May 6, 1941. N. M. McCULLOUGH 2,241,096

WIDE RANGE GOVERNOR FOR DIESEL ENGINES

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FIG. 1

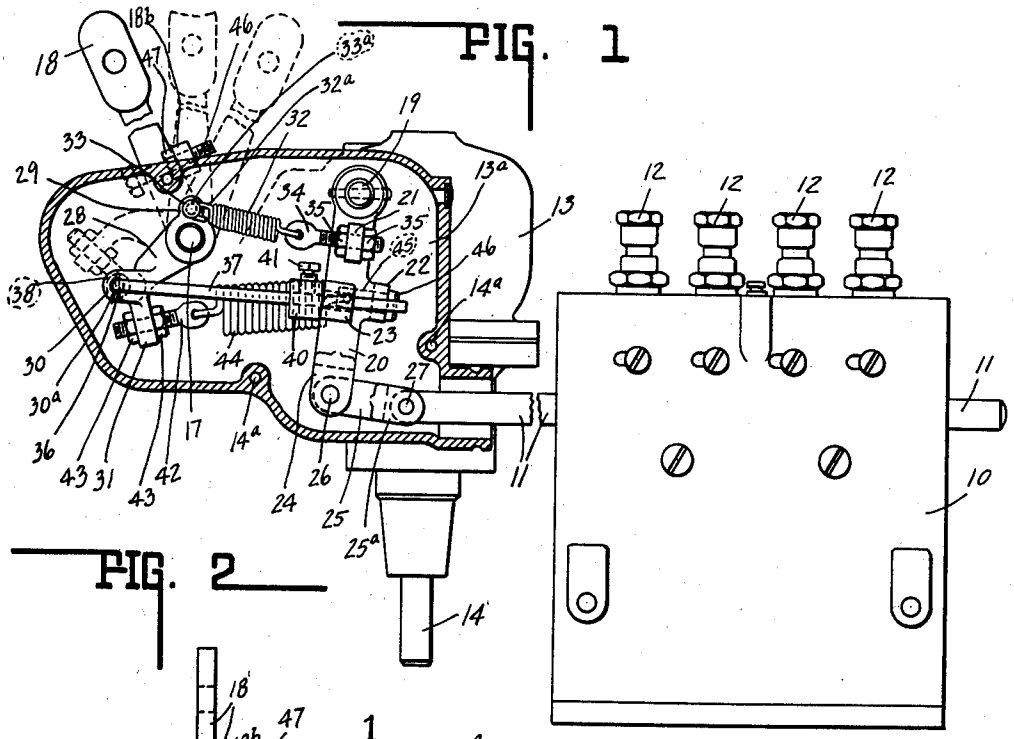


FIG. 2

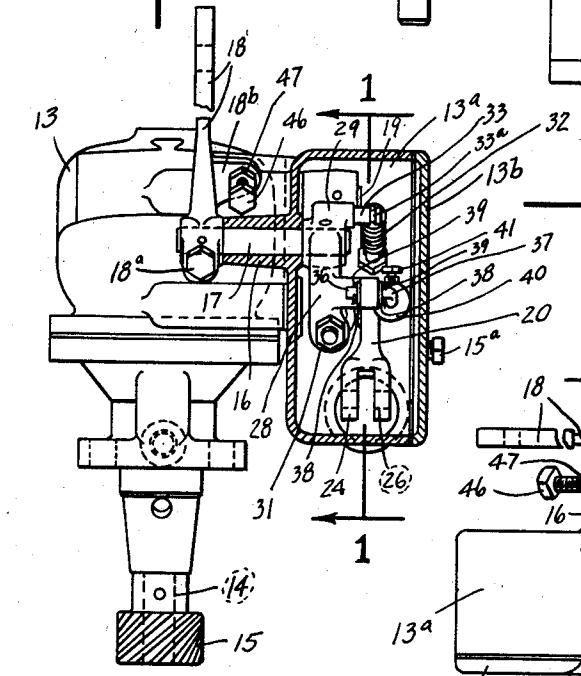
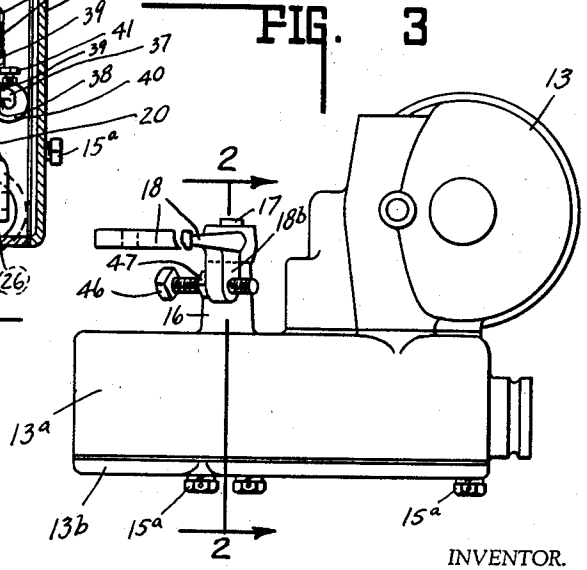


