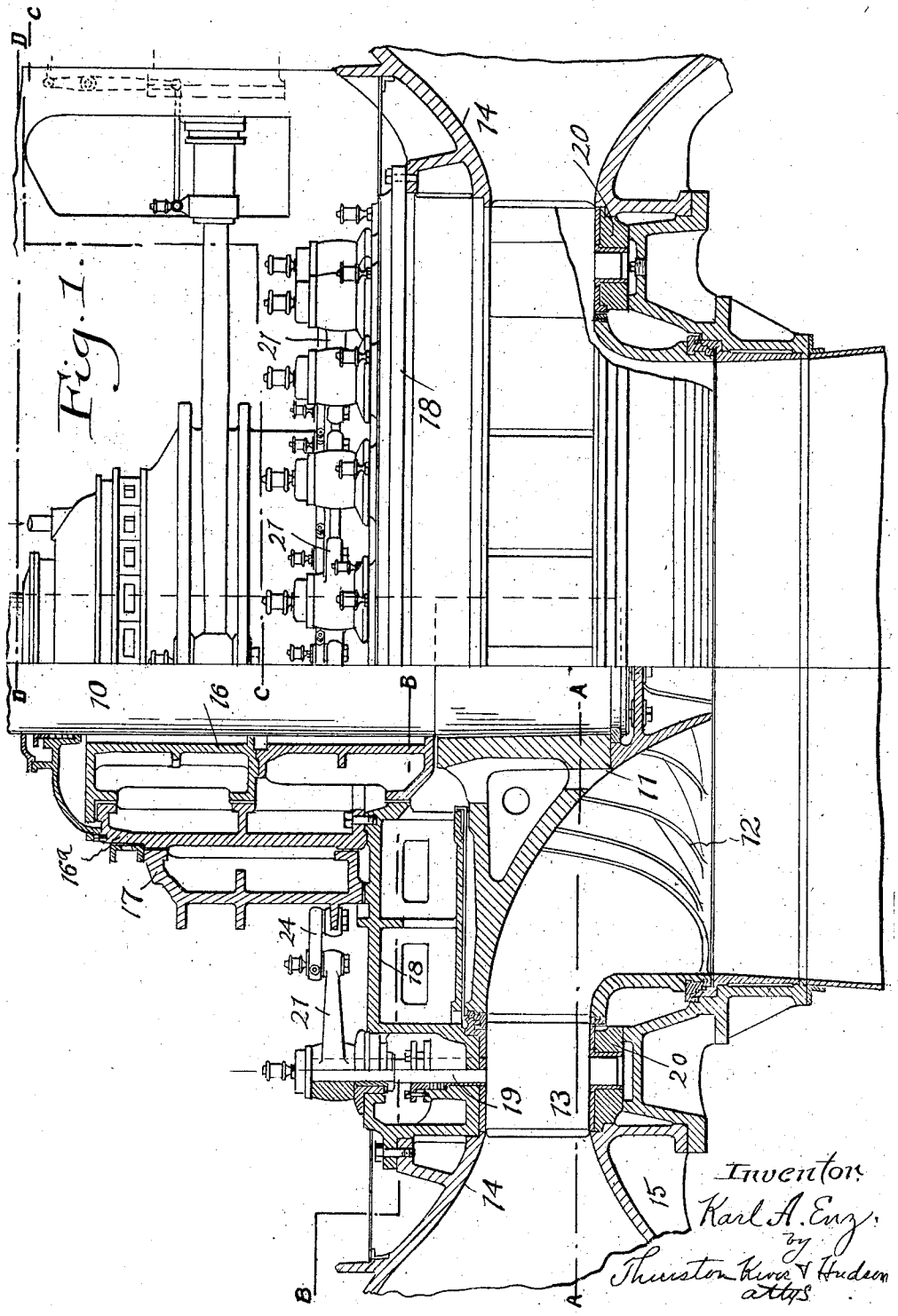
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K. A. ENZ

