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Maier

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[54] **CENTRIFUGAL RPM GOVERNOR FOR FUEL INJECTED INTERNAL COMBUSTION ENGINES**

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[51] **Int. Cl.** **F02d 1/04**

[58] **Field of Search** ..... 123/140 R, 140 J, 179 G

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[57] **ABSTRACT**

A centrifugal r.p.m. governor for fuel injected internal combustion engines. The governor includes a fuel quantity control rod of a fuel injection pump, an intermediate lever, a connecting structure connecting the control rod and the intermediate lever, an adaptor sleeve connected to the intermediate lever, centrifugal weights which are connected to the adaptor sleeve, an operating lever having a pin which engages the intermediate lever, an adaptor mechanism, an energy accumulator and a stop. The adaptor mechanism has a spring as does the energy accumulator, which are tensed as soon as and for so long as the intermediate lever tends to move the control rod beyond a position determined by the adaptor mechanism. The connecting structure has mounted thereto a first set screw a path-limiting structure and a counter stop. The counter stop includes a member which engages the stop within the limits defined by the path-limiting structure. The movement of the counter stop member is in response to the movement of the operating lever, intermediate lever and adaptor sleeve.

21 Claims, 4 Drawing Figures

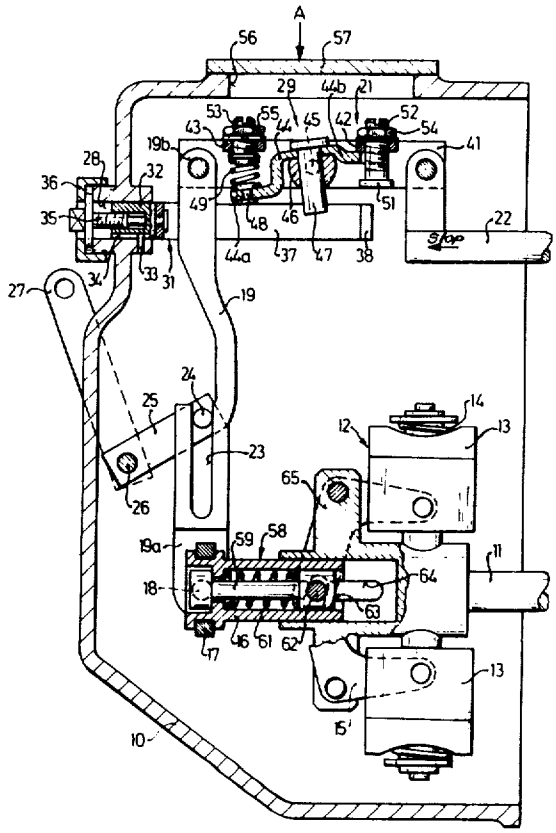

Fig. 1

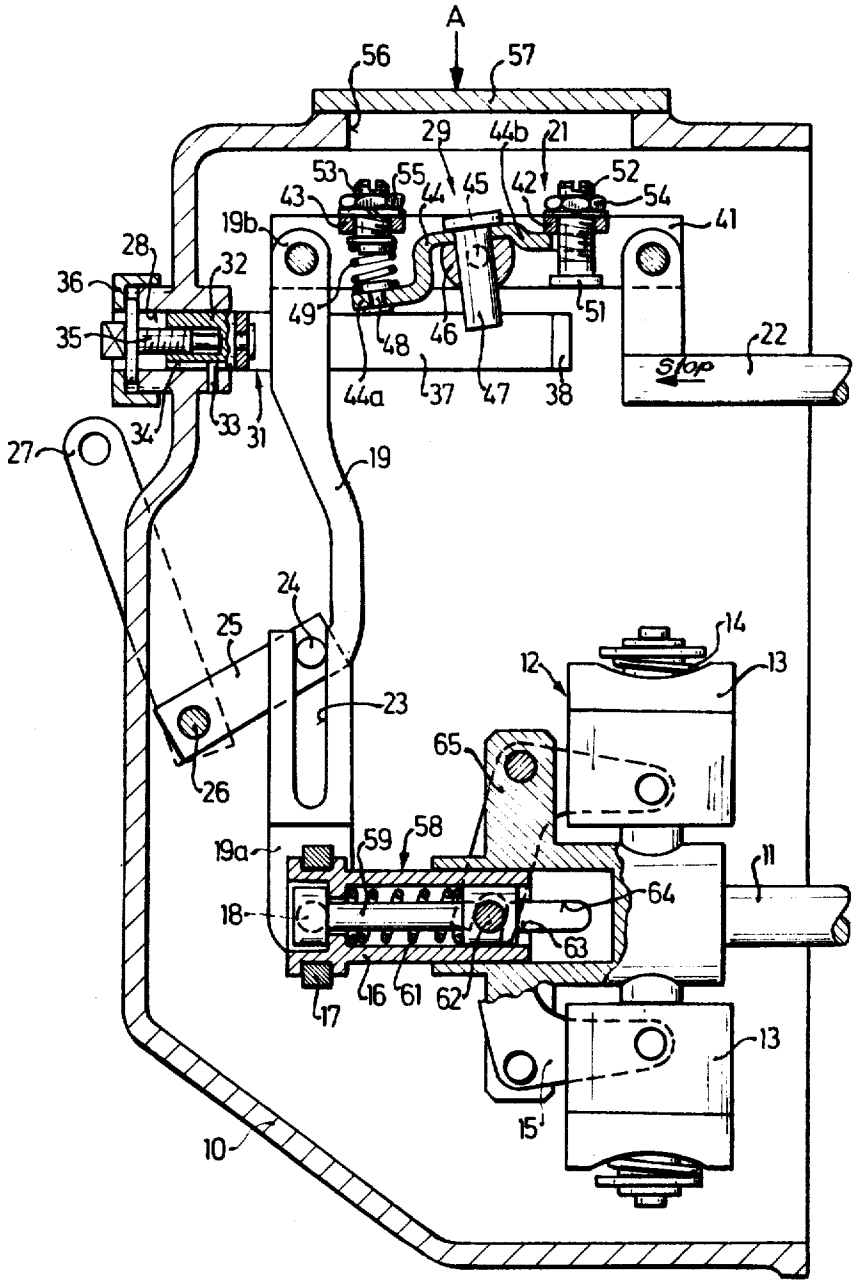
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Fig. 2

