

Oct. 4, 1955

H. G. ADLER

2,719,517

LOAD SENSITIVE GOVERNOR

Filed Nov. 13, 1951

6 Sheets-Sheet 1

FIG. 1.

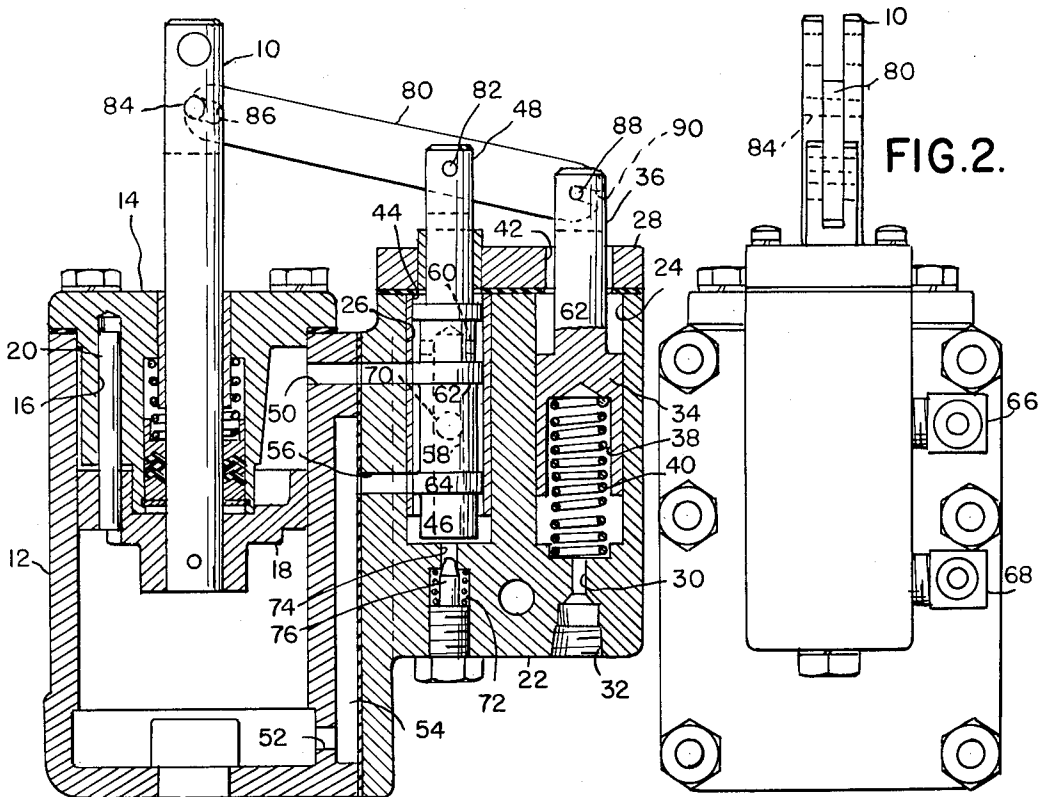
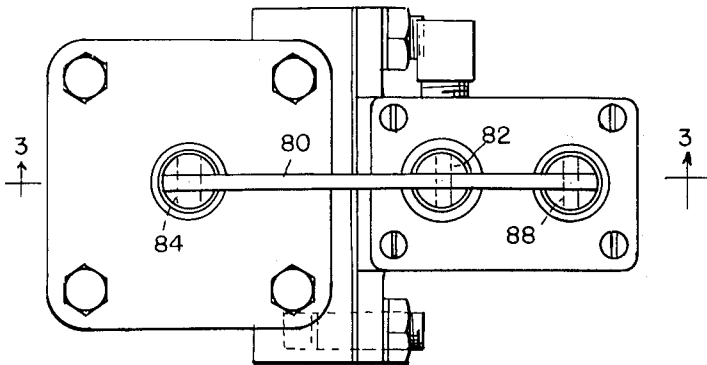


FIG. 3.

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FIG. 4.

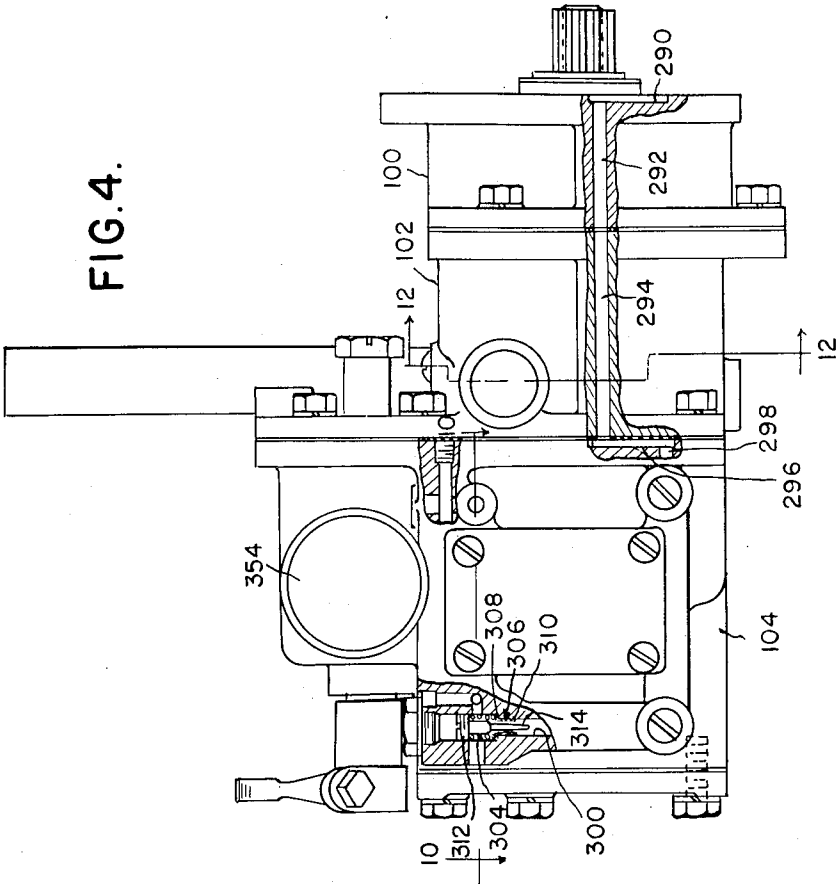
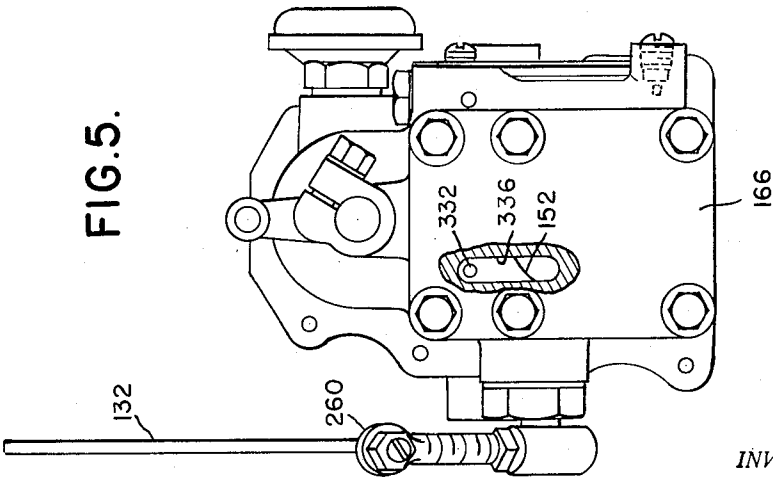


FIG. 5.



