July 15, 1952 H. G. ADLER 2,603,472

GOVERNOR FOR INTERNAL-COMBUSTION ENGINES

Original Filed June 28, 1943 2 SHEETS—SHEET 1

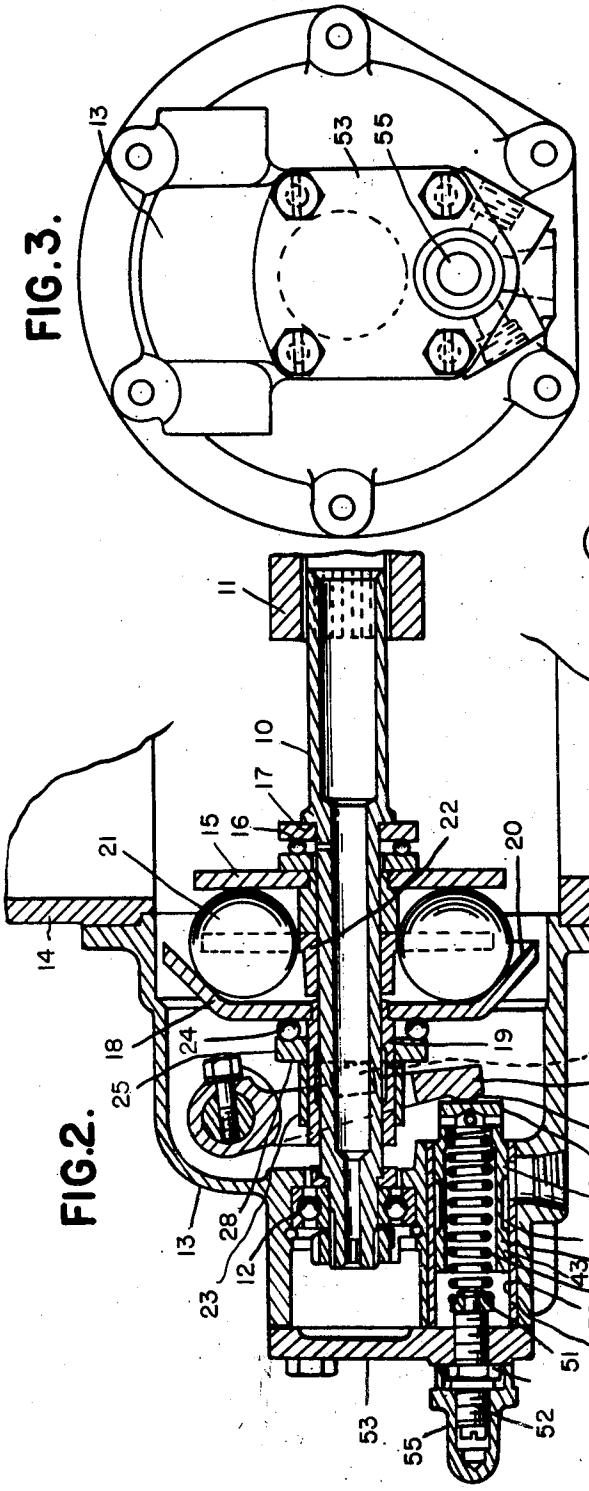


FIG.2.

FIG.3.

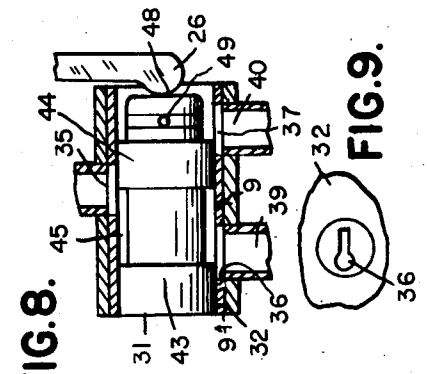


FIG.8.

FIG.9.

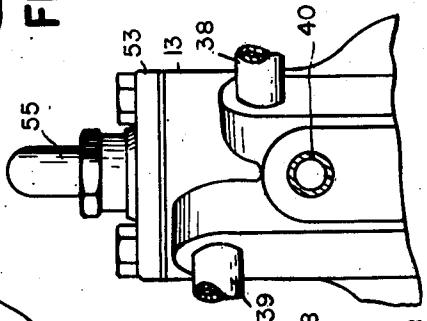


FIG.4.

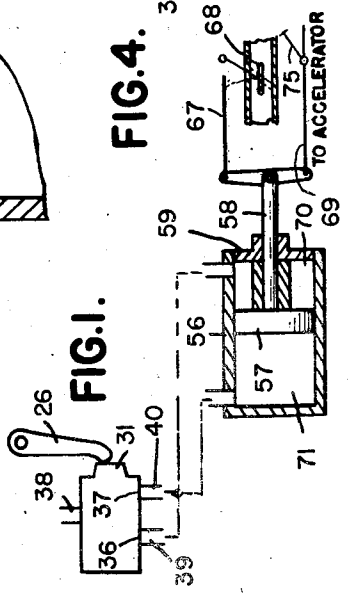


FIG.1.