FIG. 3



INVENTOR.
NEEL M. McCULLOUGH,
BY
Lockwood Goldsmith & Galt
ATTORNEYS.

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FIG. 4

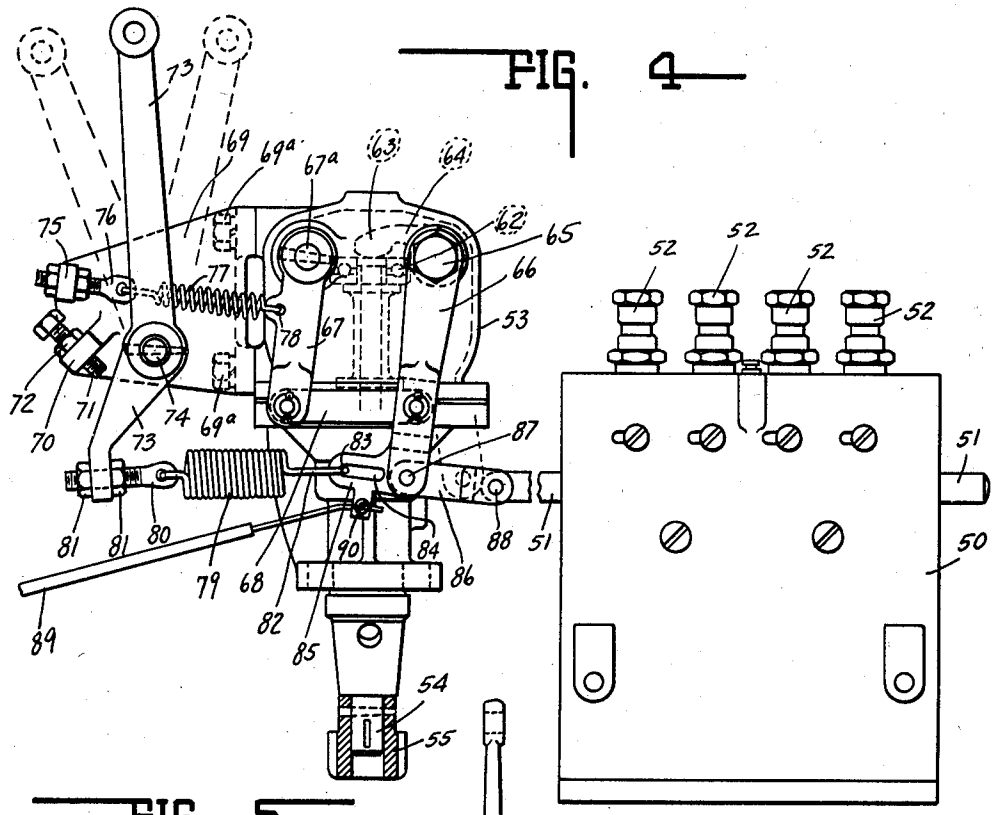


FIG. 5

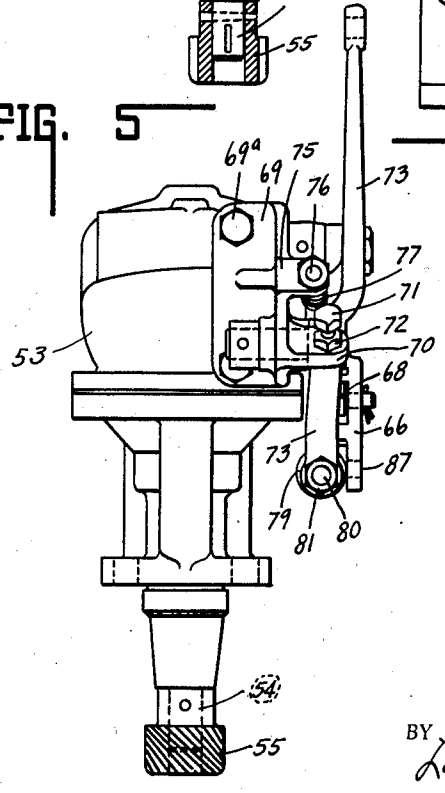
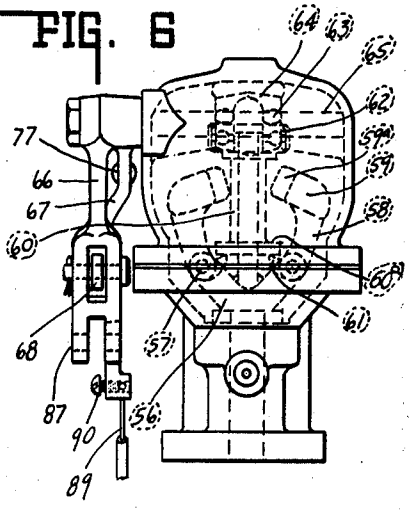


FIG. 6



INVENTOR.
NEEL M. McCULLOUGH.

BY Lockwood Goldsmith & Galt
ATTORNEYS.

May 6, 1941. N. M. McCULLOUGH 2,241,096

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FIG. 7

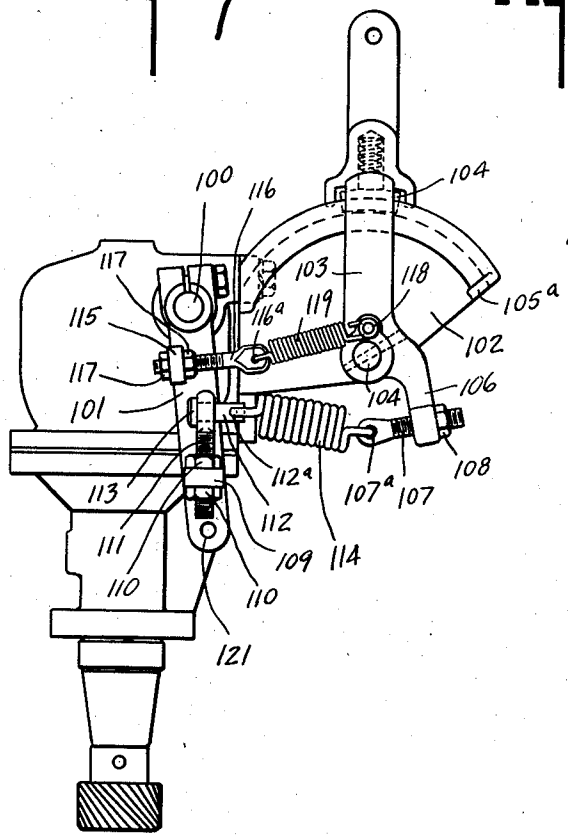
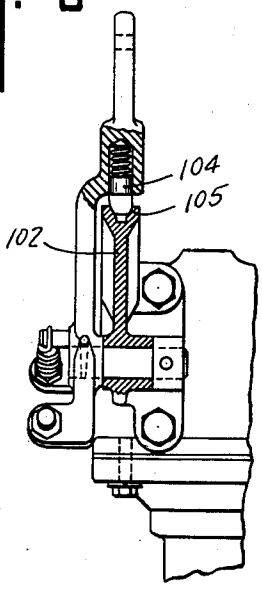


FIG. 8



INVENTOR.
NEEL M. McCULLOUGH.
BY Lockwood Goldsmith & Galt.
ATTORNEYS.

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UNITED STATES PATENT OFFICE

2,241,096

WIDE RANGE GOVERNOR FOR DIESEL ENGINES

Neel M. McCullough, Anderson, Ind., assignor to The Pierce Governor Company, Anderson, Ind., a corporation

Application December 24, 1937, Serial No. 181,680

17 Claims. (Cl. 264—3)

This invention relates to a governor which is peculiarly effective when associated with a Diesel engine fuel supply for the regulation thereof.

