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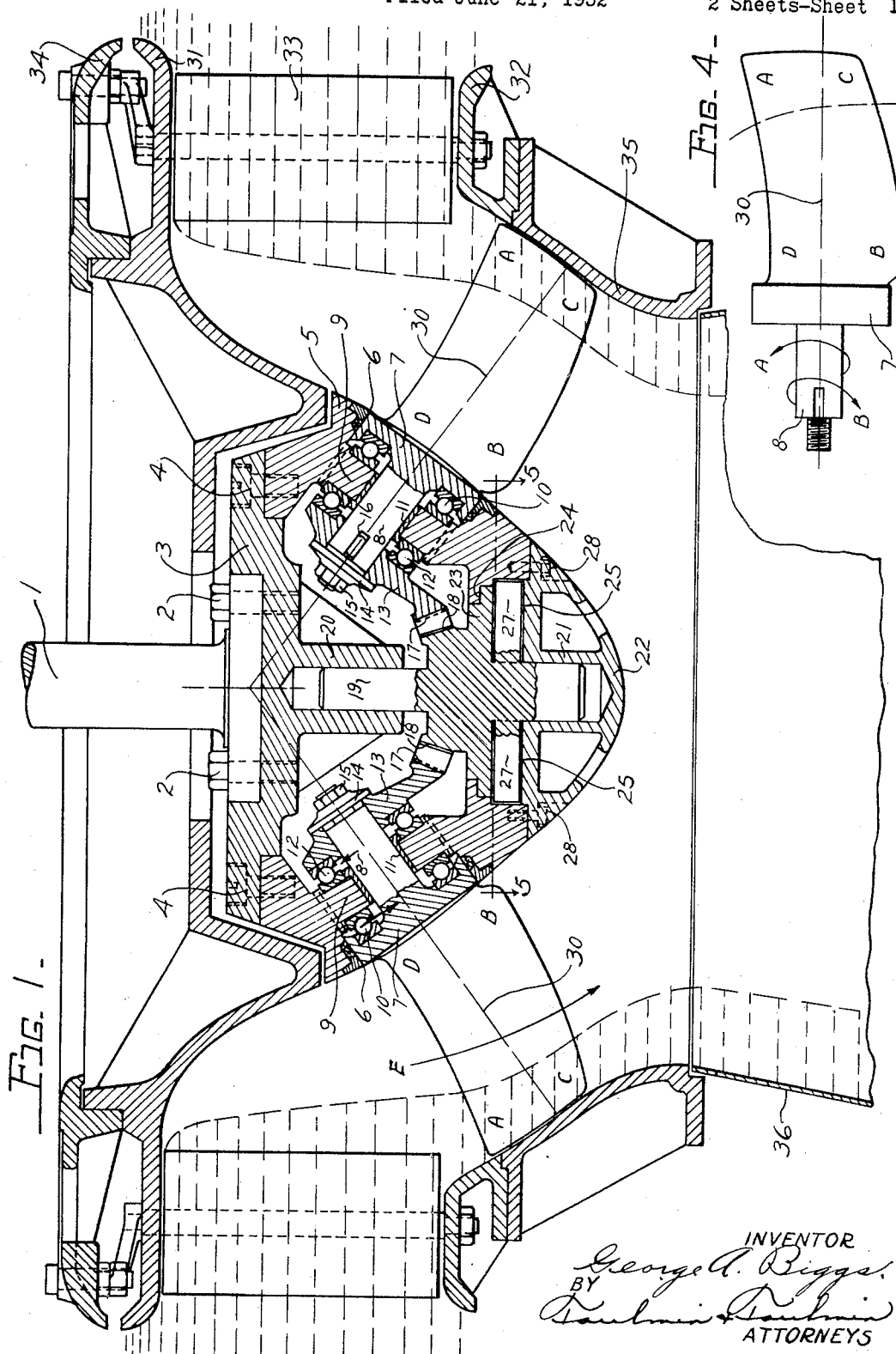
G. A. BIGGS