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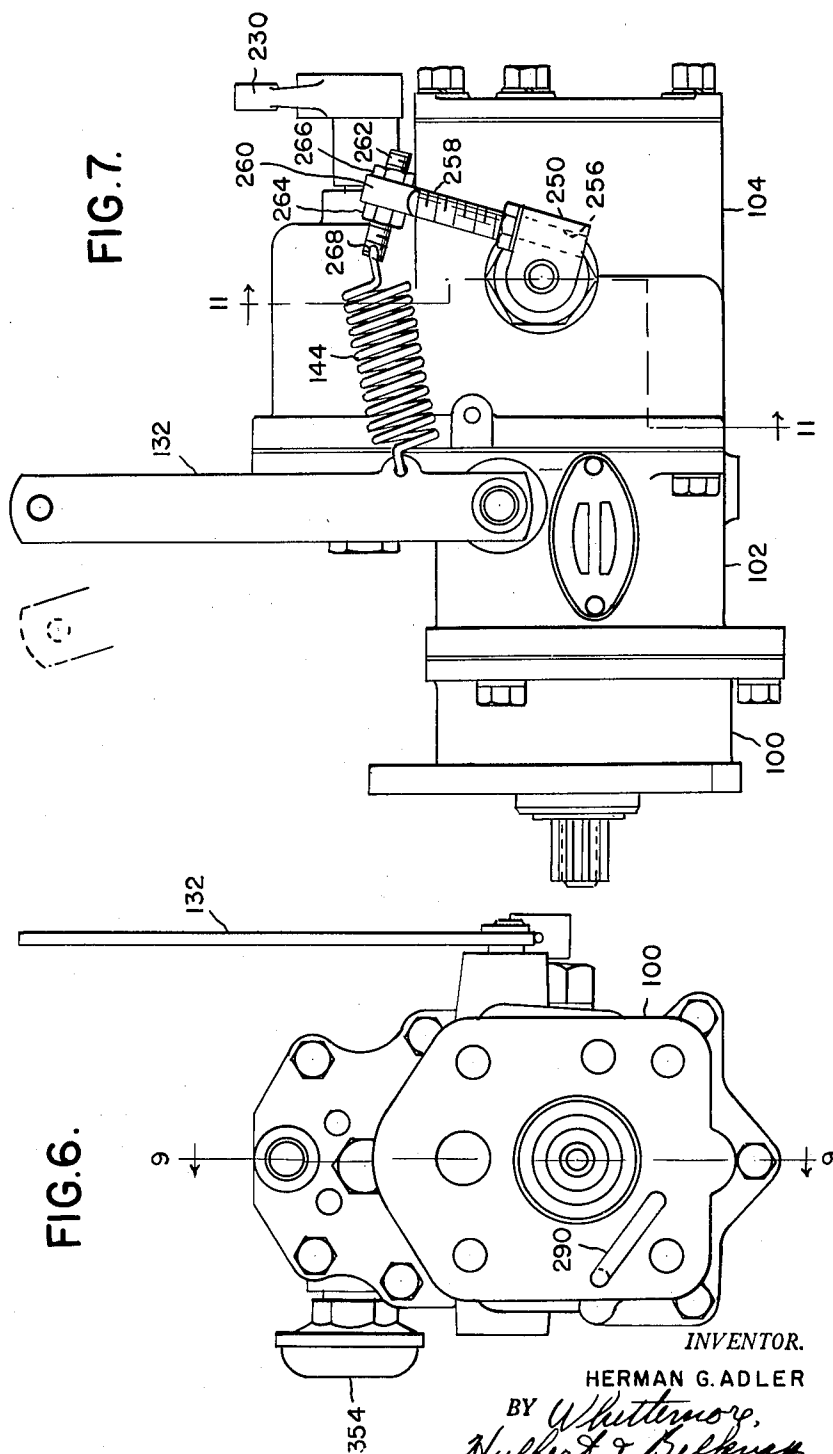
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FIG. 8.

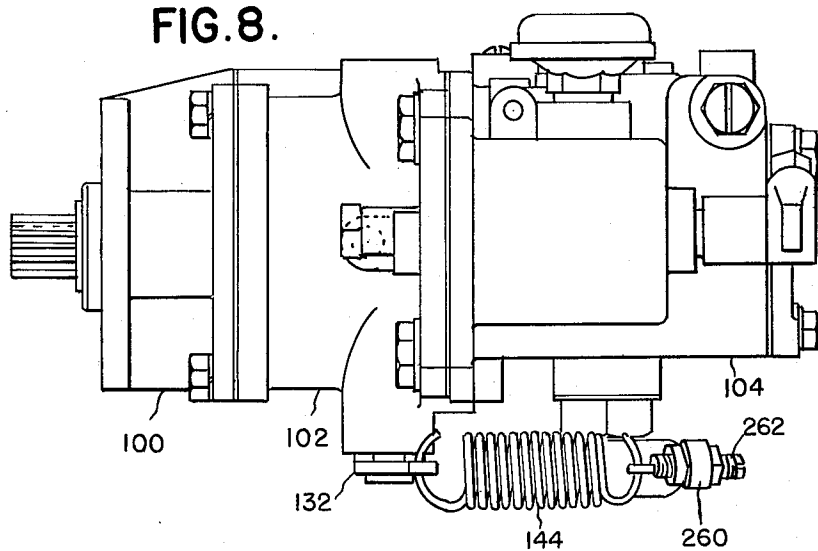
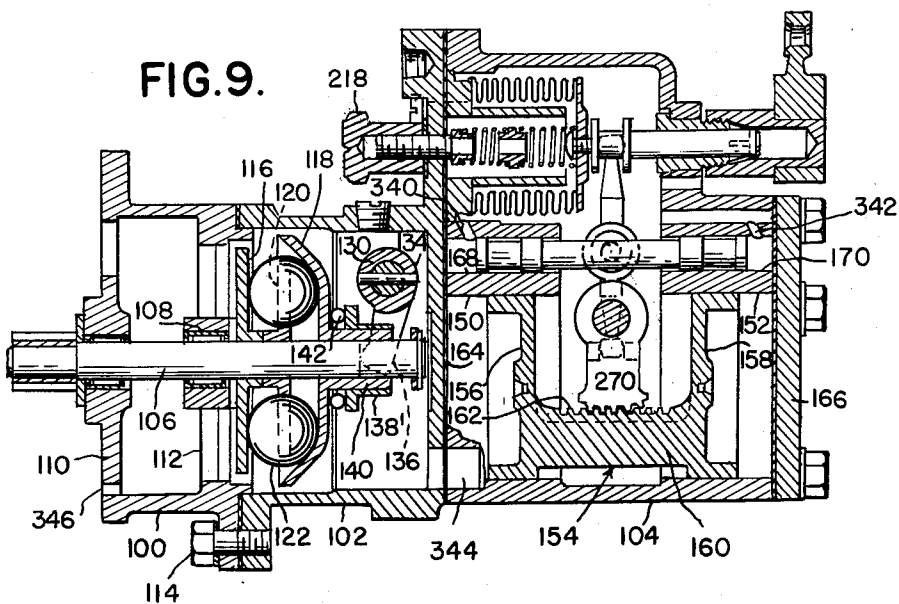


FIG. 9.



