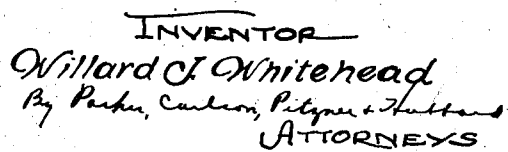


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GOVERNOR CONTROL FOR PRIME MOVERS

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GOVERNOR CONTROL FOR PRIME MOVERS

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This invention relates to the speed control of prime movers, and the general object is to provide a novel mechanism for detecting abnormal loading of the prime mover and limiting the energy supply therefor to a predetermined value for the existing speed.

Another object is to associate the limiting mechanism with a governor control in a novel manner such as to permit of normal functioning of the governor compensating mechanism.

The invention also resides in the novel manner of detecting abnormal loading and of limiting the energy supply.

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

Figure 1 is a schematic view of a governor control embodying the novel features of the present invention.

Figs. 2 and 3 are sections taken along the lines 2—2 and 3—3 of Fig. 1.

While the invention is susceptible of various modifications and alternative constructions, I have shown in the drawing and will herein describe in detail the preferred embodiment. It is to be understood, however, that I do not intend to limit the invention by such disclosure but aim to cover all modifications and alternative constructions falling within the spirit and scope of the invention as expressed in the appended claims.

The drawing shows the invention incorporated in a main hydraulic governor which operates automatically in response to changes in the speed of a prime mover (not shown) to adjust a rod 2 connected to a fuel pump, gas mixing valve, steam throttle or other device for controlling the supply of an energy medium to the prime mover.

The governor is mounted on the engine and includes a pair of flyballs 3 pivoted at 4 on a head 5 which is housed in a casing 6 and is fast on the upper end of a hollow vertical shaft 7. The latter is journaled in a body 8 and is driven by the prime mover through a coupling 9.

The inwardly projecting arms 10 of the flyball bear upwardly against the outer race of a ball bearing 11 whose inner race is urged downwardly by a compression spring 12. The force of this spring determines the engine speed which is maintained by the governor and may be adjusted by manually turning a segment 13-gearred to a sleeve 14. The latter is slidable in a cross member 13^a and receives the upper end of the spring which bears against a plug 14^a. The in-

ner race of the bearing 11 is connected to the stem 15 of a plunger 16 of a pilot valve which is slidable within a sleeve 17 that rotates with the drive sleeve 7.

The plunger 16 coacts with a port 18 opening laterally through the sleeve 17 and communicating continuously with a passage 19 that leads to a hydraulic servo motor comprising a cylinder 20 and a piston 21 slidable therein above the passage 19. This piston is on the throttle actuating rod 2 and is urged in the throttle-closing direction by a spring 22 acting in compression between the closed end of the servo cylinder cap 23 and a cap 24 on the piston.

Oil filling a sump 25 in the valve body 8 is drawn through a passage (not shown) to the inlet of a gear pump 26 having one gear rotatable with the shaft 7. The pump discharges through vertical passages 27 within the valve body and into passages 28 leading to the upper ends of accumulator cylinders 29 having pistons 30 therein and adapted to overflow through passages 30^a. The pistons are loaded by springs 31 so that the accumulators deliver oil at a predetermined pressure to the upper end of the sleeve 7, the flow being through passages 32, an annular recess 33 around the drive shaft, and ports 34 and 35 in the sleeves 7 and 17. Thus, as the engine speed decreases below a value predetermined by the speeder spring setting, the plunger 16 is lowered below the port 18 and pressure fluid will be admitted to the cylinder 20 so as to raise the servo piston 21 and therefore increase the engine throttle opening. Conversely, in response to a speed increase, the plunger 16 is raised thereby connecting the cylinder 20 to the sump 35 through the port 18 and sleeve ports 36 and 37. Fluid is thus permitted to drain from the cylinder 20 allowing the spring 22 to move the rod 2 downwardly and decrease the supply of energy medium to the prime mover.

