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[54] CENTRIFUGAL GOVERNOR FOR CONTROLLING THE RPM OF INJECTION TYPE INTERNAL COMBUSTION ENGINES

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[52] **U.S. Cl.**... **123/140 R**

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

[58] **Field of Search**............................. 123/140, 139

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[57] **ABSTRACT**

A centrifugal governor for controlling the rpm of an injection type internal combustion engine having a fuel injection pump is described which governor has a housing and a regulator member being displaceable as a function of the rpm, and the regulating movements of which member are transmitted, by means of a two-armed cam lever having lever arms which are adjustable dependent upon the position given an externally turnable operating lever, to fuel delivery control means associated with the fuel injection pump, wherein the fuel delivery control means, upon completing a first part of its movement against the force of a first control spring, acts on a force-transmitting lever which is biassed by at least one second control spring; the force-transmitting lever bears an adjusting screw for setting the first control spring to a low rpm, and is adapted for swivelling about an axis which is stationary in the governor housing, and wherein the neutral position of the force-transmitting lever is determined by a stop fixed in the housing. This governor is improved by providing therein

(*a*) a bearing lever adjustable for setting a maximum rpm and bearing a spring seat for the aforesaid second control spring,

(*b*) a second adjusting screw for the bearing lever, and

(*c*) and adjusting element for limiting the first part of the movement of the regulator member, the bearing lever, second adjusting screw and adjusting element being in engagement with the force-transmitting lever.