WATER TURBINE

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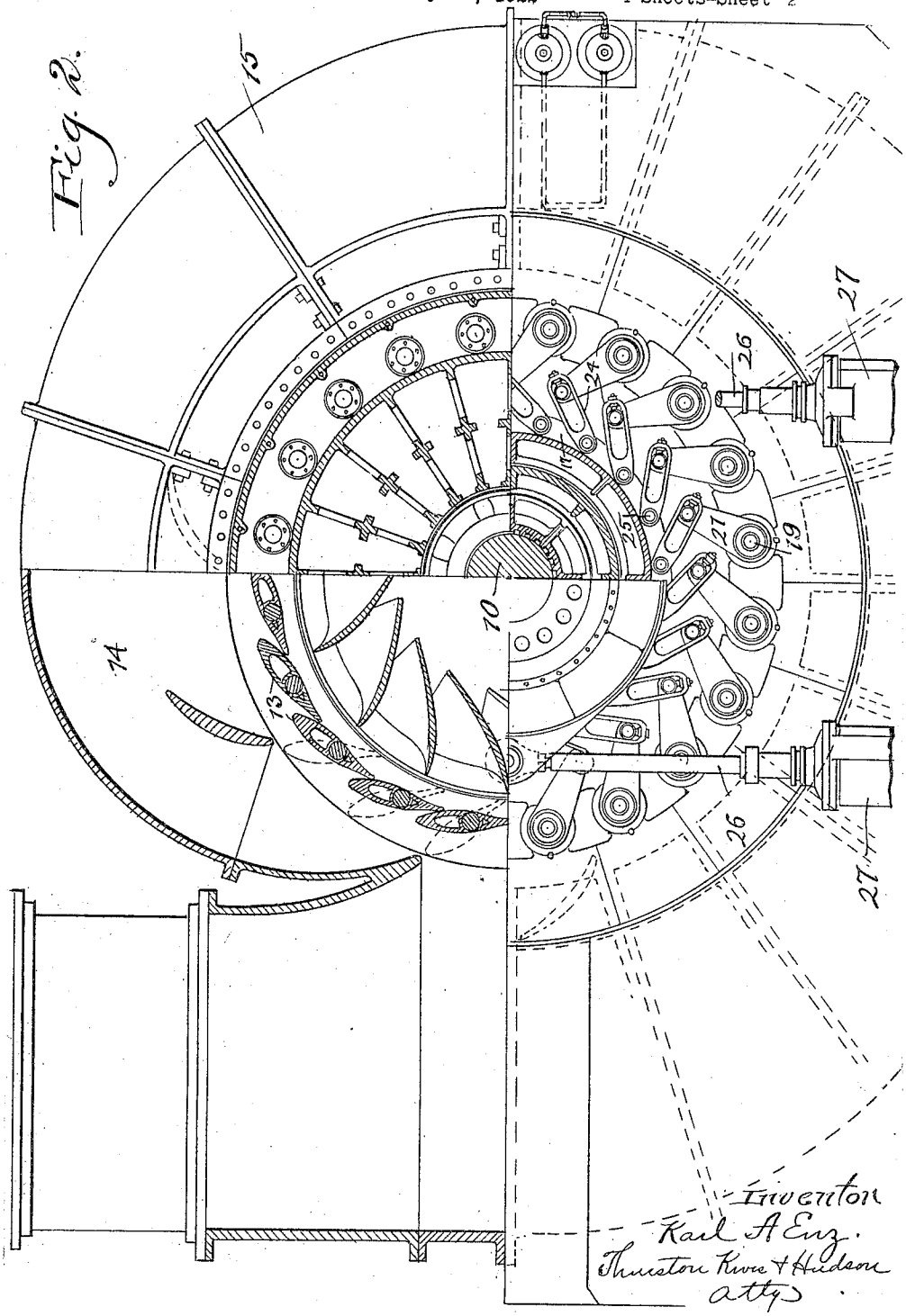
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Fig. 2.




