April 17, 1945. J. H. HOLLOWAY 2,373,684

GOVERNOR MECHANISM

Filed April 15, 1942 2 Sheets-Sheet 1

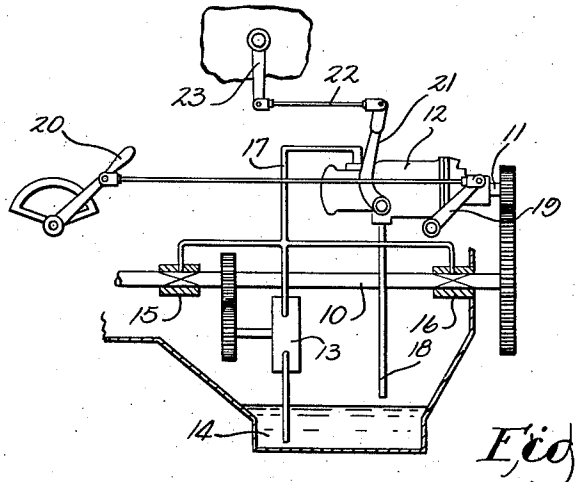

Fig. 1.

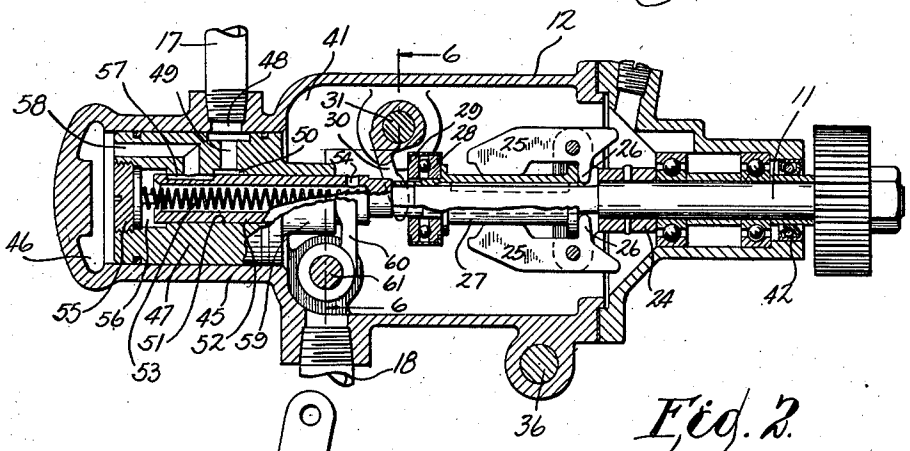

Fig. 2.

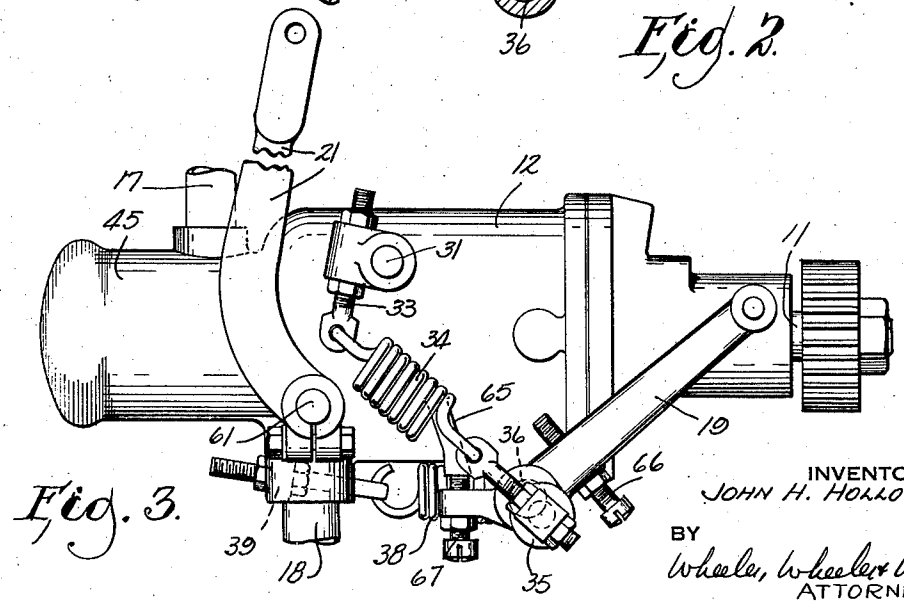

Fig. 3.