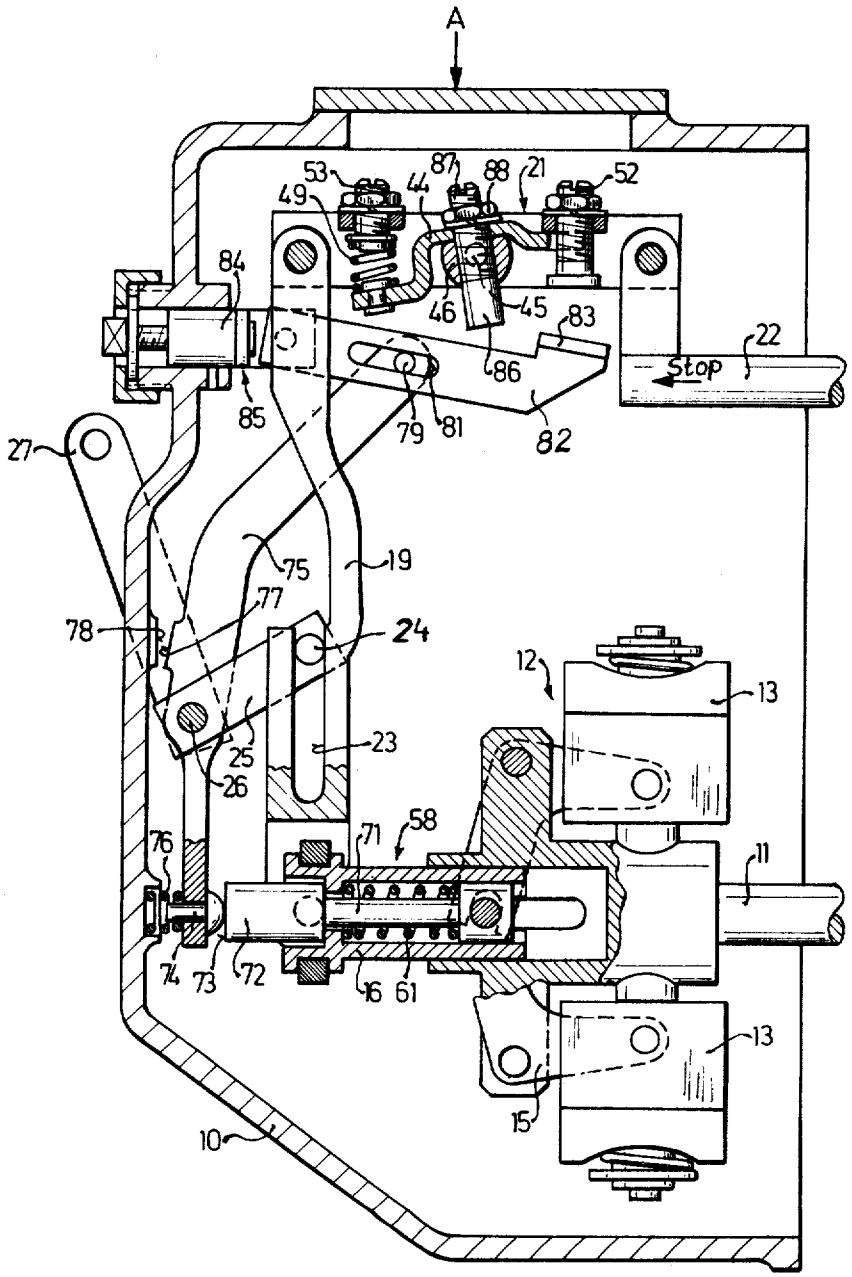
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Fig.3

