

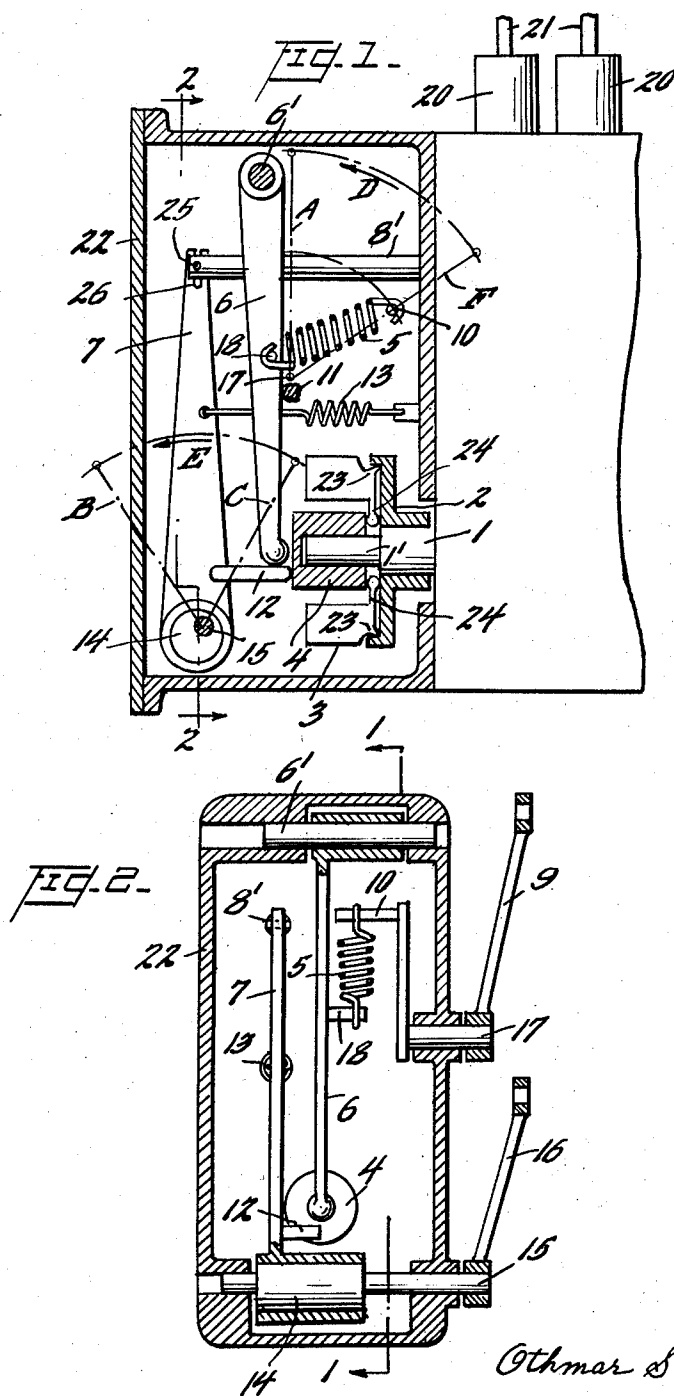
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GOVERNOR

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1

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GOVERNOR

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This invention relates to improvements in the governor mechanism for controlling the fuel injection pump of an injection type internal combustion engine.

The several different fields of use of internal combustion engines require different governing principles which are generally speaking incompatible. For instance, where the engine is used to drive a vehicle, the vehicle driver normally controls the operational speed of the engine and varies same at will. In such use the governor is required only to prevent the engine from dropping below a minimum idling speed, and from exceeding a predetermined maximum speed. On the other hand, stationary engines generally are required to operate at a substantially constant speed and, so far as is possible, independently of changes in load on the engine, though it is desirable to be able to vary the said constant speed.

Because of these basically different requirements it has heretofore been necessary to change the governor of an engine in order to adapt a stationary engine for use in powering a vehicle or vice versa.