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FIG.6.

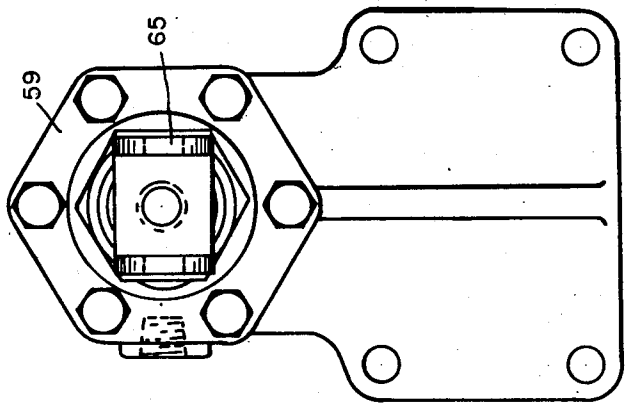


FIG.5.

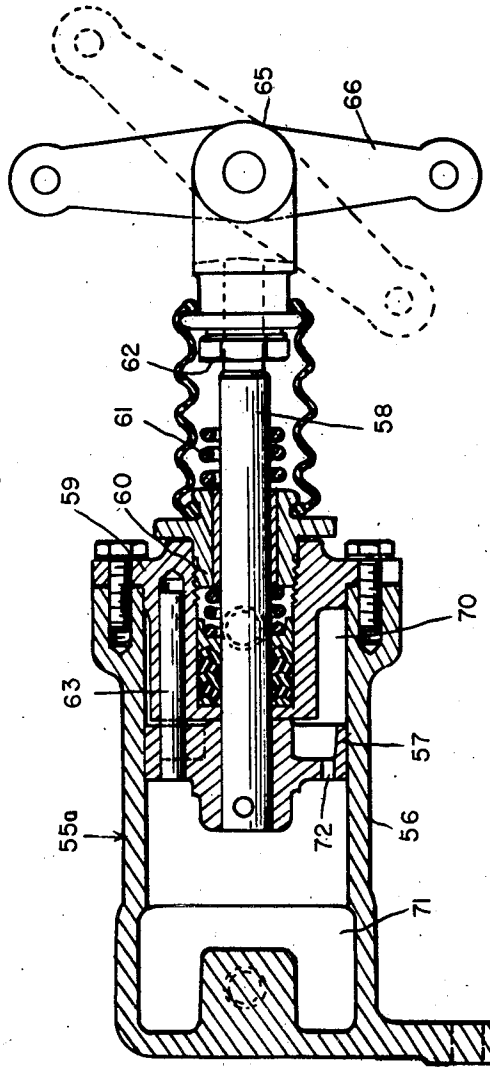


FIG.10.

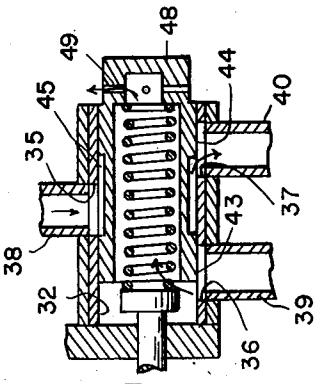
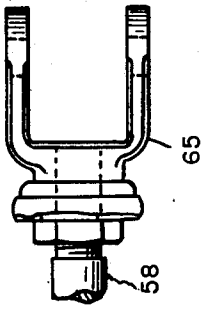


FIG.7.



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UNITED STATES PATENT OFFICE

2,603,472

GOVERNOR FOR INTERNAL-COMBUSTION ENGINES

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Continuation of application Serial No. 492,605, June 28, 1943. This application November 5, 1947, Serial No. 784,150

17 Claims. (Cl. 264—14)

1

The invention relates to governors for internal combustion engines of that type designed to restrict the speed to a predetermined maximum while permitting the development of power necessary for varying loads.

It is a primary object of the invention to obtain a construction which is applicable to high powered engines in which the operation of the governing valve or throttle requires considerable power.

It is a further object to obtain a construction which will hold the governing valve in each position of adjustment against fluctuations or hunting which is a fault of many governing devices.

Still further it is an object to obtain a simple construction which makes use of available equipment of internal combustion engines in the development of power for operating the governing mechanism.

