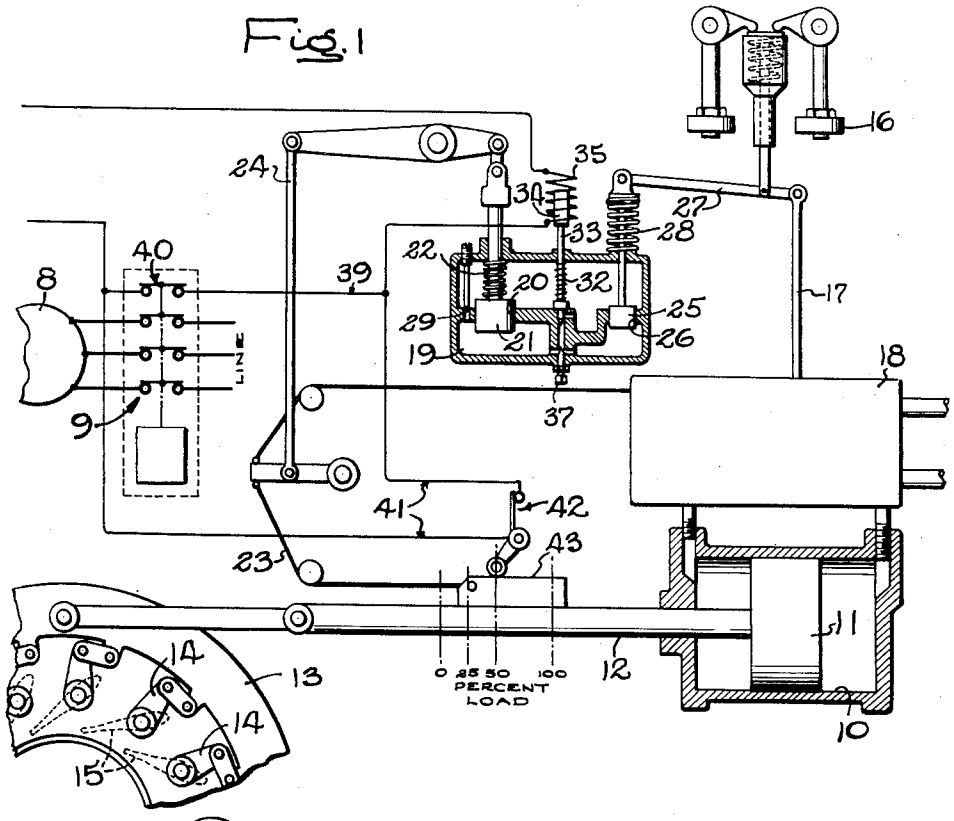
July 11, 1950 J. H. BRANHAM 2,514,930

SPEED REGULATOR FOR HYDRAULIC TURBINES

Filed Dec. 27, 1946

Fig. 1



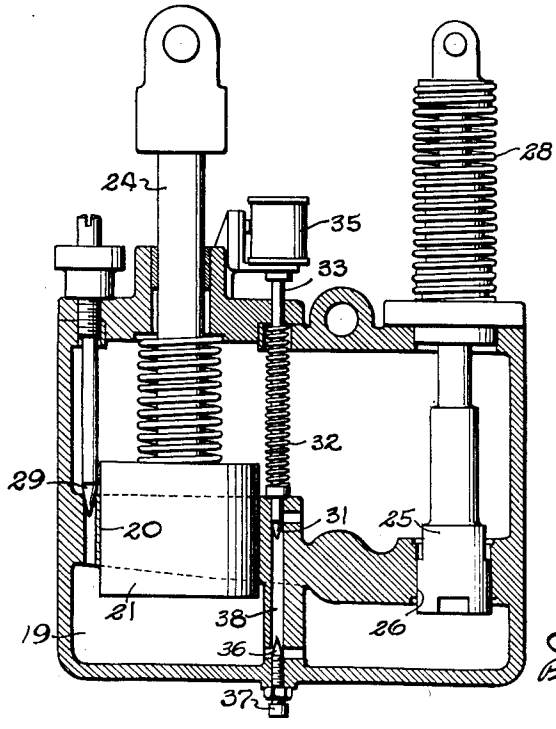


Fig. 2

INVENTOR
James H. Branham
By Carlson, Pitzner, Hubbard & Wolfe
ATTORNEYS

Patented July 11, 1950

2,514,930

UNITED STATES PATENT OFFICE

2,514,930

SPEED REGULATOR FOR HYDRAULIC TURBINES

James H. Branham, Rockford, Ill., assignor to Woodward Governor Company, Rockford, Ill., a corporation of Illinois

Application December 27, 1946, Serial No. 718,633

3 Claims. (Cl. 290—40)

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This invention relates to governor controlled regulators such as are used for controlling the speed of water turbines for driving electric generators. To prevent hunting under changing load conditions, the governor of such a regulator incorporates a so-called compensating mechanism. When constructed to provide proper speed control during idling operation of the turbine, the compensating mechanism limits to an objectionable degree the speed at which the wicket gates may be moved when the generator load is imposed on the turbine.

The primary object of the present invention is to modify the action of the governor compensating mechanism automatically in accordance with the changing turbine loads, whereby to adapt the governor for efficient regulation of the turbine speed under all conditions.

A more detailed object is to provide a compensating type turbine governor in which the compensating effect is reduced a predetermined amount in response to loading of the turbine by the generator, and is correspondingly increased by unloading of the turbine, provided that the turbine gates are positioned for no-load operation.

The invention also resides in the novel structure of the mechanism used in carrying out the foregoing objects.

Other objects and advantages of the invention will become apparent from the following detailed description taken in connection with the accompanying drawings, in which

Figure 1 is a schematic view of a turbine speed regulator embodying the novel features of the present invention.