With the foregoing considerations in mind, it is the primary object of the instant invention to produce a governor which is capable of alternate use without structural change, either in a vehicle engine or the like where the speed is adjusted at will, as above mentioned, or in a stationary engine wherein a substantially constant speed is maintained despite variations in load.

Such adaptability of the governor is attained through the novel structure of the governor per se and its new combination with the fuel injection pump in such manner that the fuel charge volume varying mechanism and the speed governing mechanism are formed separately and are mutually independently controllable either to vary the speed setting or the volumes of the injected fuel charges under a given load. Nevertheless, both said mechanisms co-act simultaneously with the speed responsive control element of the governor, except at idling speeds, and merely require to be set or adjusted in easy manner to adapt the governor for use as either a variable speed governor or as a speed limiting governor.

It is a further object of the invention to utilize the fuel charge volume varying mechanism alone for controlling the idling speed of the engine, and during idling to temporarily render the speed limiting governor mechanism inoperative, though on stand-by status to take over and resume its normal functioning in the event of an unexpected acceleration of the engine speed for any reason whatsoever. Such use of the charge volume or quantity control mechanism for idling, to the exclusion of the speed limiting mechanism, results in increased sensitivity of control and improved idling qualities.

Figure 1 represents a sectional view through the governor for the fuel pump of an injection type internal combustion engine, the section being along the line 1—1 of Figure 2, and the fuel pump being shown fragmentarily and in elevation; and

Figure 2 represents a section on the line 2—2 of Figure 1.

2

The fuel injection pump 8 may be of any conventional type customarily employed as a component of an internal combustion engine for injecting successive metered charges of fuel into the respective engine cylinders. As is well known in the art, such a pump is adapted for mounting directly on the housing of its associated engine, and to have its rotary drive shaft 1 driven from the engine in any suitable manner, at a speed proportional to the engine speed, so that the fuel charges are injected into the respective engine cylinders in properly timed relation and in the order of firing of the respective cylinders.

It will be understood that the shaft 1 produces reciprocation of pistons within the respective pump cylinders 20, to eject accurately metered charges of fuel from the cylinders through conduits 21 leading to the respective engine cylinders. The volume or quantity of fuel in each injected charge is varied responsive to lengthwise movement of a usual injection quantity control rod or member 8', which is slidably supported in the pump housing parallel to the pump shaft 1. Such a control rod 8' may be arranged for operation in any usual manner, as generally exemplified for instance in the U.S. patent to Links, 2,675,795, granted April 20, 1954, and there may be a pair of such rods, one for each bank of pump cylinders, where the pump is of the V-type.

In the pump here shown, it will suffice to explain that inward movement of the rod 8', or in other words, movement thereof toward the right in Figure 1 will reduce the volumes of the respective fuel charges, while movement of the rod in the opposite direction will increase the sizes of said charges.

The governor mechanism is preferably enclosed within a housing 22 flanged or otherwise fixedly supported on one end of the fuel pump 8. It will be seen that the adjoining end portions of the pump shaft 1 and the control rod 8' both project into this housing. Mounted on the pump shaft 1 within the housing is a conventional speed responsive governor, including the hub fixed on the shaft for rotation therewith, and the centrifugal fly weights 3 swingable radially on said hub about their fulcrum points 23 responsive to centrifugal force arising from rotation of the shaft 1. As the weights 3 swing outwardly, their radially inwardly projecting arms 24 act on the control element or barrel 4 of the governor to urge same axially of the shaft 1 toward the left in Figure 1. It will be seen that the barrel 4 is axially slidably supported on a reduced diameter extension 1' of the shaft 1.

