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GOVERNING MECHANISM FOR ELASTIC
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In the operation of turbine driven generators, it is important to provide governing mechanism which will rapidly operate to control the speed of the turbine in accordance with changes in load thereon. It is also important, particularly where two or more turbine driven generators are supplying current to the same system of electrical distribution, to provide means whereby easy adjustment of the regulation or speed change from no load to full load through which the governor of each of the turbines normally function may be effected.

The object of my invention is the provision of an improved governing mechanism for elastic fluid which will meet the requirements above noted.

For a consideration of what I believe to be novel and my invention, attention is directed to the accompanying description and the claims appended thereto.

In the accompanying drawing which is illustrative of my invention, in Fig. 1 is shown an elastic fluid turbine and governing mechanism therefor; Fig. 2 illustrates cam means whereby a number of valves may be actuated by the same servo-motor, and Fig. 3 is a detail view of a modification.

1 indicates an elastic fluid turbine of any suitable or known construction which is adapted to drive an electric generator or other load. As shown, the turbine is of the multi-stage impulse type although my invention is not necessarily limited thereto. The rotor is mounted on a shaft 2 carried in suitable bearings. Steam or other elastic fluid is admitted to the turbine by the inlet conduit 3 and valve chest 4. The admission of fluid to the turbine is subject to the control of one or more valves 5. The valve or valves is or are actuated by a servo-motor comprising a piston 6 which may be directly or indirectly connected by a rod 7 with the valve, and a cylinder 8. The fluid necessary to actuate the piston may be of any suitable character as for example oil or equivalent liquid. The admission of fluid to the motor cylinder is controlled by a pilot valve comprising a cylinder 9 and a balanced piston valve 10 having two heads which normally cover the ports communicating with the conduits 11 and 12. Fluid under pressure is admitted to the cylinder between the heads of the valve by the conduit 13.

To control the pilot valve a speed governor 14 of any ordinary or suitable construction is provided comprising the usual weights and an op-

posing spring. The governor shaft 14a is driven by the main shaft 2 of the turbine through any suitable means in a manner well understood. Pivottally connected to the governor so as to be actuated thereby is a governor lever 15, and connected thereto by a link is a floating lever 16, the latter being connected to the rod of the pilot valve so that as the position of the governor weights change the position of the valve will correspondingly be changed.

It is highly important to provide a simple adjustment of the regulation or speed change from no load to full load through which the governor normally functions, and also to provide means for preventing a change in the slope of the turbine speed-load curve without an adjustment of the governing mechanism having first been made. It is also important to provide a means for ensuring the rapid operation of the governing parts to compensate for load changes. The means whereby these desirable and important results are obtained will now be described:

In governing mechanisms of the type having a servo-motor for actuating the controlling valve or valves of the turbine and a pilot valve responsive to a speed governor for controlling the motor, a follow-up device is necessary to restore the pilot valve to its initial position after each movement of the controlling valve or valves of the turbine to prevent over-travel. For this purpose there is included in addition to the foregoing a secondary lever 17 which has a fixed pivot at one end and at the other end is pivotally connected to the piston rod 7 of the servo-motor as by a link 18 for example. Instead of directly connecting the secondary lever 17 to the pilot valve there is interposed a dash pot comprising a piston 19 and a cylinder 20 containing a liquid such as oil. The piston is provided with a small orifice 21 through which the liquid is free to move but at a low rate of speed. One member of the dash pot is connected to the secondary lever 17 by a rod 22 and the other member to the floating lever 16 by a rod 23. For any short period of time the difficulty experienced by the oil in passing from one side of the piston to the other through the orifice 21 or through the clearance between the piston and cylinder will cause the floating lever 16 and the pilot valve assembly to move as though rigidly connected and function in the usual way that such parts function. The means by which this action is modified will now be described: The pressure in any stage or region within the turbine on the exhaust side of the last point of fluid admission usually varies with nearly a

straight line relationship between the stage pressure and the load. Advantage is taken of that fact and means provided whereby this relationship with respect to the load is imparted to the pilot valve. To accomplish this an additional piston 23 and cylinder 24 are provided. The cylinder is connected by a conduit 25 to a selected stage beyond the last steam admission point. The piston is loaded against the pressure of steam in the cylinder by a compression spring 26 located above the piston, there being a stop 27 to limit its movement toward the bottom end of the cylinder. To the rod of the piston is connected a lever 28, and engaging with the free end of the lever is an adjustable tension spring 29. Any suitable means for adjusting the effect of the spring on the lever may be employed. For example, one simple arrangement is to provide the lever with an adjustable slide 30 to which the lower end of the spring 29 is attached. The slide may be moved toward or away from the pivot of the lever by a screw 31 and hand wheel 32. As the slide is moved toward the pivot, the effect of the spring is decreased, and by moving it away from the pivot its effect is increased, such movements affecting the operation of the speed governor 14 and the pilot valve. In order that the piston 23 may be utilized to modify the action of the governor, the pilot valve, the follow-up device including the floating lever 16, the secondary lever 17 and the dash pot, the rod of said piston 23 is extended through the upper head of the cylinder 24 and terminates in a head 33. To the floating lever 16 is attached a link 34 having a head 35 and between it and the head 33 on the piston rod is a coiled spring 36 which in the position shown is assumed to exert no force but when the piston 23 rises by reason of an increase of pressure in the stage of the turbine to which the conduit 25 is connected exerts an upward pushing effect on the floating lever 16. On the other hand, when said stage pressure is reduced and the piston 23 is lowered the spring 36 exerts a downward pull on the lever 16. For descriptive purposes this spring may be termed a "push-pull" spring. It will be seen from the foregoing that the centrifugal governor operates the pilot valve to control the servo-motor and that the normal return motion of the pilot valve and floating lever is responsive in part to the spring loaded piston 23 which in turn is responsive to stage pressure. The introduction of the push-pull spring overcomes any tendency to sluggish operation and also any tendency to over-travel of the pilot valve which would cause hunting. This action is assisted by the introduction of the dash pot interposed between the floating lever 16 and the secondary lever 17 which is connected to the piston rod of the servo-motor that actuates the steam admission valve or valves 4. For any short period of time the resistance to flow of fluid in the dash pot in passing through the orifice 21 will permit the floating lever pilot valve assembly to move as a rigid connection and operate in the usual way in which such mechanisms function. For a longer period of time the stage pressure actuated piston 23 will be permitted to return the outer end of the floating lever and hence the speed adjustment of the machine to the proper value by virtue of the slow leakage of fluid in the dash pot from one side of its piston to the other. By adjusting the point of connection between the spring 29 and lever 28 the regulation of the governor can be changed. In other words a change

