the passageways of the outer structure.

The outer stationary structure may be of any suitable construction but, as here shown, it comprises upper and lower annular frame members 5 and 6 between which are mounted a series of vertical vanes 7, these vanes being rigidly secured at their respective ends to the two frame members. The several vanes are spaced equal distances apart about the circumference of the annular frame members and so arranged as to form passageways between the same. Each vane extends diagonally to the annular frame members and at an acute angle to that radius of the cylindrical structure which intersects the same. While this angle may vary I have found that an angle of sixty degrees produces highly efficient results. With this arrangement of the vanes it will be noted that the passageways between the same converge slightly so that they are of less width at their inner ends than at their outer ends. The vertical body portions of the vanes are preferably flat and straight and means are provided for closing the upper and lower ends of the passageways between adjacent vanes, thus tending to confine the air within the passageways and preventing it from being diverted upwardly or downwardly while passing through the same. In the present construction each vane has its upper and lower end portions bent inwardly, as shown at 8, and overlapping the respective annular frame members 5 and 6. As here shown, these inwardly extending portions of the vanes are approximately triangular in shape so that the outer edges thereof extend at substantially right angles to the vane while the inner edges conform substantially

to the inner edge of the adjacent annular frame member. The length of these inwardly extending portions of the vanes is greater than the distance between adjacent vanes and consequently the inwardly extending portions of adjacent vanes overlap one another, as clearly shown in Fig. 3. The several vanes are secured to each annular frame member by the use of a number of rivets equal to the number of vanes but because of the overlapping arrangement of the end portions of the vanes each vane is riveted to its frame member at two points, thus providing a very strong rigid construction. It will be noted that by extending the end portions of the vanes inwardly I have not only provided closures for the ends of the passageways and means for conveniently attaching the vanes to the frame members but that the attaching means is such as to strongly brace the vanes against the action of the wind. Where the vanes are of considerable length it may be desirable to brace them one against the other and I have in the present construction shown brace bars 9 extending between and rigidly secured to adjacent vanes near the longitudinal centers thereof.

The inner structure or rotor may take various forms and may be mounted in various ways but in the particular construction here illustrated it comprises upper and lower end frame members 10 and 11, each of which is here shown as comprising a hub portion from which radiate a series of spokes, the outer ends of which support an octagonal rim. Carried by these end frame members of the rotor are a series of trough shaped vanes which are spaced equal distances about the supporting structure and are so arranged that air currents entering the cylindrical structure through the passageways therein will enter the trough shaped vanes and impart movement thereto. These trough shaped vanes are preferably materially less in number than the stationary outer vanes and they are of such width that there will be a comparatively small clearance between the outer edges thereof and the inner edges of the stationary vanes. In the present construction each trough shaped vane is, as shown at 12, formed of sheet metal and is curved about a longitudinal axis so that each vane comprises in cross section slightly less than a semicircle. These vanes are rigidly secured at their inner edges to the supporting structure, the end members 10 and 11, with their recessed sides facing rearwardly with relation to the direction of movement of the rotor. As here shown, the inner and outer edges of each trough shaped vane are arranged approximately in a radial plane but this arrangement may be varied if desired. Each trough shaped vane 12 is provided at its upper and lower ends with closures which will tend to confine the air therein and prevent it from escaping at the upper and lower ends of the vane, thereby fully utilizing the force of the air currents. These closures are here shown as end plates 13 having their forward edges curved and provided with flanges 14 to fit about the adjacent ends of the curved vane, these flanges being riveted or otherwise rigidly secured to the vane. The inner portion of each closure extends rearwardly to a point some distance beyond the inner edge of the vane and is flanged, as shown at 14, to provide means for securing the vane to the supporting structure, this being accomplished in the present instance by passing bolts 15 through the flanges 14 and the rim of the adjacent end member of the rotor. Preferably reinforcing plates 16 are interposed between the head of the bolt and the flange to prevent the flange tearing away when thin metal is used. The rear edge of each closure plate extends outwardly and forwardly from the rear end of the flange 14 to the outer edge of the vane, thus causing the rear edges of the closures to extend diagonally to the plane of the two edges of the vane and providing a very strong brace for the vane. The construction and arrangement of the closures here shown provides not only means for closing the ends of the trough shaped vanes but further provides means for rigidly attaching these vanes to the supporting structure and for bracing the same against any tendency to yield under air pressure.