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FIG. 10.

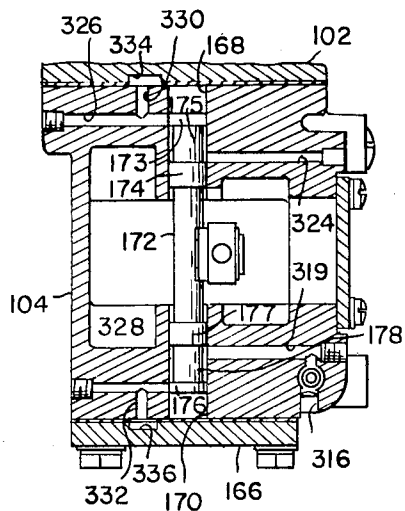


FIG. 11.

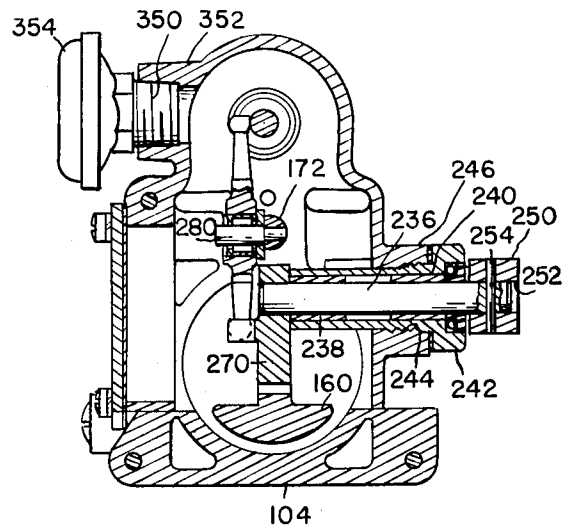


FIG. 13.

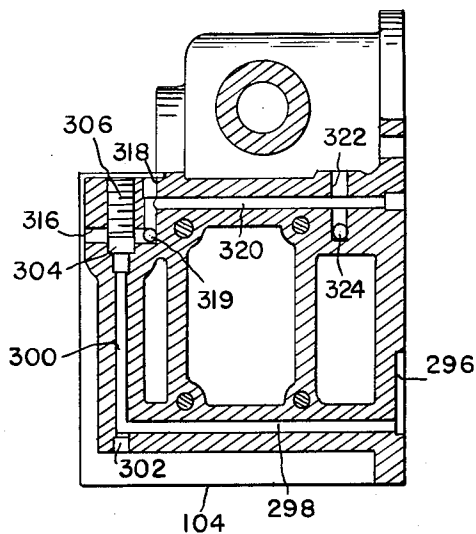
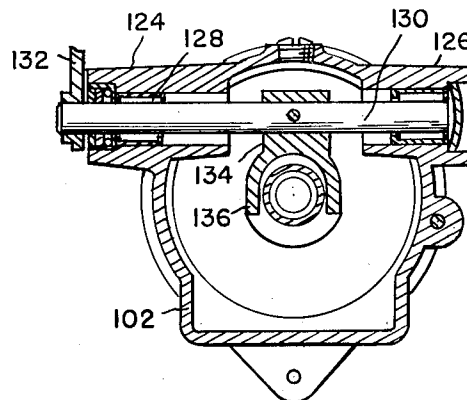


FIG. 12.



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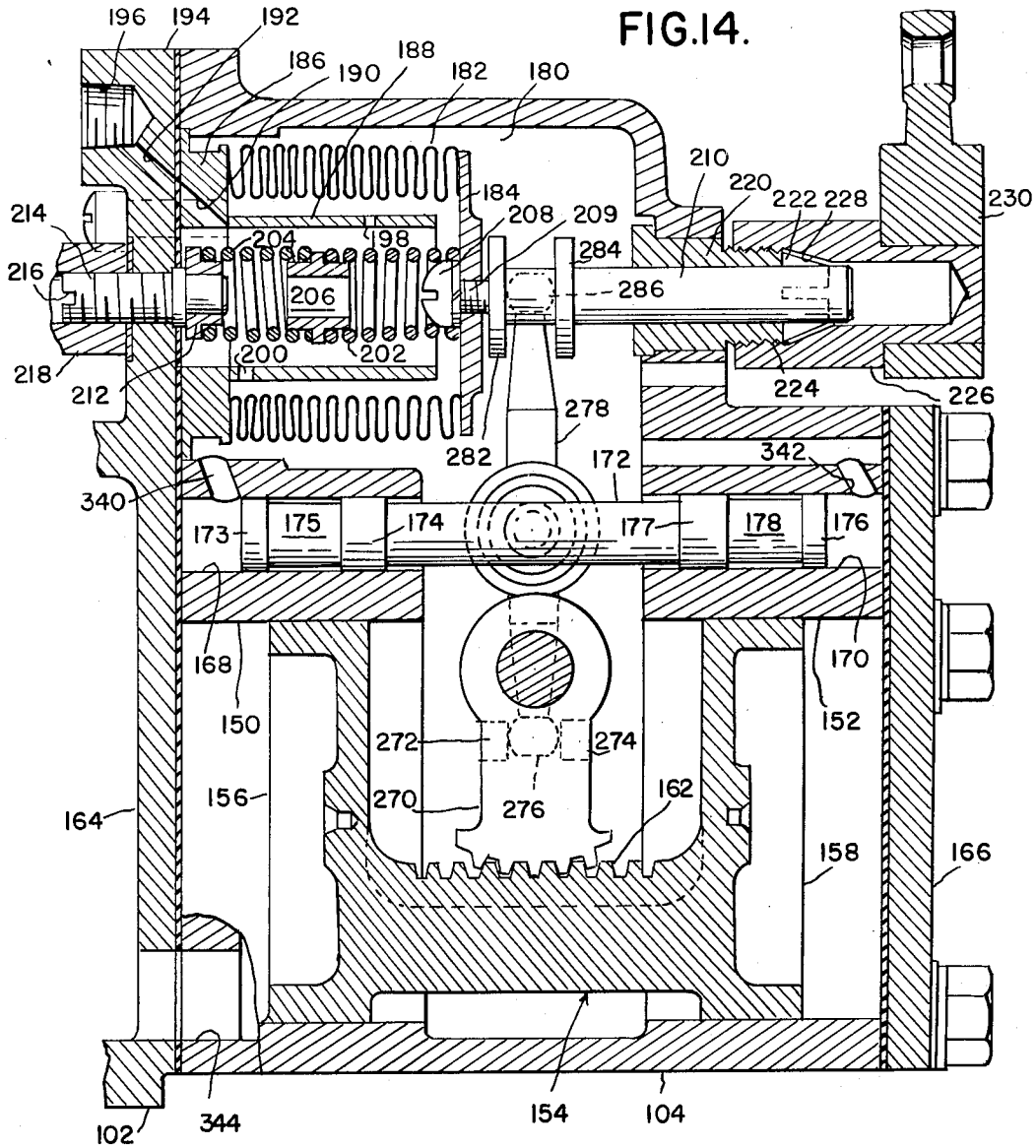
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6 Sheets-Sheet 6



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2,719,517

LOAD SENSITIVE GOVERNOR

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Application November 13, 1951, Serial No. 256,087

26 Claims. (Cl. 123—103)

The present invention relates to a load sensitive governor, and more particularly to a centrifugal governor for use with an internal combustion engine including adjusting mechanism operable in response to changes in load on the engine to produce desired governor characteristics. For example, the present construction may be designed to control an internal combustion engine so that speed increases with increases in load.