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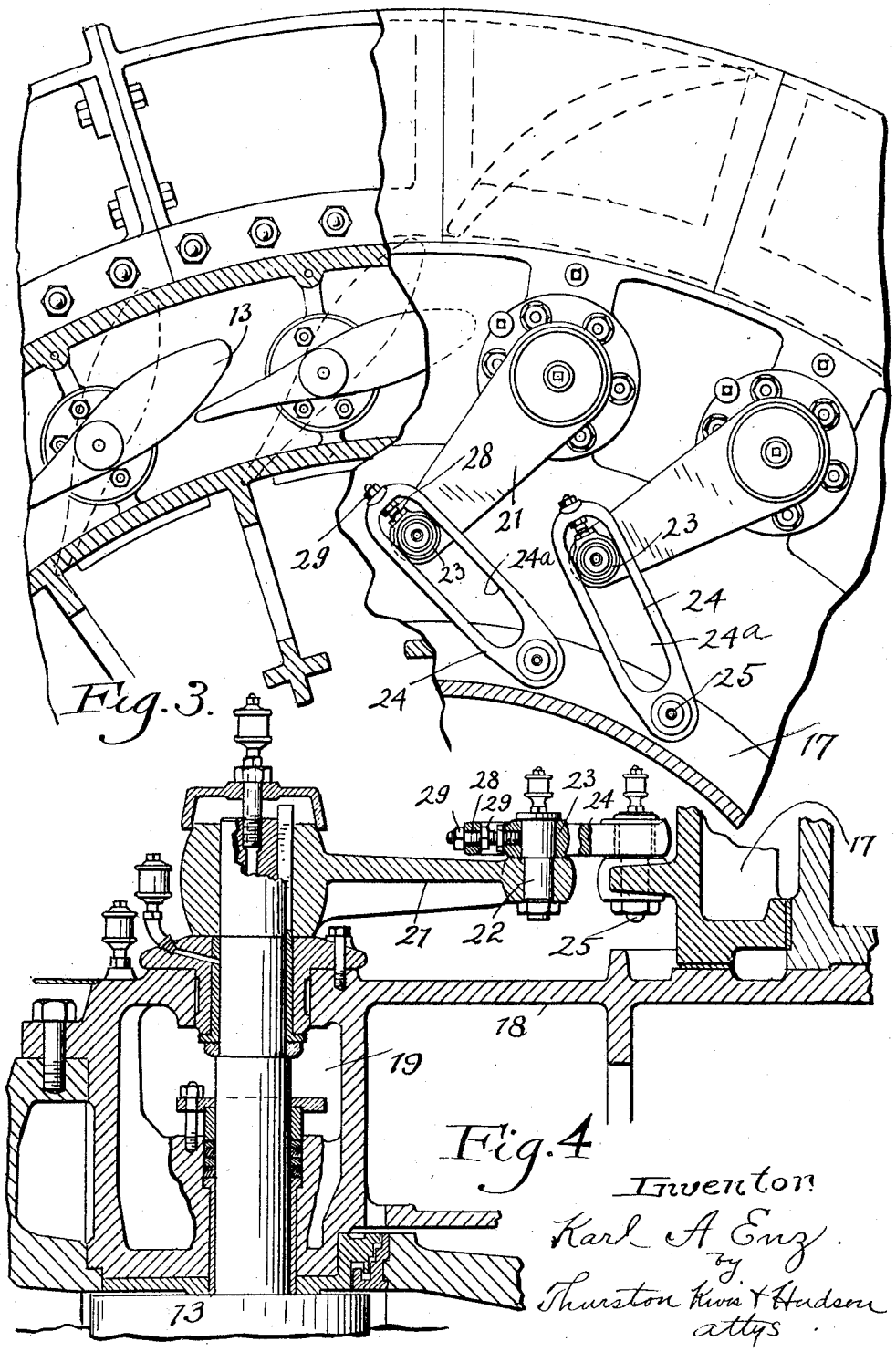



Fig. 3.

