Aug. 20, 1946. C. F. TERHUNE 2,406,268

WINDMILL

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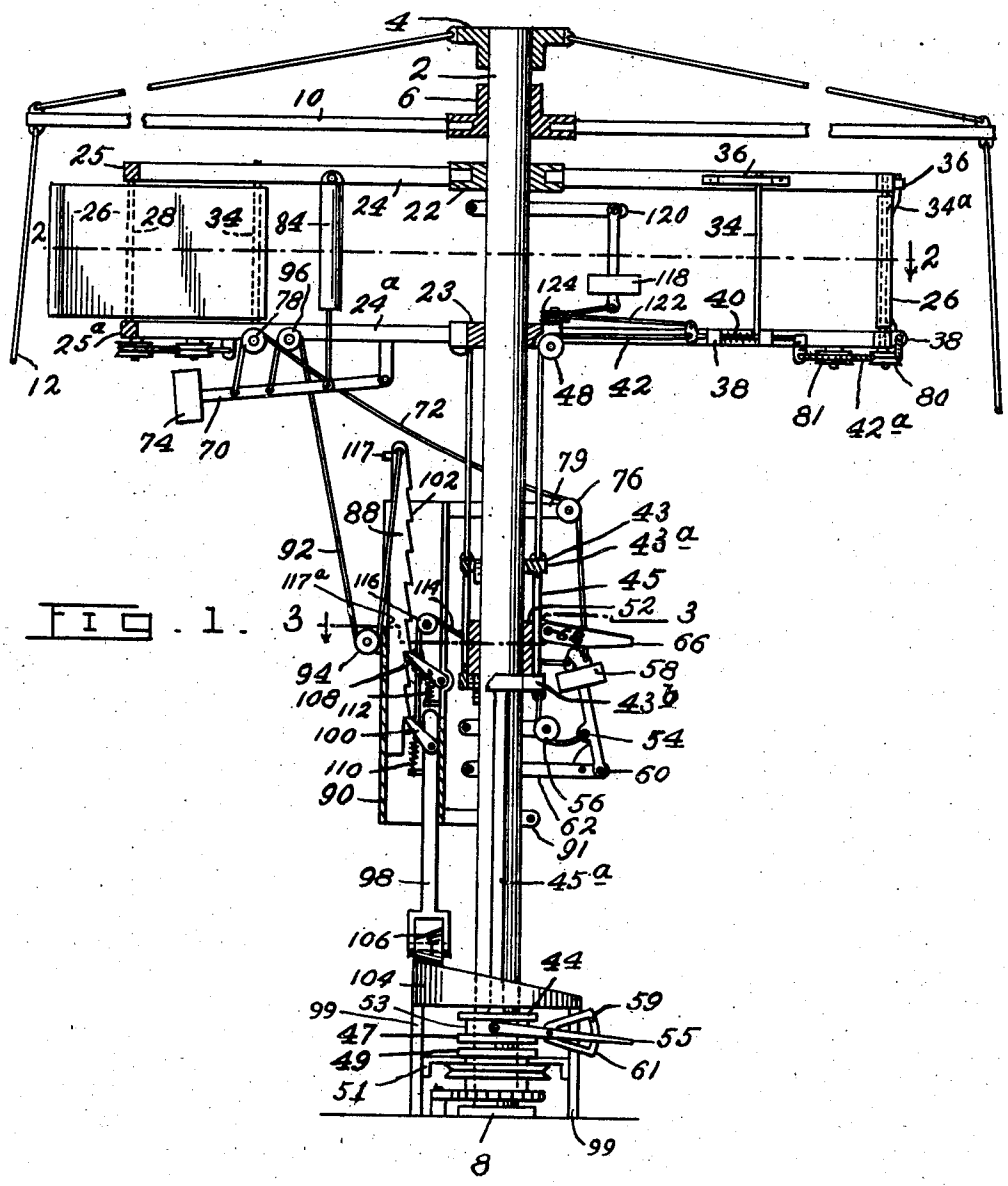

Fig. 1.

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FIG. 2.