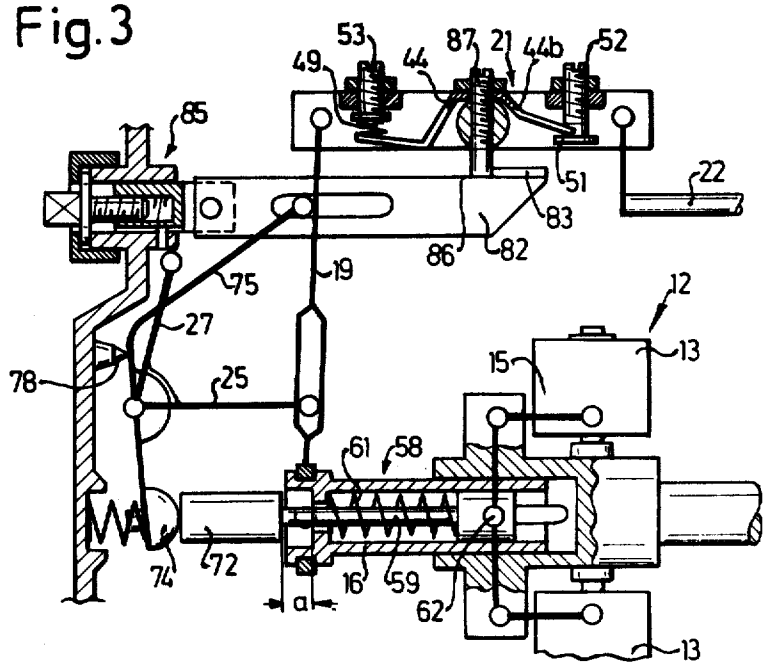
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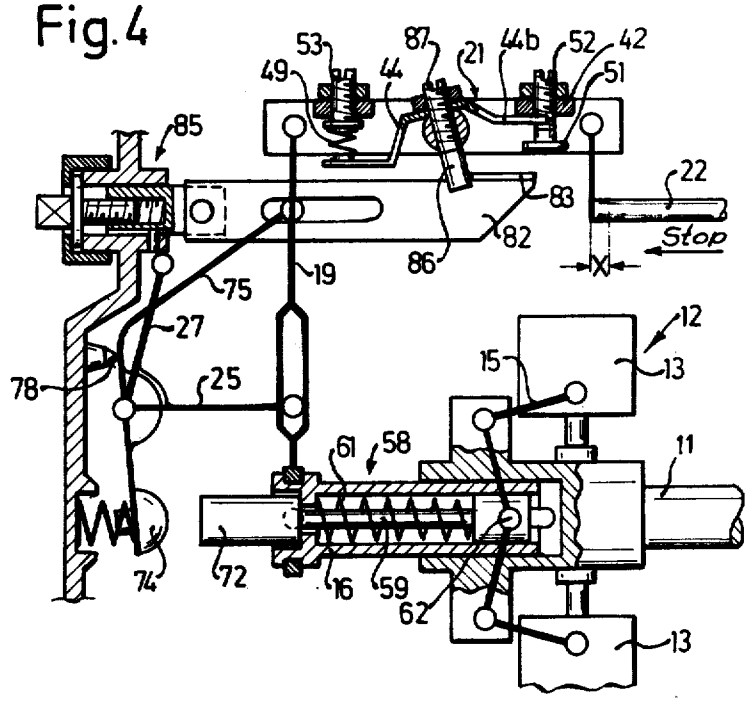
Fig.4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CENTRIFUGAL RPM GOVERNOR FOR FUEL INJECTED INTERNAL COMBUSTION ENGINES

BACKGROUND OF THE INVENTION

The present invention relates to a centrifugal r.p.m. governor for fuel injected internal combustion engines.

