R. CLADE.

WINDMILL.

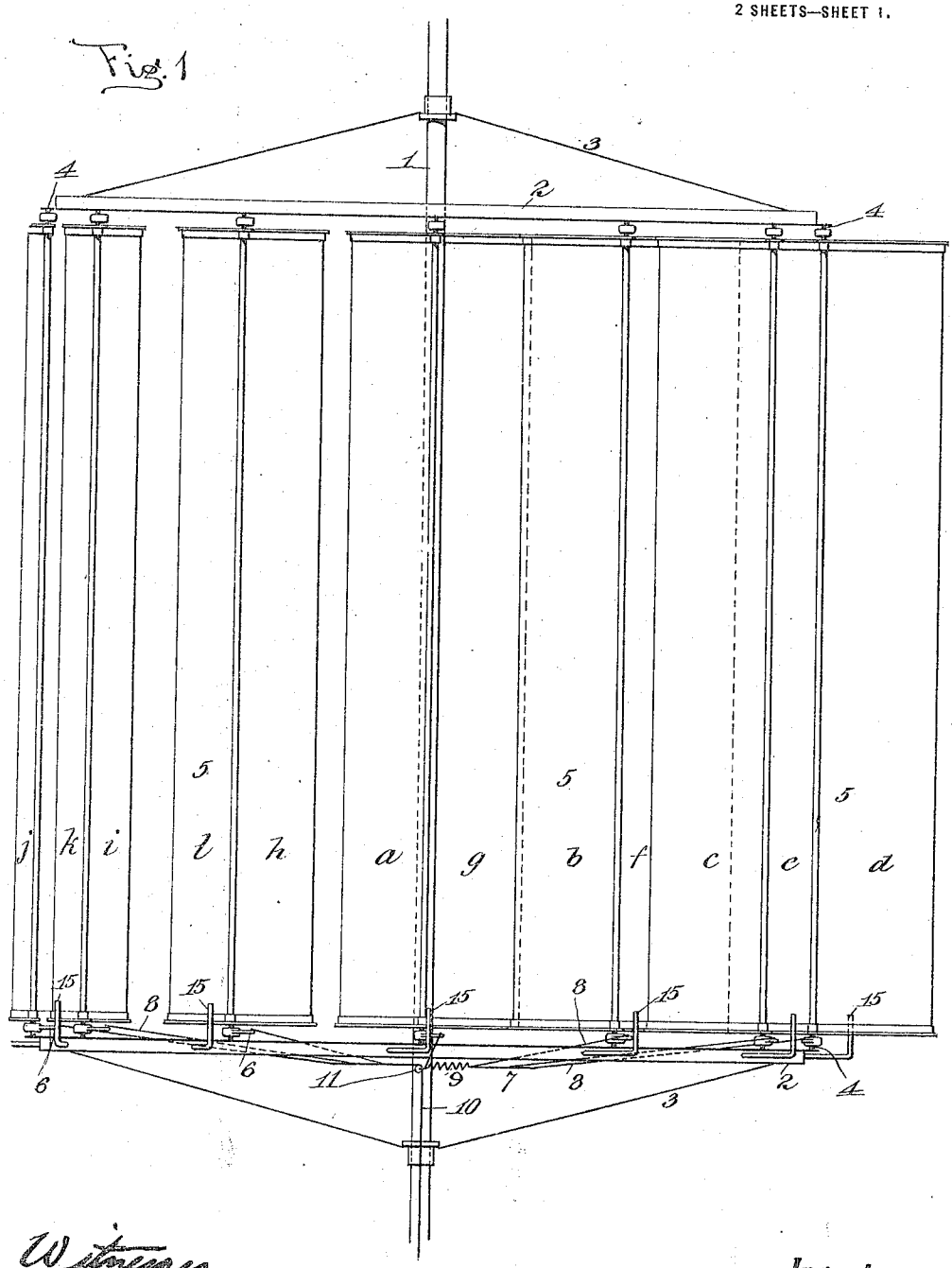
APPLICATION FILED APR. 12, 1915.

1,190,629.

Patented July 11, 1916.

2 SHEETS—SHEET 1.

Fig. 1



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2 SHEETS—SHEET 2.

