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[54] **DIESEL ENGINE FUEL INJECTION PUMP GOVERNOR**

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[51] **Int. Cl.**[2] **F02D 1/04;** F02D 1/06

[58] **Field of Search**........... 123/140 R, 140 MC, 98, 123/140 J

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[57] **ABSTRACT**

A control lever and a flyweight assembly move a floating lever which determines the position of a control rod which controls the fuel injection volume. Novel means are provided to limit the fuel injection volume during starting to prevent smoky exhaust, and to prevent the control lever from being displaced by the floating lever during engine braking.

13 Claims, 3 Drawing Figures

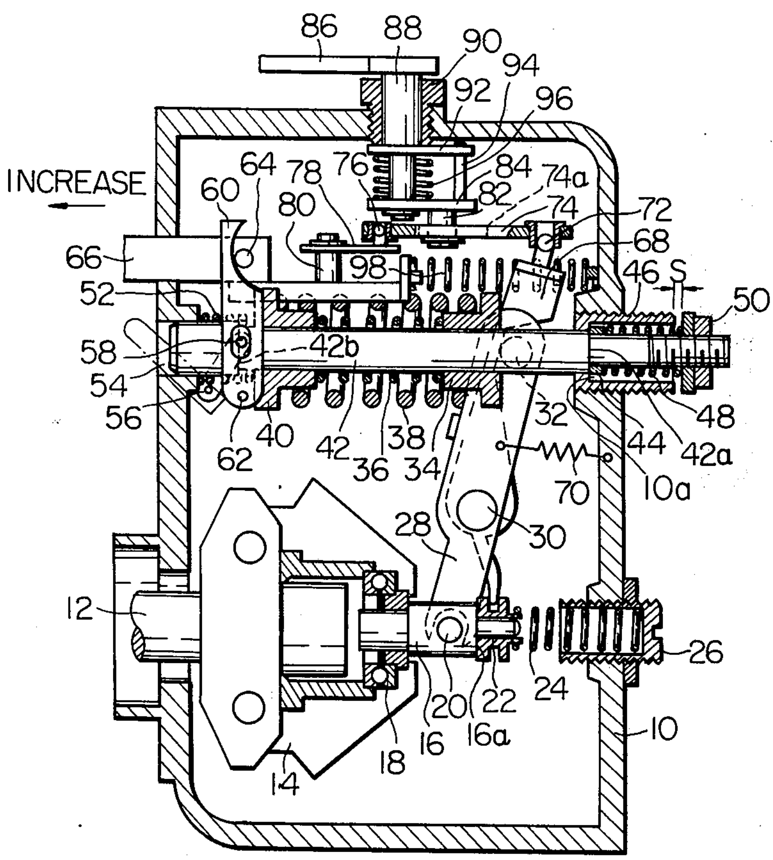


Fig. 1

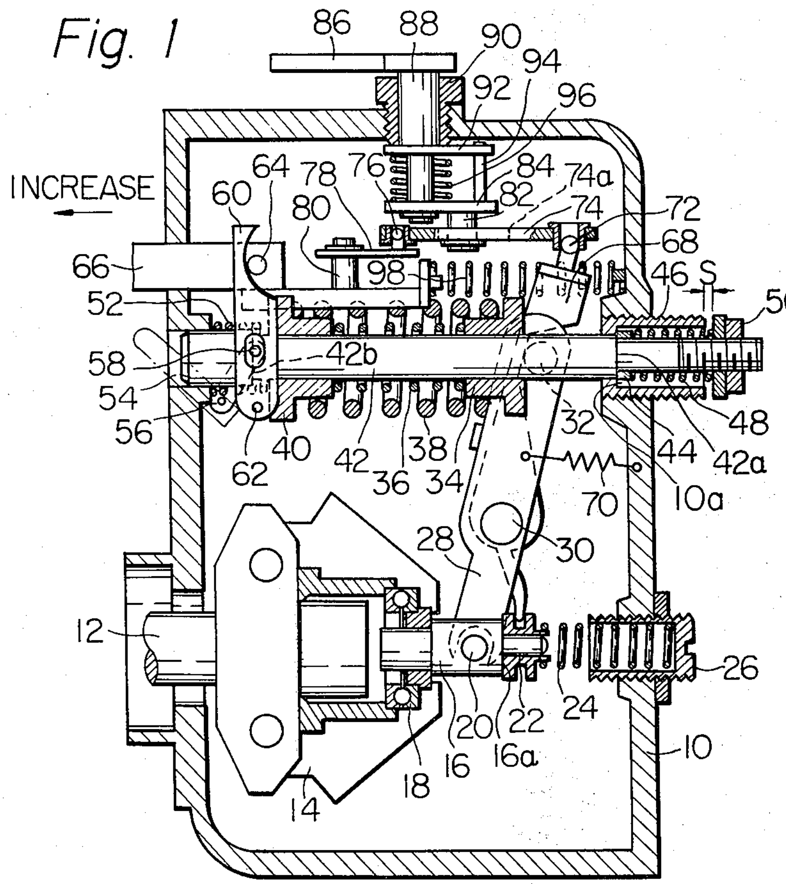


Fig. 2

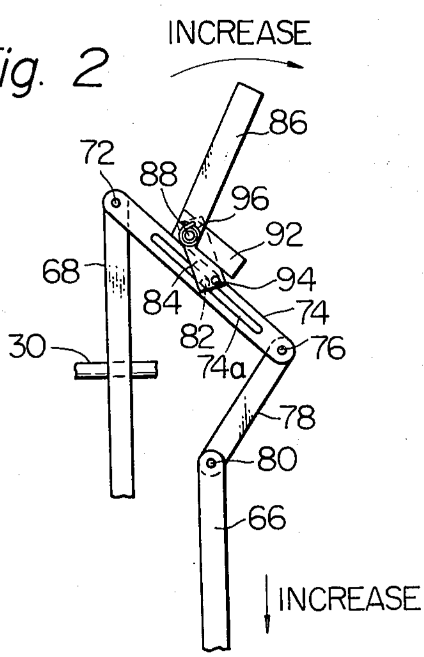
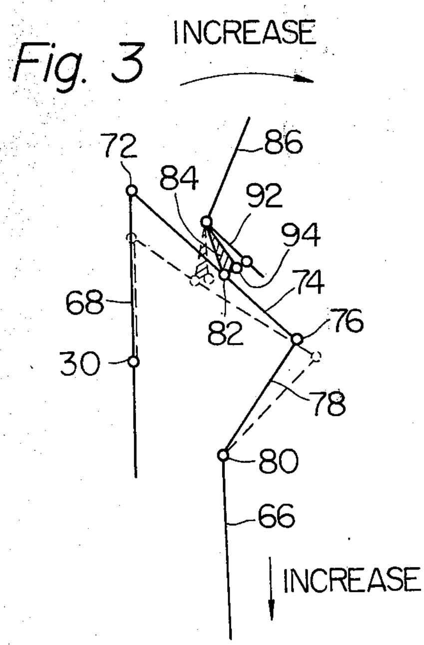


Fig. 3



DIESEL ENGINE FUEL INJECTION PUMP GOVERNOR

The present invention relates to a governor for a fuel injection pump for a Diesel internal combustion engine.

It has been proposed in the prior art to provide a governor assembly including a floating lever, the position of which is determined by a manual speed control lever and a flyweight assembly and which moves a control rod which controls the fuel injection volume. However, there are several problems in the prior art design. Firstly, in a case in which the flyweights are engageable with both a high speed spring and an idling spring and the control lever is moved to a starting position to provide maximum fuel injection volume for starting the engine, as the engine speed rises, the flyweights engage with both the high speed spring and the idling spring with the result that the fuel injection volume is not properly reduced as the engine speed rises. Smoky exhaust gases are thereby produced which pollute the environment, and another important disadvantage is that fuel is wasted since the smoky exhaust gases are produced as the result of incomplete combustion. The latter is especially important in view of the radially rising cost and depletion of supply of fuel oil suitable for powering a Diesel engine. The present invention intends to eliminate this drawback by the use of novel means to disconnect the flyweights from the idling spring during engine starting.

Another problem with this type of governor is that when engine braking is being employed to slow down the vehicle, such as when moving downhill in low gear, although the vehicle operator has moved the control lever to the idling position, the action of the flyweights on the floating lever is such that the control lever will be moved thereby away from the idling position in the accelerating direction. This results in an unnatural sensation for the vehicle operator, and interferes with the engine braking operation. The present invention intends to provide novel means by which the control lever will not unnaturally be moved by the floating lever during engine braking.

It is therefore an important object of the present invention to provide a governor for a fuel injection pump for a Diesel internal combustion engine by which smoky exhaust gases are not produced while the engine is being started and efficient use of fuel is therefore assured.

