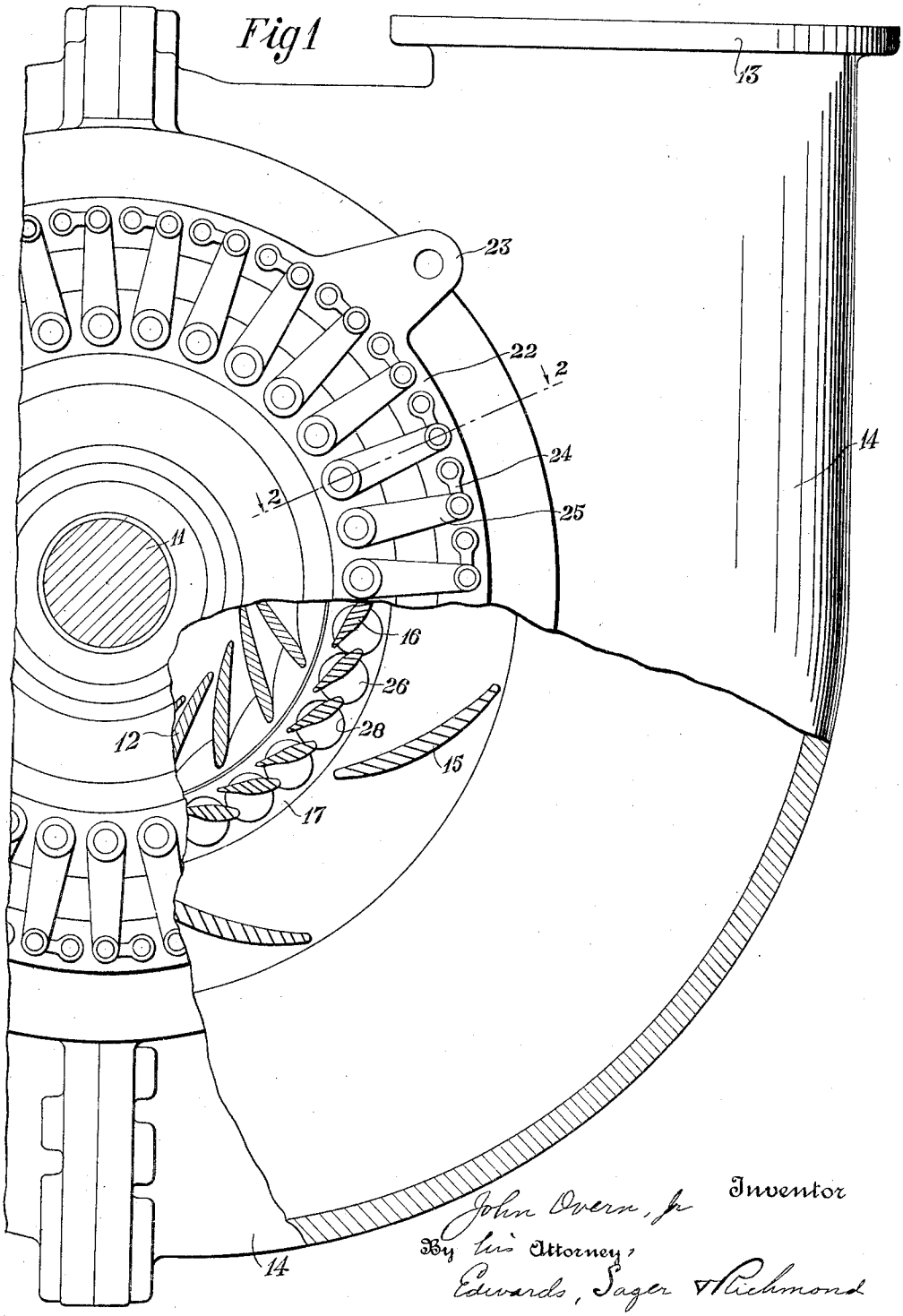
Dec. 18, 1923. 1,478,053

J. OVERN, JR

GUIDE VANE FOR HYDRAULIC TURBINES

Filed May 22, 1919 3 Sheets-Sheet 1

Fig 1



John Overn, Jr Inventor

By his Attorneys,

Edwards, Sager & Richmond

Dec. 18, 1923. 1,478,053

