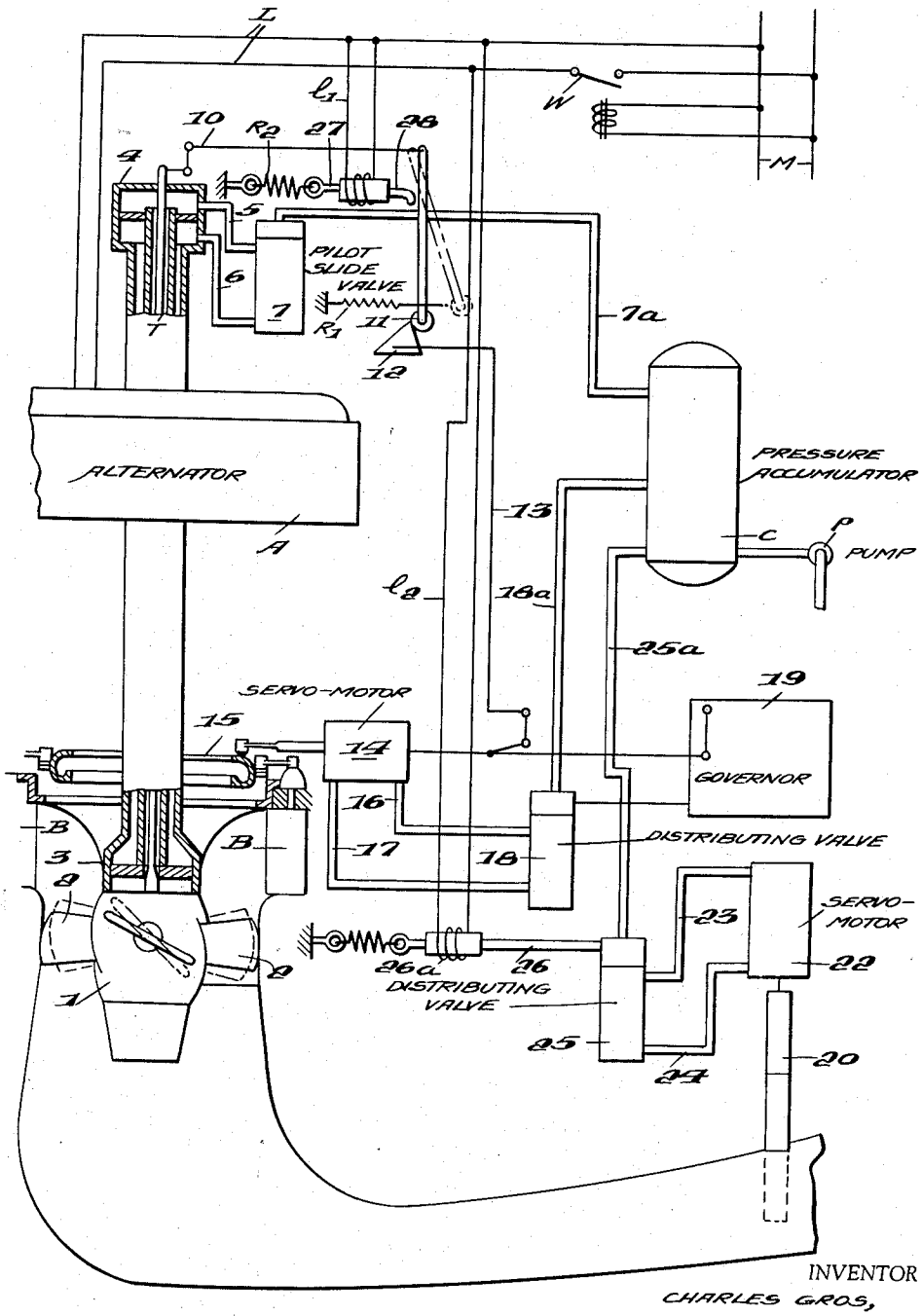
Jan. 21, 1964 C. GROS 3,118,281

HYDROELECTRIC GROUPS

Filed July 7, 1959 2 Sheets-Sheet 1



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Fig. 1.