Fig. 4

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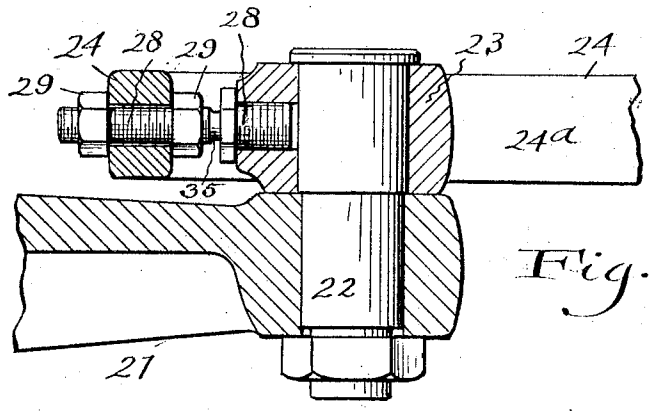



Fig. 5.

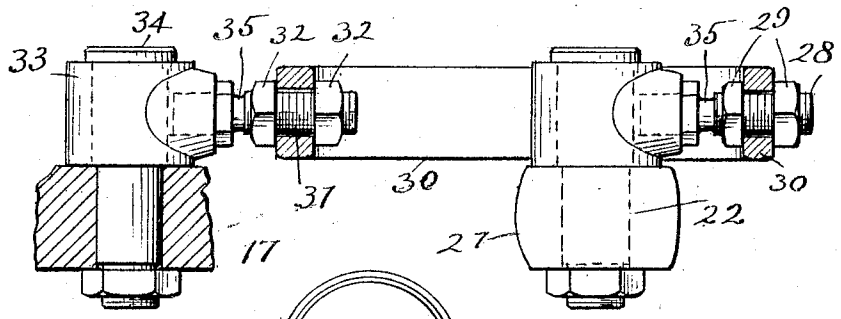



Fig. 7.

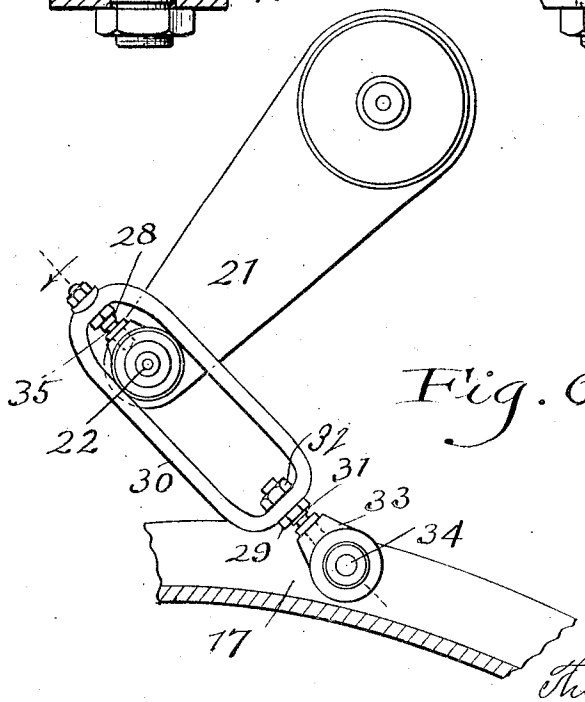



Fig. 6.

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# UNITED STATES PATENT OFFICE.

KARL A. ENZ, OF CLEVELAND, OHIO, ASSIGNOR, BY MESNE ASSIGNMENTS, TO NEWPORT NEWS SHIPBUILDING & DRY DOCK COMPANY, OF NEWPORT NEWS, VIRGINIA, A CORPORATION OF VIRGINIA.

## WATER TURBINE.

Application filed July 24, 1922. Serial No. 576,934.

*To all whom it may concern:*

Be it known that I, KARL A. ENZ, a citizen of the United States, residing at Cleveland, in the county of Cuyahoga and State of Ohio, have invented a certain new and useful Improvement in Water Turbines, of which the following is a full, clear, and exact description.