1,948,478

HYDRAULIC TURBINE

Filed June 21, 1932

2 Sheets-Sheet 1



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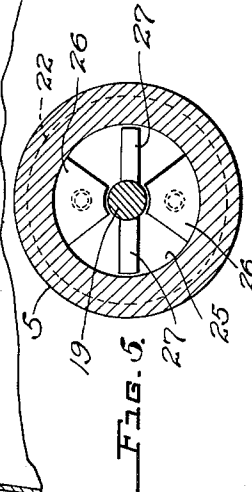
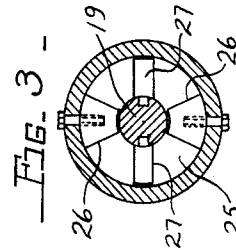
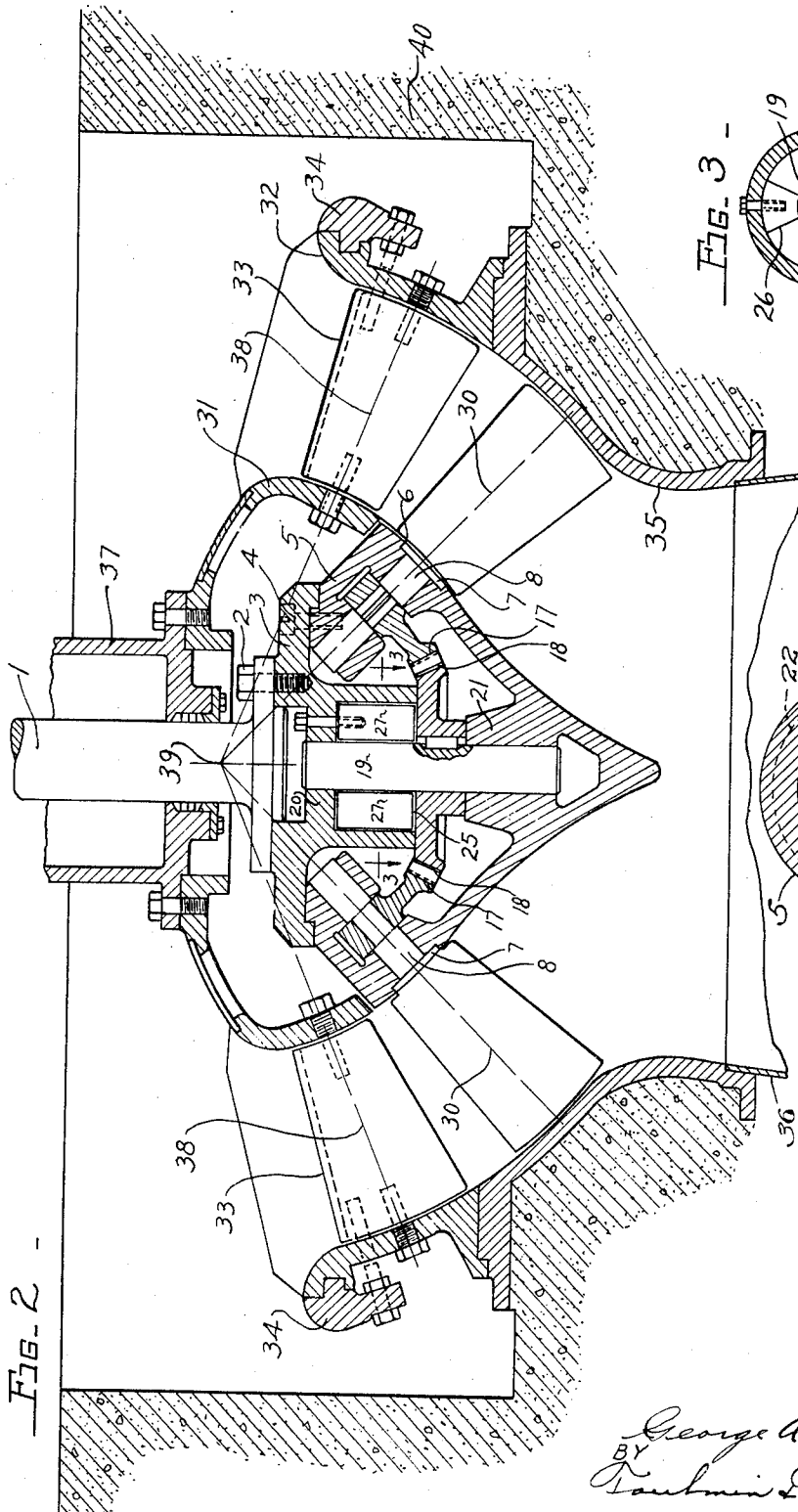
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2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

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HYDRAULIC TURBINE

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Application June 21, 1932. Serial No. 618,489

6 Claims. (Cl. 253—144)

My invention relates to hydraulic turbines and, in particular, to adjustable blade turbines.

