

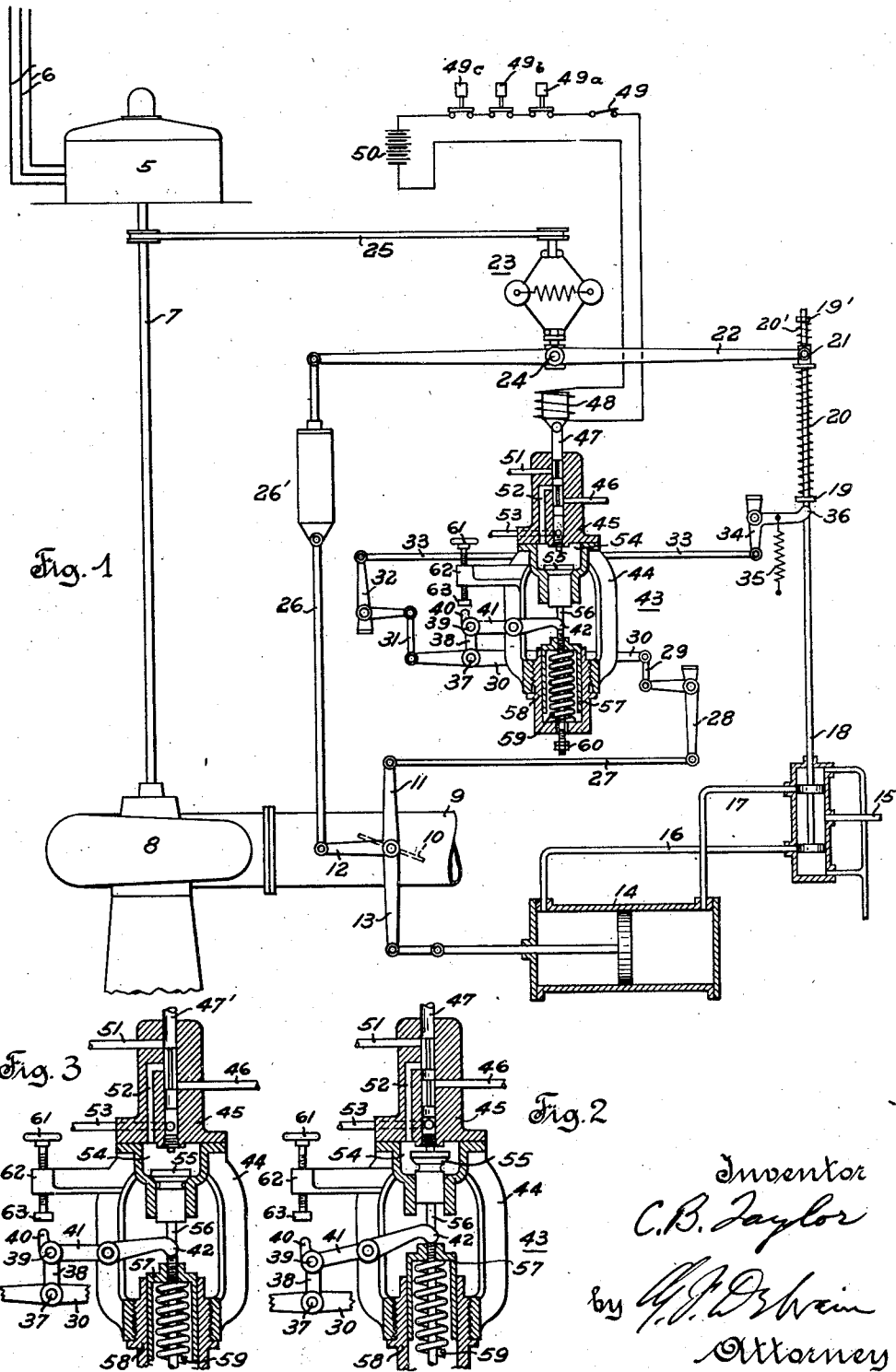
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MAXIMUM AND MINIMUM LOAD LIMITING DEVICE FOR PRIME MOVERS

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MAXIMUM AND MINIMUM LOAD LIMITING
DEVICE FOR PRIME MOVERSCharles B. Taylor, Wauwatosa, Wis., assignor to
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This invention relates generally to prime mover control systems and is especially applicable to systems in which flyball governors are used to control the admission of operating fluid to prime movers.

It has been found that hydraulic turbines when operating at zero output or with very small gate openings are more subject to wear in the guide case and pitting of the runners than when operated at a substantial gate opening.