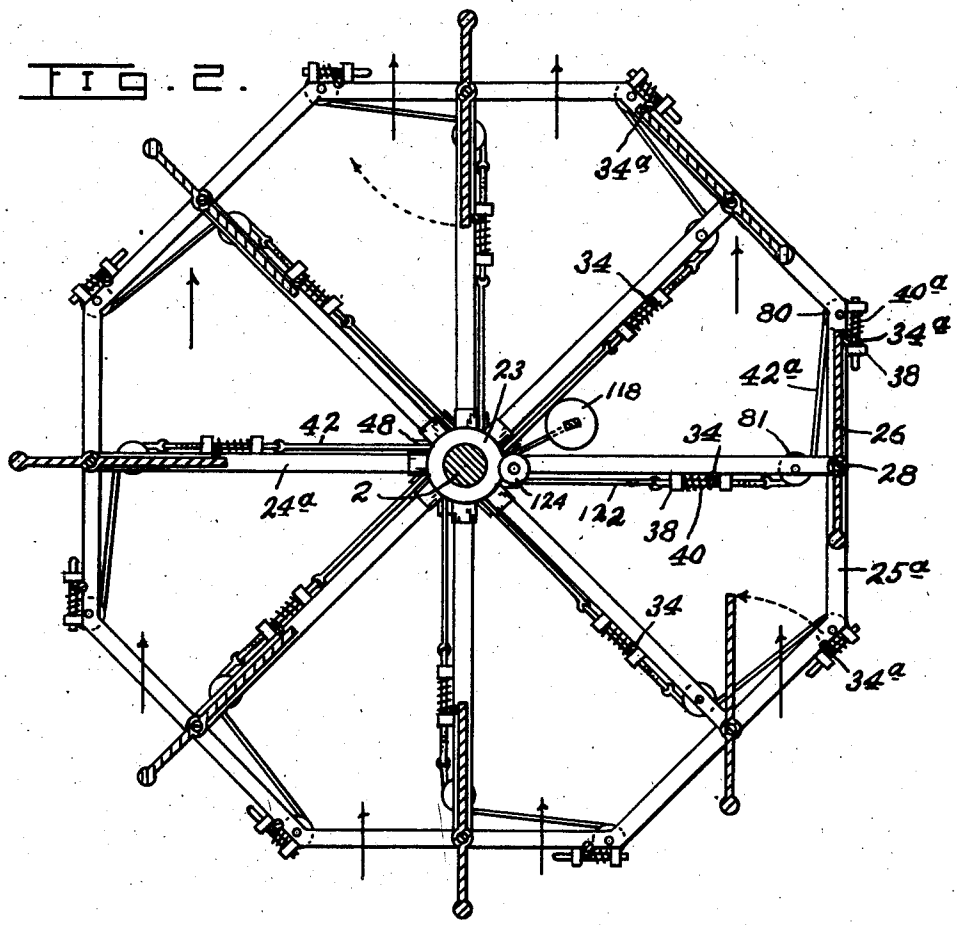
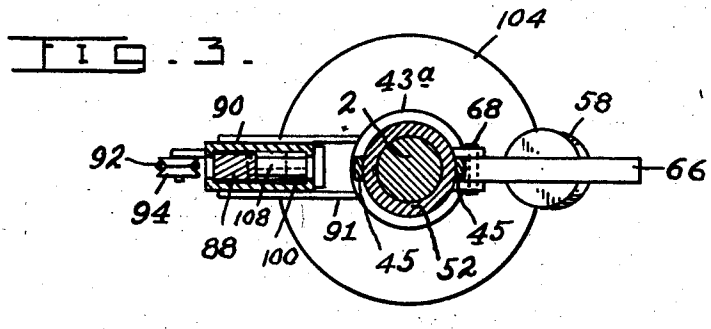


FIG. 3.



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WINDMILL

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10 Claims. (Cl. 170—26)

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This invention relates to windmills and it includes a number of improvements on the windmill disclosed by United States Patent No. 2,247,929, granted to me on July 1, 1941.