It is an object of the present invention to provide a load sensitive governor characterized by its efficiency, its simplicity, the economy with which it may be produced, the flexibility of adjustment thereof which provides different operating characteristics for the internal combustion engine controlled thereby, the close regulation achieved by the governor and its substantial avoidance of instability and hunting.

More specifically, it is an object of the present invention to provide a load sensitive governor including centrifugal speed responsive controlling mechanism and pressure responsive mechanism adapted to be connected to a point on an internal combustion engine where pressure varies as a function of load on the engine, and means connecting the pressure responsive mechanism and the centrifugal speed responsive controlling mechanism to effect adjustments of operating characteristics thereof in accordance with pressure changes.

More specifically, it is an object of the present invention to provide centrifugal speed responsive controlling mechanism and pressure responsive mechanism operatively connected thereto adapted to be subjected to the variable sub-atmospheric pressure prevailing in the intake manifold of an internal combustion engine.

It is a feature of the present invention to provide a member movable solely in response to variations in pressure in combination with governor adjusting mechanism effective to produce a single predetermined adjustment of the governor for each position of the member.

Other objects and features of the invention will become apparent as the description proceeds, especially when taken in conjunction with the accompanying drawings, wherein:

Figure 1 is a plan view of a simplified form of load sensitive governor constructed in accordance with the present invention.

Figure 2 is a side elevation of the governor shown in Figure 1.

Figure 3 is a section on the line 3—3, Figure 1.

Figure 4 is a side elevation partly in section, of a second embodiment of the present invention.

Figure 5 is an end elevation looking from the left in Figure 4, with parts in section.

Figure 6 is an end elevation looking from the right in Figure 4.

Figure 7 is a side elevation looking from the right in Figure 6.

Figure 8 is a plan view of the load sensitive governor shown in Figure 4.

Figure 9 is a section on the line 9—9, Figure 6.

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Figure 10 is a section on the line 10—10, Figure 4.

Figure 11 is a section on the line 11—11, Figure 7.

Figure 12 is a section on the line 12—12, Figure 4.

Figure 13 is a horizontal section through the controller body.

Figure 14 is a fragmentary enlargement of a portion of Figure 9.

Referring first to Figures 1—3 there is illustrated a simplified form of the load sensitive governor which nevertheless incorporates the novel operating characteristics. The mechanism illustrated in Figures 1—3 is adapted to be associated with a centrifugal governor to effect adjustments thereof in accordance with changes in load on the internal combustion engine with which the governor is associated. The centrifugal governor may be of the type shown in Adler Patent No. 2,553,736. In use the piston rod 10 is intended for connection to the governor spring of the governor to effect adjustments thereof.

The load sensitive governor controller illustrated in Figures 1—3 comprises a cylinder 12 having a removable cylinder head 14 including a bored cylindrical guide recess 16 therein. Slidably movable in the cylinder 12 is a piston 18 connected to the piston rod 10 and carrying a guide pin 20 which is slidably received in the recess 16.

Secured to the cylinder 12 is a body 22 having cylinders 24 and 26 formed therein and partially closed by a removable head 28. The lower end of the cylinder 24 is connected by a passage 30 to a threaded recess 32 adapted to receive a fitting carrying a conduit connected at its opposite end to a portion of an internal combustion engine in which the pressure is variable as a function of load on the engine. The term "pressure" is employed in a broad sense to include pressures both above and below atmospheric pressure. Excellent results are obtained with the present mechanism when the cylinder 24 is connected to the intake manifold where the pressure or so-called vacuum is variable as a function of load on the engine.

Slidably received in the cylinder 24 is a piston 34 having a piston rod 36 extending outwardly through the head 28. As seen in Figure 3, the piston 34 is recessed at its lower end, as indicated at 38, to form a seat for a compression spring 40. The piston rod 36 extends outwardly through an opening 42 in the head 28, the opening subjecting the upper part of the piston 34 to atmospheric pressure. The piston at its lower side is of course subjected to the manifold vacuum which tends to draw the piston downwardly against the compressive force of the spring 40.

Located in the second cylinder 26 is a sleeve 44 which receives a piston-type valve 46 having a piston rod 48 extending through a sealed opening in the head 28. An oil passage 50 including portions extending through the side wall of the cylinder 12, the body 22, and the sleeve 44, connects the interior of the sleeve 44 to the interior of the cylinder 12 above the piston therein. At its lower end the cylinder 12 includes a passage 52 which communicates with a vertical passage 54 formed in the outer side wall of the cylinder 12. The passage 54 in turn connects with a passage 56 which extends through a side wall of the body 22 and the sleeve 44. The passages 52, 54 and 56 afford communication between the interior of the cylinder 12 below the valve and the interior of the sleeve 44.

The valve 46 includes a central bored passage 58 communicating at its top with a transverse passage 60 thus providing communication between the upper end and the lower end of the cylinder 26 or the interior of the sleeve 44. The valve 46 in addition includes spaced lands 62 and 64 which in an intermediate position are adapted to

register with and close the ports provided at the ends of passages 50 and 56.

Conveniently, the load sensitive governor controller may be connected to the oil pressure supply of the internal combustion engine and for this purpose the body 22 is provided with an inlet fitting 66 and an outlet fitting 68. The inlet fitting 66 provides connection to a passage 70 opening into the interior of the sleeve 44 intermediate the valve lands 62 and 64. The outlet fitting 68 is connected by a passage (not shown) to a chamber 72 which in turn is connected to the lower end of the cylinder 26 by a passage 74. Flow of oil through the passage 74 is adjustably restricted by a needle valve 76 in order to slow down the response of the piston 18 to displacements of the piston 34, and to introduce a timed delay into the action of the governor controller.

A lever 80 is pivoted as indicated at 82, to the upper end of the piston rod 48. The piston rod 10 is provided with a pin 84 which enters an elongated slot 86 formed at one end of the lever 80. The piston rod 36 carries a pin 88 entering into a slot 90 at the other end of the lever 80.