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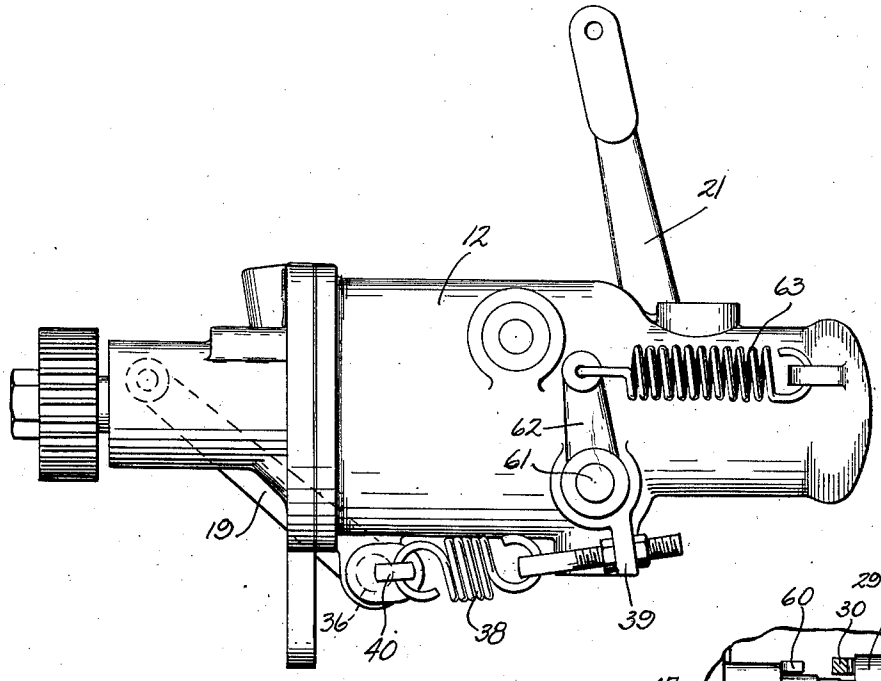

Fig. 4.

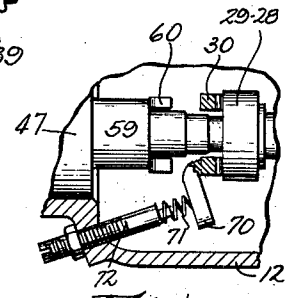

Fig. 7.

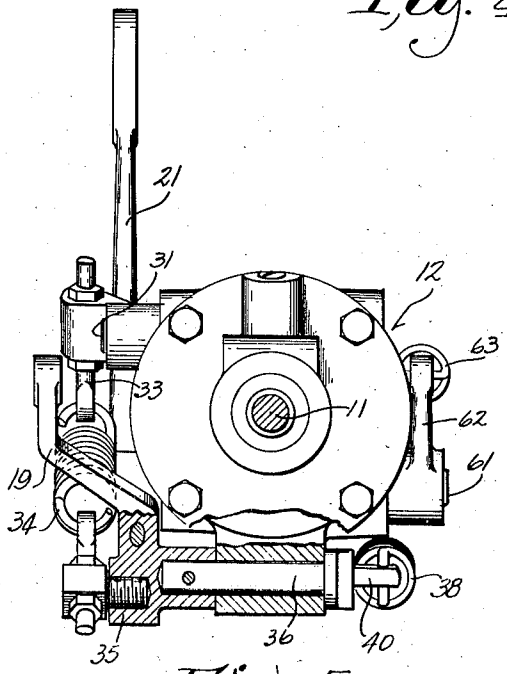

Fig. 5.

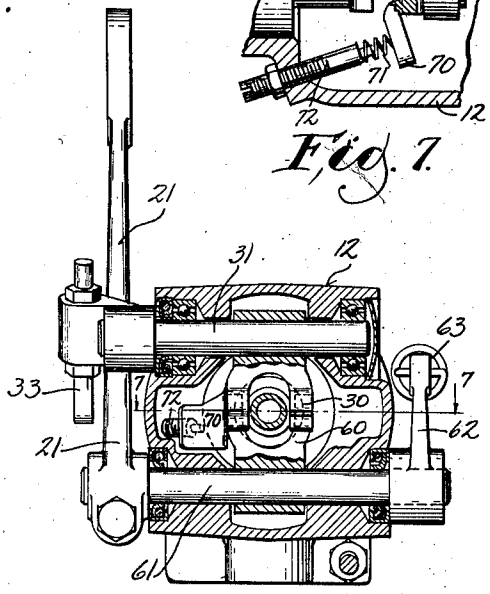

Fig. 6.