To obtain isochronous operation of the engine, the governor incorporates a stabilizing mechanism of well known construction. Herein, this includes a receiving piston 38 slidable in a cylinder 39 in the drive sleeve 7 and connected to the lower end of the valve sleeve 17. The cylinder communicates through a port 40 and a passage 41 with a cylinder 42 having therein a transmitting piston 43 which is fast on the throttle rod 2. Through orifices 44, the passage 45 communicates with the sump 25 so that oil may flow into or out of the compensating passage depending on pressure conditions. The rate of such flow is controlled by the setting of needle valves 45

and the spring force on the piston 38 which is urged toward a centered position by a spring 46 compressible from either end.

Permanent speed droop may be provided for by adjustment of the speeder spring stress independently of the segment 13 and in accordance with the movements of the servo piston 21. Herein this is accomplished by a lever 48 fulcrumed at 49 on the sleeve 14 and bearing downwardly at 50 on the plug 14^a. The free end of the lever is pivotally connected at 51 to the upper end of a rod 52 which normally moves with the servo piston 21 and is slidable in the cap 23. For any given setting of the segment 13 the position of the fulcrum 49 is fixed so that as the servo piston 21 moves in response to a speed change, the rod 52 moves the lever 48 about the fulcrum 49. The resulting movement of the plug 14^a by the lever changes the loading of the spring 12 and produces permanent speed droop.

In accordance with the present invention, provision is made for limiting the movement of the throttle rod 2 in the speed increasing direction whenever the prime mover becomes overloaded while operating below a preselected speed. For this purpose, the connection between the rod 52 and the servo piston 21 includes a valve 55 which is normally closed by a spring 56 and which when opened permits fluid below the piston 21 in the servo cylinder 20 to be by-passed through passages 57 in the piston 21, a chamber 58 in the piston cap 24, the valve 55, ports 59 and a passage 60 leading to the sump 25. The valve comprises a conical member 61 on the lower end of the rod 52 which is slidable in the cap in the direction of the servo motion. The spring 56 acts in compression against a shoulder on the rod to urge the valve member 61 upwardly against a downwardly facing seat, thereby normally maintaining the valve closed as it moves up and down with the servo piston. If the rod 52 is blocked during upward or throttle opening motion of the servo piston, the spring 56 is overcome and the valve is opened by power supplied by the servo. This permits fluid to be by-passed thereby preventing further movement of the piston.

Such blocking of the valve rod is effected in the present instance by a stop surface 62 on a bar 63 which is slidable transversely of the rod 52 in the path of a roller 64 on the rod. When the bar 63 is retracted to the position shown, a cut away portion of the bar is disposed opposite the roller 64, and the rod is not blocked during the normal movements of the servo piston, the valve 55 remaining closed. If the bar is shifted to the left to bring the stop surface 62 opposite the roller 64, upward movement of the rod 52 is limited with the result that the valve 55 will become opened in the further movement of the piston 21 thereby by-passing oil from the servo cylinder to then limit the servo and fuel rod movement.

Means is provided for measuring the speed of the prime mover and positioning the stop surface 62 so that it will become effective to limit the throttle opening at a selected speed. Herein this means comprises a power actuated servo operator controlled by an auxiliary governor or a centrifugal device having a large speed droop. As shown, this auxiliary governor includes flyballs 67 pivoted at 68 on an auxiliary head 69 which is on the upper end of a hollow sleeve 70 rotated with the head 5 through gearing 71.

The sleeve 70, which is journaled in a body 73, has a port 74 connected to the fluid pressure source or accumulator of the main governor through a passage 75, having a selectively ad-

justable restriction 75^a therein. A second port 76 leads to the head end of a cylinder 78 through a passage 77. The flow of oil to the cylinder through the passage 77 or from the cylinder to the sump 25 through a sleeve passage 79 is controlled by a valve member or plunger 80 carried by a stem 81 which slides vertically in the sleeve 70 and is urged downwardly by a compression spring 82. The latter bears against the inner race of a ball bearing 83 while the arms 84 of the flyballs bear upwardly against the outer race.