The chief object of this invention is to provide a governor structure which will regulate the fuel supply to a Diesel engine in the characteristic manner which an ordinary centrifugal governor would operate, and in addition thereto, compensates automatically for the tendency of the engine, due to the inherent fuel pump characteristics, to overspeed at slow idle running.

The invention is associated, for example only, with a Bosch fuel pump such as more or less diagrammatically illustrated in the Commercial Motor, pp. 627 for December, 1935, or a similar device, which fuel pump has the following mentioned characteristics. At slow idle speed, the Diesel engine will gradually increase its speed until the same may become excessive and dangerous. This results from the following: Fuel pumps of this general character include a fuel supply piston that is reciprocated at the same or at a speed proportional to the engine speed and the fuel supply is regulated usually by simultaneously varying all the intake intervals or the exhaust intervals or the pump stroke in certain special cases. These fuel pumps thus have a common actuating member and in the two former instances, this is called the rack bar.

The pump piston has a predetermined operative clearance in the cylinder so that at each reciprocation there is some leakage. When the piston of the fuel pump for the Diesel engine—it being understood there is usually one fuel pump piston per engine cylinder—has a relatively high rate of reciprocation, the effective leakage is relatively small comparatively between the piston and cylinder of the pump. At slow speeds, however, the leakage therebetween is proportionally greater. At very slow speeds such leakage may become quite excessive in proportion to the total fuel required for slow or low idle engine operation with the result that a governed engine will progressively increase its speed until finally it may "run away."

The chief object of the present governor, therefore, is, when associated with fuel pumps of the aforesaid general character, to prevent this overspeeding or "running away" when operating at low idle.

An ordinary governor has a spring which is normally imposed as load on a mechanism which is centrifugally operable. Due to this peculiarity of the Diesel pump of the character set forth, such a governor in order to prevent this overspeeding under slow speed idle conditions would normally require the load spring to reverse its operative relationship. This is a physical impossibility.

The present invention, therefore, provides a compensating or auxiliary spring. Since at slow speed idle position, the speed of the engine is relatively slow initially, the centrifugal force exerted on the operative members of the governor is relatively small. Wherefore, the auxiliary spring structure, before mentioned, is of a lesser force than the main load spring first mentioned and in a direction the same as the main load spring. Since this centrifugal force at this period of control is relatively small, if the main load spring were then effective, said centrifugal force would be ineffective for control purposes. Wherefore, the mechanism including both springs is so arranged that from wide open pump position to high idle position, the main load spring is operative only and the auxiliary spring is ineffective, and from the high idle speed toward the slow idle speed the main load spring is effective for the major portion of this range of operation and with the auxiliary spring still ineffective but as the operation approaches the slow idle speed the main load spring becomes ineffective and immediately the auxiliary spring becomes effective and remains in effect during the remainder of the operation toward and during slow idle speed.

With this invention, better regulation than that of the conventional governor has been obtained and it is possible to hold this close regulation for a wider range of governor speed so that the performance of the invention has produced amazing results, due consideration being given to the normal operating characteristics of the Diesel fuel pump from slow idle to high idle speeds as well as from light load to full load operation.

The chief feature of the invention consists in so arranging the main and auxiliary springs and associating them with the governor actuated lever and the throttle lever that neither spring for the major portion of its range from the remote speed limit towards the common speed limit is operative while the other spring is so operative and substantially at no time is there an intervening period during which the governor is free from spring loading. This arrangement is obtained by connecting the springs to one of the levers so that the connections are not in the alignment with the other and the axis of the connected lever.

Another feature of the invention consists in

connecting said springs to this lever so that the spring connections have different linear arcuate travel and operate through different effective leverages. This arrangement permits relatively close regulation from full load to high governed idle engine operation. The result is a governor which is more effective during all periods of operation from slow idle to and including the maximum speed for which the governor is adjusted.

Another object of this invention is to provide an arrangement of levers and main or load and auxiliary springs embodying the basic features above mentioned and adapting the same so that the main load spring associated with the throttle may be arranged whereby manual foot control is possible without undue strain upon the operator. This feature is of particular value when the governed Diesel engine is embodied in a motor vehicle which is foot throttle controlled.

