United States Patent [19]

Mayo, Jr. et al.

[11] **3,901,624**

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[54] **INTEGRATED GATE OPERATING SERVOMOTOR**

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[73] Assignee: **Allis-Chalmers Corporation,** Milwaukee, Wis.

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[52] **U.S. Cl.** **415/150**

[51] **Int. Cl.** **F01d 17/12**

[58] **Field of Search** 415/150, 159, 160, 163

[56] **References Cited**

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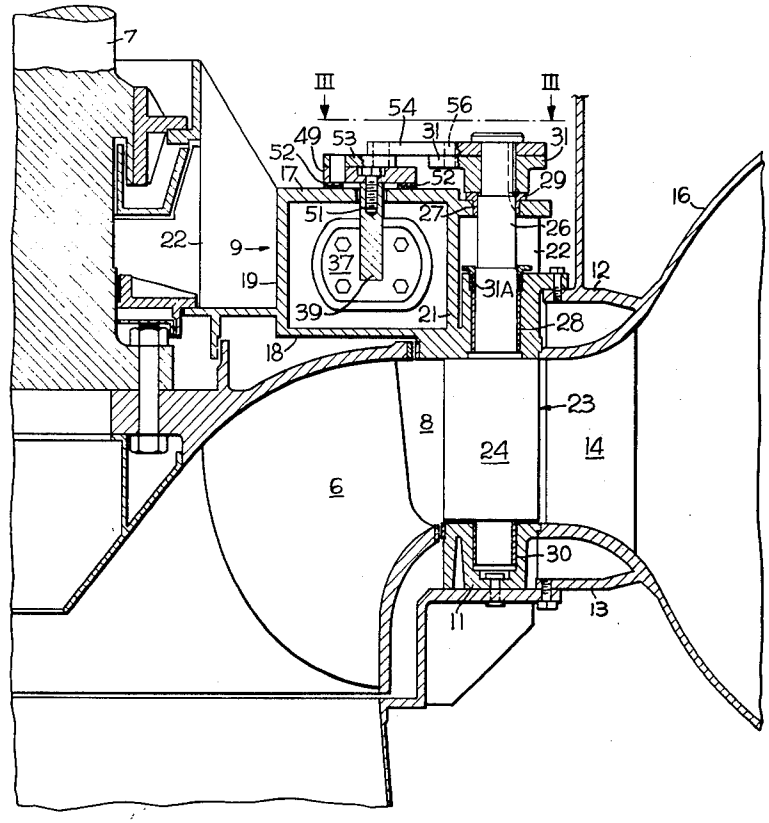
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Attorney, Agent, or Firm—John P. Hines

[57] **ABSTRACT**

A hydraulic servomotor operated mechanism for controlling the wicket gates of a hydraulic turbine. The structural compartments in the turbine head cover are utilized as the pressure cylinder for the servomotor.