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GOVERNOR MECHANISM

John H. Holloway, Green Bay, Wis.

Application April 15, 1942, Serial No. 439,091

11 Claims. (Cl. 264—14)

This invention relates to improvements in governor mechanisms.

A major object of the invention is to provide a governor of great power and improved sensitivity of response, incorporating a power relay so organized that the governor weights themselves are relieved of most load and are thereby enabled to respond with accuracy to changes of speed. More specifically, it is proposed to provide a novel and improved organization for a governor of this type and one in which fluid pressure developed in the operation of the controlled prime mover is used to actuate the servo-motor of the power relay subject to governor control.

Another important object of the invention is the provision of a manually operable regulating mechanism in which the speed for which the governor is set may be manually varied at will by changing the tension of the governor spring without, however, noticeably varying the tension or bias to which the manually operable parts are subject, these parts therefore tending to retain any adjusted position notwithstanding their function of varying the governor spring bias.

Other objects are generally to improve and simplify and render more compact a governor of the type specified, and to improve its functioning and operation and control as will be more fully apparent from the following disclosure of the invention.

In the drawings:

Fig. 1 is a diagrammatic view of the governor installation.

Fig. 2 is a detail view on an enlarged scale showing the governor in vertical axial section.

Fig. 3 is a view of the governor in side elevation.

Fig. 4 is a side elevational view of the governor, illustrating the side opposite to that shown in Fig. 3.

Fig. 5 is a view of the governor in end elevation, with parts broken away.

Fig. 6 is a detail view taken in section on the line 6—6 of Fig. 2.

Fig. 7 is a detail view taken on the line 7—7 of Fig. 6.

Like parts are identified by the same reference characters throughout the several views.

The governor herein disclosed is particularly adapted to control the speeds of relatively heavy prime movers having speed controls which require substantial power for movement from one position to another. The governor may be used with steam, air, or internal combustion engines or electric motors, but one of my objectives is to employ in the power relay fluid pressure developed by the prime mover in its normal functioning, so as to avoid the necessity of providing any separate source of power. Therefore, by way of exemplifying its preferred use, I have diagrammatically illustrated the invention applied to an internal combustion engine to derive power for its servo-motor from the oil pump and lubrication system of such an engine.

In the diagrammatic showing of installation in Fig. 1, a prime mover shaft 10 drives the shaft 11 of the governor 12 and also drives the gear pump 13 which pumps lubricant from the sump 14 of the prime mover for the prime mover bearings typified by bearings 15 and 16. The connection 17 from the lubricating system of the prime mover to the governor 12 provides power for the servo-motor hereinafter to be described, and the surplus lubricant is returned through pipe 18 to the sump.

The regulating lever 19 of the governor is linked to a hand throttle lever 20 which may be set to any desired position to determine the speed at which the governor will maintain the prime mover in operation. The power output of the governor is delivered through a lever 21 and link 22 to the speed control lever 23, whatever that may be. In practice, it may involve a steam, air, or throttle valve, a timer, a Diesel fuel injector or a rheostat, to mention some of the possibilities.

The governor shaft 11, driven in some manner from the prime mover, carries a head 24 which provides pivots for the mounting of the governor weights 25 to permit such weights to oscillate radially outwardly as the shaft is rotated. Each weight comprises a bell crank having a finger 26 bearing upon the end of a sleeve 27 which is splined to the shaft for rotation therewith and for axial movement thereon responsive to the position assumed by the governor weights 25. The end of this sleeve seats against a thrust bearing comprising races 28 and 29. The race 29 is engaged at opposite sides of the shaft by the legs of a bifurcated lever 30 mounted on a rock shaft 31 which, as best shown in Figs. 3 and 6, is journaled transversely in the casing 12.

Externally of the casing the rock shaft 31 carries a lever 33 of adjustable length, connected by tension spring 34 to an anchorage 35 which is eccentrically mounted upon a control rock shaft 36. Conveniently carried by the spring anchorage 35, or otherwise connected to the rock shaft 36, is the control lever 19 which, as diagrammatically illustrated in Fig. 1, is linked to some manually operable part.