This invention relates to water turbines, and particularly to the gate operating mechanism.

It is customary in water turbine constructions to introduce the water all around the periphery of the runner of the turbine through the medium of a spiral casing which surrounds the runner, and to control the flow of water to the runner by a circumferential series of gates which are adapted to be swung to open and closed positions, and when closed engaging one another so as to stop the flow of water, and when opened permitting the water to pass between them to the runner. These gates are usually operated by a shifting ring supported centrally with respect to the turbine shaft and provided with peripheral lugs connected by links to levers extending laterally from pivotally mounted stems carrying the gates.

With the arrangements heretofore employed, difficulty has been encountered in the event the movement of one or more of the gates becomes obstructed, and though it has been proposed to avoid breakage of the gates by forming the links which connect the shifting ring to the lever arms on the gate stems so as to break when the load becomes excessive, nevertheless these links are under compression when the gates are being closed and the breakage load cannot be determined with any degree of accuracy and will not be uniform in all the different links. Furthermore, should a link break in the prior constructions, continued movement of the shifting ring frequently causes the lugs on the ring to directly engage the lever whose link has been broken and thus shift the lever practically the same as if the breakage had not taken place, causing injury or breakage of the gate.

The object of the present invention is to provide gate operating mechanism having breakage elements so formed and arranged that breakage will occur when any one of these elements is subjected to a predetermined stress, which in this instance is due to tension, and also to provide means whereby after this element has broken the lever on the gate stem and the link connected to the shifting ring may swing clear of the latter so as to be unaffected by it so far as transmitting movement to the gate stem is concerned.

Further objects are to provide easily and cheaply renewable breakage elements, and to provide a greater amount of adjustment for the gates so that all gates will come into contact or reach closed position at the same time and prevent leakage.

The invention may be briefly summarized as consisting in certain novel details of construction, and combinations and arrangements of parts which will be described in the specification and set forth in the appended claims.

In the accompanying sheets of drawings, Fig. 1 shows in elevation and partly in section, a water turbine embodying my invention; Fig. 2 is a top plan view of the same with portions in section substantially along the line A—A, B—B, C—C and D—D of Fig. 1; Fig. 3 is an enlarged view partly in section and partly in plan showing particularly the gate operating means and two of the gates; Fig. 4 is a vertical sectional view of the same; Fig. 5 is an enlarged detail sectional view showing particularly the breakable stud connecting the link to the lever, this view being an enlargement of the corresponding parts of Fig. 4; Fig. 6 is a plan view showing a modified connection between the lever and shifting ring, this connection involving two breakable studs; and Fig. 7 is a sectional view of the same corresponding to the section shown in Fig. 5.

I have shown my invention applied to a vertical turbine, but the invention is not necessarily confined to a turbine of this type. The vertical shaft 10 of the turbine here shown, has secured to its lower end a runner 11 provided with vanes 12. The flow of water to the runner is controlled by an annular or circular series of swinging gates 13 arranged opposite the periphery of the runner between the latter and the speed ring 14 forming the inner portion of a spiral casing 15 to which the water is supplied in the usual manner.

The shaft 10 is engaged by a guide bearing indicated as a whole by the reference character 16 and not shown in detail since the in-

vention does not relate to these details. Surrounding the outer annular member 16ª of the bearing is a gate shifting ring 17 which is rotatably supported by the bearing member 16ª and by the stationary crown plate 18 which overlies the runner.

The gates 13 are of the usual form and are supported in the customary manner, that is to say, they are mounted on vertical stems 19, the upper portions of which are supported in suitable bearings carried by the crown plate 18, as shown in Fig. 4, and the lower portions in bearings of a curb plate 20, as shown in Fig. 1. At their upper ends these stems 19 are provided with inwardly projecting levers or arms 21. At their inner free ends these levers have upstanding pins 22 provided with blocks 23 which are received in slots 24ª of links 24, the inner ends of these links being connected by pins 25 to the gate shifting ring 17 which is designed to be rotated to open and close the valve by connecting rods 26 and operating cylinders 27.