18 Claims, 3 Drawing Figures

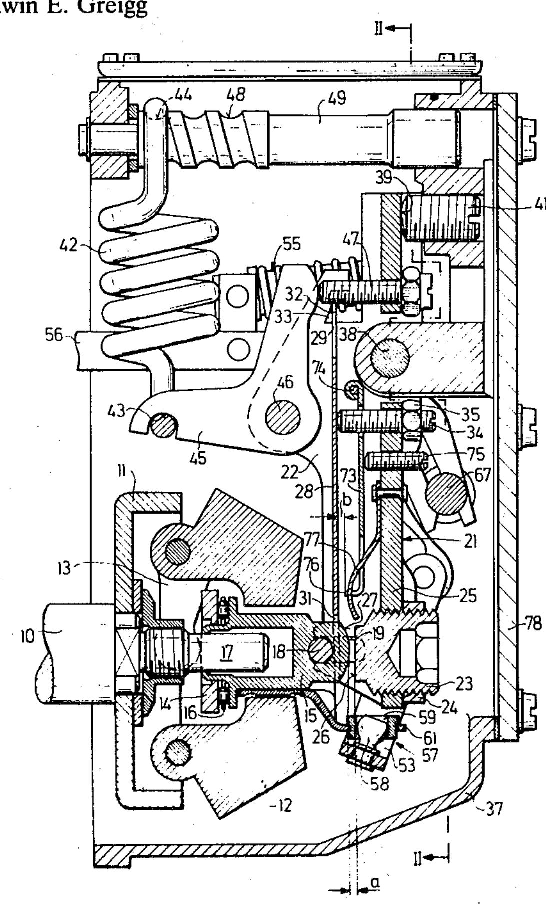

Fig. 1

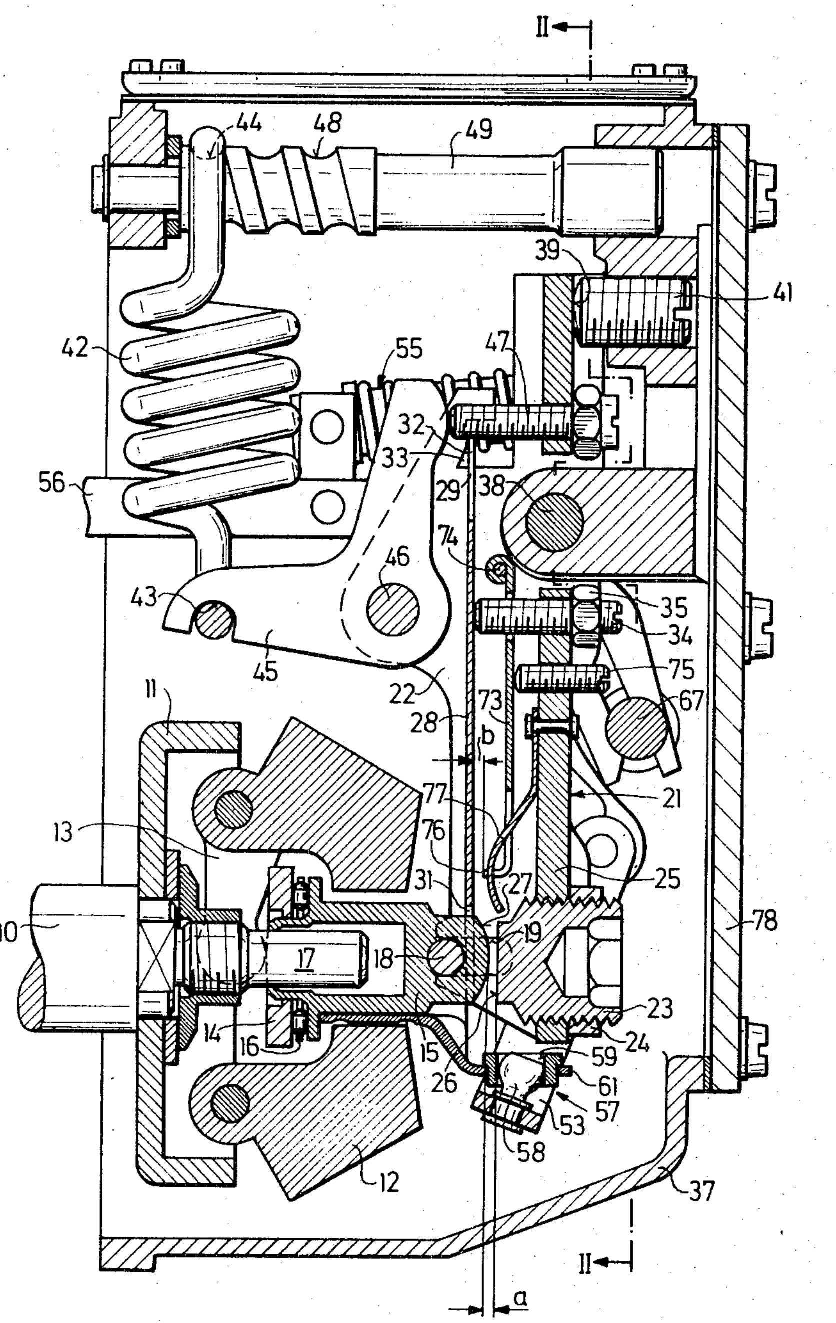
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Fig. 2