The centrifugal r.p.m. governor of the type under consideration has a control member whose position changes in dependence on engine r.p.m. and in response to the centrifugal force generated by fly weights of the governor. The control member actuates an intermediate lever which in turn acts on a control rod of the injection pump. The intermediate lever is carried on a stud belonging to a pivotable setting member whose purpose is the arbitrary movement of the control rod. The governor further includes an adaptor mechanism which limits the path of the control rod in the direction of increasing fuel quantity. The mechanism consists substantially of an adaptor spring, a stop located in the governor housing and adjustable in the direction of the control rod and also of a counter stop disposed on a connecting member lying between the intermediate lever and the control rod. Further there is provided a spring of an energy accumulator which is tensioned along with the adaptor spring as soon and for so long as the intermediate lever tends to move the control rod beyond the position determined by the adaptor mechanism.

In known centrifugal r.p.m. governors of the abovementioned contruction, the adaptor spring is a part of the adjustable stop mounted in the governor housing so that the entire stop mechanism is moved in the direction of motion of the control rod for achieving the adaptor path and this is done by an appropriate mounting of the stop and an appropriately adjusted stroke of the bearing member in which the stop is carried. This adaptor mechanism is extremely difficult to adjust, is subject to frictional losses and requires a relatively large space which extends beyond the outer dimensions of the governor and this space requirement leads to difficulties in installation in the cramped assembly conditions in motor vehicles.

OBJECT, SUMMARY AND ADVANTAGES OF THE INVENTION

It is, therefore, an object of the present invention to provide a centrifugal r.p.m. governor of the type mentioned above in which the adaptor mechanism is improved in such a way that less contructional space is required and the frictional influences are reduced, and the possibility of adjustment is simplified.

This object and others are achieved according to the present invention in that the adaptor spring is supported by the connecting member on the one hand and by the counter stop on the other hand, where the counter stop is part of a rocker arm which is pivotable about an axis located in the connecting member and within an angular sector which is limited by a first set screw and by a path-limiter on the connecting member. In the vicinity of its pivotal axis, the rocker arm is equipped with a stop member which extends beyond the axis and is perpendicular with respect to the axis and which cooperates with a stop projection of the adjustable stop mechanism attached to the governor housing. The counter stop which is embodied as a rocker arm has only negligibly small friction compared with the amount of friction of the longitudinal moving parts of the known adaptor system. The adaptor elements which have been displaced into the interior of the governor make possible a diminution of the contructional space requirements of the governor and in addition the setting of the full-load position of the control rod and of the adaptor path can be made by spatially separated adjustment elements, independently of one another and in a continuous manner.

A further improvement as to the setting capability of the present invention is given in that the pretension of the adaptor spring can be adjusted by a second set screw disposed in the connecting member and embodied as a spring support bearing.

The present invention is further embodied advantageously in that the two screws are disposed in the connecting member substantially parallel to one another and can be adjusted from the same side of the governor. This significantly simplifies the setting capability of the governor.

A further advantageous embodiment of the present invention provides that the stop in the rocker arm is the cylindrical stop stud of a further set screw which is screwed through the pivotal axis of the rocker arm and that the stop mounted in the governor housing is equipped with a pivotable stop lever of a known type provided with a stop projection. In the position of the adaptor sleeve which it assumes when the governor stands still or has at most a rotational speed lying below the lowest idling r.p.m., the stop lever can be pivoted out of the path of the stop stud by a control lever, actuated by the adaptor sleeve, coupled to the stop lever and mounted in the governor housing. In other positions of the adaptor sleeve, however, the stop lever extends into the path of the stop stud. The advantage of this disposition is that the additional set screw, together with the parts which serve for controlling an automatic surplus quantity permits, without exchange of governor elements and in a simplified fashion, the adjustment of the r.p.m. at which the pivotable stop lever arrives in the position which serves to limit the full-load position of the control rod.

It is also advantageous that the further set screw be disposed approximately parallel to the first or second set screw and that it may be adjusted from the same side of the governor which simplifies the setting of the governor in an advantageous manner.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a longitudinal sectional view of a first preferred exemplary embodiment of the centrifugal r.p.m. governor according to the present invention.

FIG. 2 is a longitudinal sectional view of a second preferred exemplary embodiment of the centrifugal r.p.m. governor according to the present invention.

FIG. 3 is a simplified representation of the essential constructional elements of the second exemplary embodiment in the position which they occupy at the beginning of the adaptation process.

FIG. 4 shows the elements of FIG. 3 in the position that they occupy at the termination of the adaptation process.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The embodiment of the centrifugal r.p.m. regulator or governor shown in FIG. 1 includes a housing 10 and a drive shaft 11 extending from an injection pump (not

shown) for internal combustion engines. The housing **10** carries a known centrifugal governor **12** which includes fly-weights **13** that extend, in a known manner, due to the effect of centrifugal force and against the force of regulator springs **14**, from the axis of the drive shaft **11**. The regulatory motions of the governor are transmitted via an angled lever **15** to a governor or adaptor sleeve **16** serving as control member. The adaptor sleeve **16** carries a sliding ring **17** equipped with a bearing stud **18** to which is coupled an intermediate lever **19** embodied as a twin armed lever whose one lever arm **19***a* is connected with the adaptor sleeve **16** and whose other lever arm **19***b* is pivotably connected to a connecting member **21** embodied as a double rail and ultimately to a control rod **22** of the injection pump.