Such movement of the barrel 4 is transmitted to the control rod 8' in a sense to decrease the sizes of the fuel charges, by means of a lever 7 fulcrumed in the governor housing at 14 for angular movement in a plane parallel to both the axis of shaft 1 and the operational movement of barrel 4. The free end of the lever is connected to the control rod 8' in any suitable manner to transmit longitudinal adjusting movement to the control rod. Such a connection is formed in the present embodiment by a pivot pin 25 disposed transversely through the slotted end portion of the member 8'. The free end of the lever 7 is received in said slotted end, and is itself formed with a vertical slot 26 which receives the pivot 25 and which permits vertical movement of the lever end relative to the rod, such as may result both from the arcuate movement of the lever end, as well as from adjustment of the lever fulcrum 14 in the manner hereinafter described. In the form shown, the lever 7 is provided with a projecting follower portion 12 which operatively engages the adjacent axial end of the governor barrel 12. Such portion 12 is held against the governor barrel and caused to return therewith (to the right in Figure 1) incident to reductions in speed of the shaft 1, this being accomplished by a comparatively light spring

3

13 connected under tension between the lever 7 and the housing 22. Because of the location of the follower 12 adjacent the fulcrum 14 of the lever 7, it will be apparent that the lever will magnify the movements of the barrel 4 in transmitting them to the rod 8', and thus will be enabled to control the rod 8' with a high degree of sensitivity.

Obviously, movement of the barrel 4 to the left in Figure 1, under the action of weights 3, will act through lever 7 to cause a similar but greater movement of the charge quantity control rod 8' to reduce the volumes of the fuel charges, and conversely movement of the barrel and rod to the right in Figure 1 will increase the sizes of the fuel charges.

In order to vary the size of the injected fuel charges at any given setting or position of the speed responsive control element or barrel 4, provision is made for adjusting the fulcrum 14 of the lever 7 in a direction generally parallel to the movement of the barrel. To this end the fulcrum 14 is shown as comprising a cylindrical shaft section fixedly carried by an eccentrically located shaft 15 which is journaled across the housing 22 as shown. A control crank or lever 16 fixed on shaft 15 exteriorly of the governor housing provides a convenient means for selectively rotating the shaft 15 to position the fulcrum 14 as desired.

For controlling the speed of rotation of the pump shaft, there is provided a tension spring 5 which acts on the governor barrel 4 through a lever 6 in opposition to the force exerted by the fly weights 3. Lever 6 is pivotally suspended within the governor housing 22 for angular movement about a pivot 6' in a direction parallel to the axis of shaft 1. The lower free end of lever 6 engages the end of governor barrel 4, preferably in alignment with the shaft axis, to properly align the opposing forces exerted on the barrel by the said lever 6 on the one hand and the fly weights 3 on the other.

Adjustment of speed is attained through adjustment of the tension of spring 5. To this end one end of spring 5 is anchored to lever 6 by pin 18. The other end of the spring is attached to the free end of a crank 10, the shaft 17 of which is rotatably journaled through a wall of housing 22. On the outer end of shaft 17 is fixed a speed control lever 9 which may be selectively positioned as desired to adjust the governor spring tension. As shown in Figure 1, the lever 9 and crank 10 are positioned to maintain the spring nearly at right angles to the lever 6 to exert a maximum rotational moment thereon when the lever 9 is positioned as indicated by the broken line F. However, as the crank 10 is adjusted in the direction of arrow D of Figure 1, the spring 5 moves toward parallelism with lever 6 to decrease the moment of force which it exerts on said lever. At the same time, in the instant embodiment, the eccentric relationship between the crank shaft 17 and the anchor pin 18 of the spring results in a shortening of the spring with still further reduction of tension.

In order to permit the spring 13 of the charge quantity control lever 7 to be in sole control of the pump during idling of its associated engine, there is provided a stop 11 projecting from the housing wall in position to abut against the lever 6 and maintain it disengaged from the governor barrel within the range of movement of said barrel at idling speed. In practice, the strength of spring 13 is only such as will suffice to maintain the lever 7 engaged with barrel 4 and to follow said barrel in its return movement. Thus the spring 13 is normally incapable of appreciably resisting the axial thrust of the barrel at other than idling speed, and therefore does not function as a speed controlling governor spring during operation at normal speeds except to the very slight extent which it supplements the spring 5. However, when the lever 16 is set in the position designated by the broken line B in Figure 1, to reduce the injected fuel charges to minimum size, the spring 13, because of its great sen-

4

sitivity, will function with a high degree of efficiency to maintain a constant idling speed of the engine associated with the pump 8.