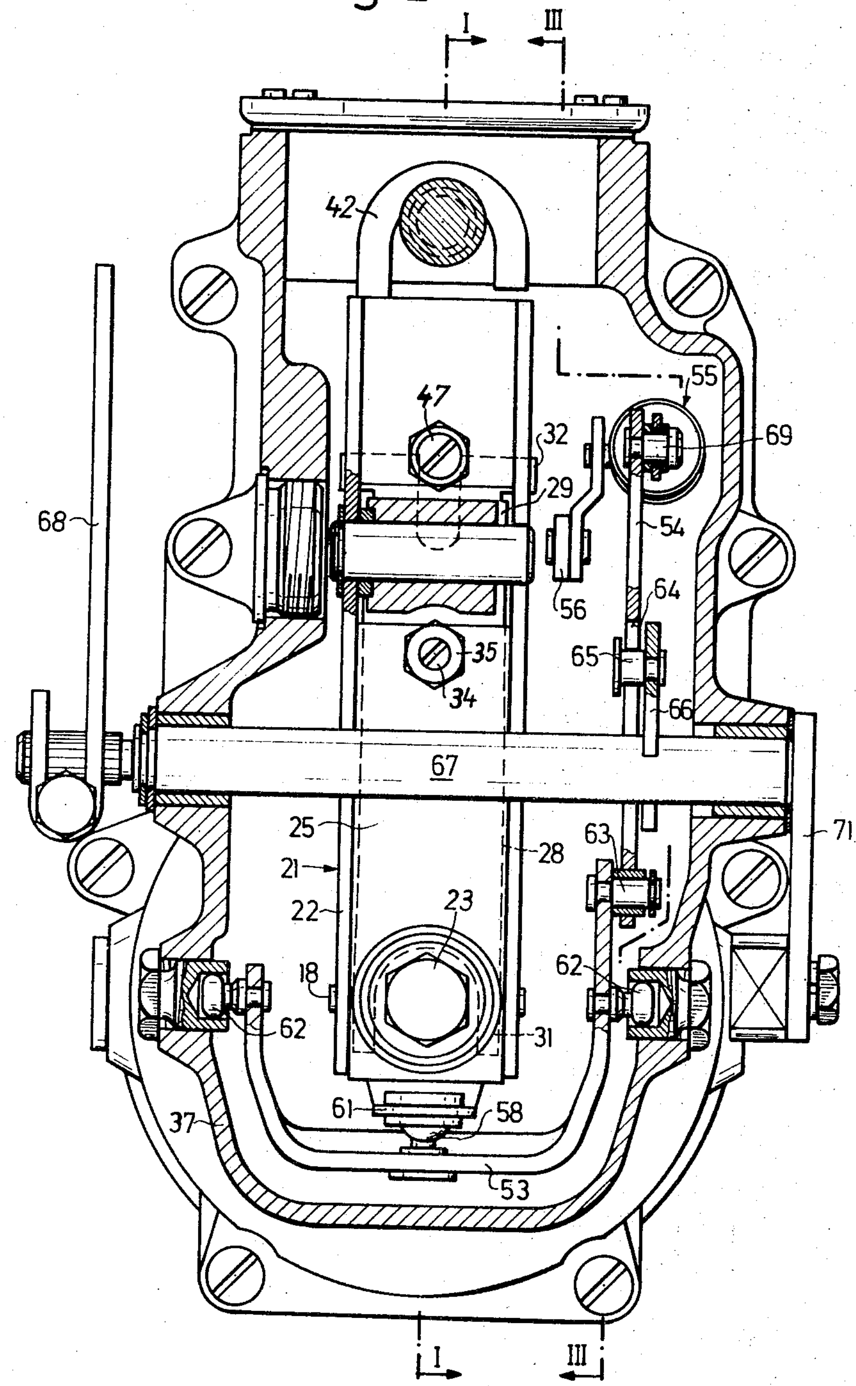
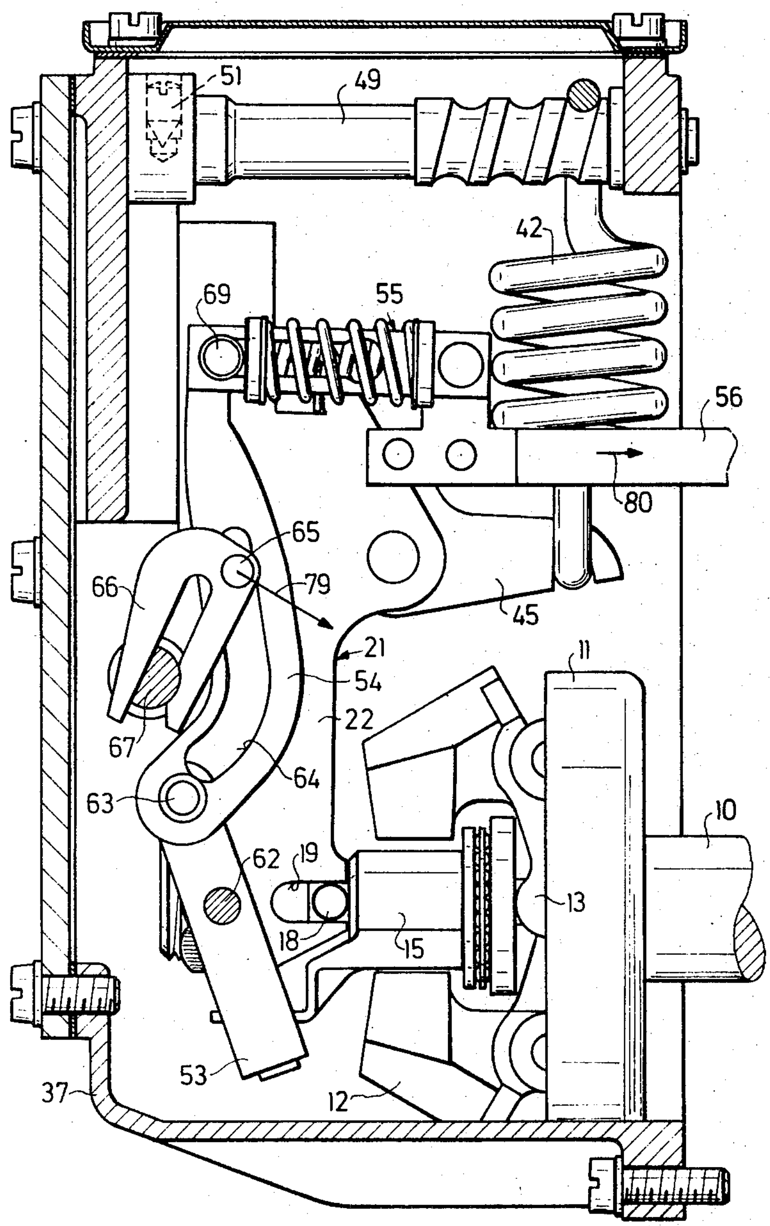