By rotating the rock shaft 36 by means of lever 19, the eccentric anchorage 35 is moved to vary the bias on spring 34 and thus to vary the opposition to movement of sleeve 27 axially of governor shaft 11 under the influence of the governor weights 25. Thus, it is possible to change the speed at which the sleeve 27 will respond to the centrifugal force acting upon the governor weights.

However, in thus changing the bias on the governor weights, a change would also be made in the bias on the manually operable controls were it not for the fact that the control shaft 36 is opposed as to its bias by another spring at 38 adjustably anchored at 39 and connected at its free end to an anchorage 40 which is eccentric on shaft 36 and so positioned with reference to the location of spring 38 as to tend in all positions of rock shaft 36 to offset the varying bias of spring 34. Thus, so far as the rotation of rock shaft 36 is concerned, the biasing effects of springs 34 and 38 are opposite. However, it will be apparent that the bias of spring 38 has little effect on the functioning of spring 34 to vary the bias to which the governor weights are subject in the different positions of the rock shaft.

Because of the fact that the centrifugal weights operate the controlled part 23 through a servo motor, the weights need not have the weight which would otherwise be required and the spring 34 which opposes their centrifugal outward movement can be correspondingly light as compared with standard practice. While the opposed spring 38 may not completely balance spring 34 in all positions, the type of springs made possible through the use of a servo motor makes the net differential bias to which the manually operable control parts are subject very slight.

This arrangement makes it possible for the manual control to be operated with the greatest ease and at all times maintained in sufficient balance so that it will, without any frictionally restraining devices, tend to remain at any position to which it may be adjusted. This is particularly advantageous where the governor is applied to a motor vehicle of any kind and where substantially complete absence of resistance to manual control is desirable. Since the tension of springs 34 and 38 may be independently varied, and the length of the lever 33 with which spring 34 engages may also be varied, it is possible not only to approach a balance of the spring system above described as a unit, but also, if desired, to oppose it against any spring pressure which may be incorporated elsewhere in the manual control linkage outside of the governor proper, so that the manual control mechanism as a whole will, if desired, tend to retain any adjustment in which it is set. The manual control mechanism as a whole being illustrated only diagrammatically, the exemplification shows the governor spring system treated as a unit so far as the control levers and rock shafts are concerned. As above noted, the ability of the controls to retain their adjustment persists throughout the range of control movement which varies the spring pressure on the governor weights. Not only may the system be made to retain any desired position of manual adjustment but, as will be apparent, if the seating of the governor spring is controlled by an accelerator pedal having a spring return of its own, the relatively light differential bias in the governor proper will have no appreciable or perceptible effect on the functioning of the accelerator pedal.

The governor casing 12 comprises a closed chamber 41 in which the parts of the governor proper are located. A seal is used at 42 where the governor shaft 11 enters the chamber to prevent the escape of lubricant or the admission of dirt. Communicating with the chamber at the end remote from seal 42, is a cylinder 45 having a closed head 46. Within the cylinder a piston 47 is reciprocable. A fluid pressure line 17 which, for the purposes of the present exemplification may be understood to come from the oil pump 13, communicates with port 48 in the side wall of the cylinder. A passage 49 formed radially in the piston 47, communicates with port 48 in all piston positions and leads to a port 50 opening to the axial bore 51 in the center of the piston in which pilot valve 52 is operable. The pilot valve 52 is tubular throughout most of its length, having an interior opening which serves as a fluid passage and also receives the compression spring 53. To release fluid from its inner end within the chamber 41 of the governor casing 12, the central passage through the pilot valve is vented at 54 within the casing. The spring 53 seats against a plug 55 threaded into the end of the piston to close a chamber 56 with which the pilot valve passage above described communicates. The spring 53 exerts its bias to the right as viewed in Fig. 1 to maintain the pilot valve in engagement at all times with the race 29 of the anti-friction bearing at the end of the governor sleeve 27. Thus, the pilot valve accurately follows the movements of sleeve 27 so that the position of the pilot valve, like that of the sleeve, is a function of the inter-action of the governor weights and the spring 34 which adjustably opposes their operation.