It is the object of my invention to provide a self-adjusting, adjustable blade turbine runner which will automatically adjust the position of the blades according to the flow of water through the runner in order to utilize the flow to the maximum.

It is a further object to cause these blades to be self-adjusting by the unbalanced pressure of the water so that, as the water varies, the adjustment of the blades will vary in a most efficient position for the blades for that particular flow of water.

It is a further object of my invention to provide in such a combination means of retarding the adjusting movement of the blades so as to prevent too rapid an adjustment and consequent fluttering of the adjustable blades.

It is my object to provide such a blade in such a combination that will be affected by different degrees of water flow through the draft tube at different settings of the gate, and of such size, form and proportion that the amount of water applied to it progressively through its length will have different effects upon it. For instance, water at part gate being applied only to the outer end of the blades will cause the blades to move towards closing position, whereas with increasing flow of the water and the extension of the water in its engagement with the blade closer to the hub of the runner, the water will engage a zone of the blade nearer the hub which will cause the blade to move towards open position.

It is a further object to provide such areas affected by the water on the blade on the respective sides of the axis of the blade from periphery to hub so as to effect the above object.

Referring to the drawings:

Figure 1 is a section through the gate casing, draft tube and one-half of the runner hub showing the bucket;

Figure 2 is a modified form of construction embodying my invention;

Figure 3 is a section on the line 3—3 of Figure 2 showing the dash pot arrangement to prevent fluttering;

Figure 4 is a diagrammatic view showing the nature of the overlapping of the blades when in closed position.

Figure 5 is a section on the line 5—5 of Figure 1.

Referring to the drawings in detail, 1 is the shaft of the runner, which is bolted by the bolts

2 to the cover plate 3 that is, in turn, bolted by the bolts 4 to the hub 5 of the runner. The hub 5 is provided with a plurality of diagonally-disposed apertures 6 in which are mounted the blade shaft hubs 7 having the shafts 8. The hub 5 of the runner is provided with an annular shoulder 9 in the aperture 6 spaced from the outer end of the aperture so that a ball bearing 10 may be interposed between the hub 7 of the blade and the annular member 9 of the runner hub. The shaft 8 is engaged by a bearing sleeve 11 carried on the annular member 9.

On the inner end of this annular member 9 is a second ball bearing 12 which is held in position by the segmental rack 13 mounted on the inner end of the blade shaft 8 and retained in position by the cap plate 14 and nut 15 threaded on the end of the shaft 8. The segmental rack 13 is keyed by a key in the key way 16. This segmental rack 13 has teeth 17 engaging with teeth on the gear 18 which is formed on and is a part of the adjusting shaft 19 which is journaled in the sleeve 20 of the cap plate 3 at its upper end and journaled in the sleeve 21 at its lower end and the detachable nose 22 forming the lower end of the runner hub. This adjusting shaft 19 is provided with a laterally-extending flange 23 which interlocks at 24 beneath a shoulder on the runner hub 5 so that the runner hub 5, the flange 23 and the top of the detachable nose 22 forming a dash pot chamber 25 containing a suitable dash pot fluid which is adapted to leak around the stationary vanes 26, mounted on the nose 22 and the rigid vanes carried by the shaft 19 designated 27. The tendency to revolve in either direction of the shaft 19 is dampened by this dash pot construction. The nose 22 is detachably mounted on the hub 5 by the screws 28.

Turning to the specific configuration of the blade which is one of the features of this invention, 30 designates the longitudinal axis of the blade and its shaft 8. It will be noted that in the zone marked "A" on the entering side of the blade, which zone is adjacent the peripheral tip of the blade that there is a larger area than in the zone "D" which is on the entering side of the blade but adjacent the hub.

It will be further seen that the zone "C" on the exit side of the blade adjacent the periphery is relatively small in area compared to the area "B" on the same side of the blade but adjacent the hub.

Thus, small quantities of water will tip the blade backwardly and large quantities will tip it forwardly. The small quantities engage pri-

marily the tip of the blade whereas the large quantities will extend towards the hub of the blade and engage the hub.