J. OVERN, JR

GUIDE VANE FOR HYDRAULIC TURBINES

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Fig3

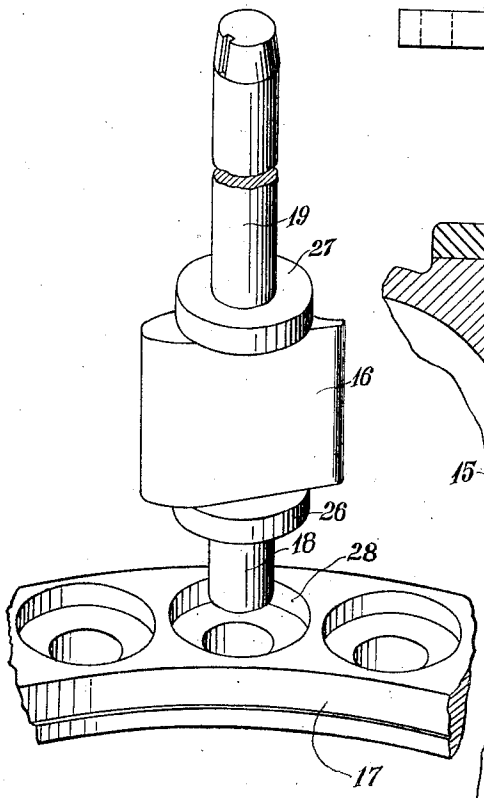
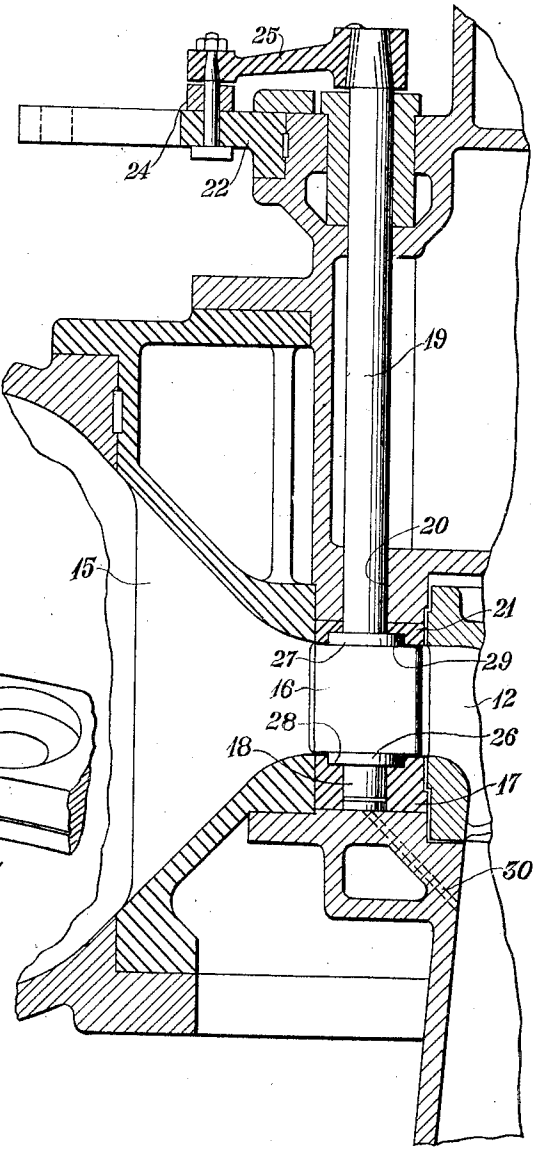


Fig2



John Overn Jr. Inventor

By his Attorneys

Edwards Sager & Richmond.