Fig. 2

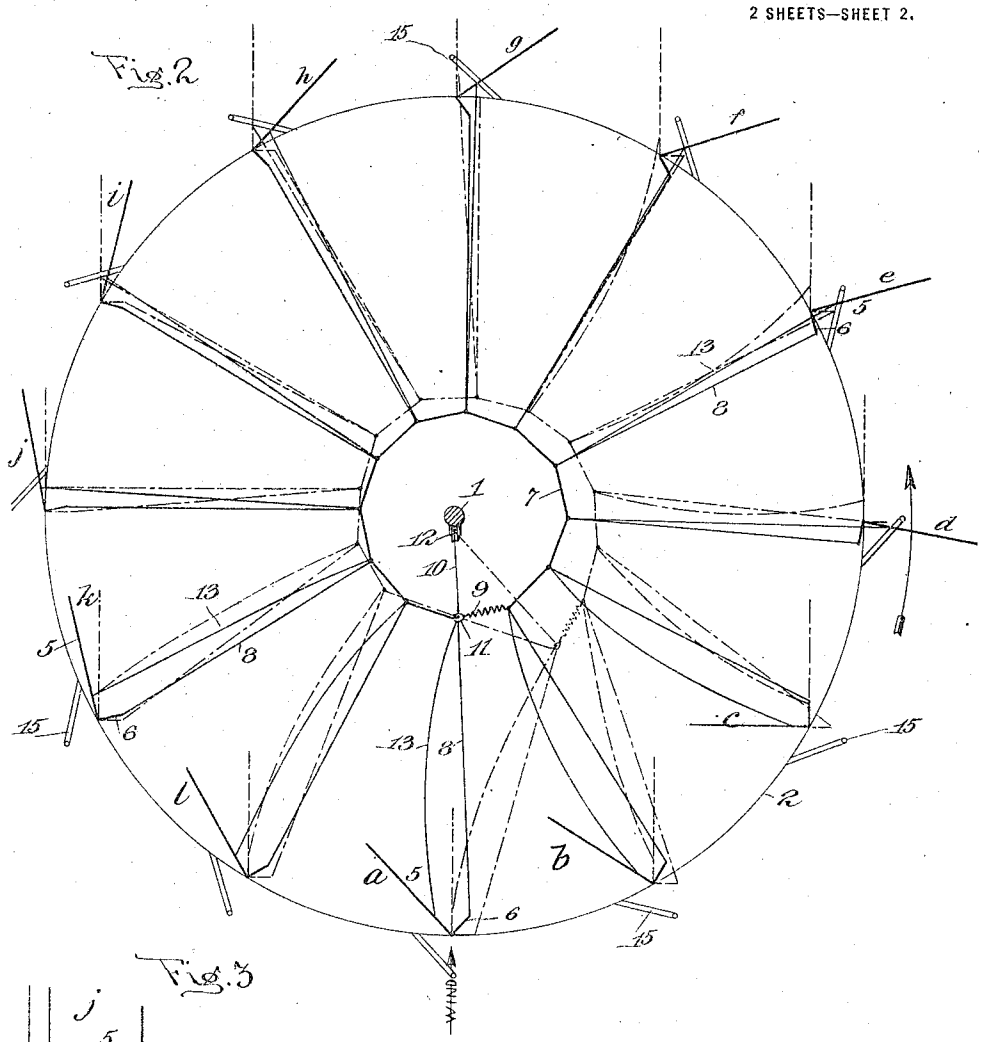

Fig. 3

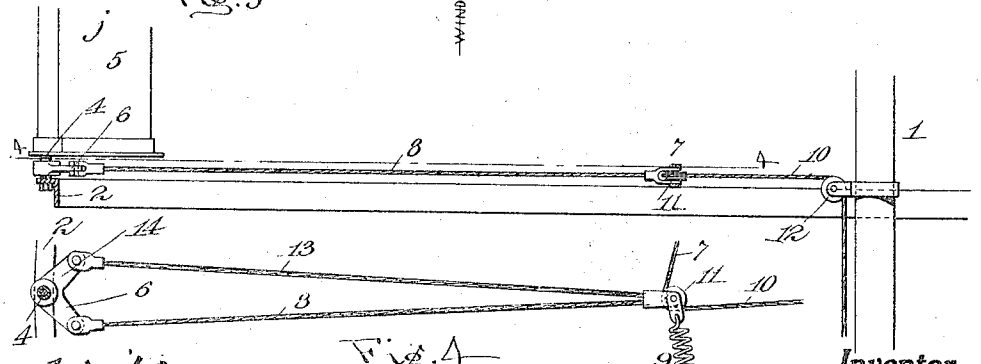

Fig. 4

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UNITED STATES PATENT OFFICE.