As indicated in Figure 1, when the water is flowing through at part gate, the area "A", which is larger than the area "C", will receive the major part of the stream pressure when operating at part gate where most of the water passes through the zone "A" and "C". At full gate the water is spread out over the entire blade surface and as the zones "B" and "C" have a greater area than "D" and "A", the blade will tip over towards "B" which is the result desired.

As all of the blades are interconnected, there being any desired number, they will all move equally, will serve to counter balance one another and will all be influenced by the dash pot.

The remainder of the construction may be of any conventional character, such as an upper gate ring 31, a lower gate ring 32 with gates 33 therebetween actuated from a ring 34. 35 designates the draft tube ring and 36 the draft tube. 37 designates the bearing for aligning the shaft 1.

In Figure 1, the gate is vertically disposed, whereas in Figure 2 the gate is diagonally disposed. Under some conditions there is advantage in having the axis 30 of the blade and the axis 38 of the gate coinciding at 39 in a common center upon the runner shaft axis.

The outer ends of the blades and the outer ends of the gates are both arcuate to suitably conform to the contour of the draft tube. 40 designates the usual foundation which may be of any desired character.

In Figure 2 the dash pot is vertically disposed whereas in Figure 1 it is horizontally disposed.

When in operation, the water flowing in the direction of the arrow E produces a pressure on the blade or bucket in the direction indicated by the arrow. This tends to cause a pressure on the bearing 10 in the direction indicated by the arrow on the bearing and tends to cause an opposite pressure on the bearing 12 as indicated by the arrow. However, this is totally or partially eliminated by the centrifugal force of the blade which tends to raise the blade so as to stand out horizontally. The blades are inclined at an angle to the axis of the turbine downwardly at the outer circumference of the blades with this in view. The centrifugal force tends to lift the tips of the blades upwardly. This force acting oppositely against the blade neutralizes the pressure on the bearings thereby making the blade easier to operate than if the axis 30 were horizontal or inclined at an angle above the horizontal in which event there would be either no benefit from centrifugal force or the centrifugal effect would be detrimental.

It will be understood that I desire to comprehend within my invention such modifications as may be necessary to adapt it to varying conditions and uses.

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

1. In a hydraulic turbine, a runner and a plurality of self-adjusting blades thereon interconnected with one another and regulated in their movement by a dash pot, the area of the trailing edge of each blade being greater at the runner than at its tip. 80

2. In a hydraulic turbine, a runner and a plurality of self-adjusting blades thereon regulated in their movement by a dash pot means, the area of the trailing edge of each blade being greater at the runner than at its tip. 85

3. In combination, a hydraulic turbine runner having a plurality of rotatable blades self adjusted by the engagement of the water therewith according to the volume of water flowing thereover, said buckets being so arranged that on the entering side at the tip there is a greater area than at the entering side adjacent the hub with respect to the longitudinal axis of the blade, and the area at the tip on the exit side with respect to the longitudinal axis is smaller than at the hub. 95

4. In combination, a hydraulic turbine runner having a plurality of rotatable blades self adjusted by the engagement of the water therewith according to the volume of water flowing thereover, said buckets being so arranged that on the entering side at the tip there is a greater area than at the entering side adjacent the hub with respect to the longitudinal axis of the blade and the area at the tip on the exit side with respect to the longitudinal axis is smaller than at the hub, and gate means adjustable for regulating the flow of water whereby the blades are adjusted. 105

5. In combination, a hydraulic turbine runner having a plurality of rotatable blades self adjusted by the engagement of the water therewith according to the volume of water flowing thereover, said buckets being so arranged that on the entering side at the tip there is a greater area than at the entering side adjacent the hub with respect to the longitudinal axis of the blade and the area at the tip on the exit side with respect to the longitudinal axis is smaller than at the hub, and gate means adjustable for regulating the flow of water whereby the blades are adjusted, and means for interconnecting said blades so they will move from one position to another as a unit. 110

6. In combination, a hydraulic turbine runner having a plurality of rotatable blades self adjusted by the engagement of the water therewith according to the volume of water flowing thereover, said buckets being so arranged that on the entering side at the tip there is a greater area than at the entering side adjacent the hub with respect to the longitudinal axis of the blade and the area at the tip on the exit side with respect to the longitudinal axis is smaller than at the hub, and gate means adjustable for regulating the flow of water whereby the blades are adjusted, and means for interconnecting said blades so they will move from one position to another as a unit, and dash pot means for regulating said movement. 115

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