It will be noted that the arrangement of the two sets of vanes is such that the rotor vanes are spaced short distances from the edges of the stationary vanes and this arrangement, coupled with the shape of the vanes, causes a resistance or air friction to be established between the vanes of the two sets as the rotor rotates, which resistance will increase as the speed of the rotor increases and will serve to automatically regulate the speed of the rotor and prevent the same from running wild or rotating at such a speed as to cause damage thereto, in high winds.

The rotor may be mounted in any suitable manner but preferably it is mounted on a shaft which serves as a power transmitting device and which may be connected through any suitable mechanism with an apparatus which is to be driven. As here shown, I have mounted on both the upper and lower annular frames of the outer structure supplemental frames 17 and 18, the supplemental frames being here shown in the form of spiders. The lower supplemental frame, 18, is of such a size that it can be moved through the upper annular frame 5 of the outer structure and I have shown the lower annular frame 6 as provided with inwardly

extending lugs 19 on which the ends of the spider arms rest and to which they are detachably secured by means of bolts 20. The lugs 19 have elongated end portions 21 which extend along the underside of the frame member 6 and are rigidly secured thereto by a part of the rivets which serve to secure the vanes to said frame member. The spider arms of the upper supplemental frame 7 rest directly upon the annular frame member 5 and are secured thereto by bolts 22 and nuts 23. Each supplemental frame carries a central bearing which is indicated as a whole by the reference numeral 24 and comprises an outer shell in which are mounted inner and outer ball races 25 and 26 between which are mounted bearing balls 27. A shaft 28 extends through the inner ball races 25 of the two bearings and is provided with a shoulder 28 which rests upon the lower bearing to limit the downward movement of the shaft with relation to the bearing. There is no positive connection between the shaft and the ball race of the upper bearing, thus leaving the parts free for relative movement due to expansion and contraction. This shaft extends through the hub portions of the upper and lower end members 10 and 11 of the rotor and is rigidly secured to these members, in the present instance by set screws 29. Rigidly secured to the shaft 28 for rotation therewith are oil cups 30 and 31 which are arranged respectively beneath the lower and upper bearings 24 and into which the bearings extend, thus providing a constant supply of lubricant for the bearings. The circumferential wall of each oil cup is curved outwardly so as to form a pocket or recess in the outer circumferential portion of the oil cup, as shown at 32. In the present instance, these outer walls of the oil cups are approximately semi-circular in cross section and the recess formed therein is of such a capacity that it will contain a relatively large quantity of oil. Consequently when the oil cups rotate with the shaft the oil will be thrown outward by centrifugal force but will be retained in the circumferential recesses 32 so that little or none of the oil will be thrown out of the oil cup. In this manner I am enabled to use a light oil which will not congeal in cold weather and thereby provide constant lubrication for the bearings, it being necessary to renew the oil supply only at long intervals. It will be noted that the tops of the oil cups are arranged close to the hub portions of the respective spiders or supplemental frames, 17 and 18, so that these portions form in effect closures for the oil cups which will prevent the entrance of dirt or dust into the same. The lower oil cup 30 is supported wholly by the shaft but the upper oil cup 31 is rigidly secured to the upper end member 10 of the rotor and forms in effect a hub portion of that frame member. The hub portion of the lower end member 11 of the rotor is arranged just above the upper end of the bearing 24 and serves to prevent the entrance of dirt into this bearing. The hub portion of this end member has an opening 33 through which oil may be introduced into the bearing and oil cup.