It is another important object of the present invention to provide a governor for a fuel injection pump for a Diesel internal combustion engine by which the engine speed control lever and accelerator pedal are not moved from their idling position by the action of the governor floating lever during engine braking conditions.

The above and other objects, features and advantages of the present invention will become more clear from the following detailed description taken with the accompanying drawings, in which directions such as "clockwise" and "righward" refer to the invention as viewed in the respective drawings, and in which:

FIG. **1** is a longitudinal sectional view of a governor embodying the present invention;

FIG. **2** is a top view, partly in section, of a portion of the governor of FIG. **1**; and

FIG. **3** is a diagrammatic view of the portion of the governor shown in FIG. **2**.

Referring now to FIG. **1**, a governor embodying the present invention includes a casing **10** rotatably supporting therein a shaft **12** rotatably driven by a camshaft of a Diesel engine fuel injection pump (not shown). The shaft **12** carries flyweights **14** which are arranged to expand by centrifugal force developed by rotation thereof by the shaft **12** and axially move a shifter rod **16** rightward as the engine speed increases. The shifter rod **16** engages with the flyweights **14** by means of a thrust bearing **18**, and carries a pin **20**. The shifter rod **16** is also formed with a right shoulder **16***a*, with which a spring seat **22** is urged into engagement by an idling spring **24**. The preload of the idling spring **24** is adjustable by means of an adjusting nut **26**. A tension lever **28** is rotatable about a fulcrum pin **30** supported by the casing **10**, and is pivotally connected at one end to the pin **20**. A pin **32** carried by the other end of the tension lever **28** is engagable with the right side of a spring seat **34**, the other side of which is engagable with a medium speed governor spring **36** and a high speed governor spring **38**. A spring seat **40** is engageable with the other ends of the springs **36** and **38**, and is slidable on a shaft or rod **42** as is the spring seat **34**. The rod **42** is slidably supported by the casing **10** and has a shoulder **42***a* formed near its right end which is engagable with the left side of a spring seat **44** which is also engagable with a shoulder **10***a* of the casing **10**.

A bushing **46** is fixed to the casing **10** and receives the rod **42** therethrough. A compensating compression spring **48** is disposed inside the bushing **46**, and engages at its right end with a nut **50** fixed to the end of the rod **42** and at its left end with the right side of the spring seat **44**. The nut **50** is screwable along the rod **42** to provide a stroke S between its left side and the right side of the bushing **46**. A spring **52** urges the spring seat **40** rightwards to eliminate play, and the rod **42** is formed with a shoulder **42***b* which is engagable with the left side of the spring seat **40**.

A stopper lever **54** is manually rotatable to stop the engine, and has an extension **56** extending integrally therefrom and carrying at its end a pin **58**. A link **60** is pivotally carried by the pin **58**, and carries a pin **62** at its one end. The pin **62** is engagable with the left side of the spring seat **40**, and the right side of the other end of the link **60** is engagable with the left side of a pin **64** fixed to a control rod **66**. The cntrol rod **66** is formed with a rack (not shown) which is operatively connected to the fuel injection pump to control the volume of fuel injected therefrom into the Diesel engine. The rack of the control rod **66** may engage with control quadrants of control sleeves of fuel injection valves (not shown) of the fuel injection pump, or be connected to control the fuel injection pump in any other manner. The control rod **66** is moved leftward as shown by an arrow to increase the fuel injection volume.

A guide lever **68** is rotatable about the fulcrum pin **30**, and engages at its lower end with a circumferential groove (no numeral) formed in the spring seat **22**. The guide lever **68** is biased clockwise against the pin **32** of the tension lever **28** by a tension spring **70**, and a ball **72** fixed to the upper end of the guide lever **68** pivotally engages in a hole (no numeral) formed through one end of a floating lever **74**. A ball **76** fixed to one end of a link **78** pivotally engages in a hole (no numeral) formed through the other end of the floating lever **74**.

A pin **80** is fixed to the control rod **66**, and pivotally supports the link **78**.

Referring now also to FIG. **2**, the floating lever **74** is formed with a longitudinal slot **74***a*, in which a pin **82** of an arm **84** is movably received. A control member or lever **86**, which may be connected to an accelerator pedal of a vehicle through a suitable linkage (not shown), is fixed on a shaft **88** which is rotatably supported by the casing **10** by a bushing **90**. An arm **92** is fixed to the shaft **88**, and is engagable with a pin **94** extending from the arm **84**. The arm **84** is urged by a spring **96** so that the pin **94** engages with the arm **92**. The control rod **66** is urged leftward by a starting spring **98**.