With these and other objects in view, the invention consists first in a construction in which the throttle or governing valve is actuated by a hydraulic motor deriving its power from the pressure oil system of the engine; second, in a construction in which there is normally a continuous restricted flow of the hydraulic fluid through the motor whenever the engine is in operation to be available for instantaneous use; third, in a construction in which the hydraulic motor not only actuates the throttle valve but also forms in effect a dashpot for checking oscillations thereof; fourth, in a construction in which a pilot valve admits pressure fluid to both sides of a control piston as the valve moves between limiting positions; fifth, in a construction in which a pilot valve uncovers a restricted port to control fluid flow to a piston to operate the throttle; and sixth, in various features of construction as hereinafter set forth.

In the drawings:

Figure 1 is a diagram illustrating my improved engine governor;

Figure 2 is a vertical longitudinal section through the centrifugally actuated valve mechanism for controlling the hydraulic motor;

Figure 3 is an end elevation thereof;

Figure 4 is a bottom plan view illustrating the inlet and outlet connections to the valve;

Figure 5 is a longitudinal section through the hydraulic motor and its connections by which the controlling valve or throttle is actuated;

Figure 6 is an end elevation of Figure 5;

Figure 7 shows the bifurcated connection between the piston rod and lever;

Figure 8 is a diagrammatic view of the valve

2

shown in Figure 2 in the position which it occupies as a result of over-speed of the engine;

Figure 9 is a section on the line 9—9 of Figure 8;

Figure 10 is a diagrammatic view similar to Figure 8 showing the valve in the position which it occupies as a result of under-speed of the engine.

With large size internal combustion engines the frictional resistance to the operation of a governing valve or throttle is relatively large. Consequently the operation of the same directly by a centrifugal governor would require a mechanism of prohibitive size. One method which has been used to reduce this frictional resistance is to provide an auxiliary throttle box mounted between the carburetor and manifold and equipped with antifriction bearings. However, this results in an undesirable disturbance of the carefully worked out fuel mixture ratios and is also unsatisfactory in its governor performance, particularly with large engines. The latter difficulty is due to the fact that large engines employ large valves upon which act relatively large unbalanced torques even when these valves are geometrically in balance. These torques form a large percentage of the governing force and vary in such a manner that it is impossible to attain close regulation without introducing hunting. Furthermore, when the carburetor valve is partly closed at governed speed, the torque acting upon the governor valve is thereby changed with the result that hunting takes place in an otherwise stable governor.

To overcome these difficulties, I have devised a construction of governor in which the centrifugally actuated governor mechanism operates only a controlling valve of a hydraulic motor which latter furnishes the requisite power for actuating the throttle. Also, as above stated, the construction is one in which the fluid for operating the hydraulic motor is derived from the pressure oil system of the engine, and a further feature is that the oil controlled by the valve normally has a constant restricted flow through the motor whenever the engine is in operation.

Described in general terms, the governor comprises a piston operatively connected to the throttle valve of an internal combustion engine, a pilot valve for controlling admission and exhaust of fluid under pressure to the cylinder, and speed responsive means connected to the engine for directly controlling the position of the valve. In order to prevent speed fluctuations and surges known as hunting, the construction employs

three constructional features. A constantly open by-pass interconnects opposite ends of the cylinder, and is herein illustrated as provided by a restricted port through the piston. The pilot valve is proportioned such that in moving to change the direction of flow of fluid through the cylinder, it simultaneously connects both ends of the cylinder to supply for a short distance of travel. Finally, in moving to connect the cylinder to pressure fluid to move the throttle, the pilot valve uncovers a restricted port, which functions as an inlet or exhaust port depending upon the direction of valve movement, while a second port in the system, which is simultaneously uncovered is not so restricted. These features cooperate to reduce the sensitivity of the governor, and in practice result in a small speed range in which there is substantially no throttle movement. Furthermore, at either side of this governed speed range, throttle movements are gradual and over-controlling, with resultant violent surges and speed fluctuations, is entirely absent.

This desirable result is accomplished with a structure characterized by its simplicity, comprising essentially only a pilot valve directly positioned by a centrifugal speed responsive device and controlling flow of hydraulic fluid to the piston and cylinder which positions the throttle.

Referring now to the drawings, and more particularly Figure 2, the speed responsive device comprises a governor shaft 10 connected to a rotating part of the engine, such for example as the cam shaft 11. The governor shaft 10 is mounted at one end in a radial and end thrust bearing 12 mounted in a housing 13 carried by engine casing 14 and covering an opening provided therein.

Mounted on the shaft 10 is a circular plate 15, a ball thrust bearing 16 being provided between plate 15 and a shoulder 17 on the shaft. A cup-shaped member 18 is rotatably mounted on shaft 15, being carried by a longitudinally movable hub 19, and has a conical portion 20. A plurality of balls 21 are provided between plate 15 and cup 18, and are rotatively driven by a radially slotted driver 22 rigidly secured to the shaft.