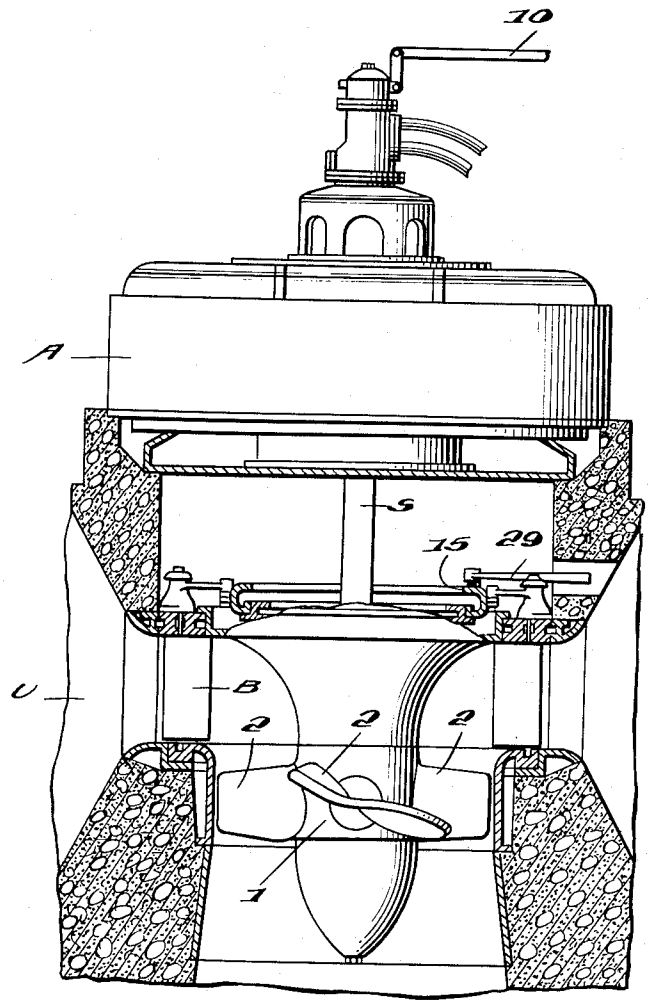
BY
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ATTORNEYS

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Fig. 2.



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United States Patent Office 3,118,281
Patented Jan. 21, 1964

3,118,281

HYDROELECTRIC GROUPS

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Filed July 7, 1959, Ser. No. 825,598
Claims priority, application France July 8, 1958
4 Claims. (Cl. 60—55)

The present invention relates to a power unit comprising a turbine having a rotatable shaft and a turbine wheel mounted on said shaft.

In the preferred embodiment of the invention, the turbine wheel has blades of adjustable pitch, first control means for modifying said pitch, an alternator having a rotor connected with said turbine shaft, electric mains, electric leads for electrically connecting said alternator with said mains, switch means for selectively connecting and disconnecting said alternator with said mains, a water upstream passageway disposed on the upstream side of said turbine wheel for imparting rotation to said wheel, a distributor gating disposed in said upstream passageway and having a series of blades, said distributor blades having a variable orientation for varying the opening of said distributor gating in view of adjusting the water flow rate admitted through said passageway to said turbine wheel, second control means for modifying said orientation, turbine governor means for actuating said first and second control means in response to speed variations of the said turbine wheel, cam means for coordinating motions of turbine blades and distributor blades upon actuation of said governor means, and a downstream water passageway disposed on the downstream side of said turbine wheel blades.

In the conventional power units of the type referred to above, when the power unit passes from a normal or full load condition to a zero load condition, i.e., when the alternator becomes disconnected from the mains by opening of the switch means, the governor means responsive to a corresponding increase of the turbine wheel rotational speed, reduces considerably both the opening of the distributor gating and the pitch of the runner blades in a coordinated manner under control of the cam means, so that the water flow rate is itself considerably reduced, the wheel rotational speed being restored substantially to the normal load speed. Such a lowering of the water flow rate between the upstream side and the downstream side of the power unit is generally compensated, in the conventional power units, by opening of water supplemental passageways separate from and shunting the water passageways passing through the turbine wheel, but such an arrangement complicates the power unit structure.

An object of the present invention is to provide a power unit of the type referred to above which is devoid of this drawback and which is more particularly characterized in that an overriding means is provided and is responsive to opening of the aforesaid switch means for overcoming normal regulation by the governor means and for imparting to the turbine wheel blades and to the distributor blades predetermined positions which preferably are the positions taken by all said blades under normal load conditions, and a gate is provided in the passageway itself which is located on the downstream side of the turbine wheel and which gate receives water from said wheel, said gate being movable between a fully opened position and a partially closed position, while a third control means is provided for moving said gate between both positions thereof, said third control means being responsive to closing and opening of said switch means so as to maintain said gate in the fully opened position when said switch means is closed and to bring said gate into the partially closed position when said switch means opens.