With the engine and governor operating at a constant load and constant speed, and with the parts of the load sensitive governor controller in the position illustrated in Figure 3, an increase in load on the engine causes a reduction in speed of the engine and a corresponding drop in the intake manifold vacuum. The drop in the intake manifold vacuum permits the spring 40 to move the piston 34 upwardly. At this time the control piston 18 is rigidly locked against movement due to the presence of hydraulic fluid or oil in the cylinder at both sides thereof. Moreover, since the needle valve 76 restricts flow of oil out of the system, this insures that the system will at all times be filled with oil. Accordingly, upward movement of the load sensitive piston 34 results in rocking movement of the lever 80 about the axis of the pin 84 and accordingly, results in a corresponding upward movement of the piston valve 46. Upward movement of the piston valve 46 causes the land 62 to move upwardly opening the passage 50 to oil under pressure in the sleeve 44 intermediate the lands 62 and 64. This oil flows through the passage 50 into the cylinder 12 above the control piston 18, moving the piston downwardly. It will be recalled that the piston rod 10 is connected to the governor spring of a centrifugal governor and accordingly, downward movement of the piston 18 and piston rod 10 results in an adjustment of the governor spring. This adjustment is such as to change the setting of the governor to cause the governor to control at an increased speed, thus applying a controlling influence to the internal combustion engine. This controlling influence may be of such magnitude to cause an actual increase in the speed of the engine in response to the increase in load. Alternatively of course, the parts may be so proportioned and adjusted as to cause the engine to operate at substantially the same speed or lower. Oil beneath the piston 18 flows through the passages 52, 54 and 56 into the sleeve 44 below the land 64 and thence outwardly through the passage 74, past the needle valve 76, into the chamber 72, and finally outwardly through the exhaust fitting 68.

The piston 34 will move to a position which is dependent solely upon the existing vacuum in the manifold, since the piston is influenced only by pressure applied to its upper end, intake manifold vacuum applied to its lower end, and the force of the spring 40. Accordingly, while the control piston 18 is moving to a new position, the lever 80 at this time rocks about the axis of the pin 88 and accordingly tends to restore the piston valve 46 to the intermediate position illustrated in Figure 3. As a result of the foregoing the pressure sensitive piston 34 is moved to a definite different position for each different degree of intake manifold vacuum and the control piston 18 is in turn moved with substantial power to a definite

predetermined position dependent upon the position of the pressure sensitive piston 34 and movement of the control piston 18 to such definite predetermined position restores the piston valve 46 to the position in which it closes the opening into passages 50 and 56. At this time control piston 18 is rigidly blocked against movement in either direction by fluid trapped in both ends of the cylinder 12.

If the load on the engine is decreased, thus producing an increase in intake manifold vacuum, pressure sensitive piston 34 moves downwardly, opening the passage 56 to the pressure supply of fluid intermediate the lands 62 and 64. Oil flows into the lower end of the cylinder 12 through the passages 56, 54, and 52, moving the piston 18 upwardly, and oil flows out of the upper end of the cylinder through the passage 50 into the sleeve 44 above the land 62 and thence outwardly through the passages 60, 58 and 74, past the needle valve 76, into the chamber 72, and thence outwardly through the exhaust fitting 68.

Referring now to Figures 4-14 there is illustrated an embodiment of the present invention in which the load sensitive governor controller is mechanically combined into a compact operating unit with the centrifugal governor, thus producing certain advantages as to efficiency of the combination as well as conservation of space and the possibility of reducing the operating parts as well as bringing the load sensitive governor controller into efficient operating relation with respect to the centrifugal governor.

As seen in these figures, the combined centrifugal governor and load sensitive governor controller comprises three main castings; namely, a base 100, a governor body 102, and a controller body 104.

Referring now to Figure 9 the centrifugal governor comprises a shaft 106 adapted to be connected to a rotary part on the internal combustion engine to be controlled, such for example as to the cam shaft thereof. The shaft 106 is mounted in bearings 108 provided in suitable openings in transversely extending webs 110 and 112. The base 100 is bolted or otherwise secured as indicated at 114, to the governor body 102, and the shaft 106 extends into the governor body.

Mounted intermediate a flat race 116 and a dished race 118 is a driver 120 including slots in which are received centrifugal elements in the form of balls 122. The driver 120 is keyed or otherwise secured to the shaft 106 for rotation thereby, and as will be apparent, rotation of the driver results in corresponding rotation of the balls 122 about the axis of the shaft 106. The centrifugal force developed by the rotation of the balls tends to cause the balls to move outwardly from the axis of the shaft and this in turn results in movement of the dished race 118 to the right as seen in this figure.

The governor body 102, as best seen in Figure 12, comprises a pair of laterally projecting bosses 124 and 126 which are apertured and receive bearings 128 in which a transverse shaft 130 is mounted for rotation. Outwardly of the body 102 the shaft 130 has rigidly connected thereto a governor lever 132 so that rotation of the shaft 130 results in movement of the lever 132 about the axis of the shaft. Within the hollow interior of the body 102 the shaft 130 has connected thereto a lever 134 terminating in forked ends 136 which are adapted to bear against a thrust bearing 138 mounted on the neck 140 of the dished race 118 and separated from the radially extending portion thereof by ball bearings 142.

As best seen in Figure 7, the governor lever 132 has connected thereto a governor spring 144, the tension of which is adjustably controlled by lever means later to be described. Tension of the governor spring 144 tends to rock the governor lever 132 clockwise as seen in Figure 7, and this in turn establishes a force tending to rotate the lever 134 clockwise as seen in Figure 9, thus establishing a resilient force opposing outward movement of the balls 122 and movement of the dished race 118 to the right as seen in Figure 9. As is usual in centrifugal gov-

ernors, the governor lever 132 is connected by suitable linkage or other means to the throttle of the internal combustion engine.

The load sensitive governor controller is housed within the controller body 104 which adjacent its lower portion as seen in Figure 9, or better seen in enlarged Figure 14, includes a pair of aligned opposed cylinder portions 150 and 152. A piston assembly indicated generally at 154 is provided having a first piston portion 156 slidable in the cylinder portion 150, and a second piston portion 158 slidable in the other cylinder portion 152. The piston portions 156 and 158 are interconnected by an integral bar portion 160 having rack teeth 162 provided along its upper surface. The outer end of the cylinder portion 150 is closed by the adjacent transverse wall 164 of the governor body 102 and the outer end of the cylinder portion 152 is closed by a removable cylinder head 166.

The interior of the load sensitive governor controller body 104 is also provided with spaced aligned cylinder portions 168 and 170 which are adapted to receive the end portions of a pilot valve 172. The end portion of the valve 172 which is received within the valve cylinder portion 168 includes an outer land 173 and an inner land 174 separated by a reduced portion 175. The opposite end of the valve 172 includes an outer land 176, an inner land 177, and an intermediate reduced portion 178.