The intermediate lever **19** is provided with a known slot and pin guide linkage **23** whose pivotal point is a pin **24** gliding in a slot and where the pin is part of a guide lever **25** which, in turn, is in fixed rotational connection with an opertaing lever **27** serving as a setting member. A lever pin **26** is affixed to the governor housing **10**. The housing **10** also includes a support bore **28** whose axis is oriented in the same direction as the axis of the control rod **22** and which carries a stop **31** which in turn forms part of an adaptor mechanism **29**. A cylindrical portion **32** of the stop **31** within the support bore **28** is secured against rotation by a pin **33** engaging a groove **34**. The portion **32** is, however, adjustable in the longitudinal direction by a set screw **35** held in its installed condition by a lock nut **36**. Of course it is possible to place a stop **31** and the other elements which serve to set and mount it in a separate housing within the governor housing **10**. Connected to the cylindrical portion **32** of the stop **31** is an abutment arm **37** which extends into the governor housing and whose extreme end is provided with a stop projection **38** bent at right angles to the plane of the figure. The double rail **21** has two mutually parallel and identical rails **41** of which only one is shown. A second section through the apparatus is superfluous since the double rail **21** is completely symmetric and is shown sectioned along its longitudinal axis. The rails **41** are connected to one another by two cross ties **42** and **43**. Disposed between the two rails **41** is a rocker arm **44** serving as a counter stop and including a pivot pin **45**. The rocker arm **44** is a counter stop for the stop **31** and includes a centerpiece **46** which carries the pivot pin **45** and through which a bolt **47** may be pushed that extends at right angles to the rotational axis of the rocker arm **44** and which serves as a stop element by extending through the centerpiece **46** so that during longitudinal motions of the control rod **22**, the bolt **47** makes contact with the stop projection **38** of the stop **31**. The rocker arm **44** has two lever arms **44**a and **44**b extending in the longitudinal direction of the double rail **21**. One of the lever arms **44***a* carries a support bearing **48** for an adaptor spring **49** while the other lever arm **44***b* moves between the path limiting cross tie **42** and a collar **51** of a first set screw **52**. In the position in which it is shown, the rocker arm **44** attaches to the path limiting cross tie **42** due to the force of the adaptor spring **49**.

The pretension P_v in the adaptor spring **49** can be adjusted by a second set screw **53** embodied as a spring support bearing. The two set screws **52** and **53** are screwed into the two cross ties **42** and **43**, respectively, and are parallel to one another and are secured in the shown position by lock nuts **54** and **55**, respectively.

This disposition of the two set screws permits their adjustment from the same side of the governor. This side is characterized by the arrow A. In order to provide access to the set screws **52** and **53** for their adjustment, the governor housing **10** has an opening **56** closed by a cover **57**.

The adaptor sleeve **16** contains a energy accumulator **58** consisting of a sliding bolt **59** and a spring **61**. This energy accumulator **58** serves as a drag link and is required in the centrifugal r.p.m. governor according to the invention because it operates as a variable r.p.m. regulator. The spring **61** is matched with the spring **49** of the adaptor mechanism **29** for the control of the adaptation process. The sliding bolt **59** is connected with the angled levers **15** by means of a lateral pin **62** and the distance between this lateral pin **62** and the bearing stud **18** is constant as long as the force exerted on the adaptor sleeve **16** does not exceed the pretension of the spring **61**. However, if for example, the operating lever **27** and hence the pin **24** is rotated in a clockwise sense in order to obtain a greater fuel quantity, and when, consequently, the intermediate lever **19** attempts to move beyond the position determined by the projection **38** of stop **31**, then the spring **16** is compressed and pretensed in a known manner. The relative motion between the transverse pin **62** and the adaptor sleeve **16** is made possible by longitudinal slits **63** in the wall of the adaptor sleeve **16** and the longitudinal motions of the transverse pin **62** are made possible by corresponding slits **64** in a travelling member **65** of the centrifugal governor **12**.