In accordance with the present invention the levers 21 are connected to the links 24 by adjustable tension studs 28 whose inner ends are screwed into the blocks 23 and pass through openings in the outer ends of the links 24 to which the studs are secured by inner and outer nuts 29.

As will be apparent, particularly from Fig. 3, the gates are closed by moving the shifting ring 17 in a counter-clockwise direction as viewed in said figure, and it will be seen that in imparting the closing movement, though the links 24 are in compression, the studs 28 are in tension. These studs are so formed as to break when subjected to a predetermined tensile load, and by reason of the fact that they are under tension during the closing movement of the gates and are in the form of studs which can be advantageously formed of material whose homogeneity can be depended upon, such as when formed of cold rolled steel or forgings, it is apparent that the tensile breakage load can be accurately determined and will be uniform in all instances, i. e. for all the gates of the turbine.

If in closing, the movement of one of the gates is obstructed by a foreign element in the water which may have lodged between two gates, the stud 28 connecting the link 24 to the arm 21 associated with this particular gate will break when the load on the stud reaches a predetermined amount, but it will be observed that with the construction shown, when the stud breaks, the continued movement of the shifting ring or gate operating ring 17 simply causes free sliding movement between the link 24 and the block 23 carried by the lever, and furthermore, ample clearance is provided between the lever and all other moving parts so that throughout the closing movement of the shifting ring it is not possible for the lever which is connected to the gate whose movement is obstructed and which has been disconnected from its link by the breakage of the stud, to be engaged by any part of the shifting ring 17 or of any part actuated by it. The contrary has been true heretofore, for the constructions have been such that lugs on the periphery of the ring and to which the links corresponding to the links 24 of my improved construction were connected could engage the disconnected lever and shift it toward closed position notwithstanding the breakage of the link, and cause breakage of the gate or of some part of the operating mechanism.

Additionally it will be observed that when the gates are in full closed position the links 24 and levers 21 are at substantially right angles to each other, this being a desirable feature though one long used in turbine constructions, since it minimizes the force necessary to operate the gates, particularly when they are near closed position. Finally it might be mentioned that by providing the breakage elements in the form of the tension studs 28, any broken studs can be easily and cheaply renewed, and the manner of connecting the links to the levers through the medium of these tension studs makes it possible by simply adjusting the nuts 29 to so adjust the parts that all the gates will come into closed position at the same time, thus preventing or minimizing leakage, and this, as well as the renewal of the studs, can be done while the turbine is in operation.

In the construction above described, a breakable stud is provided between the outer end of each link and the lever on the stem carrying the gate, this stud as already explained, being in tension when the gate is being closed and breaking when the tensile pull reaches a predetermined amount. With that construction it is assumed that the protection provided by the breakable studs is needed during the closing of the gates only. However, in some installations it may be desirable to have similar protection against the breakage of a gate when the gates are being moved to open position.

To provide this double protection, i. e. for opening as well as closing, the construction illustrated in Figs. 6 and 7 may be employed. In this instance a link is shown at 30, the link being connected by the breakable tension stud 28 to the inner or free end of the lever on the gate stem precisely as shown in the preceding figures; but the inner end of the link instead of being directly pivoted to the shifting ring 17 is connected thereto through a similar breakable stud 31 which passes through and is secured by nuts 32 to the inner end of the link and is screwed into a head or block 33 which cor-

responds to the block 23 of the first construction and is connected by a pin 34 to the shifting ring 17.

With this construction whether the gates are being closed or opened, one of the studs is always in tension, and if an obstruction occurs during closing, the tension stud 28 will break, but if an obstruction occurs in opening, the tension studs 31 will break.