If desired, a roof or top plate 34 may be mounted on the outer structure and, as here shown, this roof or top plate is in the form of a relatively flat cone and is rigidly secured to the upper annular frame member of the outer structure. In the present instance, the edges of the roof are apertured and the bolts 22, by means of which the upper spider 17 is secured to the frame member 5, extend through these apertures and nuts 36 are mounted on the bolts above the roof to secure the roof thereto. It will be noted that the roof rests upon the lower nuts 23 of the bolts so that the edge of the roof is spaced from the upper frame member to provide for the free escape of air which may pass upwardly from the rotor.

The operation of the windmill will be readily understood from the foregoing description thereof and it will be apparent that the outer structure is stationary and that the wind blowing against the same from any direction whatever will enter through the passageways and act upon the trough-shaped vanes to impart movement to the rotor, this movement being transmitted through the shaft 28 to the parts to be driven. Not only will the rotor be actuated by a wind blowing in any direction but practically all the passageways on the windward side of the mill will be effective and air currents will be acting on half of the vanes of the rotor all the time. Even the passageways at the right-hand side of the mill, as shown in Fig. 2, will be effective as the air will strike the outwardly extending portions of the vanes and be diverted laterally through the passageways. The construction and arrangement is such that there is little likelihood of the mill being damaged by high winds, it having been found in practice that the mill when not anchored to its support will withstand very high winds without being displaced. Further, the arrangement of the vanes is such as to automatically control the speed of the rotor and prevent the latter from being operated at such a high speed as to damage the same. The construction is of a very strong rigid character but is such that the mill may be built at a relatively low cost, thus providing a low initial cost and low maintenance cost.

While I have shown and described one embodiment of my invention I wish it to be understood that I do not desire to be limited to the details thereof as various modi-

fications may occur to a person skilled in the art.

Having now fully described my invention, what I claim as new and desire to secure by Letters Patent, is:

1. In a windmill, an outer structure substantially cylindrical in shape and comprising a series of stationary vanes, spaced apart and each extending at an acute angle to the corresponding radius of said cylindrical structure, a rotor mounted within said cylindrical structure and comprising a supporting structure, a plurality of trough shaped vanes carried by said structure, and closures for the ends of said trough shaped vanes, each of said closures having a part extending beyond the inner edge of the vane to provide means for securing said vane to said supporting structure.

2. In a windmill, an outer structure substantially cylindrical in shape and comprising a series of stationary vanes, spaced apart and each extending at an acute angle to the corresponding radius of said cylindrical structure, a supporting structure rotatably mounted within said cylindrical structure, a plurality of vanes carried by said supporting structure, each of the last mentioned vanes comprising a trough shaped body portion arranged with its inner edge adjacent to said supporting structure; and plates secured to the ends of said body portion, each of said end plates being so shaped that the inner portion thereof will extend rearwardly beyond the inner edge of the body portion of its vane, said rearwardly extending portion having a part by means of which said vanes may be secured to said supporting structure.

3. In a windmill, an outer structure substantially cylindrical in shape and comprising a series of stationary vanes, spaced apart and each extending at an acute angle to the corresponding radius of said cylindrical structure, a supporting structure rotatably mounted within said cylindrical structure, a plurality of vanes carried by said supporting structure, each of said last mentioned vanes comprising a trough shaped body portion arranged with its inner edge adjacent to said supporting structure; and plates rigidly secured to the ends of said body portion, each of said plates having its rear edge extending from the outer edge of said body portion to a point spaced rearwardly from the inner edge of said body portion, and means for securing the inner portion of each end plate to said supporting structure.

4. In a windmill, an outer structure substantially cylindrical in shape and comprising end frame members, and a plurality of vanes spaced apart to form passageways between adjacent vanes and each extending at an acute angle to the radius of said structure, each of said vanes having at each end thereof an inwardly extending portion secured to the adjacent end frame member of said structure and forming an end closure for one of said passageways, and a rotatable structure mounted within said outer structure and comprising a series of vanes arranged to be acted upon by air currents entering said outer structure through said passageways.