The chief feature of this embodiment of the invention is the addition of an auxiliary arm of elongated character and the elongation of the throttle lever together with a multiplying linkage arrangement.

A further object of the invention consists in the provision of means for stopping the engine by moving the fuel pump rack shaft to closed position through a device incorporated as an integral part of the first mentioned governor structure, or as an additional means which may be separate from the governor or be applied thereto as desired.

The full nature of the invention will be understood from the accompanying drawings and the following description and claims.

In the drawings:

Fig. 1 is a side elevational view of the elected form of a fuel pump for a Diesel engine with the governor invention attached thereto, parts being broken away and shown in section to illustrate the spring and lever system thereof in greater detail, the section being taken on line 1—1 of Fig. 2 and in the direction of the arrows.

Fig. 2 is an end elevational view of the governor shown in Fig. 1, parts being broken away and shown in section, the same being taken on line 2—2 of Fig. 3 and in the direction of the arrows.

Fig. 3 is a top plan view of the governor shown in Figs. 1 and 2.

Fig. 4 is a side elevational view similar to Fig. 1 but not sectioned and of a modified form of governor.

Fig. 5 is an end elevational view, similar to Fig. 2 but not sectioned and of the form of the governor shown in Fig. 4.

Fig. 6 is an end elevational view taken from the opposite side of the governor, reference being had to Fig. 5.

Fig. 7 is a view similar to Fig. 4 of a form of the invention similar to Fig. 1, the fuel pump being omitted and centrifugal operable portions of the governor being concealed in the governor housing.

Fig. 8 is a sectional view taken at right angles to Fig. 7 and of the left hand portion of the invention shown therein.

In Figs. 1 to 3 of the drawings there is illustrated one embodiment of the invention. In Fig. 1, 10 indicates a Diesel engine fuel pump structure generally as before identified, having the pump control ar rack shaft 11 and fuel supply discharges 12 which connect each to a cylinder of the governed Diesel engine.

The governor includes a speed responsive power arrangement, and operative connections between the same and the rack shaft. Herein 13 indicates a housing in which is mounted a centrifugally operable device, similar or identical to that shown dotted in Figs. 4 and 6, which is driven by shaft 14 through gear 15 meshing with a gear driven by the engine at engine speed or at a speed proportional thereto.

The housing 13 is suitably mounted upon the engine (preferably) and in juxtaposition to the fuel pump for operation by the former and for controlling the latter.

Housing 13*a* is suitably secured by means not shown, to housing 13 and supports cover 13*b* secured by bolts 15*a* at 14*a*. Housing 13*a* has boss 16 with a bore therethrough that supports shaft 17. Manual control lever 18 is secured to the exposed end of the shaft as at 18*a*, see Fig. 2.

The speed responsive device includes a shaft 19, see Figs. 1 and 2, that extends from housing 13 into housing 13*a*. Lever 20 is secured to shaft 19. It includes three offset boss portions 21, 22 and 23—see Fig. 1—and terminates in a slotted end 24 straddling link 25 to which it is pinned as at 26. Link 25 includes an opposite slotted end 25*a* which straddles the adjacent end of the rack bar 11 or pump control rod or an extension thereof and to which it is pivotally secured as at 27.

Thus, the rack bar is responsive to movement of lever 20. This lever is movable in response to the variation in engine speed and as otherwise modified by the mechanism now to be described, which is that part of the invention that produces the remarkable control results obtained and herein previously briefly set forth.

Rigid with shaft 17 is arm 28 which includes two offset portions 29 and 30 and an apertured end 31. Boss 21 on lever 20 is apertured. A spring 32 has an elongated open loop 32*a* which is mounted in groove 33*a* on pin 33 carried by portion 29. The other end of the spring 32 is connected to an eyebolt 34 having an adjustable but rigid connection with offset portion 21 and secured in such position by nuts 35.

Offset portion 30 of arm 28 is apertured at 30*a* and therein is pivotally secured angular end 36 of rod 37 and retained by washers 38 and cotter key 39, see Fig. 2. The other end of rod 37 is slidably mounted in the apertured boss 23 on lever 20, see Fig. 1. A stop collar 40 is rigidly secured in adjusted position on rod 37 by set screw 41.