The operation of the governor will now be described. When the engine is shut down, the control lever **86** will be in its maximum counterclockwise position and the control rod **66** will be in its maximum upward position as shown in FIG. **2**. To start the engine, the control lever **86** is rotated to its maximum clockwise position to provide maximum fuel injection volume for starting. In FIG. **2**, the control lever **86** is rotated clockwise and the arm **92** engages with the pin **94** to move the arm **84** and thereby the pin **82** clockwise. Since the engine speed is almost zero, the flyweights **14** will not be moved and the shifter rod **16** will assume its maximum leftward position in FIG. **1**. Also as viewed in FIG. **1**, the tension lever **28** will assume its maximum clockwise position.

Initially, the guide lever **68** will assume its maximum clockwise position as viewed in FIG. **1**, and the ball **72** will serve as a fixed pivot point for the floating lever **74**. Referring now to FIG. **2**, as the pin **82** is moved clockwise, it will exert a force on the floating lever **72** to pivot the same clockwise about the ball **72**. This will cause the control rod **66** to be moved downward in the direction to increase the fuel injection volume by means of the link **78** and the starting spring **98**. When the position of maximum fuel injection volume is reached, the pin **64** of the control rod **66** will abut against the link **60**, which will in turn be rotated about the pin **58** until the pin **62** abuts against the spring seat **40**. Due to the high stiffness of the springs **36** and **38**, further movement of the control rod **66** will be prevented and the pin **80** will then serve as a fixed pivot. Further clockwise rotation of the pin **82** will subsequently cause the floating lever **74** to pivot counterclockwise about the pin **76**, and the guide lever **68** will be thereby rotated counterclockwise as viewed in FIG. **1** away from the tension lever **28**. The lower end of the guide lever **68** will move the spring seat **22** axially rightward against the force of the idling spring **24** and out of engagement with the flyweights **14** and shifter rod **16**.

If the engine were started without disengaging the idling spring **24** from the flyweights **14**, the springs **36** and **38** would be mechanically connected in parallel with the idling spring **24**. Under starting conditions, in which the control lever **86** is moved past a full load position to the starting position, the springs **36, 38** and **24**, which normally serve to reduce the fuel injection volume in combination as the engine speed rises with the control lever **86** in a useful power producing position will provide too much resistance to reduction of the fuel injection volume, and the fuel injection volume will be too great and smoky exhaust will be produced. As described, however, the guide lever **68** disconnects the idling spring **24** from the flyweights **14**, and the problem is eliminated.

After starting, the control lever **86** is rotated counterclockwise in FIG. **2** to an idling position. The arm **84** is urged by the spring **96** to follow the arm **92**, and the floating lever **74** is pivoted counterclockwise about the ball **72** by the pin **82**. The control rod **66** is pulled upward thereby to an idling position. As the floating lever **74** is rotated to the idling position, the guide lever **68** and thereby the ball **72** itself will be rotated clockwise in FIG. **1** by the idling spring **24** and the spring **70** until the guide lever **68** engages with the pin **32** of the tension lever **28**. The spring seat **22** will then engage with the shoulder **16***a* of the shifter rod **16**.

The tension lever **28** and guide lever **68** will then rotate as a unit. As the engine speed approaches the idling speed, the flyweights **14** expand and the shifter rod **16** is moved rightward in FIG. **1** against the force of the idling spring **24**. The guide lever **68** and tension lever **28** will then rotate counterclockwise. Referring to FIG. **2**, counterclockwise rotation of the guide lever **68** will cause counterclockwise rotation of the floating lever **74** about the pin **82**. The control rod **66** will thereby be moved upward to reduce the fuel injection volume.