Collar 23 is sleeved upon hub 19, thrust bearings 24 being provided between cup 18 and collar 23. The collar has a shoulder 25 which forms a bearing for a lever 26 which is fulcrumed in the casing 13 and is apertured to embrace the shaft 10 and the collar 23. The opposite sides of lever 26 have rounded bearing portions 27 engaging the surfaces 28 of shoulder 25, and its movable end has a rounded bearing portion 30 for engaging the end of a slide valve 31.

Valve 31, as best seen in Figures 8 and 10, is of hollow cylindrical form, and slidably engages a cylinder liner 32 positioned in a cylindrically formed portion 33 of casing 13. The liner has a supply port 35, and a pair of inlet or exhaust ports 36 and 37 connected to conduits 38, 39 and 40, respectively.

The valve 31 has cylindrical lands 43 and 44 spaced apart by a reduced portion 45, which is always in communication with supply port 35. Land 44 is of a width just sufficient to cover port 37. Land 43, however, is slightly narrower than the length of port 36. Lands 43 and 44 are spaced apart by a distance slightly greater than the distance between ports 36 and 37. Therefore as valve 31 moves over ports 36 and 37 so as to reverse the direction of flow through conduits 39 and 40, there is a position at which inlet port 35 is connected to both ports 36 and 37, and ports 36 and 37 are cut off from exhaust.

In order that the operation of this aspect of the invention may be fully understood, a typical valve 31 and sleeve 32 were dimensioned as follows: Circular portion of port 36 was $\frac{3}{16}$'' in diameter, the slotted portion was .093'' wide, and its over-all length was .389''. Port 37 was .375'' in diameter. The distance between adjacent edges of ports 36 and 37 was .550''. Lands 43 and 44 of valve 31 were each .375'' wide, and were spaced apart a distance of .582''.

Port 37 is preferably circular, whereas port 36 is specially shaped to restrict fluid flow. As seen in Figure 9, port 36 is shaped to provide an initially restricted opening as valve land 43 moves to uncover it to fluid supply. Movement of piston 57 in throttle-closing direction is controlled by the opening of port 36. At this time relatively large port 37 is functioning as an exhaust port, and the relative sizes of the openings in ports 36 and 37 insure against back pressure in the cylinder 56 preventing quick response. Therefore overrunning is prevented, and the danger of excessive engine speeds is eliminated. Upon decrease of speed, port 36 is opened from its large end to function as an exhaust port, and port 37 is open to fluid supply as an inlet port. Therefore back pressure builds up in cylinder chamber 70, and piston movement is controlled chiefly by control of exhaust flow through port 36. This movement of the piston is in throttle-opening direction, and lag cannot result in dangerous over-speeds of the engine, as might result from opposite movement delay or lag in opposite movement of the piston.

The source of hydraulic fluid under pressure may conveniently be the lubricating pump of the engine, and hence exhaust through valve 31 may be freely into the casing 13, whence it returns to the lubricating pump. The head 48 of the valve has a plurality of radial exhaust passages 49 which communicate with the hollow interior of the valve. Thus when exhaust is through port 36, fluid flows through the hollow valve 31, and through passages 49 to the interior of casing 13. When exhaust is through port 37, fluid is exhausted directly into the interior of casing 13.

Valve head 48 is engaged by the movable end of lever 26, as above described, and is retained in engagement therewith by an adjustable governor spring 50. Spring 50 bears at one end against the inner surface of the valve head 48, and at its other end against a spring seat 51 mounted on an adjusting screw 52 threaded into a removable closure 53 carried by casing 13. Lock nut 54 prevents accidental displacement of screw 52, and a protecting cap 55 is provided which threads over the outer end of screw 52.

With the construction as thus far described, it will be evident that with increase in angular velocity of the shaft 10, balls 21 will be urged outwardly by centrifugal action and as these balls bear against the obliquely inclined face 20 of the cup member 18, they will cam this member axially upon the shaft 10. This movement is transmitted through collar 25 to lever 26, and thence to valve 31 which is moved against the compression of spring 50.

The hydraulic motor unit shown generally at 55a in Figure 5 is mounted in any convenient location upon the engine and is connected to the throttle of the engine. The unit comprises a

cylinder 56 containing a piston 57 to which is connected a piston rod 58 passing outward from the cylinder through a head 59 and packing gland 60. A guide rod 53 on the piston slidably engages a bore guideway in the head 59 and serves to prevent rotation of the piston in the cylinder. A buffer or bumper spring 61 is provided around the rod 58, which engages shoulder 62 on the rod under no-load conditions and prevents hunting which might otherwise occur.