Fig. 3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CENTRIFUGAL GOVERNOR FOR CONTROLLING THE RPM OF INJECTION TYPE INTERNAL COMBUSTION ENGINES

BACKGROUND OF THE INVENTION

The invention relates to a centrifugal governor for controlling the rpm of injection type internal combustion engines having a fuel injection pump, which governor has a housing and a regulator member being displaceable as a function of the rpm, and the regulating movements of which member are transmitted, by means of a two-armed cam lever having lever arms which are adjustable dependent upon the position given an externally turnable operating lever, to fuel delivery control means associated with the fuel injection pump, wherein the fuel delivery control means, upon completing a first part of its movements against the force of a first control spring, acts on a force-transmitting lever which is biassed by at least one second control spring, and the force-transmitting lever bears an adjusting screw for setting the first control spring to a low rpm, and is adapted for swivelling about an axis which is stationary in the governor housing, and wherein the neutral position of the force-transmitting lever is determined by a stop fixed in the housing.

Various rpm-regulating centrifugal governors of the above outlined structure have been known, which have been used as no-load governors and as final speed governors, or which operate as adjustable rpm-regulating governors with insertion of a spring-type storage device among the connecting elements between the regulator member and the fuel delivery control member. Due to the use of the connecting linkage and the force-transmitting lever, these known governors have an advantage over other rpm-regulating governors of similar construction, in that the adjustment of the amount of fuel to be delivered, and/or the adjustment of the rpm's to be regulated is simple and without any disturbing counteracting forces while the operating lever is actuated. A disadvantage of the known governors however, resides in that the adjustment of the rpm's to be regulated and the adjustment of the working ranges of the governor, i.e., the exact coordination of the respective positions of the fuel delivery control member in relation to the positions of the regulator member, is intricate, as some individual adjustment steps will influence, at least in part, others. Thus, in the case of a known governor of the above-outlined structure for instance, the adjustment of the full-load position of the regulator sleeve will cause changes in the initial tension of the no-load control spring as well as that of the full-load control spring.

OBJECTS AND GENERAL DESCRIPTION OF THE INVENTION

It is, therefore, an object of this invention to provide an rpm-regulating governor of the above outlined structure having adjusting members which can be regulated without affecting other adjusting members, and wherein as many functions as possible are combined in the power transmission lever.

According to the invention, this object is achieved by providing at the force-transmitting lever, apart from an adjusting screw for the first control spring, a bearing lever which can be shifted to adjust the maximum rpm and which is adapted for containing an abutment for the second control spring, as well as an associated adjusting screw and an adjusting member for limiting the first part of the movement of the regulator member.

A particularly advantageous feature of the rpm-regulating governor according to the invention is provided by the fact that the force-transmitting lever, in its neutral position, is disposed at least approximately perpendicular to the axis of the regulating member, and that the adjusting screw of the bearing lever, the adjusting member and the adjusting screw for the first control spring are screwed into the force-transmitting lever parallel in relation to one another and at least approximately parallel to the axis of the regulator member, and that they are secured in their position. This at least approximately horizontal arrangement of all adjusting elements is especially advantageous, since it allows an adjustment of the governor with access only from the front end thereof. A further advantage resides in that this arrangement facilitates the use of an automated adjusting device.

Of further advantage is the feature, whereby a stop screw is fitted into the governor housing in a position at least approximately parallel to the adjusting screws and to the adjusting member, which stop screw serves as a stop for the force-transmitting lever. This stop screw also could be adjusted with advantage by means of an automated setting device.

In a further advantageous embodiment of the invention, the second control spring is devised as a tension spring which is arranged at least approximately in parallel to the force-transmitting lever, and the one end of which is connected to a bearing bolt which is rotatably mounted in the governor housing in parallel to the axis of the regulator member, and rotary displacement of which changes the effective direction of the second control spring and thereby causes an adjustment in the proportional range of the governor. As a result of this design and arrangement of the second control spring and of the bearing bolt, an adjustment of the proportional range can also be effected from the front face of the governor.

An embodiment of especially simple design is obtained, when the second spring support consists of a helicoidal groove of semi-circular profile machined into the bearing bolt.

In a preferred embodiment of the governor according to the invention, the force-transmitting lever features an essentially U- or H-shaped cross-section, and between its two parallel legs directed towards the injection pump there is mounted a bearing pin for the bearing lever. It is a particularly advantageous feature that the two legs contain a guide groove each for the guides protruding on the sides of the regulator member, which feature results in a simple and low-friction guidance of the regulator member.