As the control lever **86** is rotated clockwise in FIG. **2** to increase the engine speed, the floating lever **74** is pivoted clockwise thereby about the ball **72**, and the control rod **66** is moved downward to increase the fuel injection volume. As viewed in FIG. **1**, as the engine speed increases, the tension lever **28** and guide lever **68** will be rotated counterclockwise by the flyweights **14** and the shifter rod **16**. The pin **32** will urge the spring seat **34**, springs **36** and **38** and spring seat **40** leftward against the force of the spring **52**, which is weak, until the left side of the spring seat **40** abuts against the shoulder **42***b* of the rod **42**. The rod **42** will then be moved leftward against the force of the compensating spring **48**, which serves to correctly determine the maximum fuel injection volume during the transition between idling and medium speed engine operation. After the rod **42** has been moved leftward by a distance corresponding to the stroke S, the left side of the nut **50** will abut against the right side of the bushing **46**, and further movement of the rod **42** will be prevented. At or slightly before this point, the left side of the spring seat **40** will engage with the pin **62** and rotate the link **60** clockwise. If the control rod **66** should be thereafter moved leftward into engagement with the link **60**, further movement thereof will be prevented. It will be understood that the tension lever **28**, spring seats **34** and **40**, springs **36, 38, 48** and **52**, rod **42** and link **60** serve to limit the maximum fuel injection volume to a point above which smoky exhaust gas would be produced, and that the floating lever **74** and associated parts serve to suitably adjust the fuel injection volume to an optimum value below the maximum allowable value based on the engine speed demand and instantaneous engine speed.

As the engine speed increases and the tension lever **28** rotates further counterclockwise, the spring **36** and thereafter the spring **38** will be compressed between the spring seats **34** and **40**. The maximum clockwise position of the link **60** will not change, however, indicating that the maximum fuel injection volume not producing smoky exhaust is constant above the engine speed at which the nut **50** engages with the bushing **46**. The guide lever **68** rotating counterclockwise will rotate the floating lever **74** counterclockwise as viewed in FIG. **2** about the pin **82**. The control rod **66** will be thereby moved upward to decrease the fuel injection volume as the engine speed increases since extra fuel is not required for further acceleration.

The condition of engine braking, such as when the vehicle is moving downhill, is illustrated in FIG. 3. Under this condition, the engine speed is high and the control lever **86** is in the idling position. The positions of the parts shown in solid line correspond to normal idling conditions, and the positions shown in broken line correspond to engine braking conditions, under which the engine is being used as a brake to slow down the vehicle. For simplicity of description, it will be assumed that the vehicle is initially coasting on a level portion of a highway with the control lever **86** in the idling position, and then starts moving downhill. The guide lever **68** will be rotated by the flyweights **14** from the position is solid line to the position in broken line since the engine will be driven by the vehicle wheels and the engine speed will increase. Since the control rod **66** is in the minimum fuel injection position and cannot be moved farther to decrease the fuel injection volume, the pin **80** will serve as a fixed pivot point. The floating lever **74** and link **78** will move as shown. Since the pin **82** must at all times be within the slot **74a**, the pin **82** and arm **84** will be rotated clockwise. If the control lever **86** was fixedly rotatable with the arm **84** as in the prior art, the control lever **86** would be rotated by the floating lever **74** clockwise in the direction to increase the fuel injection volume as described above. However, with the provision of yieldable means including the spring **96**, the arm **84** is able to rotate clockwise but the control lever **86** will remain in the position shown in solid line. Thus, the unnatural phenomenon of the control lever **86** being moved by the floating lever **74** during engine braking is eliminated by the present invention.

To shut down the engine, the stopper lever **54** is rotated clockwise as shown in FIG. **1** to move the link **60** and control rod **66** to maximum rightward positions to completely shut off fuel injection.

What is claimed is:

1. A fuel injection pump governor comprising a fuel control rod, flyweights displaceable upon rotation thereof, first linkage means operably connecting said flyweights to said control rod, governor spring means and an idling spring connected to said first linkage means and operable to biasingly oppose displacement of said flyweights upon rotational speed increase of the latter, said first linkage means comprising linkage elements operable to disengage said idling spring from said flyweights when the flyweight rotational speed is below a predetermined value.

2. A fuel injection pump according to claim **1,** further comprising a control member manually movable to engage said first linkage means and thereby move said control rod, and yieldable means normally operatively connecting said control member to said first linkage means and being arranged to yield when a force is applied to said control member by said first linkage means in a direction urging said control member toward a maximum fuel position.

3. A fuel injection pump governor according to claim **2,** in which said yieldable means comprises an arm rotatable about a fixed axis and carrying a first pin connected to said first linkage means, said arm also carrying a second pin, said control member being engagable with said second pin when rotated toward said maximum fuel position, and biasing means urging said arm in a direction to engage said second pin with said control member.

4. A fuel injection pump governor according to claim **1,** further comprising a second linkage means engagable with said flyweights and said control rod to limit movement of said control rod toward a maximum fuel position as a predetermined function of the flyweight rotational speed, said first linkage means being arranged to disengage said idling spring from said flyweights when the movement of said control rod is being limited by said second linkage means and the flyweight rotational speed is below said predetermined value.