An important feature of the present invention resides in means whereby operation of the mill wheel is rendered more constant and less responsive to frequent and comparatively slight fluctuations in the force of the wind, by permitting one or more vanes to turn edgewise to the wind when the latter attains a speed above a predetermined point, thereby stabilizing and insuring steadier operation which renders the mill wheel especially desirable for driving an electric generator as well as other machines which operate more efficiently when driven at approximately constant speed.

Another important feature of the invention resides in a positive automatic means for restoring weight 74 to an upright position through the mechanism of a ratchet-bar operating over a stationary cam.

Another important feature of the present invention resides in means whereby the broad sides of the vanes of the rotary mill wheel are presented to the full force of the wind twice during each revolution, thereby increasing and prolonging the power output for the operation of pumps and other machinery to a greater extent than if the broadsides were presented to the wind but once during each revolution.

Other features will hereinafter appear and in order that the invention may be fully understood, reference will now be had to the accompanying drawings, in which:

Fig. 1 is a diagrammatic view with some parts in section.

Fig. 2 is a horizontal section of the mill wheel taken on line 2—2 of Fig. 1.

Fig. 3 is an enlarged cross section taken on line 3—3 of Fig. 1.

In carrying out my invention I provide a rotatable vertical shaft 2 journaled at its upper portion in bearings 4 and 6 and at its lower end in a bearing 8. The upper portion of the shaft 2 is provided with a mill wheel comprising hubs 22 and 23 spaced one above another upon the shaft 2 to which they are fixed, any desired number of upper and lower horizontal arms 24 and 24a fixed to and extending radially from the respective hubs, and circumferential upper and lower frames 25 and 25a, respectively, the former of which unites the outer ends of the upper arms 24 and the latter the outer ends of the lower arms 24a.

A plurality of vanes 26 are swingably disposed

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between the upper and lower frames 25 and 25a and mounted upon vertical spindles 28 carried by said frames. The vanes 26 are held by vertical stops 34 broadside to the wind at that side of the mill wheel which is turning with the wind, and by vertical stops 34a at that side of the mill wheel turning against the wind, as shown by Fig. 2. Each stop 34 is operably mounted in guides 36 and 36 fixed to the upper and lower associated arms 24 and 24a, respectively, and yieldably held in the path of the associated vane 26 by a coil spring 40 interposed between the stop and one of the associated guides 38.

Cables 42 are provided for simultaneously pulling the stops 34 out of the path of the respective vanes 26 when the speed of the wind becomes excessive, so that the vanes will be free to swing and present their edges to the wind. Each cable 42 is attached at its upper end to the associated stop 34 and at its lower end to a slide 43 comprising an upper ring 43a, an intermediate ring 43b, a lower ring 44, vertical bars 45 connecting the rings 43a and 43b, and vertical bars 45a connecting the rings 43b and 44. The slide 43 is splined to the shaft 2 and operably mounted upon a guide 52 fixed upon the shaft. The lower ring 44 of the slide has a brake wheel 47 fixed to rotate therewith and adapted to frictionally engage a stationary brake-wheel 49 fixed upon a support 51. A band 53 is freely mounted upon the lower ring 44 and pivotally connected to a hand lever 55 which, when manually pulled upward, applies the brake and through the medium of the intervening parts above described simultaneously pulls the stops 34 out of the path of the respective vanes 26. Ordinarily the hand lever 55 is free to swing up and down to prevent interference with the automatic operation of the stops 34 but when desired the lever may be secured in raised position to hold the stops out of the paths of the vanes by suitable means such as a pin (not shown) adapted to be placed beneath the lever and inserted in a hole 59 of an associated sector 61.

A cable 54 attached to the intermediate ring 43b of the slide, extends beneath a guide sheave 56 and is attached at its lower end to a weight 58 which is responsive to centrifugal force when the mill wheel exceeds a predetermined speed. The weight 58 is mounted at its inner end upon a pivot 60 carried by a bracket 62 clamped upon the main shaft 2. When the weight 58 swings outward it, through the medium of the cable 54, pulls the slide 43 downward where it is held by an automatic clamping member 66 to prevent the

stops 34, from returning into the path of the vanes 26 until the slide 43 is released. The clamping member 66 is connected by a pivot 68 to the guide member 52 and held by the force of gravity against the slide 43 to clamp the latter into frictional contact with the guide 52.