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Fig4

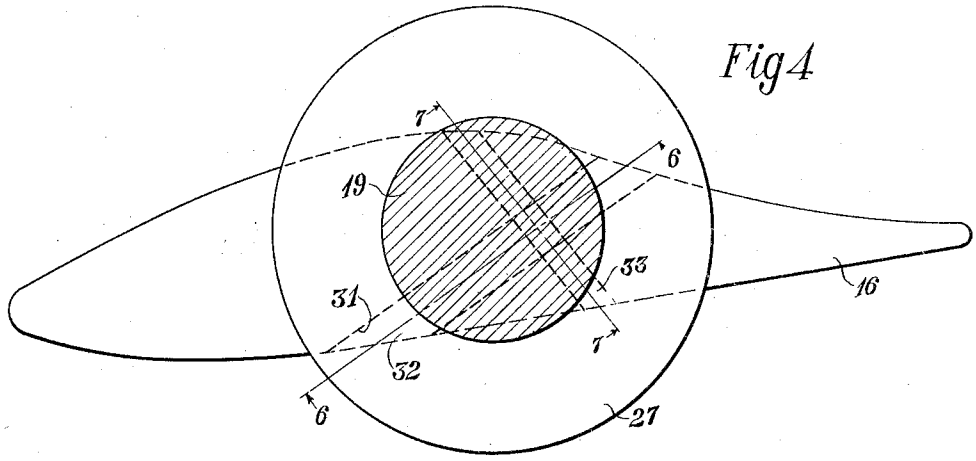


Fig5

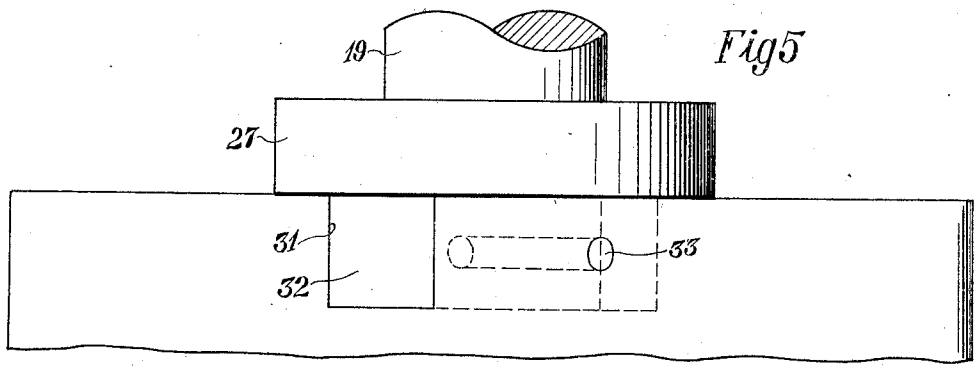


Fig6

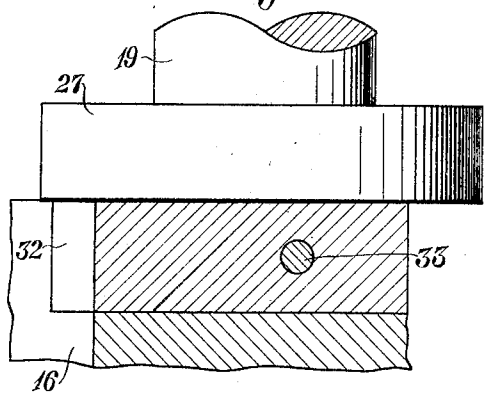
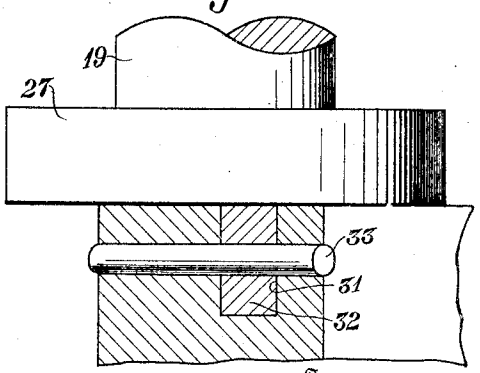


Fig7



John Overn, Jr. Inventor

By his Attorneys

Edwards, Sager & Richmond

Patented Dec. 18, 1923. 1,478,053

UNITED STATES PATENT OFFICE.

JOHN OVERN, JR., OF PHILADELPHIA, PENNSYLVANIA, ASSIGNOR TO WILLIAM CRAMP & SONS SHIP AND ENGINE BUILDING COMPANY, A CORPORATION OF PENNSYLVANIA.