As a further advantageous feature, the first control spring is preferably a leaf spring, and between the two aforesaid legs of the force-transmitting lever, there is provided a fixed abutment for the leaf spring; furthermore, the said fixed abutment for the leaf spring preferably comprises a recess in each one of the two legs; the leaf spring has two laterally projecting parts at one end which engage these recesses, and the leaf spring is supported at its other end by the guide pins of the regulator member, and the adjusting screw associated therewith is secured in its position by means of a screw connection in the cross-piece of the U- or H-section of the force-transmitting lever intermediate both ends of the leaf spring. The arrangement of the first control spring serving as a no-load control spring, and of the adjusting screw associated therewith and with the force-transmitting lever offers the advantage of having the influence of the first control spring upon the adjusting range of the second control spring eliminated.

An especially effective and space-saving embodiment is obtained by arranging at the force-transmitting lever an additional no-load spring, besides the two above-mentioned control springs, which no-load spring is at least effective on part of the first portion of the displacement of the regulator member, and whose range of action is adjustable by means of an adjusting screw which is screwed into the force-transmitting lever and is secured in its position; furthermore, similar to the first control spring acting as a no-load control spring, the additional no-load spring is also designed as a leaf spring, which acts upon the regulator member by way of the first control spring; and still further, in addition a bi-metal spring is supported on the force-transmitting lever and acts upon the regulator member by way of the control spring. The no-load regulating range and the idling of the motor during warm-up can be adjusted by means of the additional no-load spring and the bi-metal spring in a particularly simple manner without disturbing other regulating functions.

The invention will be better understood and further objects and advantages will become apparent from the ensuing detailed specification of a preferred but merely exemplary embodiment taken in conjunction with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 represents a longitudinal sectional view of the embodiment taken in a plane along line I—I in FIG. 2;

FIG. 2 is a cross-sectional view of the same embodiment taken along line II—II in FIG. 1; and

FIG. 3 is a longitudinal sectional view taken along line III—III in FIG. 2.

DETAILED DESCRIPTION OF THE EMBODIMENT

To the drive shaft **10** of a fuel injection pump (not shown) for injection type internal combustion engines there is secured a face plate **11** on which there are pivotally mounted centrifugal fly weights **12.** The arms **13** of the fly weights **12** engage the frontal face of a thrust collar **14** which is mounted on a stub of adaptor sleeve **15** serving as a regulator member, and which transmits the displacing forces of the centrifugal fly weights **12** by way of a thrust bearing **16** to the adaptor sleeve **15.** The adaptor sleeve **15** is supported at its one end on a cylindrical stub **17** of the drive shaft **10,** while its opposite end, away from the drive shaft, is fitted with laterally protruding guide pins **18,** which are guided each in guide grooves **19** of a force-transmitting lever **21** (see also FIG. 3).

The force-transmitting lever **21** is a two-armed lever, which is pivotally secured against a pivot pin **38** fixed in the governor housing **37** and whose non-operational position as illustrated is determined by an abutment **39** fixed in the housing, the latter abutment being formed by the front end of a stop screw **41** which is screwed self-locking in the governor housing **37.**

The force-transmitting lever **21** is of essentially U- or H-shaped cross-section, and its two legs **22** directed towards the injection pump contain the guide grooves **19** for the guide pins **18** of adaptor sleeve **15.** An adjusting element **23** is screwed into the cross-piece **25** of the force-transmitting lever **21** at the same level as the axis of the drive shaft **10** and the adaptor sleeve **15,** and is secured in position by means of a nut **24.** The adjusting element **23** features an end plane **26,** against which a convex surface **27** of the adaptor sleeve **15** abuts after having traversed a first part *a* of its path of travel.

While traversing the aforementioned first part *a* of its travel, the adaptor sleeve **15** acts upon a first control spring **28** which is designed as a leaf spring and which has its one end **29** supported on the force-transmitting lever **21,** and the other end **31** of which exerts pressure on the guide pin **18** of the adaptor sleeve **15.** The first end **29** of the leaf spring **28** has two laterally projecting parts **32,** which are inserted into recesses **33** of the two legs **22** of the force-transmitting lever **21.** These recesses **33** form a fixed abutment for the leaf spring **28.** A bias exerted upon the adaptor sleeve **15** is produced by an adjusting screw **34** which is screwed into the cross-piece **25** of the force-transmitting lever **21** intermediate the two ends **29** and **31** of leaf spring **28,** and which is secured in its setting by means of a nut **35.**