The governor operates as follows:

Depending on the tension of governor spring 5, the governor barrel 4 moves to the left under the influence of the axial force generated by the rotating fly weights until such force balances the opposing force exerted through the springs 5 and 13. In the event of a sudden load drop on the engine such equilibrium is destroyed through the fact that the engine speed increases, thus moving the barrel 4 further to the left until this increased axial force on the barrel is balanced by the further stressing of springs 5 and 13. Through this action the upper end of the control lever 7 is moved to the left in Figure 1 to diminish the volumes of the injected fuel charges. This, in turn, causes reduction in engine speed with the result that the barrel 4 is partially returned axially toward its original position until a new position of equilibrium is obtained which is consistent with the new load condition on the engine.

Any movement of the speed regulating lever 9 changes the rotational moment exerted on the tension lever 6 by its spring 13. When the engine is under a constant load, a movement of lever 9 in the direction of arrow D in Figure 1 reduces the force exerted by the spring 13 on the governor barrel and thus disrupts the stabilized condition. The overweighing in centrifugal action then results in the movement of the barrel 4 to the left with resultant decrease in the volume of the injected fuel charges. As a result of this decrease in the force opposing the barrel movement to the left, the barrel starts moving to the left earlier in the event of a speed increase than would be the case in the original position of the lever 9. Therefore, assuming the load condition of the engine is constant, the engine is caused to operate at a lower but substantially constant speed.

If use is made of the injection quantity adjustment and lever 16 is moved from position C, the position of maximum injection, in the direction of the arrow E, the upper end of tension lever 7 will wander to the left since the fulcrum 14 of the lever will be displaced to the right and the lever will thereby be caused to pivot around the point of contact between its follower 12 and the barrel 4. This results in a decrease in injection quantity by moving the control rod 8' to the left. Thus a new stabilized condition will be reached in which the engine is adapted for operation under a smaller load at a different speed.

By means of the stop 11 the governor spring 5 and its associated tension lever are rendered inoperative in the idling range of the engine. Thus, when idling, the governor has to overcome only the spring 13 before the barrel touches the tension lever 6 if, for any reason, the speed of the engine should be suddenly increased. It will be seen, therefore, that the tension lever and its spring, though temporarily inactive, are nevertheless on stand-by status during idling. Due to the fact that spring 13 is considerably softer than the governor spring 5, a much higher degree of sensitivity can be maintained than if the governor spring 5 were active during idling.

When adjusting the governor the following procedure should be observed:

If the governor is to be used as an idling speed limiting governor for vehicle engines, the speed control lever 9 is to be set on maximum speed, which position may be determined through a stop which is not shown in the drawing. At idling speed the smallest injection quantity at which the engine still runs safely is to be adjusted and preferably the position of the injection quantity control lever 16 at such adjustment is marked on the outside of the housing 22 for future reference; and may, if desired, be indicated by a stop. Also, the maximum permissible injection quantity which, for example, may correspond to the position indicated by the broken lines B for the lever 16, can be adjusted, and the adjusted position, if

5

desired, marked by means of a stop not shown in the drawing.

If the engine is to be used at predetermined nominal speeds, the fulcrum of the injection quantity control lever is set during operation of the engine at a nominal speed to that position which will result in the greatest shaft output of the engine. This particular position of the injection quantity control lever 16 may be marked by a stop, or otherwise suitably indicated on the housing 22 and does not have to be changed thereafter.