An eyebolt 42 is rigidly and adjustably secured by nuts 43 to the apertured end 31 of arm 28. Spring 44 has one end connected to this bolt. The other end of the spring is secured to member 45 slidably supported in boss 22 and terminating in the stop or head 46.

In the foregoing structure, spring 44 constitutes the main load spring, and spring 32 the minor or auxiliary spring. The former is effective on the lever 20 from a speed below high idle but above low idle to all other load operating speeds. The latter is effective at low idle speed and for a short range toward high idle speed.

Thus, each spring is adjustably but relatively rigidly mounted to a lever at one end and has a lost motion mounting upon the other lever and herein each lever is rigidly connected to one of the springs.

Neither spring is effective in the range from the corresponding remote speed limit towards the common speed limit when the other spring is effective. The reason for the aforesaid arrangement is that if spring 44 were effective at low

idle, no control could be obtained because it has been determined that at low idle speed, the fuel pump must supply more fuel than at high idle speeds, due to the aforementioned pump leakage characteristics.

Hence, spring **44** is operative in the usual manner throughout its operative range. At the corresponding idle speed where it would lose its usual effectiveness, due to the aforesaid condition, it is arranged to become ineffective and minor spring **32** is arranged to become effective from that speed down to and including low idle speed.

The use of this minor spring makes the governor selectively responsive to speed variations and when adjusted both initially or during operation, permits closer control over the Diesel engine.

The initial control is obtained by the eyebolts and collar **40**. The manual control is obtained by lever **18** secured to shaft **17**. An adjustable stop for said lever, see Fig. 3, includes an offset arm **18***b* on said lever which mounts a stop bolt **46** locked by nuts **47**.

The lever **18** constitutes a manual control for varying the control to insure governor maintenance of a predetermined engine speed for the load operable by the engine. Should this load vary resulting in a tendency of the engine to over or under that speed, the governor holds the speed constant.

Lever **18** also may operate as a cutoff device when the parts are in the position very close to that shown in Fig. 1. When lever **18** is substantially vertical, it is in the slow or low idle position and when in the inclined position corresponding to the dotted position of arm **28**, it is in the load speed position. Stop **46**, adapted to engage housing **13**, is the high speed adjustment stop.

Note that spring **32** at end **33***a* has lost motion movement relative to anchorage **33** and that spring **44** through member **45** has similar movement relative to anchorage **22**. This provides for the transition necessary to transfer the governor operation from the minor spring to the load spring and vice versa.

In Figs. 4 to 6, there is illustrated another embodiment of the invention. In Fig. 4, **50** indicates a fuel pump device for a Diesel engine and having a control member or rack bar **51** and outlets **52**, one for each cylinder of the engine and supplying a measured amount of fuel to each.

In Figs. 4 to 6, **53** indicates a housing into which extends shaft **54** carrying on its exposed end a gear **55** adapted to be driven by the engine at a speed proportional thereto. Within the housing **53** the shaft **54** is provided with a collar **56** which pivotally supports at **57** the weight arms **58** having weighted end portions **59** recessed at **59***a* to straddle the shaft and the sleeve **60** slidably supported thereby. The arms **58** have portions **61** adapted to engage collar **60***a* on said sleeve. As shaft **54** increases its rotational speed, the weights move outwardly from the shaft axis and the portions **61** elevate sleeve **60**.

Sleeve **60** terminates in an anti-friction collar structure **62** against which bears in diametrical relation portions **63** of a bifurcated member **64** rigid with shaft **65**. Exteriorly of housing **53** and rigid with shaft **65** is arm **66**. Also pivotally secured at **67***a* is an arm **67**. These arms are link connected as at **68**.

A bracket **69** is suitably secured as at **69***a* to housing **53**. It includes offset portion **70** which adjustably mounts the high speed stop **71**, the adjustment being fixed by nut **72**. Lever **73** is pivotally supported on the bracket **69** at **74** and when positioned as shown by the right hand dotted lines—see Fig. 4—said lever is in full load position. When positioned as shown by the full lines, it is in the slow or low idle position, while when positioned as shown by the left hand dotted lines, it is the cutoff position.

Another offset portion **75** of bracket **69** adjustably supports eyebolt **76** to which one end of the minor or auxiliary spring **77** is secured, the other end being secured to arm **67** at **78**. The eyes may be of sufficient size to provide for some play or lost motion, if desired and as illustrated.