5. In a windmill, an outer structure comprising annular end members and a plurality of vanes arranged between said end members, extending outwardly beyond the same and spaced apart to form passageways between adjacent vanes, each of said vanes having its end portions bent inwardly and overlapping the respective end members to form end closures for the respective passageways, the end portions of adjacent vanes overlapping one another, fastening devices extending through the overlapping end portions of said vanes and through the respective end members of said structure, and a rotatable structure mounted within said outer structure and comprising vanes arranged to be acted upon by air currents entering said outer structure through said passageways.

6. In a windmill, an outer structure comprising annular end members and a plurality of vanes arranged between said end members, extending outwardly beyond the same and spaced apart to form passageways between adjacent vanes, each of said vanes having its end portions bent inwardly and overlapping the respective end members to form end closures for the respective passageways, the end portions of adjacent vanes overlapping one another, fastening devices extending through the overlapping end portions of said vanes and through the respective end members of said structure, and a rotatable structure mounted within said outer structure and comprising trough shaped vanes having their ends closed and so arranged that air currents passing through said passageways will enter the same and impart movement to said rotatable structure.

7. In a windmill, an outer structure comprising upper and lower annular frame members and a plurality of vanes carried by said frame members and arranged to form passageways leading to the interior of said structure, supplemental frames supported respectively by said upper and lower annular frame members, the lower supplemental frame being of such a size that it may be moved through the upper annular frame member, an inner structure rotatably supported between said supplemental frames and comprising a series of vanes arranged to be actuated by air currents passing through the passageways of the outer struc-

ture and means for detachably securing said supplemental frames to the respective annular frame members, whereby said supplemental frames may be detached and said inner structure and said supplemental frames removed as a unit from said outer structure.

8. In a windmill, an outer structure comprising upper and lower annular frame members and a plurality of vanes carried by said frame members and arranged to form passageways leading to the interior of said structure, supplemental frames supported respectively by said upper and lower annular frame members, the lower supplemental frame being of such a size that it may be moved through the upper annular frame member, bearings carried by said supplemental frames, a shaft mounted in said bearings, a rotatable structure carried by said shaft and comprising vanes arranged to be actuated by air currents passing through the passageways of said outer structure, and means for detachably securing said supplemental frames to the respective annular frame members.

9. In a windmill, an outer structure comprising upper and lower annular frame members and a plurality of vanes secured to said frame members and arranged to form passageways leading to the interior of said structure, inwardly extending lugs carried by said lower frame member, a supplemental frame supported on said lugs, a second supplemental frame supported by said upper annular frame member, bearings carried by said supplemental frame members, a shaft journaled in said bearings, a rotatable structure mounted on said shaft and comprising vanes arranged to be actuated by air currents entering said outer structure through said passageways, and means for detachably securing said supplemental frames respectively to said upper annular frame member and to said lugs.

10. In a windmill, an outer structure comprising upper and lower annular frame members, a plurality of vanes carried by said frame members and arranged to form passageways leading to the interior of said structure, supplemental frames supported respectively by said upper and lower annular frames, bolts extending through said upper annular frame member and said upper supplemental frame, nuts mounted on said bolts above said supplemental frame, an inner structure rotatably supported between said supplemental frames and comprising a series of vanes arranged to be actuated by air currents passing through the passageways of said outer structure, a dome shaped cover arranged above said outer structure and resting upon said nuts, said cover having openings to receive said bolts, and nuts mounted on said bolts to retain said cover in place thereon.

11. In a windmill, an outer structure comprising upper and lower frame members and a plurality of vanes carried by said frame members and arranged to form passageways leading to the interior of said structure, an inner structure rotatably supported within said outer structure and comprising a series of vanes arranged to be actuated by air currents passing through the passageways of said outer structure, and a dome shaped cover arranged above and supported by said outer structure and having its edge spaced from said upper frame member.