Above the cylinders 168 and 170 the body 104 is provided with a space 180 in which is received a pressure sensitive bellows 182 carrying a rigid head 184. The opposite end of the bellows 182 is carried by and sealed to a mounting member 186 which is provided with an abutment sleeve 188 extending inwardly of the bellows. The mounting member 186 includes a passage 190 which communicates with a passage 192 provided in an upward extension 194 of the governor body 102. The passage 192 terminates in a threaded recess 196 by means of which it is connected to a conduit (not shown) leading to a portion of the internal combustion engine in which pressure is variable as a function of load, and preferably to the intake manifold of the internal combustion engine. The passage 190 communicates with the interior of the abutment sleeve 188 and in order to render the bellows active when the head 184 is in closing relation against the open end of the sleeve 188, the sleeve is provided with ports 198 and 200. Located within the bellows 182 are compression springs 202 and 204 coupled at their adjacent ends to an intermediate spacer 206. The spring 202 engages around the head 208 of a screw 209 which extends through an opening in the head 184 into a threaded recess in the end of a shaft 210. The outer end of the spring 204 is engaged on a spring seat 212 carried by the inner end of an adjusting screw 214, the outer end of which is notched as indicated at 216 to permit adjustment of the screw with a screw driver. A cover and seal member 218 is provided internally threaded to screw onto the outer portion of the adjusting screw 214 and to lock the same in adjusted position. Obviously, adjustment of the screw 214 will affect the compression of the combined spring structure including the springs 202 and 204, and hence the operation of the load sensitive governor controller. The shaft 210 extends outwardly through a bushing 220 mounted in an opening in the wall of the body 104, the bushing including a tapered and slotted end portion 222. Inwardly of the tapered and slotted portion 222 thereof, the bushing 220 includes a threaded portion 224 on which is threaded a locking cap 226 having threads cooperating with the threaded portion 224 and having a conical clamping portion 228 cooperating with the tapered slotted portion 222 of the bushing. Rigidly secured to the cap 226 is a constant speed locking lever 230 by means of which the cap may be rotated. Obviously, when the cap is rotated in a direction to cause the inner camming or clamping surface 228 of the cap to impinge forcibly upon the tapered slotted portion 222 of the bushing, the tapered slotted portion of the bushing

is compressed in a manner to grip the shaft 210 firmly and to thereafter prevent longitudinal movement thereof in response to variations in the manifold vacuum.

Referring now to Figure 11 there is illustrated a shaft 236 which is journaled in bushings 238 and 240 carried in a hollow mounting body 242 threaded as indicated at 244 in an opening in a boss 246 provided on the body 104. At its outer end the shaft 236 carries a short adjusting lever 250 having an opening 252 therethrough receiving the end of the shaft 236 and adapted to be connected thereto by a pin 254. The end of the lever 250 is provided with an internal threaded recess 256, as best seen in Figure 7, for the reception of an eye bolt 258 having an eye 260 which receives a threaded element 262 adapted to be received within the eye and adjusted longitudinally therein by virtue of adjusting nuts 264 and 266. One end of the member 262 has an opening 268 to receive the adjacent end of the governor spring 144.

At its inner end shaft 236 has keyed or otherwise rigidly secured thereto a sector 270 having pinion teeth at its lower end engageable with the rack teeth 162 provided on the bar portion 160 of the compound piston 154. The arrangement is best illustrated in Figure 9 or Figure 14 wherein it will be observed that reciprocation of the piston 154 in either direction will result in rotation imparted to the lever 250 and eye bolt 258, thereby adjusting the tension of the governor spring 144.

Referring again to Figure 14 the sector 270 is provided thereon with spaced abutments 272 and 274 between which is received the lower ball end 276 of a control lever 278. The lever 278 is pivoted to the intermediate portion of the valve 172 by means of a pivot pin 280, best seen in Figure 11. The shaft 210 is provided with a pair of spaced radially extending flanges 282 and 284 between which is received the upper ball end 286 of the lever 278.

The base 100, as best seen in Figure 4, is provided with a slot 290 in its outer face which is adapted to be clamped to a portion of the internal combustion engine having a passage therein through which oil under the pressure of the lubricating pump may be admitted to the slot 290. Extending longitudinally of the base 100 is an oil inlet passage 292 which connects to a similar passage 294 provided in the governor body 102. The outer face of the load sensitive governor controller body 104 is provided with a slot 296 establishing communication between the passage 294 and another passage 298 extending longitudinally of the body 104.

Reference is now made to Figures 10 and 13 showing the arrangement of passages providing for the appropriate flow of oil to control the load sensitive governor controller mechanism. As seen in Figure 13, the passage 298 communicates with a vertically extending passage 300 adapted to be closed at its lower end by a plug received in the opening 302 and entering an enlarged chamber 304 adjacent the upper portion of the body 104.

Referring now to Figure 4 the chamber 304 includes an upper threaded portion. A metering bushing 306 is provided having an outwardly extending flange 308 received within the chamber 304 and a reduced depending portion 310 extending downwardly into the vertical passage 300. Received within the upper threaded portion of the chamber 304 is a metering screw 312 having a tapered portion 314 entering into the opening through the metering bushing 304 to thereby restrict the flow of oil therethrough.

Referring again to Figure 13, the chamber 304 is intersected by a transverse passage 316, the outer end of which is closed in use, which in turn intersects a vertical passage 318, the upper end of which is closed in use. The passage 316 is further intersected by a horizontal passage 319 (see Figure 10). Extending longitudinally of the body 104 is a passage 320, the outer end of which is closed in use. The passage 320 in turn is intersected by a vertical passage 322, the outer end of which is closed in use, and the passage 322 at its lower end intersects

with a passage 324 parallel to and spaced from the passage 319. Passages 319 and 324 at their inner ends communicate with the valve cylinder portions 170 and 163 respectively. Thus, lubricating oil under the pressure supplied by the lubricating pump of the internal combustion engine is supplied through the passages 319 and 324 to the valve cylinders 170 and 168 as controlled by the valve 172. Also communicating with the interior of the valve cylinders 168 and 170 are passages 326 and 328, the outer ends of which are closed in use. Passages 326 and 328 communicate respectively with transverse passages 330 and 332 respectively and these in turn communicate with recesses 334 and 336 respectively provided in the adjacent surface of the governor body 102 and the removable cylinder head 166. The recess 336, as best seen in Figure 5, establishes communication between the passage 332 and the interior of the main cylinder portion 152. It will be understood that the elongated recess 334 provided in the outer face of the governor body 102, in like manner communicates with the interior of the main cylinder portion 150. Thus, oil passing through the passages 330 or 332 is admitted to one end or the other of the main piston 154.

Referring now to Figure 10, the inner lands 174 and 177 of the valve 172 normally are located intermediate the ports provided by passages 319 and 324, so that oil under pressure flows into the spaces intermediate the inner lands 174 and 177 and the outer lands 173 and 176. However, the outer lands 173 and 176 register respectively with and cover the ports provided by the passages 326 and 328 thereby preventing the flow of oil into or out of the main cylinders 150 and 152.

Referring again to Figure 14, the outer ends of the valve cylinders 168 and 170 are respectively provided with exhaust passages 340 and 342, thus when the valve 172 is shifted in either direction oil is admitted to one end of the cylinder through a port located intermediate the pair of lands at one end of the valve and is exhausted at the other end of the valve through the valve cylinder and into the interior of the body 104, whence it is permitted to drain back to the internal combustion engine through passages 344 and 346. It may be observed that the interior of the body 104 is at atmospheric pressure and in fact, an enlarged opening 350 is provided in a boss 352 and a breather 354 is located in the opening to permit ambient air pressure to be effective within the body 104 while at the same time preventing the entry of dust or dirt particles.