Load spring **79** has one end secured to an eyebolt **80** adjustably secured to the apertured end of lever **73** by nuts **81**. The opposite end of the spring **79** is elongated as at **82** and has the lateral end portion **83** thereof seated in an elongated slot **84** in the offset portion **85** of lever **66**. This is adjacent the end of the lever which is slotted to receive link **86** pivotally connected thereto as at **87**. The other end of link **86** is bifurcated and pivotally connects as at **88** to the rack bar **51** or an extension thereof.

The second form of the invention in addition to having the basic operating characteristics of the first form does not include the stop **40** because for vehicle use, to operate, the accelerator pedal would have to be raised. For stopping the engine, therefore, there is provided a Bowden wire **89**, see Fig. 4, connected at one end to pump rack shaft **51** as at **90** on lever **66** and its opposite end is positioned at a convenient location for the driver to pull upon. This accomplishes the same results as stop rod **37**—see Figs. 1 and 2, because in this latter instance the lever **18**, as a manual throttle, can be moved over center by hand whereas with a foot throttle arrangement, such action is not desirable nor usually provided since it requires a lifting effort.

This second form of the invention also has the advantage that it is capable of foot operation without undue effort being required of the operator of the vehicle. Heretofore most governor equipped Diesel engine control have embodied excessive spring tensions requiring in turn such excessive pressures from the driver's foot on the accelerator that the driver is worn out accelerating the engine. The present form of the invention includes a spring and lever arrangement as shown which relieves the operator of the necessity for exerting excessive pressure because excessive tension on the truck or car accelerator has been relieved by spacing the springs from the lever axis thereby permitting the use of softer springs and also securing a wider operating range with less tension on the main governing throttle—connected direct to a foot accelerator.

In Figs. 7 and 8 there is illustrated a further form of the invention and similar to that illustrated in Figs. 1 to 3, inclusive. Herein the centrifugal operable mechanism disclosure has been omitted since it is substantially the same as shown dotted in Figs. 4 and 6. The rock shaft **100**, however, is rigid with lever **101** similar to lever **66** of Fig. 4 and lever **20** of Fig. 1.

A segment support **102** pivotally supports throttle lever **103** at **104**. Lever **103** yieldingly supports shoe **104** which rides in the groove **105** of the support and frictionally holds the lever in the hand adjusted position. Abutment **105***a* is a lever stop.

Lever **103** includes extension **106** having an apertured and threaded end receiving eyebolt **107**

locked as at 108. Lever 101 includes the apertured boss 109 which by means of nuts 110 adjustably supports eyebolt 111, in the eye of which is slidably mounted the pin 112 with the head portion 113. Spring 114 is the main load spring and is secured at one end at 112a to pin 112 and at the opposite end at 107a to eyebolt 107 and with some play or lost motion.

Lever 101 also supports lug 115 apertured to receive eyebolt 116 locked therein by nuts 117 and extending toward lever 103. Lever 103 has a grooved pin extension 118 which is adjacent the pivot 104 of the lever 103 but upon the opposite side thereof relative to eyebolt 107. Minor spring 119 is connected at one end to eyebolt 116 at 116a and with some play or lost motion as illustrated, if desired, and its opposite end is elongated at 120 to form an elongated open loop that is mounted in the grooved portion of pin 118 thereby providing a lost motion connection. Lever 101 at 121 is adapted for connection to a Diesel engine pump rack bar.

In the form illustrated in Figs. 7 and 8, there are two levers and two springs and each spring has a lost motion connection to one lever and an adjustable (rigid) connection to the other lever and each lever is "rigidly" connected to a spring, in this respect being similar to the form shown in Figs. 1 to 4, inclusive.

In this form of the invention, see Figs. 7 and 8, neither spring is effective upon shaft 100 while the other spring is effective thereon. Thus, the springs are sequentially effective upon shaft 100 through member 101. The total range of movement of member 101 may be divided into one portion wherein only spring 114 is effective and another portion wherein only spring 119 is effective. The position of member 102 wherein one spring becomes ineffective after having been previously effective upon member 101 and wherein the other spring, previously ineffective thereon, becomes effective for movement of member 101 in one direction and vice versa for movement in the opposite direction may be called the common position.