The force-transmitting lever **21** can be swivelled counterclockwise around the pivot pin **38.** This swivelling motion takes place whenever the force originating from the centrifugal fly weights **12** and transmitted by way of the adaptor sleeve **15** and the adjusting element **23** to the force-transmitting lever is larger than the resetting force emanating from a second control spring **42.** This second control spring **42** is a tension spring which is arranged essentially perpendicular to the axis of the regulator member **15** in the governor and which is engaged at two abutments **43** and **44,** of which the abutment **43** is located on an adjustable bearing lever **45** which serves for adjustment to the maximum rpm and which is connected with the force-transmitting lever **21** by means of a bearing pin **46** extending through the two legs **22** of the said lever **21.** The bearing lever **45** is designed in the form of an angle lever and its illustrated position is determined by means of an adjusting screw **47** which serves to vary the bias of the second control spring **42.** This bias determines in a known manner the maximum rpm to be regulated or limited by the governor.

The second abutment **44** of the control spring **42** is machined in the form of a helicoidal groove **48** of semicircular profile into a bearing bolt **49** which is arranged in the governor housing **37** in a position parallel to the axis of the regulator member **15,** as well as parallel to the stop screw **41** and at least approximately parallel to the adjusting screws **34,** and **47** and to the adjusting element **23.** By means of a rotation of this bearing bolt **49,** the proportional range of the governor may be adjusted, since by rotation of the bearing bolt **49,** the point of suspension, i.e., the location of the second abutment **44,** of the second control spring **42** is shifted horizontally in such a manner that the active direction of the control spring **42** is changed. Thereby, the effective rigidity of the spring **42** in relation to the force exerted on the force-transmitting lever **21,** is changed in a known manner, which force counteracts, as a resetting force, the adjusting force of the adaptor sleeve **15.**

In order that the bearing bolt **49** should not change its position during operation of the governor, a pressure screw **51** is screwed into the governor housing **37** in a known manner, slightly eccentrically of the central axis of bearing bolt **49** in the vicinity of one of the bearings of the said bolt **49** (see FIG. 3). The adaptor sleeve **15**, opposing the resetting forces of the control springs **28** and **42**, transmits its adjusting forces by way of an intermediate lever **53** and a cam lever **54**, as well as a spring-type accumulator **55**, to the fuel delivery control rod **56** of the injection pump.

The linkage between the adaptor sleeve **15** and the intermediate lever **53** is formed by a ball joint **57** (FIG. 1) consisting of a ball pin **58** and a bore **59** in a bearing arm **61** of the adaptor sleeve **15**. The intermediate lever **53** is in the form of a U-shaped stirrup which is pivotally mounted in the governor housing **37** by means of two ball pivots **62** (see FIG. 2 for this detail) and which is linked by means of a pin **63** with the connecting linkage **54**. The cam lever **54** is provided with a guide slot **64** (FIG. 3) which is engaged by a guide pin **65** of a steering lever **66** which pin is fixedly connected to a shaft **67** supported in governor housing **37**. An operating lever **68** (FIG. 2) is secured to this shaft **67** outside the governor housing **37**, whereby the shaft **67**, together with the steering lever **66**, can be swivelled and whereby, at the same time, together with the position of the control rod **56**, the lever transmission ratio of the two-armed cam lever **54** will change. The two effective lever arms of the cam lever **54** are then constituted in a known manner, by the distances between the bolt **63** and the guide pin **65**, on the one hand, and between the guide pin **65** and a connecting bolt **69** (FIG. 3), on the other hand; the latter bolt **69** connects the cam lever **54** and the spring-type accumulator **55** with one another. The shaft **67** (see FIG. 2 for this detail) which carries at one end, outside the governor housing **37**, the operating lever **68**, is provided at its other end with a stop lever **71** for limiting the pivoting angle of the operating lever and thereby also that of the steering lever **66** in conjunction with known stop means (not illustrated). Both levers **68** and **71** may, of course, also be arranged on the same side of the governor.

In order to prevent a stalling of the motor in particularly critical operating ranges, such as while abruptly closing the throttle, an additional no-load spring **73** is engaged at the force-transmitting lever **21** in addition to the first control spring **28** serving as no-load control spring (see FIG. 1 for this detail). This additional no-load spring **73** is provided with a fixed spring seat in the form of a pin **74** which is mounted in the two legs **22** of the force-transmitting lever **21**, and its active path "*b*" is adjustable by means of an adjusting screw **75** screw-fitted into the force-transmitting lever **21**. This adjusting screw **75** is, for instance, secured in its setting by means of a securing fluid. The additional no-load spring **73** is provided with an angular bend **76** at one end which, after the no-load control spring **28** has travelled through path *b*, engages with the latter spring and assists the action of the latter on the adaptor sleeve **15**. Apart from the additional no-load spring **73**, there is also a bi-metal spring **77** secured to the force-transmitting lever **21**, which spring **77** changes its position, in case of a cold engine, in such a way as to additionally act upon the regulator member **15** by way of the first control spring **28**, which action results in an increased idling speed, as is required for the smooth running of a cold engine. Both additionallly provided springs **73** and **77** may, of course, be omitted in the case of simple regulating conditions.