At the outer end of rod 58 is a bifurcated member 65 which provides a fulcrum bearing for a centrally pivoted lever 66. As diagrammatically shown in Figure 1, one end of lever 66 is connected by a rod 67 with the throttle valve 68, while the other end is connected by a rod 69 to the accelerator pedal 75. Thus, in the position of parts shown in Figures 1 and 5, lever 66 is free to pivot under actuation of the accelerator pedal to move the throttle without interference from rod 58. On the other hand, movement of the rod 58 will operate the throttle valve, the accelerator pedal connection acting as a fulcrum for lever 66.

As previously stated, the oil or hydraulic fluid for operating the motor unit 55*a* is preferably supplied from the lubrication pressure system of the engine. From this system inlet conduit 38 leads to valve inlet port 35. Conduits 39 and 40 lead respectively from the ports 36 and 37 to the cylinder 56, and communicate respectively with chambers 70 and 71. A restricted by-pass between chambers 70 and 71 is provided by a passage 72 extending through piston 57. Passage 72 is quite small as compared to ports 36 or 37.

Operation

From the foregoing description it will be understood that when the engine is running at the governed speed valve 31 may be in an intermediate position, at which time it connects both ports 36 and 37 to pressure fluid. This insures that cylinder 56 and conduits 39 and 40 are completely filled with fluid.

If the engine speed increases centrifugal action causes outward movement of the balls 21 which results in movement of the cup 18 to the left as seen in Figure 2 and this in turn rocks lever 26 clockwise as seen in this figure, moving valve 31 to the left. Figure 8 illustrates a position of valve 31 to the left as above described, this position resulting from an engine speed greater than that for which the governor is set. Fluid admitted through port 35 passes through port 36 into conduit 39 and thence into cylinder chamber 70, thus tending to move piston 57 to the left, which results in movement of the throttle valve toward closing position. It will be recalled that the port 36 is relatively smaller than the port 37 and in addition is shaped so as to provide for initial restricted opening upon movement of the valve 31. This movement of the valve 31 opens the port 37 to permit exhaust of fluid from the cylinder and due to the relative dimension of the ports 36 and 37, the exhaust flow of fluid under these conditions is substantially unrestricted when the open area of port 37 exceeds the open area of port 36. This permits movement of the piston 57 toward throttle-closing position at a rate determined substantially by the uncovered area of port 36 which at this time is operating as an inlet port. The relatively large opening of the port 37, which at this time is operating as the exhaust port, prevents the building up of back pressure in cylinder chamber 71. This is an important feature since it effectively prevents substantial overrunning of speed of the engine which might result if response were delayed as a result of back pressure building up in cylinder chamber 71. Accordingly, if there is an instantaneous substantial reduction in load on the engine the foregoing described arrangement insures prompt closing movement of the throttle valve immediately upon the speed of the engine exceeding the speed set on the governing apparatus.

If the engine speed falls below the governed speed balls 21 move inwardly, cup 18 moves to the right as seen in Figure 2, lever 26 moves counterclockwise and the valve 31 moves to the right as seen in this figure under the force applied thereto by the compression spring 50. This position of the valve 31, corresponding to an underspeed engine condition, is illustrated in Figure 10. In this figure it will be observed that port 37 is now in communication with pressure fluid and fluid therefore flows through conduit 40 into cylinder chamber 71. At the same time the opposite side of the cylinder is connected through conduit 39 and port 36 to exhaust, the exhaust fluid flowing through the hollow valve 31 and out the radial exhaust ports 49. At this time the port 37, which is operating as an inlet port to the cylinder 56, has an open area substantially larger than the open area of the port 36 which is operating as the outlet port to the cylinder. Accordingly, flow of fluid is primarily controlled by the opening in the port 36 and the movement of the piston 57 is thereby controlled except as modified of course by the action of the piston by-pass port 72. This will result in the building up of back pressure in cylinder chamber 70 so that the resulting movement of the throttle controlling piston 57 is damped. This prevents overcontrolling. There is no particular harm that can result from the engine speed dropping below the set governor speed as may result in this instance, whereas excessive engine speed may easily result in damage to the engine.

A very important feature of the construction is that piston by-pass 72 imposes a constant restriction to flow of oil therethrough, while ports 36 and 37 are varied in area and restriction of flow of fluid therethrough by different positioning of valve 31. The restriction afforded by by-pass 72 is generally greater than that afforded by the other ports but will permit sufficient flow to check oscillation of the piston.

Variations in the reactive force of the throttle valve on the piston will be balanced by the variations in fluid pressure on opposite sides of the piston resulting in part from pressure drop through by-pass 72. Furthermore, the piston cannot be displaced by such reactive forces without producing a corresponding displacement of fluid through the restricted ports, so that the motor acts as a dashpot.