FIG. **2** illustrates a second exemplary embodiment of the present invention and it differs from that in FIG. **1** only by the additional of new constructional elements which serve to make possible providing an automatic excess starting fuel quantity. Corresponding parts of the two exemplary embodiments are provided with the same reference numberals. All movable elements of both exemplary embodiments are shown in their quiescent position (stop position). In the second exemplary embodiment, the energy accumulator **58** has s sliding bolt **71** which is longer than the sliding bolt **59** of FIG. **1** and its head **72** and face **73** abut at a transmitter pin **74** belonging to a control lever **75** pivoted on the lever pin **26** and held in contact with the head **72** of the energy accumulator **58** by a weak pressure spring **76** supported on the governor housing **10** until such time as the control lever **75** and its abutment surface **77** abuts at a locally fixed stop **78**. This position is described below with reference to FIG. **4**. The end of the control lever **75** facing away from the adaptor sleeve **16** carries a pin **79** engaging an enlongated hole **81** of a stop lever **82** and controlling its pivotal position. The stop lever **82** has a stop projection **83** and is pivotably connected with a cylindrical portion **84** of a stop **85** carried within the governor housing **10**. The mounting and the adjustability of the cylindrical portion **84** are the same as in the case of the cylindrical portion **32** of FIG. **1**. The rocker arm **44** located within the double rail **21** differs from that in FIG. **1** in that the place of the bolt **47** of FIG. **1** is taken by the cylindrical stud **86** of a third set screw **87** and serving as a stop. This third set screw **87** is screwed through the pivotal axis of rocker arm **44** formed by the centerpiece **46** and is secured in its installed position by a lock nut **88**. The third set screw **87**

is positioned approximately parallel to the other two set screws 52 and 53.

FIGS. 3 and 4 serve for the illustration of the method of operation of the apparatus according to the present invention and they show the second exemplary embodiment of FIG. 2 in a simplified representation. Whereas in FIG. 2 all movable parts were shown during the stop position of the governor and when the operating lever was in its stop position, the operating lever 27 as shown in FIGS. 3 and 4 is in its full-load position or in that operational position which determines the maximum r.p.m. of the engine.

In FIG. 3, the remaining movable parts of the governor are shown in the position which they assume at that r.p.m. at which the adaptor process is to begin. The control lever 75 abuts at its stop 78 and fly weights 13 have assumed a position where, via angled lever 15, they have moved the transverse pin 62 and hence, the sliding bolt 59 into locations such that the head 72 of the sliding bolt 59 is no longer in contact with the transmitter pin 74 of the control lever 75. The abutment stud 86 of rocker arm 44 abuts against the stop projection 83 of the stop lever 82 belonging to the stop mechanism 85 and the adaptor spring 49 is pretensed. The lever arm 44b of the rocker arm 44 abuts against the collar 51 of the first set screw 52 and spring 61 of the energy accumulator 58 within the adaptor sleeve 16 is pretensed in such a way that a clearance *a* has been established between the head 72 and the adaptor sleeve 16.

FIG. 4 represents the positions of the governor parts which are assumed at the termination of the adaptor motions. The fly weights 13 have assumed a position further removed from the drive shaft 11 due to the increased r.p.m. and the sliding bolt 59 of the energy accumulator 58 has been correspondingly moved to the right in the drawing and the head 72 of this sliding bolt 59 has again made contact with the governor sleeve 16. The spring 61 of the energy accumulator 58 and the adaptor spring 49 within the double rail 21 are relaxed and the arm 44b of the rocker arm 44 now attaches to the path limiting cross tie 42 of the double rail 21. The stop projection 83 of the stop lever 82 has resumed its original position but the rocking motion of the rocker arm 44 and the correspondingly changed position of the abutment stud 86 of the third set screw 87 have caused the control arm 22 to be moved from the position shown in FIG. 3 by an amount X in the direction of the arrow. The two simplified representations of FIGS. 3 and 4 are also valid for the adaptation control in the first exemplary embodiment because in the full-load position, the stop lever 82 has not changed and remains in the same position as the abutment arm 37 provided with an abutment projection 38 belonging to the stop mechanism 31.

In the following, the method of operation of the r.p.m. governor according to the invention shall be described, were extensive reference is to be made to the explanations already made with respect to FIGS. 3 and 4.

In FIGS. 1 and 2, the operating lever 27 and hence also the guide lever 25 and the pin 24 are in their stop position. Since the r.p.m. is zero, the fly weights 13 of the centrifugal governor 12 are in their innermost position and the adaptor sleeve 16 holds the control arm 22 in the shown stop position.