ROBERT CLADE, OF NEWARK, NEW JERSEY, ASSIGNOR TO AIR TURBINE COMPANY OF AMERICA, OF JERSEY CITY, NEW JERSEY, A CORPORATION OF NEW JERSEY.

WINDMILL.

1,190,629. Specification of Letters Patent. Patented July 11, 1916.

Application filed April 12, 1915. Serial No. 20,636.

To all whom it may concern:

Be it known that I, ROBERT CLADE, a subject of the Grand Duke of Baden, residing in the city of Newark, county of Essex, State of New Jersey, have invented a certain new and useful Improvement in Windmills, of which the following is a specification.

This invention relates to improvements in windmills of the type employing a vertical shaft supporting a plurality of rims between which a plurality of vanes are pivoted adjacent to one edge of each of the latter so that they may swing inward and outward beyond the plane of the rims. Such a type of windmill is shown in my copending application for patent filed April 12, 1915, Serial No. 20,637.

The objects of the invention are—First: to provide means for stopping the wheel. Second, to simplify the construction of the means for transmitting the centrifugal stresses from some vanes to others. These and further objects will more fully appear from the following specification and accompanying drawings considered together or separately.

In the drawings, Figure 1 is a side elevation of a windmill embodying my invention; Fig. 2 is a diagrammatical plan view of the same; Fig. 3 is an enlarged view partly in section of the mechanism for controlling the vanes and for stopping the wheel; and Fig. 4 is a plan view of the same.

In all of the views like parts are designated by the same reference characters, considered together or separately.

The mill illustrated is very similar to that shown in my copending application for patent for windmill (Case A) specification executed on even date herewith and numbered serially 20,635. The shaft 1 is vertical. The rims 2, 2 are arranged in pairs and are supported from the shaft by means of the arrangement of spokes 3. Each pair of rims is connected by a plurality of rods 4, 4. Upon these rods are supported the vanes 5, 5. The point of support of the vanes is adjacent to the front edge of each so that the vane may swing in and out of the plane of the two rims. Each vane is provided with an arm 6. Suitable connection is made with each of these arms to the stress transmission ring 7. This ring surrounds the shaft 1, but is not connected thereto. The connecting means between the ring 7 and arm 6 is by means of a flexible stay 8. The ring may conveniently be, and preferably is, made of flexible wire rope as shown. This ring contains an expansible element 9 which in the embodiment chosen for illustration is an expansion spring. This spring allows the ring to expand when subjected to unusual stress caused by increased velocity of the wind in the manner described in my copending application hereinbefore referred to. For the purpose of providing means for stopping the mill I connect some portion of the ring with a flexible leader 10. This leader may be made of wire rope and may be made integral with the wire rope of which the transmission ring is made. This leader passes through a sheave or block 11 connected to the spring 9. From this sheave it leads inward to the shaft where it passes over a sheave 12 from which it leads downward to a cleat or other device for retaining it in position. Upon the leader being slacked off it will run through the two sheaves 12 and 11 and allow the ring to increase in diameter. This situation is shown in broken lines in Fig. 2. When in this position there is no longer any strain upon the stays 8 leading to vanes consequently each vane is free to turn upon its pivot and to swing its free edge away from the wind as shown in broken lines in Fig. 2. In this position the wind does not act upon the vanes to rotate the mill, consequently the mill will be stopped.

In order to simplify the construction of the means for transmitting the centrifugal stresses from some vanes to others, I employ the following mechanism: Instead of the extra transmission ring illustrated in my application herein referred to, I utilize the transmission ring 7 for the double purpose of transmitting the wind stresses to certain of the vanes and transmitting the centrifugal stresses to certain of the vanes. The details of this construction comprise flexible stays 13 each connected to the transmission ring preferably adjacent to the stay 8 and leading from that point to the vane 5. This stay may be connected directly to the vane, as shown in Fig. 2, or may be connected to an arm 14 as shown in Fig. 4.