The pilot valve 52 is provided in its side with a by-pass port 57 of such length that its extreme ends register substantially exactly with the walls which form the ends of chamber 56 and port 50 respectively. In other words, the by-pass port 57 communicates normally neither with chamber 56 nor with port 50, but it may communicate with either in the event of the slightest displacement between the pilot valve and the piston. The by-pass port 57 is, however, constantly in communication through conduit 58 of the piston with the chamber within the cylinder head 46 of the cylinder so that the pressures to which the piston face is subject are at all times the same as those existing in port 57 of the pilot valve.

The piston 47 has a reduced end portion 59 engaged by the arms of a bifurcated lever 60 (Figs. 2 and 6) which is mounted on the rock shaft 61 which extends completely through the governor casing 12 and at one end carries the lever 21 and at the other end carries the lever 62 with which the biasing spring 63 is engaged. This biasing spring exerts a constant pressure tending to oscillate the rock shaft 61 counterclockwise as viewed in Fig. 2, and thereby to communicate through the arms of the bifurcated lever 60 a bias on piston 47 tending to advance the piston toward the cylinder head 46 against whatever compression exists in the cylinder head chamber to which the face of the piston is exposed.

To define the range through which the manually controlled parts of the device are movable, I provide on the casing 12 at 65 a stop with which the adjustable set screws 66 and 67 carried by lever 19 are engaged at the two extremes of oscillation of the rock shaft 36.

To minimize shock vibration and "hunting" of

the governor weights, I prefer to provide one of the arms of the bifurcated lever 30 with a laterally extending pad 70 which is shown in Figs. 6 and 7 and which, as the governor weights move toward their extreme high speed position, is caused to strike the cushion spring 71 adjustably supported on the spool 72 threaded through the wall of the governor casing 12.

The device operates as follows: The prime mover to which the shaft 11 is connected being in operation, the centrifugal force acting on governor weights 25 tends to throw these out radially to advance the governor sleeve 27 to the left as viewed in Fig. 2. Such movement of the sleeve is, however, opposed by the rock shaft 31 and the spring 34 with a variable resistance determined by the manually positioned rock shaft 36. It has already been explained how the spring pressures on the rock shaft 36 are adjusted to allow the manually operable portion of the system to retain its adjustment or to retain a sufficiently close balance so that no appreciable change in bias will be noted in operation, despite the variation in tension of spring 34 necessary to the adjustment of the governor. This is done by using a light spring at 34 and by connecting to the rock shaft another spring opposed to spring 34 and of a similar nature and opposite in bias and direction of tension.

Fluid pressure (derived in the present exemplification from the fuel pump 13 of the prime mover) is constantly being communicated to the cylinder 45 through pipe 17, but is not effective upon the piston until some displacement of the pilot valve with respect to port 50 occurs. When the centrifugal force exerted on the governor weight 25 finally becomes adequate to oscillate shaft 31 through the bifurcated lever 30, the same movement of sleeve 27 which effects such oscillation also moves the pilot valve 52 to the left as viewed in Fig. 2. This displaces the by-pass duct 57 sufficiently to afford communication between the cylinder head chamber through passage 58 of the piston and chamber 56 of the piston, and the interior of the pilot valve with the interior of the governor casing 12. Under pressure of the biasing spring 63 as communicated through rock shaft 61 and bifurcated lever 60, the piston 47 promptly moves to the left as viewed in Fig. 2, displacing fluid (in this case, oil) from the head of the cylinder into the governor casing, where the fluid escapes through pipe 18 (in this case back to the engine sump 14). As soon as the piston moves sufficiently to equal the movement of the pilot valve, the communication between the cylinder head and the governor casing through the port 57 will be cut off. The piston will, therefore, be moved exactly in accordance with the movement of the pilot valve.

When the slowing of the rotation of shaft 11 allows the governor weights to return under bias of spring 34 toward the positions illustrated in Fig. 2, the movement of governor sleeve 27 to the right will be followed by the pilot valve 52 under bias of its spring 53. This movement will cause the by-pass port 57 to afford communication between cylinder port 50 and passage 58 of the piston, thereby admitting to the cylinder head pressure (in this case, oil pressure) communicated through pipe 17 from the oil pump. This pressure will cause the piston to move to the right, following the movement of the valve, until the by-pass port 57 again fails to register with piston port 50, whereupon the pressure is cut off. Thus, regardless of the direction in which the pilot valve is moved, the piston will follow exactly, according as the by-pass port 57 relieves the piston 47 of pressure or subjects it to pressure. Since the spring 63 may be strong enough to exert on the piston a pressure only slightly less than that exerted by the oil pump, or other source of pressure, it will be apparent that considerable power is available for the oscillation of arm 21 to actuate the speed control 23 of the prime mover. In the particular arrangement shown, the connections are such that when the governor weights 25 move outwardly the speed control lever 23 is moved in a clockwise direction by the bias of spring 63 whereas, when the governor weights move inwardly the speed control lever 23 of the prime mover is moved in a counter-clockwise direction by fluid pressure acting on the head of the piston 47.