In FIG. 2, for the shown position of the adaptor sleeve 16, the head 72 of the sliding bolt 71 of the energy accumulator 58 has moved the control lever 75 into a position where its pin 79 has moved the stop lever 82 of the stop mechanism 85 into a position where the abutment stud 86 of the rocker arm 44 can be moved beyond the stop projection 83 that limits the pre-load position. This motion takes place when the operating lever 27 is moved from the position shown in FIG. 2 to that shown in FIGS. 3 and 4. During this motion, the double rail 21 and hence the abutment stud 86 move beyond the abutment projection 83 and displace the control rod 22 into its starting position. When the r.p.m. increases, the fly weights 13 move outwardly and, via angle levers 15, move the adaptor sleeve 16 so that the intermediate lever 19 moves the connecting rail 21 and hence the control rod 22 in the direction of "stop." During this process the head 72 of the sliding bolt 71 moves from the position shown to the right in the figure. In this process, the control lever 75 is pivoted counterclockwise by the force of pressure spring 76 and thus moves the abutment lever 82 also in the counterclockwise sense so that the abutment projection 83 is moved upwardly toward the abutment stud 86. Thus the abutment projection 83 moves up against the abutment stud 86 until the regulatory motions of the fly weights 13, the adaptor sleeve 16 and the intermediate lever 19 have moved it so far to the left that it no longer makes contact with the abutment projection 83. At this moment, the abutment lever 82 can reach the position shown in FIG. 3 and when the r.p.m. decreases further, the abutment stud 86 moves up against the abutment projection 83 and at the lowest adaptation r.p.m., the rocker arm is moved into the position shown in FIG. 3 against the force of the spring 49. If the r.p.m. increases further, the adaptor sleeve 16, intermediate lever 19, the double rail 21 and the rocker arm 44 assume the positions shown in FIG. 4 where, as already described, the control rod 22 is moved in the "stop" direction through an adaptation distance *x*.

When the r.p.m. increases even further, the fly weights 13 move beyond the position shown in FIG. 4 and a so-called arrest control process takes place and the intermediate lever 19 moves the double rail 21 and the control rod 22 further in the "stop" direction until an equilibrium condition is achieved between the fuel quantity provided by the injection pump on the one hand and the requirements of the engine on the other hand.

In an extreme case, the governor stops the fuel supply and the control rod 22 arrives at the stop position shown in FIGS. 1 and 2.

As may be clearly seen in FIGS. 1 and 2, all adjustment processes serving to control the adaptation process can be made independently of one another after cover 57 is removed from the governor housing. The first set screw 52 sets the adaptation paths *x* which the governor is to provide. The second set screw 53, and, in the exemplary embodiment shown in FIG. 2–4, the third set screw 87 sets the point at which the abutment projection 83 moves out of engagement with the abutment stud 86 and thus the control rod 22 can move beyong the full-load position into the starting position. This last mentioned setting is very important because, during the normal operation of the engine, an automatic delivery of of the starting excess quantity of fuel

must not take place. The position of the abutment projection **38** in FIG. **1** or of the abutment projection **83** in FIGS. **2–4** determines the position of control rod **22** governing the pre-load fuel quantity and can be changed by rotation of the set screw **35** (see FIG. **1.**).

What is claimed is:

1. In a centrifugal r.p.m. governor for fuel injected internal combustion engines, including a housing mounting therein: centrifugal weight means; an adaptor sleeve slidably displaceable under the influence of the centrifugal weight means and as a function of engine r.p.m.; a fuel quantity control rod; an intermediate lever; means connecting the intermediate lever to the control rod; operating lever means having a pin which engages the intermediate lever, the operating lever means displacing, by said pin, the intermediate lever to thereby arbitrarily move the control rod; an adaptor mechanism which limits the movement of the control rod in the direction of increasing fuel supply, said adaptor mechanism including an adaptor spring, stop means adjustable in the direction of the control rod, and counter stop means mounted to the connecting means; and an energy accumulator having a spring, said adaptor spring and said accumulator spring being tensed as soon as and for so long as the intermediate lever tends to move the control rod beyond a position determined by the adaptor mechanism, the improvement comprising:

a. pivot means;

b. a first set screw;

c. path-limiting means; and

d. a stop member,

wherein:

said connecting means comprises a connection member to which one end of said adapter spring is attached;

said first set screw and said path-limiting means being mounted to said connecting member;

said counter stop means includes said stop member and a rocker arm which is mounted by said pivot means to said connecting member, said rocker arm being pivotable about an axis defined by said pivot means within an angular sector which is limited by said first set screw and said path-limiting means, and having the other end of said adaptor spring attached thereto, and

said stop member is mounted to said rocker arm in the vicinity of said pivot axis to extend perpendicularly with respect to the pivot axis and so that it can engage said stop means.

2. The centrifugal r.p.m. governor as defined in claim **1,** wherein the improvement further comprises a second set screw mounted to said connecting member, said second set screw serving as a spring support bearing which is adjustable for adjusting the pretension of said adaptor spring.

3. The centrifugal r.p.m. governor as defined in claim **2,** wherein said connecting member comprises two parallel rails extending between and being pivotably connected to said control rod and said intermediate lever, and wherein said rocker arm, said adaptor spring and said first and second set screws are mounted between said rails.