When the wind subsides the weight 58 is restored to its inward, raised position, Fig. 1, by the inward movement of an oscillatory lever 70 which takes up slack in a cable 72 attached at its ends to the weight 58 and the lever 70, respectively. The oscillatory lever 70 is pivotally connected at its inner upper end to one of the lower mill wheel arms 24a and provided at its outer end with a counterweight 74. The cable 72 runs over guide sheaves 76 and 78 on a bracket 79 and one of the lower arms 24a, respectively, so that when the lever 70 moves inward it will take up the slack in the cable 72 and restore the weight 58 to its inward, raised position and when the lever 70 swings outward it will permit the cable 72 to become slack, so that the weight 58 will be free to respond to centrifugal force. Sudden movement of the lever 70 is prevented by a retarding device 84 pivotally connected at its upper and lower ends to an arm 24 and the lever 70, respectively. As the weight 58 is restored to inward, raised position it contacts and lifts the free end of the clamping member 66, thus releasing the slide 43 which is then pulled upward by action of the springs 40.

The foregoing parts may be similar in construction and operation to a number of parts in my patent above referred to, the majority of which bear corresponding reference numerals to the parts above described.

Referring now more particularly to the new features of the present invention, 34a designates a set of stops whereby the vanes 26 are presented to the wind a second time during each revolution and while traveling against the wind, Fig. 2. The stops 34a are associated with the upper and lower circumferential frames 25 and 25a, respectively, and guided and controlled in approximately the same manner as the stops 34, as is evident by similar reference numerals with exponents a, excepting that the cables 42a are attached to the stops 34a to which they are directed by sheaves 80 and 81 associated with the lower circumferential frame 25a and the arms 24a, respectively.

Another new feature of the present invention resides in means for restoring the lever 70 and weight 74 to outward, raised position so as to leave sufficient slack in the cable 72 to permit weight 58 to respond to centrifugal force. Such means includes a vertical ratchet-bar 88 operably mounted in a guide 90 fixed to the bracket 79 and a bracket 91 clamped to the shaft 2. The ratchet-bar 88 is adapted to automatically restore the lever 70 and weight 74 to raised position through the instrumentality of a cable 92 attached at its ends to the lever 70 and the ratchet-bar 88 and operating around guide sheaves 94 and 96 associated with the guide 90 and adjacent lower arm 24a, respectively, of the mill wheel. The ratchet-bar 88 is raised step by step by means of a vertical plunger 98 operating in the guide 90 and provided at its upper end with a pawl 100 which successively engages the ratchet-teeth 102 to raise the ratchet-bar one step at each upward stroke of the plunger 98.

The plunger 98 is actuated by a stationary cam 104 fixed upon suitable supporting means 99 and arranged concentrically with the lower portion of the shaft 2. To avoid undue friction the plunger 98 is provided at its lower forked terminal with a conical roller 106 which travels in a circuit upon the cam 104. As the ratchet-bar 88 is moved upward its teeth are successively engaged by a pawl 108 and thereby prevented from moving downward at each downward stroke of the plunger 98. The pawl 108 is spaced above the plunger 98 and pivotally mounted in the guide 90. The pawls 100 and 108 are yieldably pressed against the ratchet-bar 88 by springs 110 and 112, respectively. When the speed of the windmill increases sufficiently to cause the weight 58 to respond to centrifugal force, said weight will withdraw and hold the pawls 100 and 108 from engagement with the ratchet-bar 88 by means of a cable 114 running over a guide sheave 116 to both of the pawls. The ratchet-bar then drops by gravity until checked by a lip 117 on its upper end contacting the lower end of a vertical slot 117a in the guide 90.

Another new feature of the present invention relates to means for controlling the speed of the mill wheel by automatically throwing one or more vanes 26 out of gear when the speed of the wind exceeds a predetermined point. In the present instance such means includes a weight 118 suspended from an arm 120 secured to the shaft 2, so that when the mill wheel is in operation the weight 118 will be free to respond to centrifugal force and swing outwardly should the speed of the wind become abnormal. On swinging outwardly the weight 118, through the instrumentality of a cable 122 operating around a guide sheave 124 and attached to the adjacent cable 42, withdraws an associated stop 34 from the path of the associated vane 26, so that the latter may swing edgewise to the wind.