Due to such an arrangement, when the power unit passes from the normal load condition to the zero load condition, the downstream gate partially closes and reduces only slightly the water flow rate passing through the turbine wheel since normal opening of the distributor gating is maintained by the governor overriding means. Partial closing of the downstream gate furthermore reduces the head between the upstream side and the downstream side of the power unit sufficiently for restoring substantially the wheel rotational speed to the normal load speed, since, as understood from those skilled in the art, in a power unit of the type described, the flow rate is proportional to the wheel rotational speed and the wheel rotational speed is proportional to the square root of the head.

A form of embodiment of the present invention will now be described, by way of example, with reference to the accompanying drawings, wherein:

FIG. 1 diagrammatically shows a power unit of the Kaplan type in accordance with the invention; and

FIG. 2 is a sectional view, partly in elevation, of the turbine and of the alternator of the power unit.

Referring to FIG. 2 of the drawings, a power unit comprises a turbine of the Kaplan type having a rotatable shaft S and a turbine wheel **1** mounted on this shaft. The wheel **1** includes a series of blades **2** of adjustable pitch. A water passageway U is disposed on the upstream side of the wheel **1** and feeds water for rotating the turbine wheel.

A distributor gating **15** comprises a series of blades B (FIG. 1) disposed in the upstream passageway U and having a variable orientation for varying the water flow rate admitted through the passageway U to the turbine blades **2**. A water passageway or draft tube **21** is disposed on the downstream side of the wheel **1** for discharging water therefrom.

The power unit also comprises an alternator A having a rotor R connected with the turbine shaft S. As shown in FIG. 1, electric leads L electrically connect the alternator A with mains M while a switch means, diagrammatically shown at W, is provided with selectively connecting and disconnecting the alternator A with the mains M. In the normal load condition it is understood that the switch W is closed, while the switch W opens for cutting off the alternator when it is necessary or desirable to pass from the normal load condition to a zero load condition.

First control means are provided for modifying the pitch of the turbine blades **2**, and comprise a hydraulic servo-motor **3** having a distributing head **4** which is connected through pipes **5** and **6** with a control slide valve **7**. The valve **7** is fed through a pipe **7***a* by fluid pressure means comprising a pump P and a hydraulic pressure accumulator C. The valve **7** is movable between three positions: (1) a neutral position; (2) a turbine blade pitch increasing position; and (3) a turbine blade pitch decreasing position. The valve **7** is actuated by a rod **8** connected with a lever **9** one end of which is displaced in response to pitch variations of the blades **2** by means of a rod **10**, while the other end of the lever **9** carries a roller **11** cooperating with a cam **12** the operation of which will be later described.

Second control means are provided for modifying the orientation of the blades of the distributor gating B, adjusting the flow of water to the turbine wheel **1**, and comprise a hydraulic servo-motor **14** connected through pipes **16** and **17** with a control slide-valve **18**. The valve **18** is fed through pipe **18***a* by the fluid pressure means P and C. The valve **18** is movable between three positions: (1) a neutral position, (2) a distributor opening position, and (3) a distributor closing position. The valve **18** is actuated by a governor **19**.

The governor **19** is responsive to speed variations of the

turbine runner **1** so as to hold the valve **18** in the neutral position when the speed of the turbine wheel remains constant but to place the valve **18** in the distributor opening position if the speed of the wheel decreases, and to place the valve **18** in the distributor closing position if the speed of the wheel increases. The servo-motor **14** is connected through linkage **13** to the cam **12** for coordinating the pitch of the blades **2** with the distributing gating B. The linkage between the servo-motor **14** and the governor **19** is also a feedback for avoiding hunting by the governor.

In accordance with the invention, an over-riding means, comprising an adjustable abutment **28** cooperating with the lever **9**, is provided and is responsive to opening of the switch W for overcoming the normal regulation by the governor **19**. In normal operation, before opening of the switch W, the lever **9** is located in the position shown in full lines with the end roller **11** yieldably urged against the cam **12** by a tension spring R_1. The electro-magnet **27** is energized and holds the push rod **28** retracted against the force of the compression spring R_2, thereby leaving the lever **9** free to move in response to regulation by the governor **19**, which adjusts the position of the cam **12** through adjustment of the servo-motor **14**.