3 Claims, 4 Drawing Figures



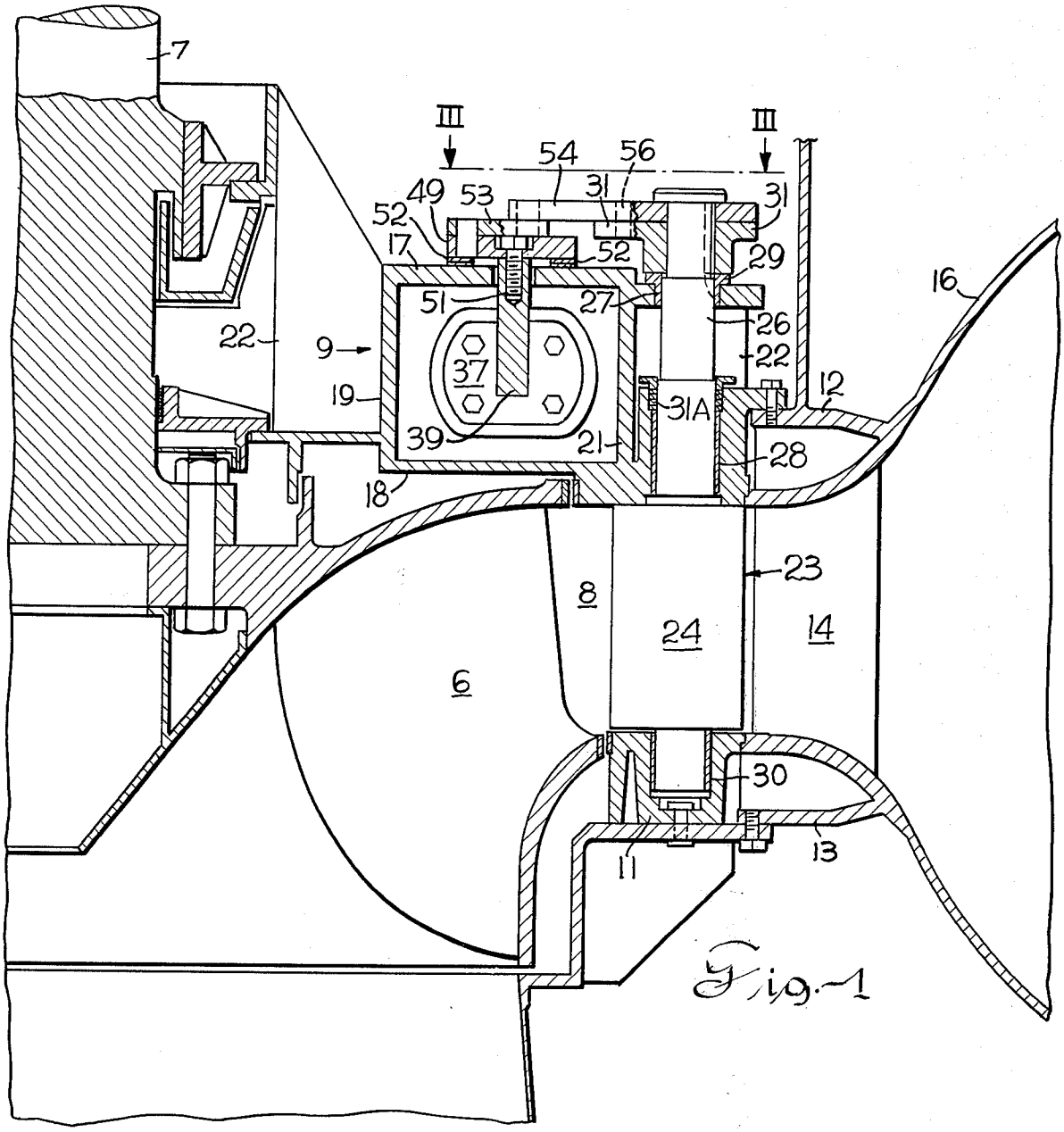

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Fig.-1

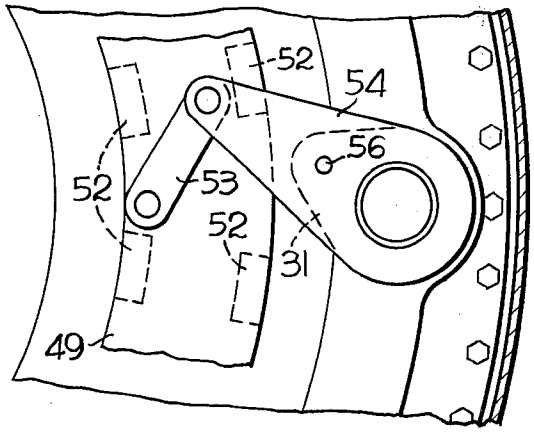

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Fig.3

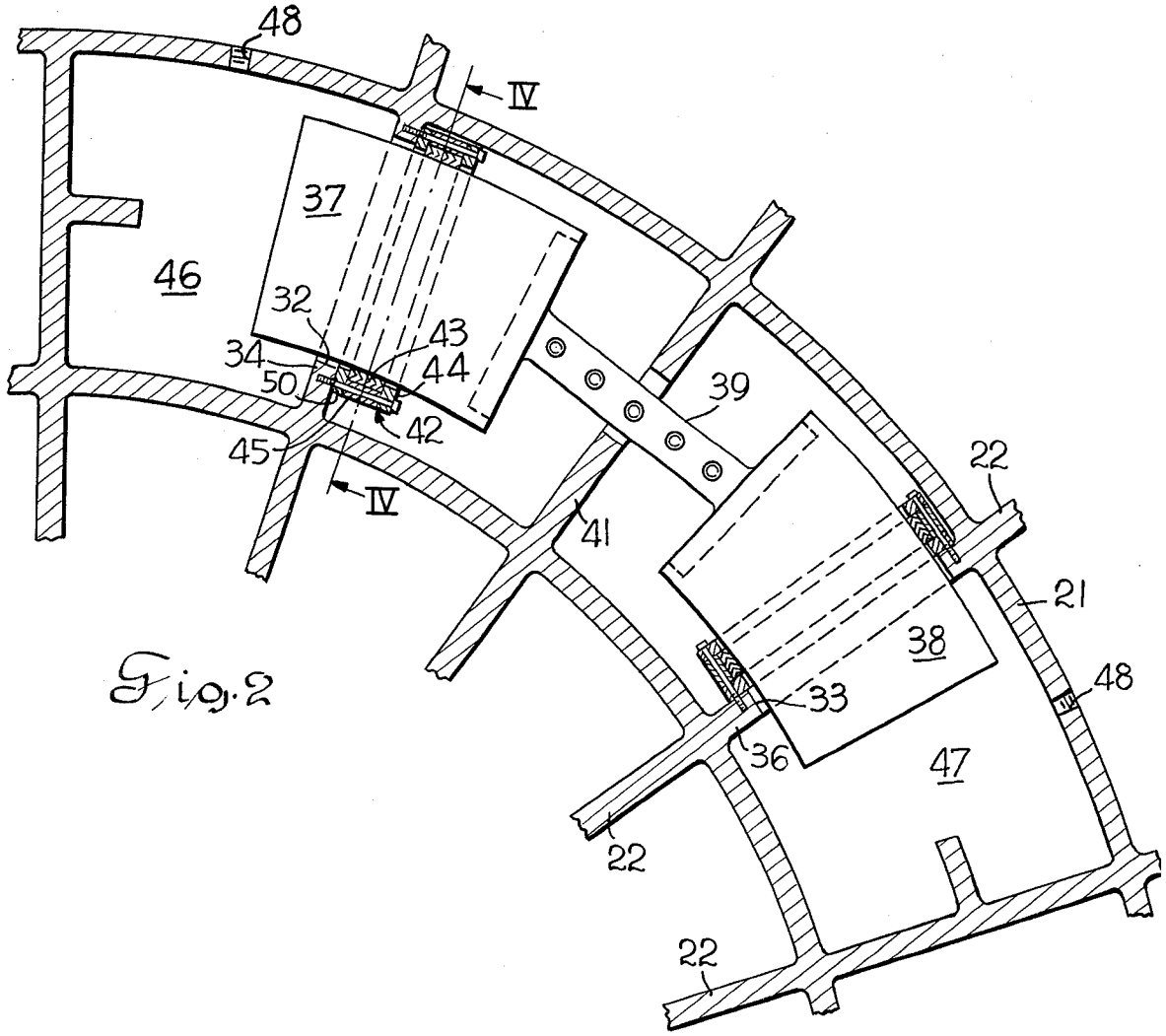

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Fig. 2

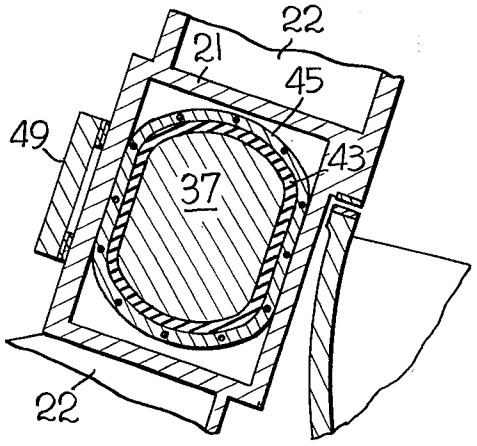

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Fig. 4

INTEGRATED GATE OPERATING SERVOMOTOR

This invention pertains in general to hydraulic turbines and more particularly to an improved mechanism for operating the turbine wicket gates.

BACKGROUND OF THE INVENTION

The output of certain types of hydraulic turbines such as for instance the Francis turbine is controlled by a series of wicket gates. The wicket gates are circumferentially spaced about the water inlet passageway to the turbine runner and are pivotal to different positions to control the amount of water flowing to the runner.