I have shown but one weight 118 and one cable 122, but it is to be understood that any desired number of weights may be employed and each may be connected to more than one cable 42 if desired. When a plurality of weights 118 and cables 122 are employed, cables 122 of different lengths to provide different amounts of slack are preferably provided to effect release of the associated vanes 26 one at a time instead of simultaneously, and thereby prevent sudden changes in the speed of the mill wheel by releasing only the necessary number of vanes to insure fairly constant speed of the mill wheel.

The operation briefly stated is as follows: Assuming that the parts are in the position shown by Figs. 1 and 2, and that the wind is blowing in the direction indicated by the arrows, Fig. 2, the mill wheel will be driven in a clockwise direction and the stops 34 and 34a will be held in active position by the springs 40 and 40a, so that those vanes 26 traveling with the wind will be held broadside thereto by the stops 34 while one or more vanes traveling against the wind will be held broadside thereto by the associated stops 34a. As the mill wheel rotates outward and upward movement of the lever 70 and counterweight 74 is effected through the medium of the intervening ratchet mechanism and the cable 92. The cable 72 becomes slack and thereby leaves the weight 58 free to respond to centrifugal force.

Should the speed of the wind become excessive the weight 58 will be thrown outward by centrifugal force and simultaneously withdraw the stops 34 and 34a from the path of the respective vanes 26 through the medium of the cables 42, 42a and the slide 43 and cable 54. The slide 43 is pulled downward by the cable 54 and au-

tomatically held in lowered position by the clamping member 66 which forces the slide into frictional engagement with the guide 52. When the stops 34 and 34a are pulled out of the path of the respective vanes 26 as above stated, the latter are free to swing edgewise to the wind, so that little or no driving effect will be exerted on the mill wheel which is checked by the brake mechanism 47, 49 when engaged on the downward movement of the slide 43.

When the weight 58 responds to centrifugal force as above stated, the pawls 100 and 108 are disengaged from the ratchet-bar 88 which descends and permits the lever 70 and its counterweight 74 to move downward and inward. However, the retarding device 84, which is proportioned to act as slowly as desired, retards the descent of the lever 70 and counterweight 74, for a predetermined period of time during which the wind may have subsided before the vanes 26 are again held broadside to the wind. As the lever 70 and counterweight 74 descend they restore the weight 58 to raised position through the instrumentality of the cable 72.

About the time that the lever 70 and counterweight 74 finally reach the end of their downward movement the pawls 100 and 108 engage the ratchet-bar 88, which is then operated to restore the lever 70 and weight 74 to raised position. Should the velocity of the wind still be excessive the foregoing operations are repeated until the wind subsides whereupon the windmill resumes normal operation. When the speed of the wind is reduced to a predetermined point the weight 58 is drawn upward and inward by the lever 70 and disengages the clamping member 66 from the slide 43, which in turn is drawn upward and releases the brake mechanism. The slide 43 is drawn upward by the action of springs 49 and 49a as they move stops 34 and 34a, respectively, into the path of the vanes 26 to hold the latter broadside to the wind.

From the foregoing description taken in connection with Fig. 2, it will be understood that when the wind is blowing in the direction indicated by the arrows it will act on the vanes 26 at that side of the mill wheel turning with the wind for approximately a one-half revolution and act on the vanes traveling against the wind for approximately one-fourth of a revolution, thereby increasing the power effort of the mill wheel.

While I have illustrated and described a preferred embodiment of my invention, it will be apparent by those skilled in the art that further embodiments and improvements may be made falling within the scope of my invention as claimed.