It is an object of this invention to obviate or at least reduce the above difficulties.

Another object of this invention is to provide a device which will limit the minimum load that may be carried by a prime mover.

A further object of the invention is to provide an electrically controlled device which may be applied to the usual flyball governor system of a prime mover to limit the minimum and maximum openings of the valve which regulates the flow of operating fluid to the prime mover.

These and other objects and advantages are attained by this invention, various novel features of which will be apparent from the description and drawing herein, and will be more particularly pointed out in the claims.

An illustrative example of the application of this invention is shown in the accompanying drawing in which:

Fig. 1 shows a typical prime mover generator system embodying the invention.

Fig. 2 shows an enlarged view of the spring operated fluid pressure controlled governor blocking mechanism in its spring released position.

Fig. 3 shows a modified form of this mechanism with the blocking mechanism in its ineffective position.

Referring now to Fig. 1, generator 5 is driven by hydraulic turbine 8 through shaft 7 and is connected to distribution circuits through conductors 6. Operating fluid is supplied to the turbine 8 through conduit 9 and valve 10 which, as shown, is of the butterfly type. Valve 10 is operated by servo-motor 14 which is connected to lever 13 which in turn rotates valve 10. Servo-motor 14 is operated by fluid under pressure which travels through inlet pipe 15 and either pipe 16 or 17 depending on the position of control valve 18. 19 is a collar which is fixed to the stem of valve 18 and forms an abutment for one end of spring 20. The other end of spring 20 presses against collar 21 which is slidable upon the stem of valve 18. A similar spring 20' is mounted between collar 19' and slidable collar 21. Floating lever 22 is connected to collar 21

at its right end and to relay rod 26 at the other end and to governor 23 at an intermediate point 24. Relay rod 26 connects compensator arm 12, which moves in unison with valve 10, to floating lever 22 through the usual compensating device 26'. Governor 23 is suitably driven from shaft 7 by belt 25.

Control crank 11 also moves in unison with valve 10 and is connected at its outer end to horizontal connecting rod 27 which in turn is connected to bell crank 28, link member 29 and to the right end of normally floating lever 30. The left end of lever 30 is connected to horizontal rod 33 by means of bell crank 32 and link 31. Connecting rod 33 is connected at its right end to crank 34 which has a finger member 36 integral therewith. Spring 35 is attached to finger 36 and serves to balance the weight of the linkage, including lever 30 and link 31. Lever 30 is connected at a point intermediate its ends to one end of pivoted lever 41 by means of link 38 which has a protrusion 40 and a finger member 42.

Load limiting device 43 comprises a frame member 44 and valve housing 45 provided with a pressure inlet pipe 46 and a longitudinally movable valve 47. Valve 47 is operated by solenoid 48 which is controlled by switches 49, 49a, 49b, 49c, which are in series with source of power 50. 51 and 53 are exhaust or drain outlets for pressure chamber 54. A conduit or bore connects chamber 54 with either pressure inlet pipe 46 or drain 51 depending on the position of valve 47. Piston 55, as shown, is urged to its downward position by a source of fluid pressure (not shown). Piston rod 56, is connected to piston 55 and extends downwardly through an opening in plug member 58 which screws into a body member 44. Attached to piston rod 56 is a sleeve 57 which is adapted to slide upwardly in the inner bore of member 58 when moved by spring 59 which is coiled about rod 56. Lock nuts 60 on piston rod 56 are adjustable to vary the limit of upward movement of sleeve 57. A bracket arm 62 extends from frame member 44 and carries the maximum load adjusting knob 61 which by means of a threaded shaft varies the position of stop member 63.

Fig. 2 shows the load limiting mechanism in its minimum load limiting position, noting that lever 41 has moved about its pivot point and that sleeve 57 has engaged and raised finger 42.

The mechanism shown in Fig. 3 differs from the load limiting device shown in Figs. 1 and 2 only in the construction of valve 47'. Instead

of having two reduced portions as in Fig. 2 the valve 47' in Fig. 3 has but a single reduced portion. This construction permits solenoid 48 to be deenergized during the normal operation of the system and therefore only requires energization during the time that it is desired to limit the minimum load on the turbine.