GUIDE VANE FOR HYDRAULIC TURBINES.

Application filed May 22, 1919. Serial No. 298,982.

To all whom it may concern:

Be it known that I, JOHN OVERN, Jr., a citizen of the United States, residing at Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented certain new and useful Improvements in Guide Vanes for Hydraulic Turbines, of which the following is a specification.

The principal object of my invention is to provide a new and improved axially mounted gate or guide vane for a hydraulic turbine. Another object of my invention is to provide such a gate with means to reduce the leakage past its ends to a minimum when the gate is partially or entirely closed. Still another object of my invention relates to establishing a strong mechanical connection between the gate and the shaft on which it is mounted. Another object of my invention is to enable a gate to be used having an improved shape to suit the flow of the water and one which will leave a clear passage for the water at all points of the gate surface. Another object of my invention is to enable the gates to be mounted in the most desirable position with respect to the axis of motion of the gate without the necessity of having the axis pass through the body of the gate. Still another object of my invention is to provide a convenient method of removing or replacing a gate without disturbing the gate shaft or other parts of the turbine. All these and other objects of my invention will be appreciated upon consideration of the disclosure of a limited number of specific embodiments as set forth in the following specification and claims and the accompanying drawings. It will be understood that modifications may be made within the scope of the invention. I will now proceed specifically to describe the embodiments shown in the drawings.

Fig. 1 is a top plan view partly broken away showing a hydraulic turbine equipped with my improved gates.

Fig. 2 is a vertical section on an enlarged scale on the radial line 2—2 of Fig. 1.

Fig. 3 is a perspective view of a gate and its shaft and a fragment of one of the distributor plates with which the gate cooperates.

Fig. 4 is a top plan view of a gate involving a modified construction.

Fig. 5 is an elevation of the same and

Figs. 6 and 7 are sections on the lines 6, 6 and 7, 7 of Fig. 4.

Referring to the embodiment of my invention disclosed in Figs. 1 to 3, as applied to a vertical shaft unit, the vertical turbine shaft 11 carries the runner with vanes 12 adapted to be actuated by radial inflow of water from the turbine casing 14, which may be connected by the flange 13 to a supply of water under appropriate head. The water passing from the spiral casing 14 goes between the fixed vanes 15 and then between the adjustable wicket gates or vanes 16. Each gate 16 is integral with a shaft 19 rotatably mounted in the bearings 20. The gates 16 stand in a circular row, below them being the distributor plate or wearing ring 17 and above the distributor plate or wearing ring 21. The distributor plate 17 has suitable holes to receive the pintles 18 on the respective gates, and is also counterbored to form shallow cylindrical recesses 28 to receive the corresponding enlarged disks 26, integral with the gates 16, where the pintles 18 join the gates. Similarly above the gates 16 the distributor plate 21 is counterbored to form shallow cylindrical recesses of large diameter 29 that receive the collars 27. The recesses in the distributor plates 21 and 17 such for example as the recesses 28 in the plate 17 are cut as close together as may be and still leave enough metal between to guard against any breaking of the division wall thereof. The faces of the disks 26 and 27 on the sides toward the vane are made fair and flush with the surfaces of the distributor plates. By referring to Fig. 3, it will be seen that in the embodiment of the invention now under discussion, the shaft 19, collars 27 and 26, vane 16 and pintle 18 are all one integral structure.

When the turbine is operating at normal load or nearly normal load the vanes will

have about the position shown in Fig. 1 and the water will flow freely between them acting on the runner vanes 12 and causing rotation of the shaft 11 with its load. To shut the turbine down, the ring 22 will be rotated counterclockwise, and through the links 24 and the cranks 25 the shafts 19 will also be rotated counterclockwise, thus bringing the points of the gates 16 against the backs of the succeeding vanes and closing the spaces between the gates 16.