I claim:

1. The combination with a rotor and a pilot valve in axial alignment, of governor controlled means axially movable for actuating said pilot valve in one direction, a piston having a bore through which the pilot valve extends, elastic means seated between the piston and pilot valve and biasing the pilot valve from the piston into engagement with said governor controlled means, pressure and relief means including piston openings controlled by said pilot valve for admitting and releasing pressure with respect to the face of the piston, a cylinder in which said piston operates, and actuating connections having portions disposed in the path of piston movement to receive motion therefrom.

2. A governor casing having an aligned cylinder and bearing in combination with a piston reciprocable in the cylinder, a rotor operable in the bearing, governor weights carried by the rotor, an axially movable part connected with the governor weights, means for varying the resistance of such part to movement, a pilot valve engaged by said part, said piston having a bore in which the pilot valve is reciprocable, elastic means interposed between the piston and valve and biasing said valve from said piston into engagement with said part, means biasing said piston for movement in said cylinder, pressure and relief means including pressure and relief passages formed in said piston and opening to said bore, and a third passage formed in said piston and opening from the head thereof to said bore intermediate said pressure and relief passages and affording communication subject to control of said valve, between said pressure and relief passages and said cylinder beyond the piston, said pilot valve controlling communication of said third passage with said pressure and relief passages, whereby to induce movement of the piston corresponding to the movement of the valve, and a piston actuated part provided with connections for controlling the rate of rotation of said rotor.

3. In a governor, the combination with a casing and a shaft journaled in one end thereof, of a cylinder in axial alignment with the shaft, a piston reciprocable in the cylinder axially of the shaft and provided with a central bore and three openings communicating with said bore and with a passage leading from the intermediate opening to the head of the piston, a pressure conduit communicating through the cylinder with another of said openings, a tubular pilot valve having a relief duct through its center communicating with the third piston opening, said pilot valve having a by-pass port registering with the intermediate

piston opening and normally just out of communication with the pressure and relief openings of the piston, whereby any movement of the pilot valve in any direction will place the piston head in communication alternatively with the pressure and relief openings, a spring provided with a seat on the piston and engaging the pilot valve in a direction to bias said pilot valve outwardly from the piston, a bifurcated lever having legs between which the pilot valve extends, said legs engaging the piston, a rock shaft upon which said lever is mounted, said rock shaft providing an actuator and a biasing spring exerting pressure through the rock shaft and lever upon the piston, a sleeve reciprocable axially of the shaft and having bearing means engaged by the pilot valve, governor weights operatively mounted upon the shaft and provided with connections to the sleeve for the reciprocation thereof in accordance with the outward movement of the weights, a second bifurcated lever having legs engaged through said bearing means with said sleeve for the biasing of said weights therethrough, a rock shaft upon which said second bifurcated lever means is mounted, spring means acting on said rock shaft for the oscillation thereof in a direction to bias said governor weights against outward movement, and means for manually adjusting the rock shaft.

4. In a governor, the combination with a casing provided at one end with a cylinder and at the other end with bearings in axial alignment with the cylinder, of a shaft rotatably mounted in the bearings and provided internally of the casing with governor weights, a sleeve reciprocable axially of the shaft and operatively connected with the governor weights to receive motion therefrom for its reciprocation, bearing means connected with the sleeve, a rock shaft at one side of the sleeve provided with lever means engaging the bearing means, a spring biasing the rock shaft and lever means in a direction against said sleeve to oppose the outward movement of the governor weights, means for adjusting the bias to which the rock shaft is subject, a piston reciprocable in the cylinder and provided with a central bore, a pilot valve reciprocable in the bore of the piston, a compression spring within the pilot valve bearing upon the piston and biasing the pilot valve into engagement with the bearing means, whereby said pilot valve will follow the bearing means in accordance with movement of the governor weights, a second rock shaft at the opposite side of the casing from the rock shaft first mentioned and provided with lever means engaging the end of the piston beside the pilot valve, means biasing the second rock shaft in a direction to urge said piston outwardly in said cylinder, a power output lever connected with said second rock shaft for the delivery of governor movement, and hydraulic communication ducts, passages, and ports in the cylinder, pilot valve, and piston, for the movement of the piston subject to the control of the pilot valve.