The arrangement whereby valve 31 operates to connect both ports 36 and 37 to pressure in one position, the relationship between the size and shape of the ports 36 and 37, and the provision of a piston by-pass port 72 all cooperate to result in stable operation. There is a limited range at and below the governed speed throughout which the governor is substantially insensitive. Overcontrolling with resultant violent variations in speed is thus effectively prevented by an extremely simple construction involving as it does only a centrifugal device operating directly on a pilot valve which controls admission and exhaust of fluid pressure to a piston and cylinder device mechanically connected to the throttle.

Reference was previously made to the bumper spring 61 which is adapted to be engaged by the shoulder 62 when the piston 57 is moved far to the left as seen in Figure 5. The function of this spring is to provide for increased stability of the structure under no-load conditions. Under these conditions small variations in throttle opening may result in wide speed fluctuations of the engine. By providing the spring 61 the tendency toward instability under no-load conditions is avoided.

The present application is a continuation of my prior co-pending application, Serial No. 492,605, now abandoned, which was filed June 28, 1943.

The drawings and the foregoing specification constitute a description of the improved governor for internal combustion engines in such full, clear, concise and exact terms as to enable any person skilled in the art to practice the invention, the scope of which is indicated by the appended claims.

What I claim as my invention is:

1. A speed governor for internal combustion engines comprising a source of hydraulic fluid under pressure, a cylinder and piston hydraulic motor connected to the engine throttle for actuation of the same, said motor having a restricted by-pass from one side to the other of said piston, a valve controlling said motor having ports connecting with said cylinder on opposite sides of the piston therein, also pressure fluid inlet and exhaust ports, said valve in normal position permitting continuous flow of fluid from said inlet through one of said cylinder connecting ports, said by-pass and the other of said cylinder connecting ports to said exhaust, the restriction of said by-pass producing a differential pressure on opposite sides of said piston to hold the latter in open throttle position, and centrifugal means for shifting said valve toward a position for reversing said inlet and exhaust connections to said cylinder ports, said valve being adapted in passing from its normal position to temporarily connect said inlet port with both of said cylinder connecting ports whereby differential pressure on said piston is gradually changed to shift said throttle toward closed position with avoidance of hunting.

2. A speed governor for internal combustion engines having a single throttle and an accelerator pedal for operating the same, said governor comprising a source of hydraulic fluid under pressure, a cylinder and piston hydraulic motor also connected to said throttle, a lever forming a common link in the pedal and motor connections to said throttle permitting independent operation of either one, said motor having a restricted by-pass from one side to the other of said piston, a valve controlling said motor having ports connecting with said cylinder on opposite sides of the piston therein, also pressure fluid inlet and exhaust ports, said valve in normal position permitting continuous flow of fluid from said inlet through one of said cylinder connecting ports, said by-pass and the other of said cylinder connecting ports to said exhaust, the restriction of said by-pass producing a differential pressure on opposite sides of said piston to hold the latter in open-throttle position, and centrifugal means for shifting said valve toward a position for reversing said inlet and exhaust connections to said cylinder ports, said valve being adapted in passing from its normal position to temporarily connect said inlet port with both of said cylinder ports whereby differential pressure on said piston is gradually changed to shift said throttle toward closed position with avoidance of hunting.

3. A speed governor for internal combustion engines comprising a source of hydraulic fluid under pressure, a cylinder and piston hydraulic motor connected to the engine throttle for actuation of the same, said motor having a restricted by-pass from one side to the other of said piston, a valve controlling said motor having ports connecting with said cylinder on opposite sides of the piston therein, one of said ports having a restricted extension toward the other of said ports, also pressure fluid inlet and exhaust ports, said valve in normal position permitting continuous flow of fluid from said inlet through one of said cylinder connecting ports, said by-pass and the other of said cylinder connecting ports to said exhaust, the restriction of said by-pass producing a differential pressure on opposite sides of said piston to hold the latter in open-throttle position, and centrifugal means for shifting said valve toward a position for reversing said inlet and exhaust connections to said cylinder ports, said valve being adapted in passing from its normal position to connect said inlet port with both of said cylinder connecting ports and through the restricted extension of the one whereby differential pressure on said piston is gradually changed to shift said throttle toward closed position with avoidance of hunting.

4. A speed governor for internal combustion engines comprising a source of hydraulic fluid under pressure, a cylinder and piston hydraulic motor connected to the engine throttle for actuation of the same, said motor having a restricted by-pass from one side to the other of said piston, a valve controlling said motor having ports connecting with said cylinder on opposite sides of the piston therein, one of said ports having a restricted extension toward the other of said ports, also pressure fluid inlet and exhaust ports, said valve in normal position permitting continuous flow of fluid from said inlet through one of said cylinder connecting ports, said by-pass and the other of said cylinder connecting ports to said exhaust, the restriction of said by-pass producing a differential pressure on opposite sides of said piston to hold the latter in open-throttle position, centrifugal means for shifting said valve toward a position for reversing said inlet and exhaust connections to said cylinder ports, said valve being adapted in passing from its normal position to connect said inlet port with both of said cylinder connecting ports and through the restricted extension of the one whereby differential pressure on said piston is gradually changed to shift said throttle toward closed position with avoidance of hunting, and a resilient buffer for resisting inertial over-movement of said piston.