In this form of the invention one spring immediately becomes effective upon removal of the effectiveness of the other spring.

This operation characteristic is common to all three forms of the invention and all forms have common operation except as hereinbefore differentiated or as is obvious from an inspection of the drawings illustrating the several specific differences.

The invention claimed is:

1. In a single governor structure for an engine, the combination of a fuel controlling member, a single centrifugal device, manually operable means, and dual springs interconnected with the manually operable means and member, each spring being operable upon said member and similarly and successively relative to the other spring time of operation thereon and independent thereof for full range control, and opposed by said device whereby dual governor results are obtainable from said single centrifugal device.

2. In a single governor structure for an engine, the combination of a lever, a single centrifugal device connected thereto for lever movement, a manually operable means for moving the lever, a pair of springs, and means operatively connecting said springs to the manually operable means and lever such that the lever is always spring constrained, said spring constraint being applied by each spring in succession and independently of the other spring time of application.

3. In a single governor structure for an engine, the combination of a single centrifugal device, arm means tiltable by the device, a fuel control means connected to the arm means remote from the tilting axis thereof, a main load spring connected to the arm means between the control means connection thereto and the tilting axis thereof, an auxiliary spring operatively connected at one end to the arm means between the tilting axis thereof and the load spring connection to the arm means, the opposite end of the auxiliary spring being relatively stationarily mounted, and lever means pivotally supported between the springs and including a manually movable end and an oppositely directed extension to which the other end of the load spring is connected.

4. In a single governor structure, a single centrifugal device, arm means tiltable by the device, a fuel control means connected to the arm means remote from the tilting axis thereof, a main load spring connected to the arm means between the control means connection thereto and the tilting axis thereof, lever means having a manually operable end, and an auxiliary spring operatively connected at one end to the arm means between the tilting axis thereof and the load spring connection thereto, said lever means having an end extending oppositely from its axis and manually operable end, the other end of the load spring being connected to said lever means opposite end, the auxiliary spring opposite end being connected to the lever means opposite the load spring connection thereto relative to the lever means pivotal axis, the pivotal axis of the lever means being positioned between the lever means-spring connections.

5. A device as defined by claim 3, characterized by the arm means being of dual character and by the addition of a link therebetween for simultaneous and parallel arm movement, the auxiliary spring having connection with the arm closest to the lever means.

6. A device as defined by claim 3, characterized by the load spring having a lost motion connection at one end and an adjustable connection at the opposite end.

7. A device as defined by claim 3, characterized by the load spring having a lost motion connection at one end and an adjustable connection at the opposite end, the lost motion connection being to the arm means and the adjustable connection being to the lever means.

8. A device as defined by claim 3, characterized by the auxiliary spring having a lost motion connection at one end and an adjustable connection at the opposite end.

9. A device as defined by claim 3, characterized by the auxiliary spring having a lost motion connection at one end and an adjustable connection at the opposite end, the lost motion connection being to the lever means and the adjustable connection being to the arm means.

10. A device as defined by claim 3, characterized by the auxiliary spring having a lost motion connection at one end and an adjustable connection at the opposite end, and the main load spring having similar connections.

11. A device as defined by claim 3, characterized by the auxiliary spring having a lost motion connection at one end and an adjustable connection at the opposite end, and the main load spring

having similar connections but reversely positioned.

12. A device as defined by claim 3, characterized by the addition of an elongated control rod carried by one of said means and slidably supported by the other means, and stop means on said rod adjacent the last mentioned means.

13. A device as defined by claim 3, characterized by the addition of a manually operable member connected to the arm means for cutoff purposes.

14. A device as defined by claim 3, characterized by the inclusion of a multiplying arrangement for relief of operator strain, said arrangement including a supplemental lever and link.

15. A device as defined by claim 2, characterized by the inclusion of a multiplying arrangement for relief of operator strain, said arrangement including a supplemental lever and link.

16. A device as defined by claim 4, characterized by the auxiliary spring connection to the lever means being immediately adjacent the pivotal axis of the lever means.

17. A device as defined by claim 3, characterized by the addition of another arm means to which the first mentioned end of the auxiliary spring is connected, and a link between the two arm means for conjoint operation thereof.

NEEL M. McCULLOUGH.