Preferably the point of connection is the same distance from the pivot of the vane as the point of connection of the arm 6 so that the two points move through an arc of a circle of the same diameter, and therefore the vane on one side of the wheel will move through the same arc as the vane on the opposite side.

The operation of the whole mill is as follows, reference being had to Fig. 2: In this figure the twelve vanes illustrated are represented in the positions *a* to *l* inclusive. Assuming that the wind is blowing in the direction of the arrow and that the mill is rotating in the direction indicated by the curved arrow—the vanes will be in substantially the position illustrated in solid lines. In the positions *a*—*g* the wind tends to blow the vanes at an extreme angle from the tangent. Blowing the vane in the position *a* inward will, through the agency of the arm 6, stay 8, ring 7 and stay and arm connected to the vane *g* tend to move the latter inward also. In the positions *b*—*h* there is a greater stress tending to turn the vane in position *b* inward, than turns the vane *h* outward. These stresses are compensated for by means of the stays 8 and connecting mechanism. In the position *c*—*i* the differences are still greater. The wind tends to blow the vane in position *c* inward to the maximum position, pulling the stay outward to the maximum position. At the same time the wind tends to blow the vane in position *i* outward to the dotted line position which will not move the stay 8 connected by this vane so far out. As the arms 8 of the vanes *c*, *d*, and *e* are thrown outward toward the rim 2 the ring 7 will be drawn in the general direction toward the side of the mill carrying the vanes in positions *c*, *d* and *e*. As the vane travels from the position *c* to *d* it will present a gradually decreasing surface to the wind and just before it reaches the position *d* the centrifugal force will overcome the pressure of the wind and the vane will be swung outward until it is brought to a stop by means of the pull exerted by the centrifugal force tending to swing the vane *j* outward. The wind exerts the maximum pressure to force the vane at *d* outward and consequently will draw the transmission ring 7 to the maximum position in that direction. At the same time in the position *j* there will be no pressure of the wind tending to blow the vane outward, and its normal position would be in the broken line position shown were it not for the centrifugal stresses which will blow it out to about the position shown in solid lines. In the positions *e*—*k* and *f*—*l* the vanes in the *e*—*f* positions are drawn outward farther than those in the *k*—*l* positions are drawn inward. The tendency, therefore, is to draw the transmission ring more toward the positions *e*—*f* than toward the positions *l*—*k*.

In addition to the stresses caused by the pressure of the wind upon the vanes there are also the centrifugal stresses to be considered. These stresses, of course, will tend to draw all the vanes outward irrespective of the pressure of the wind upon them. Through the agency of the stays 13, a means is provided which, connected to the ring 7, will distribute the stresses and may cause certain of the vanes which have small wind pressure upon them to be kept from being drawn outward more than the minimum amount. This is particularly true in connection with the vanes in positions *d*—*j*. In the position *d* through the agency of the stay 13 connected thereto the ring 7 will be drawn to the maximum degree of eccentricity away from the shaft 1. This will also have the tendency through the stay 13 connected to the vane in position *j* to draw the latter vane inward. In the positions *e*—*k* and *c*—*i* the same will hold true, but to a less degree. In the positions *i*—*k* there is very little pressure of wind upon the vanes and were it not for the stays 13 connected to the ring 7 the centrifugal forces would throw these vanes out to such a point that they would cease to be effectively acted upon by the wind. Each two vanes in opposition are to some extent acted upon by stresses in opposite directions, the stresses from one vane being greater than from the other. These stresses will keep the ring in a position substantially oval and will not allow it to be distorted to any great degree. When the pressure of the wind increases beyond a designed amount the spring sector 9 of the ring will be expanded due to the increased pressure on the vanes. The effect of this will be to turn the vanes at a sharper angle to the wind, and the speed of the mill will therefore not dangerously increase.

In order to prevent the vanes from turning too far in one direction when the leader 10 is slacked off I provide a stop 15 for each vane. Each stop is preferably so located that it will be engaged by the vane when the latter lies in a substantially radial position in relation to the wheel. The purpose of this stop is to prevent the vanes from turning around in the wrong direction and thus entangling the stays 8 and 13 around the rods 4. The function of these stops will be made clear from an inspection of Fig. 2. If the leader 10 were to be slacked when the vanes are in the positions shown, the vanes *g*, *h*, *i*, *j*, *k*, *l*, *a*, *b* and *c* will be free to swing away from the wind. The vanes *d*, *e* and *f* will be forced into engagement with the respective stops. The pressure of the wind on these vanes will rotate the mill so much of a turn until it is in such a position that each vane is edge-on to the wind. The

final position of the wheel will be that in which the vane *d* is in substantially the position occupied by the vane *g* in the drawing.