If the load on the internal combustion engine to which the illustrated mechanism is connected is increased there results a decrease in the speed of the engine and a corresponding decrease in the manifold vacuum. The decreased vacuum in the manifold is communicated to the interior of the bellows 182 through the passages 192 and 190 and the head 184 of the bellows is thus permitted to move outwardly or to the right, as seen in Figure 14, under the influence of springs 202 and 204. This movement of the head 184 is communicated to the upper end of the lever 278 through the shaft 210 and results in rocking motion of the lever 278 about the axis of its lower end 276 and a corresponding movement to the right of the valve 172. Movement of the valve 172 to the right, as seen in Figure 14, or downwardly as seen in Figure 10, causes the lower valve land 176 to uncover the port defined by its intersection between the passage 328 and the valve cylinder 170, thereby admitting fluid under pressure through passages 328, 332, and 336 to the right hand main cylinder 152, as seen in Figure 14. This in turn results in movement of the piston assembly 154 to the left and oil is exhausted from the left hand main cylinder 150 through the slot 334 and passages 330 and 326 to the valve cylinder 168 outwardly beyond the land 173. This oil is exhausted through the port 340 into the interior of the body 104 and returns by drain to the internal combustion engine.

Movement of the piston assembly 154 to the left however, results in a re-adjustment of the valve 172 and accordingly closes off the inlet and exhaust ports controlled by the lands 173 and 176 when the piston assembly has reached a predetermined position dependent upon the instantaneous position of the shaft 210. A reverse action takes place upon a decrease in load on the internal combustion engine.

It will be observed that the only forces operating on the bellows 188 are the atmospheric pressure acting on the outside of the bellows, the vacuum present in the manifold acting on the interior of the bellows, and the spring assembly made up of the springs 202 and 204. Accordingly, the shaft 210 is moved into a definite predetermined position for each stage of vacuum present in the manifold.

While the response of the bellows 188 to variations in manifold vacuum is substantially instantaneous it will be recalled that the supply of oil to the control valve assembly is restricted by the metering screw 312. Accordingly, movement of the main adjusting piston 154 and the governor adjusting lever 250 takes place at a substantially slower rate or is subjected to a timed delay. Thus, instantaneous fluctuations in manifold vacuum produce no effect on the adjustment setting of the governor. The metering screw is of course adjustable so as to permit an accurate control of the timed delay introduced between the instantaneous movements of the shaft 210 and the eventual resulting movement of the main control piston 154.

Attention is also directed to the control lever 250, the eye bolt 258, and the adjusting threaded element 262, as best seen in Figure 7. The eye bolt 258 is adjustable longitudinally by virtue of its threaded connection to the lever 250 thereby varying the effective lever arm acting on the spring 144. At the same time the threaded adjusting element 262 is longitudinally adjustable thereby varying the tension of the spring 144 independently of the automatic operation of the device.

It is important to note that after the main control piston 154 has reached a new position following its re-positioning as a result of movement of the shaft 210, the piston is effectively blocked by fluid in the cylinders against movement. At the same time the valve 172 is designed to be in balance at all times so that no changes are applied to the shaft 210 through the lever 278. In fact, movement of the shaft 210 and corresponding movement of the valve 172, applies no appreciable load on the shaft 210 due to the balanced condition of the valve 172.

The provision of the constant speed locking lever 230 is an important feature of the present invention. Thus, at any given speed, the lever 230 may be moved so as to clamp the shaft 210 in its instantaneous position and thereafter the governor assembly will function in the usual manner without correction or response to variations in load.

In order to clarify the initial adjustments and operation of the governor a typical example will be given. Assume that the governor is required to control the engine at 1700 R. P. M. at no-load and to increase the speed to 2900 R. P. M. under a stated load. First, the spring adjusting screw 214 is adjusted to apply a minimum compression to the bellows springs 202 and 204. Thereafter the governor is connected to the engine and the threaded adjusting element 262 is adjusted to obtain a speed of 1700 R. P. M. at no load. Next, the specified load is applied to the engine and the threaded adjusting element 262 is adjusted so that a small further increase in load will increase engine speed. The next step is to adjust the metering screw 312 so that the engine is stable under loads greater than the specified load. The final step is to adjust the arm or eye bolt 258 so that the maximum engine speed is 2900 R. P. M.

The governor and load sensitive governor controller will thereafter operate to produce a stable operating

engine which will operate at no-load at 1700 R. P. M., and with increases in load will produce increases in speed up to a maximum of 2900 R. P. M.

Satisfactory operation of the centrifugal governor and load sensitive governor controller is rendered possible only by the provision of timed delay means which introduces a predetermined but adjustable time lag between the substantially instant response of the shaft 210 to variations in manifold pressure and the eventual corresponding adjustment of the governor spring resulting from movement of the main piston assembly 154. Moreover, satisfactory operation of the mechanism is further rendered possible only by the fact that the governor spring and its variable tension has no effect whatever on the movement of the bellows and the bellows controlled shaft 210 in response to variations in manifold pressure. Thus, for each predetermined degree of vacuum in the manifold pressure the shaft 210 will be located at a definite predetermined position. Moreover, for each definite predetermined position of the shaft 210 the main piston assembly 154 will reach a corresponding definite predetermined position and will be hydraulically blocked against movement in such position so long as the shaft 210 is not moved. Thus, the lever including the eye bolt 258 is hydraulically blocked in adjusted position and the adjustment of the governor spring 144 is likewise maintained positively until there has occurred a change in manifold vacuum which continues for a period sufficient to allow the timed delay response of the main control piston to take place.

It may be noted that abutment sleeve 188 limits collapse of the bellows under vacuum and predetermines the load at which the load sensitive controller begins to adjust the settings of the governor spring.

The drawings and the foregoing specification constitute a description of the improved load sensitive governor 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 load responsive governor for in internal combustion engine comprising a governor arm for connection to the throttle of the engine, centrifugal means operated in accordance with engine speed and operatively connected with said arm, a governor spring operatively connected to said arm and opposing the action of said centrifugal means, and means for controlling the engine speed in accordance with load thereon comprising a pressure sensitive device for connection to a part of the engine wherein pressure is variable as a function of engine load, an adjustable seat for said governor spring, adjusting means operated by said pressure sensitive device to move said seat into adjusted positions dependent upon the amount of said pressure, said adjusting means including means operable to prevent movement of said seat except in response to changes in the load on the engine.

2. A governor as defined in claim 1 in which said adjusting means comprises a hydraulic motor.

3. A governor as defined in claim 2 in which the means for preventing movement of said seat comprises valve means operatively connected to said pressure sensitive device and to said hydraulic motor and operable by said device to admit hydraulic fluid to said motor to effect a predetermined movement thereof and movable by said motor into position to thereafter block said motor against further movement.