The cylinder 78 is disposed above the flyballs 67 and extends perpendicular to the rotational axis thereof. A piston 85 slides in the cylinder and carries the stop bar 63. To provide for axial and also vertical adjustment of the bar, the latter is clamped by screws 63^a and a block 63^b in a seat on the end of the piston 85. Springs 86 disposed within the piston act in compression between a plug 87 and shoulders 88 and 89 to urge the piston to the right against the pressure maintained in the head end of the cylinder. To provide a large speed droop, usually about fifty percent, the speeder spring 82 of the auxiliary is loaded variably in accordance with changes in the position of the piston 85. For this purpose, the upper end of the spring 82 bears against a plug 90 slidable axially in the body 91 of the cylinder and carrying a roller 92 which is held by the spring 82 in contact with a cam surface 93 cut along the exterior of the piston.

Under normal load conditions, the parts of the limit control will be positioned as shown, the piston 85 having assumed a position determined by the speed at which the governor is running, in this case near the upper end of the speed range. If now the engine speed decreases, the force of the spring 82 will move the fly-weights 67 inwardly lowering the plunger 80 to admit high pressure oil to the cylinder 78 at a rate determined by the adjustment of the metering orifice 75^a. The piston 85 is thus moved to the left and continues to move until the roller 92 rises sufficiently, as permitted by the moved cam surface 93, to reduce the spring load to a value at which the flyballs will return to centered position and close off the port 76. In response to a speed increase, the flyballs move out lifting the pilot valve and allowing oil to drain from the cylinder 78 until, in the ensuing movement of the piston 85 to the right, the spring 82 is loaded sufficiently to center the flyballs and again close the port 76. The surface 93 is curved so that the relationship between the engine speed and the movement of the piston 85 is essentially a straight line.

By thus moving the stop surface 62 in accordance with speed changes and locating the surface so that it will block the rod 52 at a predetermined position in response to an increase in throttle opening, provision is made for automatically limiting the amount of fuel capable of being delivered at a given speed. Thus, when the engine is running at the maximum predetermined load for a given speed the roller 64 is in contact with the cam surface 62 but the valve 55 is closed. If the torque requirement increases so that the engine speed falls as a result of the increased load, the port 18 will be opened, admitting oil to the servo cylinder 20. Since the roller 64 is at this time against the cam surface 62, the valve 55 will be opened as the piston 21 is moved upwardly, thus by-passing oil admitted to the cylinder 20 and preventing further upward movement of the piston. The admission of more fuel to the

engine being thus prevented, the speed of the engine cannot be restored to normal as long as the excessive torque requirement exists and the auxiliary governor will still further reduce the amount of fuel supplied to the engine by admitting oil to the cylinder 78, forcing the piston 85 to the left and the rod 52 downwardly thereby opening the valve 55 further and permitting the spring 22 to force the piston 21 down until the valve 55 is by-passing all of the oil supplied to the servo cylinder. It will be seen, therefore, that the engine speed will be reduced until the torque requirement balances the torque output of the engine with the amount of fuel permitted by the auxiliary governor. It will be obvious that unless the torque is reduced by the nature of the connected load, the engine will be overloaded further as the speed is reduced and the speed will ultimately be reduced to zero. If, however, the torque requirement reduces with the speed, as in a marine propulsion installation, a balance between the torque requirements and the torque output as limited by the speed of the engine may be reached. Also, if the torque is reduced manually by some external means to a point equal to that determined by the maximum position of the rod 2 for a given speed, a state of equilibrium will once more exist. As soon as the torque requirement is reduced to a value below that established by the limiting governor, the engine speed will rise and the valve 80 will permit the discharge of oil from the cylinder 78, allowing the springs 86 to force the piston 85 to the right and permitting the roller 64 to move up the slope of the cam surface 62. This allows the valve 55 to close and the piston 21 to move upwardly as long as the valve 16 is below the port 18 as a result of an engine speed lower than that established by the setting of the segment 13. Upward movement of the piston 21 will continue until the engine speed is again restored to normal since, as a result of the increase in engine speed the piston 85 is moving still further to the right, keeping the valve 55 closed against oil in the cylinder 20.