It has been common practice to provide an operating ring about the runner shaft with pivotal connections to each of the wicket gates. Pivotal movement of the wicket gates is accomplished by shifting the operating ring in either direction by a pair of large hydraulic servomotors usually supported in the concrete foundation of the power house. An example of this type of prior art structure is shown in U.S. Pat. No. 2,082,927 issued to W. M. White, June 8, 1937. While the wicket gate structure disclosed in the White patent has been operated satisfactorily, it is quite expensive and does result in added vertical height to the turbine which in certain installations can create a problem. Furthermore, any additional height in the turbine may require additional excavation or power house height which are expensive portions of the entire power house installation cost.

Additional examples of prior art wicket gate operating mechanisms are shown in U.S. Pat. Nos. 2,671,635 issued to R. B. Willi, Mar. 9, 1954 and 2,746,713 issued to H. Peyrin et al. May 22, 1956. The Willi patent shows a hydraulic turbine wherein the wicket gate operating servomotors are contained within the head cover of the turbine. While this arrangement does cut down on the vertical height of the turbine, it does not utilize the structural compartments of the head cover as the pressure cylinders for the servomotors. The Peyrin et al patent discloses a torus-shaped hydraulic servomotor for operating the wicket gates. However, this patent also does not utilize the structural compartments of the head cover as the pressure cylinder for the servomotor.

As an additional indication of prior art structures for wicket gate operating mechanisms for hydraulic turbines, reference may be had to a Russian textbook entitled "Hydro-Turbines" written by M. N. Kovalev about 1961.

OBJECT OF THE INVENTION

It is the intention and general object of this invention to provide a fluid pressure operated mechanism for controlling the wicket gates of a hydraulic turbine which utilizes structural parts of the turbine head cover.

A more specific object of the subject invention is to provide a wicket gate operating mechanism of the hereinbefore described type wherein the structural compartments of the turbine head cover are utilized as the pressure vessels for the wicket gate operating servomotors.

An additional object of the subject invention is to provide a hydraulic turbine gate operating mechanism of the hereinbefore described type wherein torus-shaped servomotor pistons are sealed between structural compartments in the head cover and connected to the wicket gates for pivotal control thereof.

These and other objects of the subject invention will become more fully apparent as the following description is read in light of the attached drawings wherein:

FIG. 1 is a vertical cross sectional view of a portion of a hydraulic turbine having a wicket gate operating mechanism constructed in accordance with this invention;

FIG. 2 is a partial plan view in section taken through the turbine head cover showing the sealing arrangement of the servomotor pistons;

FIG. 3 is a view taken in the direction of the line III—III of FIG. 1; and,

FIG. 4 is a cross sectional view taken along the line IV—IV of FIG. 2.

Referring to the drawings, a hydraulic turbine, shown herein for purposes of illustration as a Francis turbine, includes a runner **6** supported for rotation by a shaft **7** and being open to a water passageway **8.** The water passageway **8** is defined by a head cover generally designated **9** and a bottom ring **11.** The head cover and bottom ring are in turn supported by a stay ring structure including upper and lower flanges **12** and **13,** respectively, connected together by a plurality of circumferentially spaced stationary stay vanes **14.** The stay ring is connected to a spiral case **16** both of which are embedded in the concrete foundation of the power house.

Because of its size and the forces it must withstand, the head cover is a fabricated member comprising upper and lower vertically spaced, horizontally disposed plate members **17** and **18,** respectively, a pair of horizontally spaced cylindrical plate members **19** and **21** together with a plurality of circumferentially spaced radially disposed transverse rib members **22** which together form box sections or compartments of adequate strength and rigidity to withstand the pressures of the water in passageway **8** and the hydraulic load on the wicket gates generally designated **23.**

Conventional wicket gate construction includes a gate vane **24** and a gate stem **26.** The stem **26** is rotatably supported in bushings **27, 28** and **30.** Axial thrust of the gate vane is counteracted by the shoulder **29** on a lever **31** keyed to the free end of the gate stem **26.** Conventional gland packing **31A** is utilized to seal the wicket gate stem **26.**

Referring now more particularly to FIG. **2,** openings **32** and **33** are provided through the ribs **34** and **36,** respectively. These openings provide access between the box compartments which have the radial ribs **34** and **36** as a common wall. As shown herein for purposes of illustration, a pair of pistons **37** and **38** extend through the openings **32** and **33,** respectively. The pistons may be connected together in any conventional manner and are herein shown connected together by a cross piece **39** which may be bolted or otherwise connected to each of the pistons **37** and **38.** The cross piece **39** extends through an opening in the radial rib **41** and upward through an opening provided through the horizontal member **17** of the head cover. The pistons **37** and **38** are curved to correspond to the annular shape of the head cover so as to provide adequate stroke to operate the wicket gates through the gate ring and linkage.