5. A speed governor for internal combustion engines comprising a source of hydraulic fluid under pressure, a piston and cylinder hydraulic motor mechanically connected to the engine throttle for actuation of the same, a restricted by-pass connecting opposite ends of said cylinder, a valve controlling said motor comprising a sleeve having end ports connecting with said cylinder on opposite sides of said piston and an inlet port intermediate said end ports, and a valve element in said sleeve movable in accordance with engine speed and having end portions closely fitting within said sleeve and adapted to control the open area of said end ports, and a reduced portion intermediate said end portions always in

communication with said inlet port, the inner edges of the end portions of said valve element being spaced apart axially of said element further than the spacing between the inner edges of said end ports, whereby upon movement of said valve element along said sleeve, said inlet port is simultaneously connected to both of said end ports, said end ports affording connections to the corresponding ends of said cylinder to exhaust when the adjacent end portions of said valve element pass inwardly of said sleeve therefrom.

6. A speed governor for internal combustion engines comprising a source of hydraulic fluid under pressure, a piston and cylinder hydraulic motor mechanically connected to the engine throttle for actuation of the same, a restricted by-pass connecting opposite ends of said cylinder, a valve controlling said motor comprising a sleeve having end ports connecting with said cylinder on opposite sides of said piston and an inlet port intermediate said end ports, and a valve element in said sleeve movable in accordance with engine speeds having end portions closely fitting within said sleeve and adapted to control the open area of said end ports, and a reduced portion intermediate said end portions always in communication with said inlet port, the inner edges of the end portions of said valve element being spaced apart axially of said element further than the spacing between the inner edges of said end ports, whereby upon movement of said valve element along said sleeve, said inlet port is simultaneously connected to both of said end ports, said end ports affording connections to the corresponding ends of said cylinder to exhaust when the adjacent end portions of said valve element pass inwardly of said sleeve therefrom, the end port communicating with said cylinder at the side of said piston effective to move said motor in throttle-closing direction having a restrictive opening first uncovered by movement of said valve element in response to an increase in engine speed, and a larger opening uncovered by further movement of said element in the same direction.

7. A speed governor for internal combustion engines comprising a source of hydraulic fluid under pressure, a piston and cylinder hydraulic motor mechanically connected to the engine throttle for actuation of the same, a valve for controlling admission and exhaust of hydraulic fluid to and from opposite ends of said cylinder including ports connected with opposite ends of said cylinder, and a valve element movable in accordance with engine speed and having portions to connect said ports alternately to said source of fluid under pressure and to exhaust, and a restricted by-pass connecting opposite ends of said cylinder and effective to damp the movement of said piston to reduce the tendency of the governor to hunt.

8. In a speed governor for internal combustion engines comprising a source of hydraulic fluid under pressure and a piston and cylinder hydraulic motor mechanically connected to the engine throttle for actuation of the same: a valve for controlling admission and exhaust of hydraulic fluid to and from opposite ends of said clinder including ports connected with opposite ends of said cylinder, and a valve element movable in accordance with engine speed and having portions to connect said ports alternately to said source of fluid under pressure and to exhaust and constructed to have appreciable intermediate movement throughout which it connects both of said ports to said source of fluid under pressure, one of said ports being relatively restricted as compared to the other, whereby movement of said piston in one direction is effected without substantial back pressure and is controlled by the inlet flow of fluid, and movement of said piston in the other direction is controlled primarily by control of exhaust flow of fluid.

9. In a speed control system for an internal combustion engine comprising an engine throttle, a reversible fluid motor for positioning the throttle and having motor ports each of which is adapted to function as an inlet or exhaust port dependent upon the direction of movement of the motor, and a speed responsive device including a movable member positionable in accordance with engine speed: a valve structure for controlling flow of fluid through the motor comprising a pair of valve ports adapted to be connected to the motor ports, a slidable valve mechanically positioned by said movable member dimensioned in intermediate position to close both of said valve ports to exhaust and to provide restricted openings at both of said valve ports to fluid under pressure, the valve port which functions as an inlet port to the motor during overspeed conditions being shaped in relation to the valve associated therewith to provide a valve opening which opens more slowly upon movement of the valve than does the other valve part upon movement of the valve in either direction from its governed speed position.