in speed of the turbine may be effected correspondingly to a change of load on the turbine from zero to full load.

In Fig. 2 is shown cam means for actuating one or several steam admission valves. In this case the piston rod 7 of the servo-motor is connected to the rack 37. Meshing with the teeth of the rack is a gear 38 which as the rack moves up and down turns the shaft 39 of the gear upon which are mounted one or more cams 40 depending upon the number of valves to be actuated. The stem of the valve 5 is actuated by a lever 41 having a roller at one end which rides on a cam. The usual springs 42 for closing the valves will also be employed.

Instead of adjusting the spring 29 to change the operating characteristics of the speed governor, this may be done by changing the point of application of the force of the push-pull spring 36 on the floating lever 16. Such an arrangement is shown in Fig. 3 where 42 indicates a slide mounted on the lever and a screw and hand wheel 43 employed to move the slide toward or away from the pivotal connection between the floating lever and the rod of the pilot valve.

What I claim as new and desire to secure by Letters Patent of the United States, is:—

1. A governing mechanism for elastic fluid turbines comprising an admission valve, a servo-motor for actuating the valve, a pilot valve for controlling the motor, a speed governor driven by the turbine for moving the pilot valve, a follow-up device including a floating lever actuated by the servo-motor for restoring the pilot valve to its initial position after each operation thereof, and mechanism acting at all times on the floating lever in response to changes of fluid pressure within the turbine in a region where the pressure varies nearly in a straight line relationship with the changes in load for modifying the restoring action of the follow-up device.

2. A governing mechanism for elastic fluid turbines comprising an admission valve, a servo-motor for actuating the valve, a pilot valve for controlling the motor, a speed governor driven by the turbine for moving the pilot valve, a follow-up device including a floating lever actuated by the servo-motor for restoring the pilot valve to its initial position after each operation thereof, means responsive to changes of fluid pressure within a region of the turbine beyond the point of fluid admission thereto where the pressure varies nearly in a straight line relationship with changes in load, and a connection between the means and the floating lever which includes a spring, said means and connection acting on the floating lever after each operation of the servo-motor.

3. A governing mechanism for elastic fluid turbines comprising an admission valve, a servo-motor for actuating the valve, a pilot valve for controlling the motor, a speed governor driven by the turbine for moving the pilot valve, a follow-up device including a floating lever actuated by the servo-motor for restoring the pilot valve to its initial position after each operation thereof, a cylinder to which fluid is admitted from an intermediate stage of the turbine where the pressure varies nearly in a straight line relationship with changes in load, a weighted piston in the cylinder movable in response to changes in said stage pressure, and means connecting the piston to the floating lever of the follow-up device and acting each time the servo-motor moves the admission valve for modifying its action on the pilot valve.

4. A governing mechanism for elastic fluid turbines comprising an admission valve, a servo-motor for actuating the valve, a pilot valve for controlling the motor, a speed governor driven by the turbine for moving the pilot valve, a follow-up device including a floating lever actuated by the servo-motor for restoring the pilot valve to its initial position after each operation thereof, a cylinder which is in free communication with an intermediate stage of the turbine, where the pressure varies nearly in a straight line relationship with changes in load, a piston in the cylinder movable in response to changes in said stage pressure, a connection between the piston and the follow-up device, said piston and connection acting each time the servo-motor operates, and an adjustable means for controlling the effective action of the piston on the speed governor and follow-up device.

5. A governing mechanism for elastic fluid turbines comprising an admission valve, a servo-motor for actuating the valve, a pilot valve for controlling the motor, a speed governor driven by the turbine for moving the pilot valve, a follow-up device comprising a floating lever moved by the governor and connected to the pilot valve for actuating it, a secondary lever moved by the servo-motor, a dash pot comprising a piston and cylinder, one of said parts being connected to the

floating lever and the other to the secondary lever, there being provision for a restricted leakage of fluid around the piston, a means responsive to changes of pressure within the turbine in a region where the pressure varies nearly in a straight line relationship with the changes in load, and a yielding connection between the means and the floating lever for modifying the action of the lever on the pilot valve each time the servo-motor operates.

6. A governing mechanism for elastic fluid turbines comprising an admission valve, a servo-motor for actuating the valve, a pilot valve for controlling the servo-motor, a speed governor driven by the turbine for moving the pilot valve, a follow-up device including a floating lever actuated by the servo-motor for restoring the pilot valve to its initial position after each operation thereof, a cylinder in communication with a stage of the turbine where the pressure varies nearly in a straight line relationship with changes in load, a weighted piston in the cylinder which moves in response to said stage pressure, and a connection between the floating lever and the piston which includes a push-pull spring, said spring pushing on the floating lever when said stage pressure increases and pulling when the pressure decreases.

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