4. The centrifugal r.p.m. governor as defined in claim **3,** wherein said rocker arm has two lever arms extending in the longtudinal direction of said parallel rails, and wherein one of said arms is provided with a counter bearing for said adaptor spring while the other lever arm is movable between said path-limiting means and a collar portion of said first set screw.

5. The centrifugal r.p.m. governor as defined in claim **3,** wherein said parallel rails are connected at spaced locations by two cross ties, said cross ties also serving to threadedly engage respective ones of said first and second set screws, and wherein the improvement further comprises lock nuts for securing said first and second set screws to their respective cross tie.

6. The centrifugal r.p.m. governor as defined in claim **5,** wherein the cross tie to which said first set screw is engaged also serves as said path-limiting means.

7. The centrifugal r.p.m governor as defined in claim **2,** wherein both said set screws are mounted to said connecting member so that they extend in an approximately parallel direction to one another, and so that they can be adjustable from the same side of said housing.

8. The centrifugal r.p.m. governor as defined in claim **7,** wherein said connecting member comprises two parallel rails extending between and being pivotably connected to said control rod and said intermediate lever, and wherein said rocker arm, said adaptor spring and said first and second set screws are mounted between said rails.

9. The centrifugal r.p.m. governor as defined in claim **8,** wherein said parallel rails are connected at spaced locations by two cross ties, said cross ties also serving to threadedly engage respective ones of said first and second set screws, and wherein the improvement further comprises lock nuts for securing said first and second set screws to their respective cross tie.

10. The centrifugal r.p.m. governor as defined in claim **8,** wherein said parallel rails are connected at spaced locations by two cross ties, said cross ties also serving to threadedly engage respective ones of said first and second set screws, and wherein the improvement further comprises lock nuts for securing said first and second set screws to their respective cross tie.

11. The centrifugal r.p.m. governor as defined in claim **10,** wherein the cross tie to which said first set screw is engaged, also serves as said path-limiting means.

12. The centrifugal r.p.m. governor as defined in claim **1,** wherein the improvement further comprises control lever means operatively connected between said adaptor sleeve and said stop means, wherein said stop member comprises a cylindrical portion of a third set screw which is in threaded engagement with said pivot means, wherein said stop means includes a pivotable stop lever having a stop projection extending therefrom, and wherein said control lever displaces said pivotable stop lever out of the path of said stop member whenever said adaptor sleeve assumes a position which corresponds to an engine r.p.m. below the lowest idling r.p.m.

13. The centrifugal r.p.m. governor as defined in claim **12,** wherein said connecting member comprises two parallel rails extending between and being pivotably connected to said control rod and said intermediate lever, and wherein said rocker arm, said adaptor spring and said first and second set screws are mounted between said rails.

14. The centrifugal r.p.m. governor as defined in claim **13,** wherein said rocker arm has two lever arms extending in the longitudinal direction of said parallel

rails, and wherein one of said arms is provided with a counter bearing for said adaptor spring while the other lever arm is movable between said path-limiting means and a collar portion of said first set screw.

15. The centrifugal r.p.m. governor as defined in claim **13,** wherein said parallel rails are connected at spaced locations by two cross ties, said cross ties also serving to threadedly engage respective ones of said first and second set screws, and wherein the improvement further comprises lock nuts for securing said first and second set screws to their respective cross tie.

16. The centrifugal r.p.m. governor as defined in claim **15,** wherein the cross tie to which said first set screw is engaged also serves as said path-limiting means.

17. The centrifugal r.p.m. governor as defined in claim **12,** wherein said third set screw is mounted to said rocker arm so that it extends in a direction approximately parallel to the direction of said other set screws, and so that it can be adjustable from the same side of said housing as said other set screws.

18. The centrifugal r.p.m. governor as defined in claim **17,** wherein said connecting member comprises two parallel rails extending between and being pivotably connected to said control rod and said intermediate lever, and wherein said rocker arm, said adaptor spring and said first and second set screws are mounted between said rails.

19. The centrifugal r.p.m. governor as defined in claim **18,** wherein said rocker arm has two lever arms extending in the longitudinal direction of said parallel rails, and wherein one of said arms is provided with a counter bearing for said adaptor spring while the other lever arm is movable between said path-limiting means and a collar portion of said first set screw.

20. The centrifugal r.p.m. governor as defined in claim **18,** wherein said parallel rails are connected at spaced locations by two cross ties, said cross ties also serving to threadedly engage respective ones of said first and second set screws, and wherein the improvement further comprises lock nuts for securing said first and second set screws to their respective cross tie.

21. The centrifugal r.p.m. governor as defined in claim **20,** wherein the cross tie to which said first set screw is engaged also serves as said path-limiting means.

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