The operation of the system is as follows:

Consider that the positions of the various parts of the system shown in Fig. 1 correspond to full load operating conditions. Upon occurrence of an increase in load the speed of shaft 7 drops causing governor 23 to move lever 22 and slidable collar 21 downwardly thus compressing spring 20 and causing valve 18 to move downwardly. This downward movement of the valve 18 permits fluid under pressure to flow through pressure inlet pipe 15 and pipe 16 to servo-motor 14 which thereupon moves crank 13 to open wider the operating fluid admission valve 10. This opening movement of valve 10 causes crank 12 to move rod 26 downwardly and also causes the prime mover 8 to speed up to its normal speed thereby moving pivot point 24 upwardly. Both of these movements tend to raise the collar member 21 and will in time restore valve 18 to its original neutral position.

Upon occurrence of a decrease in load the governor action is the converse of the above operations, namely, the prime mover will speed up slightly, governor 23 will lift valve 18 and servo-motor 14 will impart a closing impulse to valve 10, to cause the prime mover to slow down to its normal speed thereby causing both the governor 23 and the linkage 12, 26 to restore valve 18 to its neutral position. During the normal running of the turbo-generator the control valve 18 will be oscillated up and down many times per minute.

Should it be desired to prevent the turbo-generator from exceeding a certain predetermined load, stop 63 is moved down into the path of travel of protrusion 40 by turning knob 61 either by hand or by a small motor controlled from the switchboard. As the load increases the governor causes valve 10 to open as described above and this movement of valve 10, moves crank 11 anti-clockwise and moves rod 27 to the left. Bell crank 28 and link 29 transfer this motion to floating lever 30 which pivots about its left end and raises link 38 and protrusion 40. When valve 10 opens to a predetermined position protrusion 40 will engage stop member 63 which prevents any further upward movement of the protrusion 40. Further opening movement of valve 10 causes floating lever 30 to pivot about point 37 which is now a fixed pivot thus moving link 31 down, and link 33 to the right due to the connections to bell crank 32. This motion of link 33 causes bell crank 34 to move finger 36 upward into contact with collar 19 and prevents downward motion of valve 18 from its neutral position. Any further tendency for the governor 23 to move valve 18 downward merely compresses spring 20 against the unyielding finger 36. Inasmuch as the governor is thus "blocked" the speed of the turbo-generator reduces upon the occurrence of any additional increment of load and if there are other turbo-generators connected in parallel with this unit they will share this increment. It is thus seen that the maximum opening of valve 10 can be adjustably limited by adjusting the setting of stop member 63.

Upon occurrence of an abnormal condition in the turbo-generator unit such as excessive over-

load or underload, over-heated bearings, over-speed, failure of water, reverse power, etc., one or more of the relays 49, 49a, 49b, etc., which are connected in any known manner so as to be responsive to these conditions, will open and de-energize solenoid 48, thus permitting valve 47 to drop and connect chamber 54 to the atmosphere through drain 51. This operation of valve 47 also cuts off fluid pressure from piston 55 which is consequently moved to its upper position, as shown in Fig. 2, by the compression spring 59. Sleeve 57 is thus forced into engagement with finger 42 and moves this finger upward an amount determined by the adjustment of lock nuts 60, and also moves point 39 and link 38 downwardly. The downward motion of link 38 causes lever 30 to pivot about its right end and to move link 31 downward, thereby transmitting motion through bell crank 32, rod 33, and bell crank 34 to finger 36. Finger 36 is consequently moved upward striking against collar 19 and causing the valve 18 to rise. The raising of valve 18 causes servo-motor 14 to move valve 10 toward its closed position, thus tending to reduce the load and speed on the unit. The governor, however, still attempts to maintain normal speed but can only move collar 21 down to compress spring 20 against finger 36. The closing movement of the valve 10 is relayed to finger 36 through arm 11, rod 27, bell crank 28, lever 30, which is now pivoted at point 37, link 31, bell crank 32, rod 33, and bell crank 34, and causes finger 36 to move downwardly, thus permitting spring 20 to move valve 18 down toward its neutral position. Servo-motor 14 will continue to move valve 10 toward its closed position until the finger 36 is moved downwardly by the linkage connecting arm 11 with bell crank 34 to a position permitting valve 18 to be returned to neutral by spring 20. It is thus seen that finger 36 when moved into the path of travel of valve 18 by releasing spring 59 blocks the governor action and causes the valve 10 to move to a partially closed position which may be varied by adjusting the lock nuts 60.

The operation of the system employing a valve 47' such as shown in Fig. 3 is the same as described above except that the valve is arranged so that the spring 59 is released upon energization of solenoid 48 instead of upon deenergization thereof as in Fig. 1.