The governor housing **37** is closed by means of a cover **78** on the frontal face thereof away from the injection pump, which cover allows, after its removal, access to all essentially horizontally disposed adjusting elements of the governor. These adjusting elements are, to summarize them, the bearing bolt **49** for adjusting the proportional range of the governor, the stop screw **41** for the adjustment of the non-operational position of the force-transmitting lever **21**, the adjusting screw **47** for changing the bias of the control spring **42**, the adjusting screw **34** for changing the bias of the no-load control spring **73**, and the adjusting element **23** for the adjustment of the first partial travel *a* of the path of the adaptor sleeve **15**, which travel *a* is normally identical with the idling stroke of the adaptor sleeve **15**.

The governor operates as follows:

All movable parts of the governor have been illustrated in non-operating position; the operating lever **68** and therewith the steering lever **66** are in their rest position. For starting the internal combustion engine, the operating lever **68** and therewith the steering lever **66** (see FIG. 3 for this detail) are brought into full-load position by swivelling in the direction of the arrow **79**, which results in shifting of the control rod **56** by means of the cam lever **54** and by way of the accumulator **55** in the direction of the arrow **80** into the starting position. In the starting position of the control rod **56**, the injection pump delivers a quantity of fuel to the internal combustion engine, which is in excess of the fuel quantity required for full load operation in order to facilitate the starting of the engine.

After the engine has been started, and while the operating lever **68** is, for instance, being kept in the full load position, the rpm rises further and the centrifugal fly weights **12** swing outwardly, under the influence of the centrifugal forces, from their position as shown in the drawing. The centrifugal fly weights **12** thereby transmit the adjusting forces with their arms **13** via the thrust collar **14** and the thrust bearing **16** to the adaptor sleeve **15**, which is displaced against the force of the no-load control spring **28** until it abuts with its front face **27** at the end plane **26** of the adjusting element **23**, which is screw-fitted into the force-transmitting lever **21**. This displacement of the adaptor sleeve **15** by the partial travel path *a* causes the bearing arm **61** with the ball joint **57** to be displaced by the same length of travel, and the control rod **56** is shifted by means of the linkage members **53, 54** and **55** from the starting position into the full load position. The governor remains in this position as the rpm increases further until the final rpm is reached, which is predetermined by the bias of the second control spring **42** serving as main control spring. If this final rpm is exceeded in the case of the engine operating under partial load, the force-transmitting lever **21** lifts off its stop **39** due to the increasing force at the adaptor sleeve **15**, and the latter travels further beyond the partial distance a. The adaptor sleeve **15** thereby moves the linkage members **53, 54, 55** and the control rod **56** into a position in which the fuel quantity of the injection pump is decreased until it corresponds with the power output of the motor and until the rpm is maintained within the proportional range. As the forces of the control spring **42** are taken up, on the one hand, by the abutment **44**, and, on the other hand, by the stop **39** of the force-transmitting lever **21** or by the adaptor sleeve **15**, the linkage members **53, 54** and **55** are free from resetting forces in all operating conditions. If, for example, the control rod **56** abuts in its end position against a stop not shown in the drawing, and if the operating lever **68** of the governor moves beyond a setting corresponding with the said stop, a spring of the accumulator **55** is compressed, and only these relatively small forces are transmitted to the linkage members.

Due to the fact that, as mentioned above, all adjusting elements are acessible from the one front end of the governor, and since they are all arranged in parallel or at least approximately in parallel with one another, the centrifugal rpm-regulating governor according to this invention is particularly suited for an automated setting. But even without such automated setting, the centrifugal governor according to the invention offers the advantage that all adjusting elements are accessible from one end only, and that they can be adjusted independently of each other, i.e., without influencing the function of other adjusting elements.

A further advantage resides in the fact that the no-load control spring **28**, the additional no-load spring **73**, as well as the bi-metal spring **77** with their associated adjusting screws **34** and **75** are supported at the force-transmitting lever **21**, whereby these springs are fixedly clamped, upon abutment of the front face **27** of the adaptor sleeve **15** at the supporting lever **21**, or at its adjusting element **23**, so that they no longer have any influence on the regulation of the final rpm. A further advantage to be noted is that the spacings of the adjusting elements **23, 34, 41, 47, 49** and **75** do not change during the various adjusting procedures, but remain constant, which fact facilitates a rapid and optionally an automated setting of the governor, as, for this purpose, a multiple-adjusting tool having adjusting means arranged in parallel can be applied from the front end of the regulator.