10. In a speed control system for an internal combustion engine comprising an engine throttle, a reversible fluid motor for positioning the throttle and having motor ports each of which is adapted to function as an inlet or exhaust port dependent upon the direction of movement of the motor, and a speed responsive device including a movable member positionable in accordance with engine speed: a valve structure for controlling flow of fluid through the motor comprising a pair of valve ports adapted to be connected to the motor ports, a slidable valve mechanically positioned by said movable member dimensioned in intermediate position to close both of said valve ports to exhaust and to provide restricted openings at both of said valve ports to fluid under pressure, the valve port which functions as an inlet port to the motor during overspeed conditions being shaped in relation to the valve associated therewith to provide a valve opening which opens more slowly upon movement of the valve than does the other valve port upon movement of the valve in either direction from its governed speed position, but which opens more rapidly in response to valve movement resulting from decreases in engine speed below governed speed than it does in response to increases in speed above governed speed.

11. In a speed control system for an internal combustion engine comprising an engine throttle, a reversible fluid motor for positioning the throttle and having motor ports each of which is adapted to function as an inlet or exhaust port dependent upon the direction of movement of the motor, and a speed responsive device including a movable member positionable in accordance with engine speed: a valve structure for controlling flow of fluid through the motor comprising a valve cylinder provided with axially spaced valve ports in the side wall thereof adapted to be connected to the motor, a supply

port in the wall thereof intermediate said valve ports, a spool valve having axially spaced lands and a central reduced portion always in communication with said supply port, the one of said valve ports operable as a supply port upon increase in engine speed above governed speed being shaped relative to the valve land cooperable therewith as to open more slowly upon valve movement in either direction than does the other valve port.

12. In a speed control system for an internal combustion engine comprising an engine throttle, a reversible fluid motor for positioning the throttle and having motor ports each of which is adapted to function as an inlet or exhaust port dependent upon the direction of movement of the motor, and a speed responsive device including a movable member positionable in accordance with engine speed: a valve structure for controlling flow of fluid through the motor comprising a valve cylinder provided with axially spaced valve ports in the side wall thereof adapted to be connected to the motor, a supply port in the wall thereof intermediate said valve ports, a spool valve movable by said member and having axially spaced lands and a central reduced portion always in communication with said supply port, the one of said valve ports operable as a supply port upon increase in engine speed above governed speed having an opening which is relatively restricted at the end adjacent the other valve port and relatively enlarged at the other end, said other valve port being of larger size than said one valve port, the land cooperable with said other valve port being cylindrical and having an axial extent equal to said other valve port, the land cooperable with said one valve port being cylindrical and having an axial extent slightly less than the axial extent of said one valve port, the axial spacing between the lands being slightly greater than the axial spacing between said valve ports, and the outer ends of said lands being spaced apart a distance slightly greater than the outer edges of said valve ports.

13. A speed governor for an internal combustion engine having a throttle comprising a source of hydraulic fluid under pressure, a reversible hydraulic motor mechanically connected to the engine throttle, a valve structure for controlling the flow of fluid through said motor, a by-pass providing a restricted flow of fluid from one side to the other of said motor, said valve structure comprising a valve cylinder provided with axially spaced valve ports in the side wall thereof adapted to be connected to the motor, a supply port in the wall thereof intermediate said valve ports, a spool valve movable in accordance with engine speed and having axially spaced lands and a central reduced portion always in communication with said supply port, the one of said valve ports operable as a supply port upon increase in engine speed above governed speed having an opening which is relatively restricted at the end adjacent the other valve port and relatively enlarged at the other end, said other valve port being of larger size than said one valve port, the land cooperable with said other valve port being cylindrical and having an axial extent equal to said other valve port, the land cooperable with said one valve port being cylindrical and having an axial extent slightly less than the axial extent of said one valve port, the axial spacing between the lands being slightly greater than the axial spacing between said valve ports, and the outer ends of said lands being spaced apart a distance slightly greater than the outer edges of said valve ports.

14. Mechanism as defined in claim 13 in which said motor comprises a piston and cylinder, and said by-pass comprises a restricted port through said cylinder.

15. A speed governor for an internal combustion engine having a throttle, a piston and cylinder hydraulic motor connected to said throttle, a restricted fluid by-pass from one side of said piston to the other, a source of hydraulic fluid under pressure, a valve structure connected to said fluid source and having a pair of ports connected respectively to opposite ends of said cylinder, a valve element associated with said ports and relatively movable thereto in accordance with engine speed, said valve element including closure portions which under stable conditions connect one port to fluid under pressure and the other port to exhaust, thus providing a constant flow through said by-pass.

16. Mechanism as defined in claim 15 in which under stable conditions, the port opening of the port connected to fluid under pressure is increased upon movement of said element in response to increase in engine speed.

17. Mechanism as defined in claim 16 in which said portions first simultaneously close both of said ports to exhaust and connect both of said ports to fluid pressure and then reverse the fluid pressure-exhaust relationship of said ports upon movement of said element in response to a substantial decrease in engine speed.

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