When the switch W is open, the electro-magnet **27** is deenergized and the spring R_2 expands to extend the rod **23** thereby swinging the lever **9** about the end of the rod **10** and away from the cam **12** as shown in dotted lines in FIGURE 1. This movement of the lever **9** causes the displacement of the control rod **8** to adjust the valve **7** in the direction which supplies oil through the conduit **6** for downward movement of the piston of the servo-motor **3**, thereby increasing the pitch of the blades **2**. At the same time, a rod T which is fixed to the end of the piston of the servo-motor **3** also moves downward. Movement of the rod T is transmitted through the follow-up return rod **10** to the lever **9** to pull the lever **9** so that it pivots about the end of the push rod **28** and displaces the control rod **8** to increase the pitch of the blades farther. If the rod **8** is at the limit of its travel, displacement of the rod **10** moves the lever **9** farther away from the cam **12**. Consequently, although the governor **19** regulates the distributor gating **15** after the switch W is open, it does not control the pitch of the blades **2**.

The gate **20** is provided in the downstream passageway **21**, and is movably mounted between a fully opened position (shown in FIG. 1 in full lines) and a partially closed position (shown in FIG. 1 in dotted lines).

A third control means is provided for moving the gate **20** between both positions thereof and comprises a hydraulic servo-motor **22** connected through pipes **24** to a control slide-valve **25**. The valve **25** is movable between three positions: (1) a neutral position, (2) a gate opening position, and (3) a gate partial closing position. The valve **25** is actuated through a rod **26** by an electro-magnet **26***a* connected through leads l_2 with the leads L. As long as the switch W remains normally closed, the valve **25** is in the neutral position and the gate **20** remains fully opened. When the switch W opens, the electro-magnet **26***a* becomes deenergized and the valve **25** is moved into the gate partial-closing position whereby the gate is placed in its partially closed position. When the switch W closes, the electromagnet **26***a* is energized and places the valve **25** first in the opening position thus fully opening the gate **20** while thereafter the valve **25** is placed in neutral position as usual in conventional three-position valve systems.

With the arrangement according to the invention, when the power unit passes from the normal load condition to the zero load condition due to opening of the switch W, the downstream gate **20** partially closes and reduces only slightly the water flow passing through the turbine wheel **1**, since normal opening of the distributor gating

15 is maintained by the governor over-riding means **28**. On the other hand, the head between the upstream side and the downstream side is reduced by partial closing of the gate **20** sufficiently for restoring the rotational speed of the wheel **1** to the normal load speed.

I claim:

1. A power unit comprising a turbine having a rotatable shaft and a turbine wheel mounted on said shaft, said wheel having blades of adjustable pitch, first control means for modifying said pitch, an alternator having a rotor connected with said turbine shaft, a water upstream passageway at the upstream side of said turbine wheel for imparting rotation to said wheel, a distributor gating disposed in said upstream passageway and having a series of blades, said distributor blades having a variable orientation for varying the opening of said distributor gating in view of adjusting the water flow rate admitted through said passageway to said turbine wheel, second control means for modifying said orientation, turbine governor means for actuating said first and second control means in response to speed variations of the said turbine wheel, cam means for coordinating motions of turbine blades and distributor blades upon actuation of said governor means, overriding means responsive to a zero load condition of the alternator for overcoming normal regulation by said governor means, for imparting to said wheel blades a predetermined position when said zero load condition is effective, a downstream water passageway disposed at the downstream side of said turbine wheel, a gate in said downstream passageway movably mounted between a fully open position and a partially closed position, and a third control means for moving said gate between both positions thereof, said third control means being responsive to the load condition of the alternator so as to maintain said gate in the fully open position when the load of the alternator is normal and to bring said gate into the partially closed position when the alternator passes to a zero load condition.

2. A power unit as claimed in claim 1 wherein said first control means comprises fluid pressure means, valve means fed by said fluid pressure means and having a neutral position, a wheel blade pitch increasing position and a wheel blade pitch decreasing position, a hydraulic motor connected with said valve means and operating said wheel blades, a lever connected with said valve means and controlled by said governor means for moving said valve means from one position thereof to another, said overriding means comprising abutment means cooperating with said lever and maintaining said valve means in the wheel blade pitch increasing position thereof in response to a zero load condition of the alternator.

3. A power unit as claimed in claim 1, wherein said third control means comprises fluid pressure means, valve means fed by said fluid pressure means and having a neutral position, a gate opening position, and a gate partial-closing position, a hydraulic motor connected with said valve means and operating said gate, said valve means being controlled by the load of the alternator so as to be held in said neutral position when the load of the alternator is normal and to move the valve means to the gate partial closing position when the alternator is in zero load condition.

4. A power unit as claimed in claim 1, wherein said overriding means is a locking means fixing the turbine wheel blades in the position of said blades when the alternator passes from a normal load condition to a zero load condition.

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