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

1. In a windmill, a vertical rotatable shaft, a mill wheel fixed upon said shaft and including a plurality of freely mounted vanes, stops mounted on said mill wheel for automatic engagement with the respective vanes, means associated with the shaft and the mill wheel for withdrawing the stops from engagement with the vanes, a weight associated with the shaft and adapted to be swung outwardly to active position by centrifugal force or moved inwardly and upwardly to inactive position, means connecting said weight to the means for withdrawing the stops, a lever swingably mounted on the mill wheel for inward and outward movement, a cable connecting the weight and the lever whereby when the latter

moves inward it moves the former inward and upward to inactive position, means for moving the lever outwardly comprising a ratchet-bar, flexible means connecting the lever to said ratchet-bar, and means associated with the shaft for actuating said ratchet-bar.

2. In a windmill, a vertical rotatable shaft, a mill wheel fixed upon said shaft and including a plurality of freely mounted vanes, stops mounted on said mill wheel for automatic engagement with the respective vanes, means associated with the shaft and the mill wheel for withdrawing the stops from engagement with the vanes, a weight associated with the shaft and adapted to be swung outwardly to active position by centrifugal force or moved inwardly and upwardly to inactive position, means connecting said weight to the means for withdrawing the stops, a lever swingably mounted on the mill wheel for inward and outward movement, a cable connecting the weight and the lever whereby when the latter moves inward it moves the former inward and upward to inactive position, means for moving the lever outwardly comprising a ratchet-bar, means connecting the lever to said ratchet-bar, reciprocatory means for actuating the ratchet-bar, and means associated with the shaft for operating said reciprocatory means.

3. In a windmill, a vertical rotatable shaft, a mill wheel fixed upon said shaft and including a plurality of freely mounted vanes, spring-pressed stops mounted on said mill wheel and normally projecting into the path of the respective vanes, means associated with the shaft and the mill wheel for withdrawing the stops from the path of the vanes, including a weight responsive to centrifugal force, a lever swingably mounted on the mill wheel for inward and outward movement, a cable connecting the weight and the lever whereby when the latter moves inward it moves the former inward and upward to inactive position, means for moving the lever outwardly comprising a ratchet-bar, means connecting the lever to said ratchet-bar, reciprocatory means including a pawl for advancing said ratchet-bar, means for operating said reciprocatory means, and guide means whereby the ratchet-bar and said reciprocatory means are rotated with the shaft.

4. In a windmill, a vertical rotatable shaft, a mill wheel fixed upon said shaft and including a plurality of freely mounted vanes, stops mounted on said mill wheel and normally projecting into the path of the respective vanes, means associated with the shaft and the mill wheel for withdrawing the stops from the path of the vanes, including a weight responsive to centrifugal force, a lever swingably mounted on the mill wheel for inward and outward movement, a cable connecting the weight and the lever whereby when the latter moves inward it moves the former inward and upward to inactive position, means for moving the lever outwardly comprising a ratchet-bar, flexible means connecting the lever to said ratchet-bar, reciprocatory means including a pawl for advancing said ratchet-bar, cam means for operating said reciprocatory means, and guide means whereby the ratchet-bar and said reciprocatory means are rotated with the shaft.

5. In a windmill, a vertical rotatable shaft, a mill wheel fixed upon said shaft and including a plurality of freely mounted vanes, stops mounted on said mill wheel and normally projecting into the path of the respective vanes, means associated with the shaft and the mill wheel for

withdrawing the stops from the path of the vanes, including a weight responsive to centrifugal force, a weighted lever swingably mounted on the mill wheel for inward and outward movement, a cable connecting the weight and the lever whereby when the latter moves inward it moves the former inward and upward to inactive position, means for moving the lever outwardly comprising a vertical ratchet-bar, flexible means connecting the lever to said ratchet-bar, reciprocatory means including a pawl for lifting said ratchet-bar step by step, means associated with the reciprocatory means for actuating the same, a pawl for preventing accidental downward movement of the ratchet-bar, flexible means connecting the pawls to the weight whereby when the latter responds to centrifugal force it will disengage the pawls from the ratchet-bar and permit the latter to move downward to its starting point, and guide means whereby the ratchet-bar and the reciprocatory lifting means are connected to the shaft to rotate therewith.