What is claimed is:

1. In a centrifugal governor for controlling the rpm of an injection type internal combustion engine having a fuel injection pump, which governor has a housing and a regulator member being displaceable as a function of the rpm, and the regulating movements of which member are transmitted, by means of a two-armed cam lever having lever arms which are adjustable dependent upon the position given an externally turnable operating lever, to fuel delivery control means associated with said fuel injection pump, wherein said fuel delivery control means, upon completing a first part of its movement against the force of a first control spring, acts on a force-transmitting lever which is biassed by at least one second control spring, and said force-transmitting lever bears an adjusting screw for setting said first control spring to a low rpm, and is adapted for swivelling about an axis which is stationary in said housing, and wherein the neutral position of said force-transmitting lever is determined by a stop fixed in said housing, the improvement comprising

a. a bearing lever adjustable for setting a maximum rpm and bearing a spring seat for said second control spring,

b. a second adjusting screw for said bearing lever, and

c. an adjusting element for limiting the first part of the movement of said regulator member,

said bearing lever, second adjusting screw and adjusting element being in engagement with said force-transmitting lever.

2. The improvement as described in claim **1**, wherein said force-transmitting lever is arranged, in its neutral position, at least approximately perpendicular to the axis of said regulator member.

3. The improvement as described in claim **1**, wherein said regulator member is an adaptor sleeve.

4. The improvement as described in claim **1**, wherein said bearing lever is an angle lever having a pivot axis stationary relative to said force-transmitting lever.

5. The improvement as described in claim **1**, wherein said adjusting screw for setting said first control spring, said adjusting element and said second adjusting screw for said bearing lever are disposed in parallel with one another and at least approximately in parallel with the axis of said regulator member, and are screw-connected to said force-transmitting lever and secured in their position thereon.

6. The improvement as described in claim **1**, further comprising a stop screw screwed into said governor housing in a position at least approximately in parallel with said adjustment screws and with said adjusting element, said stop screw forming an abutment for said force-transmitting lever.

7. The improvement as described in claim **1**, wherein said second control spring is a tension spring which is disposed at least approximately in parallel with said force-transmitting lever.

8. The improvement as described in claim **7**, further comprising a bearing bolt mounted in said governor housing in parallel with the axis of said regulator member and being turnable for changing the active direction of said tension spring and thereby adjusting the proportional range of the governor.

9. The improvement as described in claim **8**, wherein said tension spring engages at its one end said bearing bolt, and at its other end said bearing lever.

10. The improvement as described in claim **9**, wherein said bearing bolt is provided with a helicoidal groove in which said one end of said tension spring is held.

11. The improvement as described in claim **1**, wherein said force-transmitting lever is of U- or H-type cross sectional configuration and has two parallel legs facing toward said injection pump.

12. The improvement as described in claim **11**, further comprising a pivot pin mounted traversely in said legs of said force-transmitting lever and serving as pivot for said bearing lever.

13. The improvement as described in claim **11**, wherein each of said legs is provided with a guiding slot, and said regulator member is provided with a pair of guide-pins being inserted each in one of said guiding slots.

14. The improvement as described in claim **13**, wherein said first control spring is a leaf spring, wherein a fixed spring seat for one end of said leaf spring is located on said force-transmitting lever between the two legs thereof, and wherein the other end of said leaf spring abuts said guide pins of said regulator member.

15. The improvement as described in claim **14**, wherein said adjusting screw for said first control spring is screw-connected to and secured in position at said force-transmitting lever in the cross part thereof intermediate said two legs and engages said leaf spring intermediate the ends thereof.

16. the improvement as described in claim 1, further comprising an additional no-load control spring supported on said force-transmitting lever and adapted for engagement by said first control spring so as to increase the bias of the latter, and a third adjusting screw screwed into said force-transmitting lever and adapted for changing the effective range of engagement of said additional no-load spring with said first control spring, said latter spring being adapted for affecting the operation of said regulator member during at least a part of the travel of said regulator member from rest position into contact with said adjusting element.

17. The improvement as described in claim 16, wherein said first control spring and said additional no-load control spring are both leaf springs.

18. The improvement as described in claim 16, further comprising a bi-metal spring supported on said force-transmitting lever and adapted for acting via said first control spring on said regulator member.

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