Sealing means are provided for each piston. These sealing means may be provided in any conventional

manner and are herein shown as including a seal housing 42 consisting of a cover 44, barrel 45, and base ring 50 (best shown in FIG. 2) provided about each opening 32 and 33 and bolted or otherwise connected to the radial rib members 34 and 36, respectively. Liquid sealing means shown herein for purposes of illustration as chevron packing 43 are then provided around the pistons, and within the seal housing 42 to provide a fluid tight sliding fit therebetween. This packing is held in place by means of the ring cover 44 bolted or otherwise removably connected to the barrel 45 or radial ribs 34 and 36.

With this arrangement the compartments 46 and 47 behind the pistons 37 and 38, respectively, are liquid tight. Pressure fluid can be selectively admitted and exhausted from each of these compartments through the openings 48 provided through the outer cylindrical plate member 21 to cause reciprocating movement of the pistons.

A flat circular gate operating ring 49 is attached to the cross piece 39 in any conventional manner such as by the bolts 51. This operating ring is slidably supported on the outer surface of the upper horizontal member 17 in any conventional manner such as by low friction pads 52. A link 53 is provided with one end pivotally connected to the operating ring 49 and its other end pivotally connected to the free end of the lever arm 54. The lever arm 54 is connected to lever 31 by means of a shear pin 56. In this manner, movement of the pistons 37 and 38 imparts movement to the ring 49 which in turn rotates the wicket gates 23 through the required angular movement.

From the above description, it can be seen that this arrangement utilizes conventional structural compartments in the head cover as the pressure vessels for the gate operating servomotors. In general, this invention facilitates a less costly, more compact turbine structure and in many cases would permit closer coupling of the turbine and generator components further reducing equipment and power house cost.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A hydraulic turbine having a runner comprising: a head cover constructed of upper and lower ring-like members connected together by a plurality of spaced substantially radially directed rib-like members defining a plurality of box-like liquid tight normal structural compartments; a bottom ring spaced from said head cover and defining therewith a water passageway leading to said runner; a plurality of pivotally supported circumferentially spaced wicket gates disposed across said water passageway; walls defining an opening through at least one of said rib-like members; a pressure fluid operated piston operatively associated with said opening seal means engaging said piston and the associated rib-like member about said opening to provide a fluid tight sliding seal therebetween, said seal and piston defining with the associated compartment a fluid tight chamber on at least one side of said piston; means for providing pressure fluid to said chamber to cause movement of said piston; and means pivotally connecting said piston to said wicket gate to cause pivotal movement thereof upon movement of said piston.

2. A hydraulic turbine having a runner comprising: a head cover constructed of upper and lower ring-like members connected together by a plurality of spaced substantially radially directed rib-like members defining a plurality of box-like liquid tight normal structural compartments; a bottom ring spaced from said head cover and defining therewith a water passageway leading to said runner; a plurality of pivotally supported circumferentially spaced wicket gates disposed across said water passageway; walls defining openings through at least two adjacent and facing rib-like members of said compartments; a pair of rigidly connected pressure fluid operated pistons contained within said openings; seal means connected to said adjacent walls about said openings and engaging said pistons to provide a fluid tight sliding seal therebetween, said pistons closing said openings and sealing the associated compartments behind said pistons; means providing pressure fluid to said associated compartments to cause movement of said pistons in one direction when said pressure fluid is delivered to one of said compartments; and means pivotally connecting said pistons to said wicket gates to cause pivotal movement thereof upon movement of said pistons.

3. The hydraulic turbine set forth in claim 2 wherein said pivotal means includes an operating ring slidably supported on said head cover, means connecting said ring to said piston and means pivotally connecting said ring to said wicket gates.

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