While the governor has been described and illustrated as applied to a fuel pump of the type having a single bank of fuel injection cylinders controlled by a common injection quantity control rod, it will be obvious that the invention is also adapted for use with a pump in which the cylinders are arranged in V-shape in two banks, with each said bank having its own separate quantity injection control rod. In such case it will be obvious that the control lever 7 may simply be provided with separate control arms or bifurcated at its upper end whereby each of the arms or furcations may cooperate with one of the control rods in the same manner as above described.

It will be readily apparent from the foregoing that the invention embodies a number of important advantages including compactness achieved through positioning of the governor spring on the side of the fly weight governor and use of control levers swingable parallel to the governor or pump shaft, all to the end that the governor mechanism can all be housed in a narrow housing at the end of the pump. Also, the governing mechanism is all assembled as a self-contained unit within the governor housing; there is required but a short regulating travel of the charge volume control lever because of its movement magnifying ability and this, in spite of the strong tension of the relatively independent governor spring. It is important, also, that the invention results in the governing of the idling speed solely by means of the quantity control lever and its relatively weak spring with resulting high sensitivity of the governor at idling speeds.

Obviously the invention is capable of other embodiments than that herein shown and described and its various details are capable of modification, all without departing from the scope of the invention as hereinafter defined in the appended claims.

Having thus described my invention, I claim:

1. A fuel injection pump for successively injecting meter charges of fuel into the several cylinders of an internal combustion engine, comprising a rotary drive shaft the rotational speed of which determines the frequency of injection of such charges, and a charge quantity varying means displaced from and movable parallel to the rotational axis of said shaft, in combination with a speed responsive governor driven by said pump shaft, said governor including a control element movable parallel to the axis of said shaft responsive to variations in the operational speed of said pump, a charge quantity control lever fulcrumed on said pump for swinging movement parallel to the axis of said shaft and operatively connected to said charge volume varying means to vary the volumes of the injected fuel charges incident to its swinging movement, said lever being positioned for engagement by said control element for movement by said element incident to increases in shaft speed, and a relatively weak return spring acting on said lever to return it incident to decreases in shaft speed, and spring means acting on said control element independently of the quantity control lever to govern the rotational speed of said shaft, said spring means including a tension lever fulcrumed on said pump for angular movement parallel to said shaft and in axial abutment with said control element, a spring connected under tension between said tension lever and said pump and means for varying the angular relationship of the said last mentioned spring to said tension lever to change the moment of force which the last-mentioned spring exerts on said lever.

6

2. A fuel injection pump for successively injecting metered charges of fuel into the cylinders of an internal combustion engine, comprising a rotary drive shaft, the rotational speed of which determines the frequency of injection of said charges, and a charge quantity varying means displaced from and movable parallel to the axis of said shaft for varying the volumes of the fuel charges, in combination with a governor housing fixed on one end of said pump, and receiving the ends of said pump shaft and said rod, a governor on said shaft including a control element urged axially of the shaft with a force which increases with the rotational speed of the shaft, a charge quantity control lever fulcrumed in said housing for angular movement parallel to the shaft axis and normally in axial abutment with said element for movement therewith, spring means operative independently of said control lever for applying a force to said element in opposition to the force exerted thereon incident to shaft rotation, said quantity control lever being operatively connected to said charge quantity varying means to decrease said charge quantity as the rotational speed of the shaft increases, said spring means including a tension lever fulcrumed on said housing parallel to said shaft and in axial abutment with said control element, a spring connected under tension between said tension lever and said housing and means for varying the angular relationship of the said last-mentioned spring to said tension lever to change the moment of force which the last-mentioned spring exerts on said lever.