When the gates 16 are closed or nearly closed, the difference of pressure on the opposite sides will be substantially equal to the whole head on the turbine. In the absence of collars 27 and 26 and depressions 29 and 28, it would be necessary in practice to provide at least a slight clearance between the upper and lower ends of the gates 16 and the wearing rings 21 and 17 in order to insure free motion. These narrow clearance spaces would permit thin sheets of water to leak past the gates above and below. It has been the common practice heretofore to construct gates without the collars such as 27 and 26 and when the gates were closed there would be these thin sheets of water leaking past adjacent to the wearing rings 21 and 17. Not only has this resulted in a loss of water, that it would be desirable to save for power purposes, but these leakage streams have eroded the runner vanes 12, and in high head turbines that have been in use for a considerable time it is not uncommon to find the outer edges of the runner vanes deeply notched opposite the wearing rings above and below where the vanes have been cut into by these thin leakage streams. This notching tends to start active corrosion during normal operation. The wide collars 27, 26 of my invention almost completely block off these leaks.

Another advantage of my invention is realized when as is commonly the case the thickness of the vanes 16 is less than the diameter of the shaft 19. In such a case in the absence of the collars 26 and 27 it has been necessary, particularly at the point where collar 27 is now introduced, either to change abruptly from the circular section of the shaft to the vane shaped section of the gate, or to extend the shaft down on the face of the vane in the form of a local swelling or lug in order to increase the cross-section of the metal at this point, and to increase the strength. If the shaft is not extended in this manner the point of transition from the circular shaft to the vane shaped portion of the gate represents a section of greatly reduced strength, but on the other hand if the circular section is extended, the swelling or lug thus formed on the vane surface interferes with the proper flow of water along the vane, and even at best this form of gate does not have all the strength that is desirable at the junction point between the shaft and vane. It will be seen that in my improvement as exemplified in Fig. 3, there is no reduction of torsional strength for cross sections at any height. Where the shaft 19 joins the collar 27, there is the same cross section as anywhere along the shaft, and where the collar 27 joins the vane 16 the cross section is enough to give the same or greater torsional strength as across shaft 19. Farther down, the cross section and torsional strength of the vane will ordinarily be greater than of the shaft 19.

The need for torsional strength in the assembled shaft and vane becomes apparent when it is considered that sometimes stones or other hard objects may get into the water supplied to the turbine and lodge between two consecutive wicket gates during a closing motion of the gates, whereupon practically the entire governor effort communicated through the ring 22 will be thrown on one or two gate shafts 19, and it is important that the connection of the shaft 19 with its gate 16 shall be strong enough to withstand the resulting torque.

The collars 26 and 27 when accompanied by suitable methods of relieving the pressure on the end faces within the distributor plates can be so arranged as to balance the hydraulic thrust tending to force the gates in an axial direction. Attention is called to the relief holes 30 connecting the space below the lower pintle with the draft tube.

It is frequently possible to improve the design of the guide vanes by shifting them laterally away from their center of rotation. One reason for doing this is to place them nearer to the turbine runner and thus to reduce the width of clear space between the guide vanes and runner, while at the same time permitting the shaft to be located a sufficient distance away from the runner to provide the necessary space for the bearings which support it. Another consideration which makes it desirable to be able to shift the vane with respect to its center of rotation is the reduction which can be secured in this way in the hydraulic load which the governor must overcome in moving the vane.

Referring to the modification disclosed in Figs. 4 to 7, these figures show only the connection between the vane and the shaft, the casing and wearing rings and other parts being the same as for Figures 1 to 3. In the modification of Figures 4 to 7 the gate is made detachable from the shaft and the design is such that the gate can be removed without removing the shaft above or the pintle below. The shaft 19 carries the disk 27 and a diametral rib or feather 32 projecting across the face of the disk 27. The gate 16 has a corresponding slot 31 filled by the feather 32. A transverse pin 33 through the gate 16 and the feather 32 keeps the parts

in assembled relation. The joint between the gate and the pintle on the lower side is of exactly the same character. Heretofore it was common when it was desired to remove a single gate, to remove the turbine head cover because the removal of the gate required the removal of the shaft on which it was mounted. By the present invention, if a particular gate is to be removed the pins 33 will be driven out and then the gate can be displaced horizontally in the direction of the slot 31 and key 32 and at any time it, or a substitute gate, can readily be replaced. At all points the cross sections may be made sufficient to give the same strength as that of the cross section of the shaft 19. In this case the collar 27 not only affords a check against leakage but gives a base for the rib 32 with adequate cross section for torsional strength. In other respects the principle of operation of the modification of Figs. 4 to 7 will be understood from the foregoing discussion in connection with Figs. 1 to 3, this modification of Figs. 4 to 7 being separately claimed in my copending divisional application Serial No. 600,626.