It is to be understood that the term "load limiting" means the restriction of the permissible load on a prime mover energy translating unit by establishing the limits of flow of operating fluid thereto.

Other uses to which this invention may be put will be apparent to those skilled in the art, it being understood that the invention is not limited to the illustrative embodiment shown, and is only limited to the extent indicated in the appended claims.

It is claimed and desired to secure by Letters Patent:

1. In a control system for an energy translating device, a valve for admitting operating fluid to said energy translating device, a servo-motor for operating said valve, a control member operable to control said servo-motor, means responsive to the speed of said prime mover for operating said control member, and means responsive to an abnormal condition in said translating device for moving said control member independently of said speed responsive means so as to cause said valve to move to a predetermined partially closed position.

2. In a control system for a prime mover, a valve for controlling the flow of operating fluid to said prime mover, a servo-motor for opening and closing said valve, means responsive to the speed of said prime mover for controlling the valve opening and closing movement of said servo-motor, and means operable upon actuation thereof to cause said servo-motor to move said valve to a predetermined partially closed position and to thereafter prevent valve opening movement of said servo-motor.

3. In a control system for a prime mover, a valve for controlling the flow of operating fluid to said prime mover, a servo-motor for operating said valve, said servo-motor having a control member movable in one direction to cause opening movement of said valve and movable in the opposite direction to cause closing movement of said valve, means responsive to the speed of said prime mover for controlling the movement of said control member, and means for blocking the valve opening movement of said control member so as to limit the maximum and minimum opening of said valve.

4. In a prime mover control system having means including a servo-motor and a control valve therefor for governing the opening of a fluid admission valve, the combination of a floating lever connected at one end to said fluid admission valve and at the other end to a finger adapted to limit the movement of said control valve, and means for limiting the movement of said floating lever to limit the minimum opening of said fluid admission valve.

5. In a prime mover control system having means including a servo-motor and a control valve therefor for governing the opening of a fluid admission valve, the combination of a floating lever connected at one end to said fluid admission valve and at the other end to a finger adapted to limit the movement of said control valve, and means for establishing a fulcrum for said floating lever intermediate its ends to cause the fluid admission valve to close to a predetermined minimum opening.

6. In a turbo-generator system having means including a servo-motor and control valve therefor for governing the movement of an operating fluid admission valve, the combination of a stop member in the path of travel of said control valve, and means responsive to an abnormal condition in said turbo-generator for moving said stop member into engagement with said control valve to cause the fluid admission valve to close to a predetermined partially closed position.

7. In a system comprising a prime mover energy translating unit, an operating fluid admission valve actuated by a servo-motor and con-

trolled by a governor and by a control valve, the combination of, a stop member, and means including a floating lever for moving said stop member in accordance with the movement of said fluid admission valve, and fluid pressure controlled means responsive to an abnormal condition in said unit for moving said floating lever to cause said stop member to assume control of said servo-motor to close said fluid admission valve to a predetermined partially closed position.

8. In a system comprising a prime mover, an operating fluid admission valve actuated by a servo-motor and controlled by a governor and by a control valve, the combination of, a finger member adapted to move into engagement with said servo-motor control valve, linkage including a floating lever for moving said finger member in accordance with the movement of said fluid admission valve, a pivoted member connected to one end to said floating lever, a spring actuated member adapted when actuated to engage the other end of said pivoted member, an electrically controlled fluid operated piston member for normally retaining said spring actuated member in its inactive position, whereby upon movement of said spring actuated member the fluid admission valve is caused to close to a predetermined partially closed position.

9. In a system comprising a prime mover, an operating fluid admission valve, a servo-motor for operating said valve, a governor and a control valve for controlling said servo-motor, the combination of, a member, means for actuating said member in accordance with the movement of said fluid admission valve, means including an adjustable stop member for limiting the motion of said valve actuated member to render said governor inoperative to cause said fluid admission valve to open more than a predetermined amount, and auxiliary means including a second stop member for limiting the motion of said valve actuated member to render said governor inoperative to cause said fluid admission valve to open more than a different predetermined amount.

10. In a system comprising a prime mover, an operating fluid admission valve, a servo-motor for operating said valve, a governor and a control valve for controlling said servo-motor, the combination of, means for rendering said governor ineffective to cause said servo-motor to open said fluid admission valve beyond a predetermined limit, and means including an electrically controlled stop member for rendering said governor ineffective to cause said servo-motor to open said fluid admission valve beyond a different predetermined limit.

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