3. A fuel injection pump for successively injecting metered charges of fuel into the cylinders of an internal combustion engine, comprising a rotary drive shaft, the rotational speed of which determines the frequency of injection of said charges, and a charge quantity varying means displaced from and movable parallel to the axis of said shaft for varying the volumes of the fuel charges, in combination with a governor housing fixed on one end of said pump, and receiving the ends of said pump shaft and said rod, a governor on said shaft including a control element urged axially of the shaft with a force which increases with the rotational speed of the shaft, a charge quantity control lever fulcrumed in said housing for angular movement parallel to the shaft axis and normally in axial abutment with said element for movement therewith, spring means operative independently of said control lever for applying a force to said element in opposition to the force exerted thereon incident to shaft rotation, said quantity control lever being operatively connected to said charge quantity varying means to decrease said charge quantity as the rotational speed of the shaft increases, said spring means including a tension lever fulcrumed in said housing for angular movement parallel to the shaft, said tension lever axially abutting against said control element in opposition to its movement under the influence of increased rotational speeds of the shaft, a spring connected under tension between said tension lever and the housing and means for varying the angular relationship of the spring to said tension lever to change the moment of force which the spring exerts on said lever.

4. The combination of claim 3 including selectively controllable mechanism for shifting the fulcrum of said quantity control lever in a generally axial direction relative to said shaft to vary the quantities of said charges independently of the speed set by said tensioning lever.

5. A fuel injection pump for successively injecting metered charges of fuel into the cylinders of an internal combustion engine, comprising a rotary drive shaft, the rotational speed of which determines the frequency of injection of said charges, and a charge quantity varying means displaced from and movable parallel to the axis of said shaft for varying the volumes of the fuel charges, in combination with a governor housing fixed on one end of said pump, and receiving the ends of said pump shaft and said rod, a governor on said shaft including a

control element urged axially of the shaft with a force which increases with the rotational speed of the shaft, a charge quantity control lever fulcrumed in said housing for angular movement parallel to the shaft axis and normally in axial abutment with said element for movement therewith, spring means operative independently of said control lever for applying a force to said element in opposition to the force exerted thereon incident to shaft rotation, said quantity control lever being operatively connected to said charge quantity varying means to decrease said charge quantity as the rotational speed of the shaft increases, said spring means including a tension lever fulcrumed in said housing for angular movement parallel to the shaft, said tension lever axially abutting against said control element in opposition to its movement under the influence of increased rotational speeds of the shaft, a spring connected under tension between said tension lever and the housing and means for varying the angular relationship of the spring to said tension lever to change the moment of force which the spring exerts on said lever, the spring of said tensioning lever being anchored to said lever at one end, said spring means including a crank shaft rotatably journaled through the housing parallel to the fulcrum of said quantity control lever, a crank fixed on said shaft within the housing for angular movement with respect to said quantity control lever, a governor spring connected under tension between said control lever and the free end of said crank and a speed control lever fixed on said shaft exteriorly of the housing.

6. The combination of claim 3, including a stop fixed within said housing in the path of movement of said tension lever to limit the return movement of said lever under the action of said spring, thereby placing the governing function solely under control of the quantity control lever and its spring at idling speeds of the said shaft.

7. The combination of claim 3, including a stop fixed within said housing in position to arrest the movement of said tension lever, but outside of the path of movement of said quantity control lever, whereby the quantity control lever is in sole charge of the governing function within a predetermined range of rotational speeds of the shaft.

8. A speed governor mechanism as defined in claim 3, wherein the fuel pump includes several banks of cylinders, and a quantity control mechanism for each said bank, the quantity control lever in turn comprising a plurality of arms positioned for simultaneous control of the said mechanisms.

9. A speed governor mechanism for the injection pump of an internal combustion engine, comprising a housing, a rotatable shaft in said housing, a centrifugal governor on said shaft including a control element and fly weights urging same axially of the shaft responsive to rotation of its shaft, a tension lever and a quantity control lever, both fulcrumed in said housing for angular movement parallel to the rotational axis of said shaft, and in axial abutment with said control element for movement therewith, responsive to increase in shaft speed, spring means connected between said housing and said tension lever and urging said tension lever against the control element in opposition to the force produced by said fly weights, and a relatively weaker spring means urging said control lever against the control element.

30

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