It will be observed from the foregoing that the torque limiting control including the auxiliary high speed droop governor and the means for limiting the main servo motion operates independently of the main governor and therefore does not in any way interfere with the normal functioning of the latter until control of the fuel supply is taken away from the main governor upon the occurrence of an overload for that particular speed. Thus, the desired compensating action may be obtained as well as permanent speed droop. Moreover, by employing a power actuator for the cam bar 63, the latter may be moved to permit either an increase or a decrease in engine torque as engine speed decreases, although in the arrangement shown, a decrease in torque is required with a decrease in speed. The cam 62 may of course be shaped in various ways and positioned to become effective at any desired speed thereby producing a limiting action of the desired character.

I claim as my invention:

1. The combination of a regulating member, a hydraulic servo actuator therefor, a speed responsive governor including a valve controlling the admission of pressure fluid to said actuator, a normally closed valve having an actuating member movable with said regulating member and adapted when blocked to open said valve and divert the pressure fluid, a second speed re-

sponsive device driven in unison with said governor, a hydraulic operator, an element moved thereby in proportion to detected speed changes, and means carried by said element and operable to block said actuating member in response to a change in speed to a predetermined value.

2. A governor mechanism having in combination, a cylinder, a piston therein carrying a normally closed valve controlled by-passage, a member movable with said piston and operable when blocked to cause opening of said by-passage, speed responsive means including a valve controlling the admission of pressure fluid to said cylinder, a device movable into and out of blocking position with respect to said member, and auxiliary speed responsive means for moving said device into blocking position in response to a predetermined decrease in speed.

3. A governor mechanism comprising, in combination, a cylinder, a piston therein having a by-passage therethrough, speed responsive means including a fluid control valve controlling the admission of pressure fluid to said cylinder on one side of said piston, a rod carried by said piston and movable axially relative thereto, a second valve controlling said by-passage and having an element continuously movable with said piston, spring means urging said element toward closed position, and a stop member mounted for movement into and out of active position to block the rod and cause opening of said valve at a predetermined point in the travel of said piston.

4. A governor having, in combination, a servo motor comprising a cylinder and a piston movable therein, a speed responsive valve controlling the flow of pressure fluid into said cylinder on one side of said piston to cause movement of the latter in one direction, a spring closed valve carried by said piston and having a member movable relative to the piston in the opposite direction to open the valve and permit the escape of fluid from said cylinder independently of said speed responsive valve, and normally inactive means adapted to be rendered operative selectively to block the advance of said valve member at a predetermined point and cause opening of the valve in the further movement of said piston.

5. A governor mechanism comprising a fluid servo having a movable actuated element, a main valve governing the flow of pressure fluid to said servo, speed responsive means actuating said valve to vary the fluid pressure in said servo and thereby change the position of said element, an auxiliary valve adapted when open to reduce the fluid pressure in said servo irrespective of the condition of said main valve, means urging said auxiliary valve to closed position during normal movements of said servo element, an abutment movable into and out of an active position, and means engageable with said abutment as the servo element reaches a predetermined position while the abutment is in said active position and operable in response to movement of the servo element beyond said predetermined position during such engagement to open said auxiliary valve, the auxiliary valve remaining closed as the servo element moves to said predetermined position while said abutment is in said inactive position.

6. A governor having, in combination, a servo motor comprising a cylinder and a piston movable therein, a speed responsive valve controlling the flow of pressure fluid into said cylinder on one side of said piston to cause movement of the latter in one direction, a spring closed valve carried by said piston and having a member mov-

able relative to the piston in the opposite direction to open the valve and permit the escape of fluid from said cylinder independently of said speed responsive valve, and normally inactive means adapted to be rendered operative selectively to block the advance of said valve member at a predetermined point and cause opening of the valve in the further movement of said piston, said last mentioned means including a stop element guided for rectilinear movement back and forth in a path extending transversely of and substantially normal to the path of movement of said valve member.

7. A governor mechanism having, in combination, a fluid servo, a main valve governing the

flow of pressure fluid to said servo, means responsive to detect speed changes to actuate said valve and vary the fluid pressure in said servo and correct for said speed deviations, an auxiliary valve adapted when open to reduce the fluid pressure in said servo, means urging said auxiliary valve to closed position, a second speed responsive means driven in unison with said first means, and means responsive to changes in the fluid pressure in said servo and coacting with said second speed responsive means to open said auxiliary valve irrespective of the condition of said main valve when the servo pressure has deviated to a predetermined value.

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