6. In a windmill, a vertical rotatable shaft, a mill wheel fixed upon said shaft, a weighted lever swingably mounted on the mill wheel for inward and outward movement, a ratchet-bar associated with the lever to move the same outwardly, reciprocatory means including a pawl for advancing the ratchet-bar step by step, a pawl for preventing accidental backward movement of the ratchet-bar, a weight associated with the shaft to rotate therewith and adapted to be moved outward by centrifugal force, flexible means connecting said weight to the pawls to disengage them from the ratchet-bar on outward movement of the weight, and means connecting said weight to the lever whereby when the latter is moved outwardly it will move the former inwardly and upwardly.

7. In a windmill, a vertical rotatable shaft, a mill wheel fixed upon said shaft and including a plurality of freely mounted vanes, spring actuated means, stops mounted on said mill wheel for automatic engagement with the respective vanes, means mounted upon the shaft and the mill wheel and attached to the stops for withdrawing the latter from engagement with the vanes, a weight operably connected to the shaft and adapted to be swung outwardly to active position by centrifugal force or moved inwardly and upwardly to inactive position, means connecting said weight to the means for withdrawing the stops, a lever swingably mounted on the mill wheel for inward and outward movement, a cable connecting the weight and the lever whereby when the latter moves inward it moves the former inward and upward to inactive position, reciprocatory ratchet means rotatable with the shaft, reciprocatory means rotatable with the shaft for actuating the ratchet means, means for actuating said reciprocatory means, and flexible means connecting said ratchet means and the lever whereby the latter is moved outwardly by said ratchet means.

8. In a windmill, a vertical rotatable shaft, a mill wheel fixed upon said shaft and including a plurality of freely mounted vanes, stops mounted on said mill wheel for automatic engagement with the respective vanes, means associated with the shaft and the mill wheel for withdrawing the stops from the path of the vanes, including a normally raised swingable member adapted to be swung downwardly and outwardly by centrifugal force, a lever operably connected to the mill wheel and adapted to swing in one direction to restore the swingable member to raised position, means operably connecting the swingable member and the lever, ratchet mechanism rotatable with the shaft for restoring said lever to normal position, flexible means connecting the ratchet mechanism and the lever, a plunger for actuating said ratchet mechanism, and a cam adjacent to the lower portion of the shaft and adapted to actuate said plunger.

9. In a windmill, a vertical rotatable shaft, a mill wheel fixed upon said shaft and including a plurality of freely mounted vanes, stops mounted on said mill wheel for automatic engagement with the respective vanes, means operably mounted upon the shaft and the mill wheel for withdrawing the stops from the path of the vanes, including a normally raised member pivoted to the shaft and adapted to be swung downwardly and outwardly by centrifugal force, a lever pivotally connected to the mill wheel and adapted to swing downward and restore the pivoted member to raised position, a cable connecting the lever and said member, a ratchet-bar mounted for rotation with the shaft and adapted to restore the lever to raised position, flexible means connecting the ratchet bar and said lever, a reciprocating plunger, means interposed between the plunger and the ratchet bar whereby the latter is operated by the former, and stationary means surrounding the shaft and adapted to operate the plunger.

10. In a windmill, a vertical rotatable shaft, a mill wheel fixed upon said shaft and including a plurality of freely mounted vanes, stops mounted on said mill wheel for automatic engagement with the respective vanes, means mounted on the shaft and the mill wheel for withdrawing the stops from the path of the vanes, including a normally raised swingable member adapted to be swung downwardly and outwardly by centrifugal force, a lever operably connected to the mill wheel and adapted to swing downward and restore the swingable member to raised position, a ratchet-bar mounted for rotation with the shaft and adapted to restore the lever to raised position, means connecting the lever and said ratchet-bar, a reciprocating plunger associated with said ratchet-bar to actuate the latter, means for actuating the plunger, a pawl on said plunger normally engaging the ratchet-bar, a second pawl associated with the first-mentioned pawl and normally engaging the ratchet-bar, flexible means connecting the pawls to the swingable member whereby when the latter responds to centrifugal force it withdraws the pawls from the ratchet-bar to permit the latter to return to initial position and allow the lever to move downward.

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