Another feature of the invention resides in the arrangement of the stays in relation to the vanes. These stays should be slightly slack so that there are no strains on the bearings. In light winds, therefore, the vanes will be blown to leeward and the mill rotated. This feature of the loose or slack stays functions best with the arm 6 located at a greater angle than 90° as disclosed in my copending application for patent hereinbefore referred to.

In accordance with the provisions of the patent statutes, I have described the principle of my invention, together with the apparatus which I now consider to represent the best embodiment thereof; but I desire to have it understood that the apparatus shown is merely illustrative and that the invention may be carried out in other ways.

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

1. A windmill having a vertical shaft, a plurality of rims carried by the shaft, a plurality of vanes each mounted on a vertical axis adjacent to one edge, said vanes swinging outside and inside of the perimeter of the rims, a ring surrounding the shaft, connections between the ring and the vanes between the free edges and the axis thereof to restrain wind stresses, and connections between the ring and the vanes at the opposite sides of the axis to restrain centrifugal stresses.

2. A windmill having a vertical shaft, a plurality of rims carried by the shaft, a plurality of vanes each mounted on a vertical axis adjacent to one edge, said vanes swinging outside and inside of the perimeter of the rims, a ring surrounding the shaft, two arms associated with each vane, one arm between the free edge and the axis thereof, and one arm extending in the opposite direction from the axis thereof, and a stay connecting each arm with the ring.

3. A windmill having a vertical shaft, a plurality of rims carried by the shaft, a plurality of vanes mounted on vertical axes adjacent to their edges, said vanes swinging outside and inside of the perimeter of the rims, a noose surrounding the shaft, and connections between the vanes and noose.

4. A windmill having a vertical shaft, a plurality of rims carried by the shaft, a plurality of vanes mounted on vertical axes adjacent to their edges, said vanes swinging outside and inside of the perimeter of the rims, a noose surrounding the shaft, and connections between the vanes and noose, said connections being equally spaced when the noose is at its smallest diameter.

5. A windmill having a vertical shaft, a plurality of rims carried by the shaft, a plurality of vanes mounted on vertical axes adjacent to their edges, said vanes swinging outside and inside of the perimeter of the rims, a noose surrounding the shaft, connections between the noose and the vanes between the free edges and the axes thereof, and connections between the noose and the vanes at the opposite sides of the axes.

6. A windmill having a vertical shaft, a plurality of rims carried by the shaft, a plurality of vanes mounted on vertical axes adjacent to their edges, said vanes swinging outside and inside of the perimeter of the rims, a noose surrounding the shaft, and means for increasing the diameter of the noose.

7. A windmill having a vertical shaft, a plurality of rims carried by the shaft, a plurality of vanes mounted on vertical axes adjacent to their edges, said vanes swinging outside and inside of the perimeter of the rims, a noose surrounding the shaft, means for securing the noose at its minimum diameter, and means for increasing the diameter of the noose.

8. A windmill having a vertical shaft, a plurality of rims carried by the shaft, a plurality of vanes mounted on vertical axes adjacent to their edges, said vanes swinging outside and inside of the perimeter of the rims, a noose surrounding the shaft, connections between the noose and vanes between the free edges and the axes thereof, and connections between the noose and vanes at the opposite sides of the axes, the connections for each vane being attached to the noose at the same point.

9. A windmill having a vertical shaft, a plurality of rims carried by the shaft, a plurality of vanes mounted on vertical axes adjacent to their edges, said vanes swinging outside and inside of the perimeter of the rims, a noose surrounding the shaft, two arms associated with each vane, one arm extending from the vane between the free edge and the axes thereof, one arm extending from the opposite side of the axis, and a stay connecting each arm with the noose, the connection of both stays with the noose being at the same point.

This specification signed and witnessed this eleventh day of March, 1915.

ROBERT CLADE.

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