Fig. 2 is an enlarged vertical cross sectional view of the governor compensating mechanism.

For purposes of illustration, the invention is shown in the drawings incorporated in a hydraulic governor for controlling the flow of fluid to a servo actuator such as a cylinder 10 and a piston 11 operating through the usual rod 12 to shift a ring 13 which is connected through arms 14 with wicket gates 15 of the hydraulic turbine. The latter drives an electric generator 8 which is rendered operative by closure of the usual remotely controlled power actuated breaker switches indicated generally at 9.

The governor includes flyballs 16 driven by the turbine and operating the stem 17 of a pilot valve which, together with a relay valve and associated mechanism indicated at 18, controls the flow of pressure fluid to and from the servo cylinder 10. The so-called compensating mechanism

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of such governors is also hydraulically operated and, as shown, includes a fluid filled chamber 19 communicating with a cylinder 20 in which slides a transmitting piston 21 urged inwardly by a spring 22 and moved outwardly through a cable 23 and linkage 24 in accordance with changing positions of the servo piston 11. A piston 25 for receiving the compensating force slides in a cylinder 26 and applies the compensating force through a lever 27 to the pilot valve stem 17. In response to each movement of the piston 21, a spring 28 is either tensioned or compressed, and thereafter acts to center the piston 25 as permitted by leakage into or out of the chamber 19 through a needle valve 29. The restoring force initially applied to the pilot valve to produce temporary speed droop is thus dissipated gradually by such leakage, as the turbine speed, following a load change, is brought back to the isochronous value.

The magnitude of the compensating force applied to the control valve may be increased or decreased as desired by closing or opening the needle valve 29. Ordinarily the latter is set to provide a substantial amount of compensation in order to enable the turbine speed to be regulated properly when the turbine is being started or idling with the generator switches 9 open, the flywheel effect then being comparatively low. However, when the generator has been rendered operative and the flywheel effect of the system increased correspondingly, such a high compensating effect slows down to an objectionable degree the rate at which the gates may be moved under the control of the governor.

In accordance with the present invention, provision is made for reducing the compensating effect automatically, and preferably by a predetermined amount when the generator is rendered operative and then, after the generator has been disabled, increasing the compensating effect to its full original value only after the gates 15 have become substantially closed. In this way the effect of the compensating mechanism in restricting the gate movement is minimized so that the gates may be moved rapidly whenever the turbine is loaded or when the gates are being closed after disabling the generator.

Such automatic modification of the compensating mechanism is accomplished in the present instance through use of an auxiliary fluid valve 31 which is normally closed by a spring 32 and which, when opened, permits fluid to by-pass the main needle valve 29, the resultant effect being

to enlarge the leak restriction in the compensating mechanism.

Preferably the valve 31 is controlled electrically so that it may respond to the desired combination of operating conditions. To this end the valve is of the needle type, with its stem 33 connected to the armature 34 of a solenoid 35 by which the valve may be opened against the action of the spring 32. To enable the flow of fluid through the by-passage 38 to be adjusted, a needle valve 36 is arranged in the other end of the passage for adjustment by manual turning of a knob 37. To open the by-passage 38 automatically when the generator 8 is rendered operative, an energizing circuit 39 for the solenoid 35 is extended through a switch 40 which is closed and opened simultaneously with the switches 9 by which the generator is thrown into and out of operation. Thus, during starting of the turbine, when a substantial amount of compensation in the governor is required, the by-passage 38 is closed and the needle valve 29 alone determines the compensating effect. The latter is reduced, however, as soon as the flywheel effect of the generator is applied to the system, thereby permitting the gates to be operated at the desired rate.

Reclosure of the by-passage 38 by deenergizing the solenoid 35 is dependent upon a combination of two conditions; that is, cutting the generator out of operation together with the approach of the gates 15 to the highest no-load position likely to be encountered in service. Accordingly, a parallel energizing circuit 41 for the solenoid is extended through a switch 42 which is operated by a cam 43 movable in unison with the gates 15, for example as by being carried by the servo piston rod 12. As a result, the solenoid is not deenergized to close the by-passage 38 when the generator is disabled with the gates open a substantial distance. Instead, the by-passage remains open to leave the governor conditioned for rapid closure of the gates to the no-load position, whereupon the switch 42 is opened to increase the compensating effect of the governor as required for idle operation of the turbine.

I claim as my invention:

1. For use with a gate controlled turbine for driving an electric generator, the combination of a servo actuator having a member movable back and forth to open and close the turbine gates, a governor controlling said actuator in response to the turbine speed and having mechanism for producing compensation, means by which said compensation may be decreased a predetermined amount, means for maintaining said last mentioned means disabled during idling of said turbine and for actuating the same to decrease the compensation of said governor when said generator is rendered operative, and means for disabling said compensation reducing means when the generator is rendered inoperative and said servo member has been returned to a no-load position.

2. For use with a hydraulic turbine for driving an electric generator, the combination of, a speed regulator for the turbine including a governor having automatically acting compensating mechanism, means for decreasing the compensating effect of said mechanism automatically as an incident to imposition of the generator load on the turbine, and means for increasing the compensating effect of said mechanism automatically in response to return of said regulator to no-load position after disabling of the generator.

3. For use with a hydraulic turbine for driving an electric generator, the combination of, a speed regulator for the turbine including a governor having automatically acting compensating mechanism, means by which the compensating effect of such mechanism may be changed, a device responsive to changes in the loading of said turbine, and means operable by said device when the load of said generator is imposed on said turbine to actuate said last mentioned means in a direction to decrease the effect of said compensating mechanism.

JAMES H. BRANHAM.

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