5. The device of claim 4 in which the cylinder is provided with a pressure inlet port and the piston has a radial passage leading therefrom to a first piston port opening to the pilot valve bore, the piston having a passage leading from its head and an intermediate port opening to said bore with which said passage communicates, said piston also having an interior chamber beneath its head opening to said pilot valve bore and said pilot valve having a relief duct opening longitudinally of the pilot valve from the chamber last mentioned into the casing exteriorly of the cylinder and both provided with a port, the length of which registers at all times with said intermediate port and barely fails normally of communication either with said chamber or the piston port first mentioned, whereby any displacement of the pilot valve in either direction respecting the piston will afford communication alternatively between the intermediate port and either the piston port first mentioned or the relief chamber of the piston.

6. The device of claim 4 in which the lever means engaging the bearing means of said sleeve is provided with means for cushioning and damping its movement as it approaches an extreme position in the outward movement of the governor legs.

7. In a governor, the combination with a casing and a shaft rotatably mounted therein, of a cylinder closed at its end and comprising an outward extension of the casing in substantial alignment with the shaft, governor weights mounted on the shaft to turn therewith, a speed responsive part operatively connected for actuation by said weights axially of the shaft, a headed piston reciprocable in the cylinder to and from the closed outer end thereof and provided with a bore approximately parallel to said shaft and opening toward the casing, a tubular pilot valve reciprocable in the bore, a spring within the pilot valve seated at its outer end against the head of the piston and at its inner end provided with a seat upon said valve, the interior of said pilot valve communicating with said casing, a pressure supply line leading to said cylinder, said cylinder having a lateral opening to which said line is connected, the piston having a generally radial pressure duct communicating with said opening and leading toward said bore and also having a relief passage opening from said bore about the end of the pilot valve and also having a passage leading to the end of the cylinder from a point in said bore intermediate the passages first mentioned, the pilot valve having transfer means adjustable in the relative movement of the valve respecting the pistons to afford alternative communication between the passage last mentioned and the pressure and relief passages aforesaid.

8. In a governor, the combination with a cylinder closed at its end and a speed responsive part movable in a direction axial respecting the cylinder, of a piston reciprocable in the cylinder, a pilot valve likewise reciprocable axially of the cylinder and in bearing contact with the piston, said pilot valve being in thrust relation to said part to receive motion therefrom, a spring seated against said piston and against said valve whereby said valve is biased toward said part and said piston is biased toward the head of the cylinder, and pressure and relief connections controlled by the relative positions of the valve and piston for actuating the piston in accordance with the position of said part, said cylinder piston and pilot valve having coacting ports and passages with which said connections communicate.

9. The device of claim 8 in further combination with a spring biased member acting directly upon said part independently of said pilot valve and in the same direction in which said part is engaged by said pilot valve under the thrust of the aforesaid spring.

10. The device of claim 8 in further combination with a pair of rock shafts each subject to

bias, one of said rock shafts having an arm engaged with said part to oppose movement thereof toward said cylinder and the other of said rock shafts having an arm engaged with said piston and opposing movement of the piston away from said cylinder whereby the bias of said rock shafts is exerted in opposite directions upon said part and piston.

11. In a device of the character described, a servo motor comprising the combination with a casing containing a sump, and a cylinder closed at its end and constituting an extension of said casing away from the sump, of a supply connection opening through a side of the cylinder toward the interior thereof, a piston reciprocable in the cylinder and having a generally radial pressure duct in communication with said connection and a central bore to which said duct leads, and an axial communicating duct opening from the face of the piston and extending axially thereof to an intermediate point in said bore, said piston having a counter bore constituting an enlargement of the bore first mentioned, a plug in the head of the piston closing the counter bore and providing a spring seat, a pilot valve reciprocable in the piston bore and having a drain conduit, a compression spring seated against said plug and against said pilot valve, said drain conduit leading from the counter bore of said piston to said sump, and governor means in the casing acting axially upon the pilot valve in opposition to said spring, said pilot valve having a peripheral bias conduit selectively affording communication between the communication duct of the piston and the pressure duct and counter bore respectively.

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