12. In a windmill, an outer structure substantially cylindrical in shape and comprising a series of stationary vanes spaced apart and each extending at an acuate angle to the corresponding radius of said cylindrical structure, and a rotor mounted within said cylindrical structure and comprising a series of trough-shaped vanes having their inner edges spaced from the axis of said rotor to provide an axial passageway opening through the end of said rotor and having said inner edges spaced one from the other to provide passageways opening into said axial passageway, said trough-shaped vanes being materially less in number than said stationary vanes and being so arranged that air currents passing between said stationary vanes will enter said trough-shaped vanes, impart movement to said rotor and escape through said axial passageway.

13. In a windmill, an upright outer structure substantially cylindrical in shape and comprising a series of stationary vanes spaced apart and each extending at an acute angle to the corresponding radius of said cylindrical structure, and a rotor mounted within said cylindrical structure and comprising a series of trough-shaped vanes closed at their ends, having their outer edges substantially parallel with the inner edges of said stationary vanes and so arranged that a narrow clearance will be provided between said edges, having their inner edges spaced from the axis of said rotor to provide an axial passageway opening through the end of said rotor, and having said inner edges spaced one from the other to provide passageways leading to said axial passageway, said trough-shaped vanes being so arranged that air currents passing between said stationary vanes will enter said trough-shaped vanes, impart movement to said rotor and escape through said axial passageway.

14. In a windmill, an outer structure substantially cylindrical in shape and comprising a series of stationary vanes spaced apart and each extending at an acute angle to the corresponding radius of said cylindrical structure, and a rotor mounted within said

cylindrical structure and comprising end members having openings therethrough and a series of vanes secured to said end members, having their inner edges spaced one from the other and from the axis of said rotor, each of the last mentioned vanes being curved about a longitudinal axis and arranged with its longitudinal edges in a substantially radial plane, and individual closures for the ends of said curved vanes, said curved vanes being so arranged as to provide a narrow clearance between the outer edges thereof and the inner edges of said stationary vanes.

15. In a windmill, an upright outer structure substantially cylindrical in shape and comprising a series of stationary vanes spaced apart and each extending at an acute angle to the corresponding radius of said cylindrical structure, and a rotor arranged within said outer structure and comprising end members mounted respectively near the upper and lower ends of said outer structure for rotation about a common axis and having openings therethrough, and a series of trough-shaped vanes rigidly secured at their inner edges to the peripheral edges of said end members and having their inner edges spaced one from the other to provide passageways between the same, and individual closures for the upper and lower ends of each of said trough-shaped vanes.

16. In a windmill, an upright outer structure substantially cylindrical in shape and comprising a series of stationary vanes spaced apart and each extending at an acute angle to the corresponding radius of said cylindrical structure, and a rotor arranged within said outer structure and comprising end members mounted respectively near the upper and lower ends of said outer structure for rotation about a common axis and having openings therethrough, a plurality of trough-shaped vanes spaced one from the other about the peripheries of said end members, and individual closures for the respective ends of each of said trough-shaped vanes, each of said closures having a part extending beyond the inner edge of its vane, and fastening devices for securing said parts of said closures to the respective end members.

17. In a windmill, an upright outer structure substantially cylindrical in shape and comprising a series of stationary vanes spaced apart and each extending at an acute angle to the corresponding radius of said cylindrical structure, and a rotor arranged within said outer structure and comprising end members mounted respectively near the upper and lower ends of said outer structure for rotation about a common axis and having openings therethrough, a plurality of trough-shaped vanes spaced one from the other about the peripheries of said end members, individual closures for the respective ends of each of said trough-shaped vanes, each of said closures having a flange to embrace the adjacent end of its vane, said flange extending beyond the inner edge of said vane, and fastening devices for securing the projecting ends of said flanges to said end members.

In testimony whereof, I affix my signature hereto.

FERDINAND A. PFEIFER.