The studs 28 of the construction first described, and the studs 28 and 31 of the modification shown in Figs. 6 and 7 are preferably provided with reduced portions designated 35 in Figs. 5, 6 and 7, the reduced sections constituting the breaking points. The studs all being formed of the same or uniform material and reduced at 35 to the same cross section, it is obvious that the tensile load or pull which will break a stud is accurately known and will be uniform for all gates. In each instance the stud is screwed solidly into the block or head 33 until a shoulder or enlargement firmly contacts the head, and in the construction shown, the reduced part 35 is next to this shoulder, and is therefore in all instances located between the head or block and the adjacent end of the link.

I do not desire to be confined to the exact details shown, nor to the type of water turbine herein illustrated, as modifications may be made within the scope of the appended claims, and the invention may be applied to turbines of other forms.

Having described my invention, I claim:

1. In combination in a turbine having a runner and a plurality of gates for controlling the flow of water to the runner, gate operating mechanism comprising a movable gate shifting member, and means for connecting the shifting member to the different gates and comprising for each gate a breakable member which is in tension during the closing movement.

2. In a turbine having a runner and a plurality of gates for controlling the flow of water to the runner, a gate shifting mechanism comprising a movable shifting member, levers connected to the gates, links connected to said shifting member, and breakable members connecting the links to the levers and in tension during the closing movement of the gates.

3. In a water turbine having a runner and a plurality of gates for controlling the flow of water to the runner, a gate operating mechanism comprising a movable shifting member, and adjustable connecting means between said shifting member and the different gates, said means comprising for each gate a pair of movement transmitting members and an adjustable breakable connecting member.

4. In a water turbine having a runner and a plurality of gates for controlling the flow of water to the runner, a gate operating mechanism comprising a movable shifting member, connecting means between said shifting member and the different gates, said means comprising levers connected to the gates, links connected to said member, and adjustable breakable studs connecting the links to the levers, said studs being disposed axially of the links.

5. In a water turbine having a runner and a plurality of gates for controlling the flow of water to the runner, a gate shifting mechanism comprising a movable shifting member, and means connecting said member to the gates, said means comprising for each gate a breakable member in tension during the opening movement of the gates.

6. In a turbine having a runner and a a plurality of gates for controlling the flow of water to the runner, a movable shifting member, and means connecting said shifting member to the gates and including links connected to the shifting member by adjustabl breakable studs in tension during the opening movement of the gates.

7. In a water turbine having a runner and a plurality of gates for controlling the flow of water thereto, gate operating mechanism including a shifting member, devices connecting each gate to the shifting member and including two breakable members, one in tension during the closing movement of the gates, and one in tension during the opening movement of the gates.

8. In a water turbine having a runner and a plurality of gates for controlling the flow of water thereto, means for operating the gates comprising a movable shifting member, levers connected to the gates, and links connected to the shifting member, the links and levers being connected together by breakable studs in tension during the closing movement of the gates, and the links being connected to the shifting member by breakable studs in tension during the opening movement of the gates.

9. In combination with a turbine having a runner and a plurality of gates for controlling the flow of water thereto, gate operating mechanism including a shifting member, connecting means between the shifting member and each gate including a breakable stud fixed to one part and adjustably connected to another part of the connecting means.

10. In a water turbine, the combination with a runner having a plurality of gates for controlling the flow of water thereto, a gate operating mechanism comprising a rotary shifting member, a plurality of levers connected to the gates, adjustable means connecting the levers to the shifting member and involving breakable elements adapted to break under predetermined load, said levers, shifting means, and connecting means, be-

ing constructed and arranged to permit the levers to remain stationary, if the connecting means should break.

11. In combination with a water turbine having a runner and a plurality of gates for controlling the flow of water thereto, a gate operating mechanism comprising a rotary gate shifting member, levers connected to the gates, links connected to the shifting member, and breakable tension elements connecting the links and levers, said parts being constructed and arranged, upon the breaking of one of said elements to permit the associated lever to be clear of the shifting member and parts associated therewith and to remain stationary during further movement of the shifting member.

In testimony whereof, I hereunto affix my signature.

KARL A. ENZ.