5. A fuel injection pump governor according to claim **4,** in which said first linkage means comprises a first rod axially movable by said flyweights, a first spring seat slidable on said first rod and engaging at one end with said idling spring and engagable at its other end with said first rod, a tension lever having an intermediate fulcrum and being pivotally connected at one end to said first rod, a second rod slidably carrying thereon said governor spring means, said second rod also slidably carrying thereon second and third spring seats engagable with the opposite ends of said governor spring means, the other end of said tension lever being engagable with said second spring seat, a guide lever having an intermediate fulcrum at the same axis of rotation as said tension lever and having one end engaging with said first spring seat, a floating lever, the other end of said guide lever pivotally engaging with one end of said floating lever, a link, the other end of said floating lever pivotally engaging with one end of said link, the other end of said link pivotally engaging with said control rod, said second linkage means comprising a second link having an intermediate fulcrum and pivotally engaging at one end with said third spring seat and at the other end with said control rod.

6. A fuel injection pump governor according to claim **5,** further comprising a compensating spring, said second rod being movable within a limited range and being engagable with said compensating spring in such a manner that said flyweights move against the biasing forces of said idling and compensating springs prior to moving against the biasing force of said governor spring means as the flyweight rotational speed increases.

7. A fuel injection pump governor according to claim **18,** further comprising a stopper member pivotally connected to said fulcrum of said second link and being manually movable to move said fulcrum of said second link and thereby said control rod to a minimum fuel position.

8. A fuel injection pump governor according to claim **1,** in which said governor spring means is in a substantially free state when the flyweight rotational speed is zero.

9. A fuel injection pump governor comprising a fuel control rod, flyweights displaceable upon rotation thereof, a first linkage means operably connecting said flyweights to said control rod, governor spring means and an idling spring connected to said first linkage means and operable to biasingly oppose displacement of said flyweights upon rotational speed increase of the latter, a control member manually movable to engage said first linkage means and thereby move said control rod, a second linkage means engagable with said flyweights and said control rod to limit movement of said control rod toward a maximum fuel position as a predetermined function of the flyweight rotational speed, said first linkage means comprising linkage elements operable to disengage said idling spring from said flyweights when said control rod is moved by said control member through said first linkage toward said maximum fuel position to an extent that the movement of said control rod is limited by said second linkage means and the flyweight rotational speed is below a predetermined value, and yieldable means for connecting said control member to said first linkage means, said yieldable means normally operatively connecting said control member to said first linkage means and being arranged to yield when a force is applied to said control member by said first linkage means in a direction urging said control member toward said maximum fuel position.

10. A fuel injection pump governor according to claim **9**, in which said first linkage means comprises a first rod axially movable by said flyweights, a first spring seat slidable on said first rod and engaging at one end with said idling spring and engagable at its other end with said first rod, a tension lever having an intermediate fulcrum and being pivotally connected at one end to said first rod, a second rod slidably carrying thereon said governor spring means, said second rod also slidably carrying thereon second and third spring seats engagable with the opposite ends of said governor spring means, the other end of said tension lever being engagable with said second spring seat, a guide lever having an intermediate fulcrum at the same axis as said tension lever and one end engaging with said first spring seat, a floating lever, the other end of said guide lever pivotally engaging with one end of said floating lever, a first link, the other end of said floating lever pivotally engaging with one end of said first link, the other end of said first link pivotally engaging with said control rod, said second linkage means comprising a second link having an intermediate fulcrum and pivotally engaging at one end with said third spring seat and at the other end with said control rod, said yieldable means comprising an arm rotatable about a fixed axis and carrying a first pin slidable in a longitudinal slot formed through said floating lever, said arm also carrying a second pin, said control member being engagable with said second pin when rotated toward said maximum fuel position, and biasing means urging said arm in a direction to engage said second pin with said control member.

11. A fuel injection pump governor according to claim **10**, further comprising a compensating spring, said second rod being movable within a limited range and being engagable with said compensating spring in such a manner that said flyweights move against the biasing forces of said idling and compensating springs prior to moving against the biasing force of said governor spring means as the flyweight rotational speed increases.

12. A fuel injection pump governor according to claim **10**, further comprising a stopper member pivotally connected to said fulcrum of said second link and being manually movable to move said fulcrum of said second link and thereby said control rod to a minimum fuel position.

13. A fuel injection pump governor according to claim **9**, in which said governor spring means is in a substantially free state when the flyweight rotational speed is zero.

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