I claim:—

1. In a hydraulic turbine, an annular plate at the water inlet to the runner, a series of wicket gates at said inlet, rotatable shafts each carrying a respective gate, and an enlarged collar where each shaft joins its gate, said annular plate having recesses to receive the respective collars.

2. In a hydraulic turbine, two annular plates, one above and one below at the water inlet to the runner, a series of gates between said plates, shafts parallel to the axis on which said gates are mounted respectively and enlarged cylindrical collars adjacent to the gates, said plates having shallow cylindrical recesses to receive said collars, these recesses being closely spaced around the ring but separated enough to leave a clear portion of the ring between them.

3. In a hydraulic turbine, an annular plate at the water inlet to the runner, a series of wicket gates at said inlet, said plate having cylindrical openings of large diameter, and each said gate having a corresponding cylindrical member movable with said gate fitting into its respective opening, the surface of each member being flush with the surface of the plate to leave an unobstructed water passage.

4. In a hydraulic turbine, a distributor plate at the water inlet to the runner, a series of wicket gates at said inlet, said plate having shallow cylindrical recesses, and each said gate having a corresponding collar fitting into a respective recess, the recesses being closely spaced around the ring but separated enough to leave a clear portion of the ring between any two successive recesses.

5. In a hydraulic turbine, a distributor plate at the water inlet to the runner, a series of wicket gates at said inlet and means substantially to prevent leakage of water between the said plate and the adjacent ends of the gates.

6. In a hydraulic turbine, two distributor plates at the water inlet to the runner, a series of wicket gates between them, said gates having the same sectional outline everywhere between the distributor plates, such outline being adapted for the clear flow of water along the gate surface at all points, respective shafts connected with the gates, and means adjacent to one of the distributor plates connecting said gates and shafts with a torsional strength as great as for a section of the shaft.

7. In a hydraulic turbine, a distributor plate at the water inlet to the runner, a series of wicket gates forming adjustable guiding passages between them at said inlet, respective shafts for said gates, each gate being eccentric to its respective shaft, and means connecting said shaft with the gates having a torsional strength as great as for the cross section of a shaft.

8. In a hydraulic turbine, an annular plate at the water inlet to the runner, a series of wicket gates at said inlet, rotatable shafts each carrying a respective gate, and an enlarged collar integral with each shaft where it joins its gate, said annular plate having recesses to receive the respective collars.

9. In a hydraulic turbine, an annular plate at the water inlet to the runner, a series of wicket gates at said inlet, rotatable shafts each carrying a respective gate integral therewith, and an enlarged collar where each shafts joins its gate, said annular plate having recesses to receive the respective collars.

10. In a hydraulic turbine, a distributor plate at the water inlet to the runner, a series of wicket gates at said inlet and means integral with each gate substantially to prevent leakage of water between the said plate and the adjacent ends of the gates.

11. In a hydraulic turbine a runner, distributor plates, a series of adjustable guide vanes between said plates and adapted to contact with each other in closed position, a shaft for each vane having its axis passing outside of the surface of said vane and means rigidly connecting said vane and said shaft so that said shaft adjusts said vane around the axis of said shaft as a center, said means serving to secure said vane to said shaft so that said vane lies intermediate the runner and shaft axis and when in operating position is near to said runner.

12. In a hydraulic turbine, distributor plates having a series of cylindrical recesses therein, a series of adjustable guide vanes

between said plates and adapted to contact each other in closed position, each having the same smoothly guiding sectional outline everywhere between the distributor plates, a shaft for each vane having its axis passing outside of the surface of said vane and means rigidly connecting said vane and said shaft so that said shaft adjusts said vane around the axis of the shaft as a center, said means having a cylindrical form adapted to be seated in a cylindrical recess in said distributor plate.

JOHN OVERN, JR.