4. A load responsive governor for an internal combustion engine comprising a governor arm for connection to the throttle of the engine, centrifugal means operated in accordance with engine speed and operatively connected with said arm, a governor spring operatively connected to said arm and opposing the action of said centrifugal means, and means for controlling the engine speed in accordance with load thereon comprising a pressure sensitive device for connection to a part of the engine wherein pressure is variable as a function

of engine load, a valve, a hydraulic piston and cylinder motor, fluid supply and exhaust passages controlled by said valve, and means connecting said valve to said pressure sensitive device and to said motor to effect a follow-up action, and means connecting said motor to said spring to effect adjustments thereof.

5. A load responsive governor for an internal combustion engine comprising a governor arm for connection to the throttle of the engine, centrifugal means operated in accordance with engine speed and operatively connected with said arm, a governor spring operatively connected to said arm and opposing the action of said centrifugal means, and means for controlling the engine speed in accordance with load thereon comprising a pressure sensitive device for connection to a part of the engine wherein pressure is variable as a function of engine load, a servo-motor for adjusting the setting of the spring comprising an element movable to predetermined position in response to predetermined pressure applied to said pressure sensitive device, a motor, a valve, and means connecting said element, valve and motor operable to effect predetermined operation of said motor in a direction and in an amount determined by movement of said element, and means connecting said motor and spring to effect adjustment of said spring by operation of said motor.

6. Means for adjusting the setting of a governor spring in accordance with load on an internal combustion engine comprising a pressure sensitive device for connection to the intake manifold of the engine including an element movable to predetermined position upon changes in pressure in the manifold, motor means including a motor and a motor control member movable to control forward and reverse operation of said motor, means connecting the element, the member and the motor effective to shift the control member by movement of said element to start the motor and effective to shift the control member by operation of said motor to stop the motor in a predetermined position corresponding to the position of said element, and means connecting the motor to said governor spring to adjust the setting thereof upon operation of the motor, said motor means comprising locking means effective to prevent movement of said motor by variations in the reaction of said governor spring.

7. Means for adjusting the setting of a governor controlling an internal combustion engine in accordance with load on the engine comprising a pressure sensitive device adapted to be operatively connected to a part of the engine wherein pressure is variable as a function of engine load and including an element movable to positions corresponding to predetermined engine loads, a valve movable generally parallel to the path of movement of said element, a cylinder having its axis parallel to the path of movement of said valve, a piston in said cylinder, a lever pivoted intermediate its ends to said valve, connections between the opposite ends of said lever and said element and said piston respectively, passages for supplying and exhausting liquid from said cylinder including ports controlled by said valve, and means operated by said piston for adjusting the setting of the governor.

8. Structure as defined in claim 7 in which said valve is movable by said piston to a position cutting off both supply and exhaust passages to block said piston rigidly in position.

9. Structure as defined in claim 7 comprising a manually adjustable metering valve in one of said passages to regulate the response of the piston and cylinder.

10. Structure as defined in claim 7 comprising an abutment in position to prevent movement of said element until a predetermined load is placed on the engine.

11. Structure as defined in claim 7 comprising means for locking said element in any desired position to thereafter control the engine without adjustment for load.

12. Structure as defined in claim 7 in which said piston has a rack section thereon, and the means operated by the piston for adjusting the setting of the governor comprises a second lever pivoted at one end and having pinion teeth at the other end thereof meshing with the teeth of the rack section.

13. Structure as defined in claim 12 in which the connection between said first mentioned lever and piston includes said second lever.

14. Structure as defined in claim 13 in which said second lever has spaced abutments thereon, and one end of said first lever is received between said abutments.

15. Means for adjusting the setting of a governor controlling an internal combustion engine in accordance with load on the engine comprising a double acting piston and cylinder device, hydraulic fluid passages connected to opposite ends of said piston device, valve means for said passages operable to block exhaust from said cylinder device when fluid supply is cut off, means responsive to load on the engine for controlling said valve means whereby said piston is rigidly blocked in position by hydraulic fluid when said piston is stationary, and means operated by said piston for adjusting said governor.

16. Means for adjusting the setting of a governor controlling an internal combustion engine in accordance with load on the engine comprising a servo-motor mechanism including an element movable in accordance with variations in load on the engine and a hydraulic fluid motor under control of said element, and means connecting said motor to the governor for adjusting its setting.

17. Apparatus of the character described comprising a pair of spaced aligned cylinders, a piston device comprising a piston head slidable in each of said cylinders and a part rigidly interconnecting said piston heads, an actuating lever member mounted for rocking movement about an axis perpendicular to the axis of said cylinders and having means at one end operatively connected to said part, fluid passages connected to said cylinders, a valve member for controlling said passages slidable parallel to the axis of said cylinders, a condition sensitive member movable in a path generally parallel to the axis of said cylinders, a control lever interconnecting said condition sensitive member, said valve member and said actuating lever member and pivotally mounted on one of said members for bodily movement therewith and for rocking movement with respect thereto.

18. Apparatus as defined in claim 17 in which said part comprises rack teeth, and the end of said actuating lever includes pinion teeth in mesh with said rack teeth.

19. Apparatus as defined in claim 17 comprising means for locking said condition sensitive member in any position within its range of movement.

20. For use with an internal combustion engine having a centrifugal governor including a governor spring, a load sensitive governor controller comprising a first movable member for adjusting the setting of said spring, a second movable member movable substantially instantaneously to a definite predetermined position in response to a change in load on the engine to a definite predetermined load, and mechanism whose operation is initiated by movement of said second member to a new position in response to a change in load on the engine to effect a delayed movement of said first member to its corresponding position and to lock said first member against

further movement while said second member remains in said new position.

21. Apparatus of the class described comprising a reversible fluid motor including a first member movable back and forth thereby in substantially straight line relationship, valve structure for controlling said motor including a valve member movable substantially parallel to the path of movement of said first member, a condition sensitive device comprising a third member movable substantially parallel to the path of movement of said first member, and a control lever pivotally mounted on one of said members and operatively connected to the other two members.

22. Apparatus as defined in claim 21 in which said valve member is located intermediate said other two members, and said lever is mounted on said valve member.

23. Apparatus as defined in claim 22 in which said motor comprises a pair of spaced aligned cylinders, and a piston device having a pair of piston heads in said cylinders and in which said first member rigidly interconnects said heads, an actuating lever operatively connected to said first member, said control lever being operatively connected to said first member through said actuating lever.

24. Apparatus as defined in claim 22 comprising a clamp engageable with said third member to lock said third member in any position within its range of movement.

25. A load responsive governor for an internal combustion engine comprising a governor arm for connection to the throttle of the engine, centrifugal means operated in accordance with engine speed and operatively connected with said arm, a governor spring having one end operatively connected to said arm and opposing the action of said centrifugal means, and means for controlling the engine speed in accordance with load thereon comprising a pressure sensitive device for connection to a part of the engine wherein pressure is variable as a function of engine load, spring adjusting means operated by said pressure sensitive device to adjust the other end of said spring to adjust the setting thereof, and means operably connected to said spring adjusting means to prevent variation in the setting of said spring except in response to changes in the load on the engine.

26. A governor as defined in claim 25 in which said spring adjusting means includes adjustable time delay means for adjusting the interval between variation in load as determined by the pressure sensitive device and the corresponding adjustment of the governor spring.

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