July 26, 1938. G. J. TRAPP 2,125,210

GOVERNING MEANS FOR INJECTION PUMPS

Filed Aug. 13, 1936

Fig. 1.

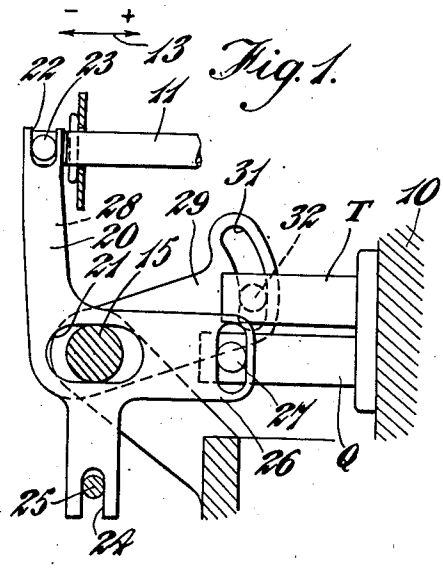


Fig. 3.

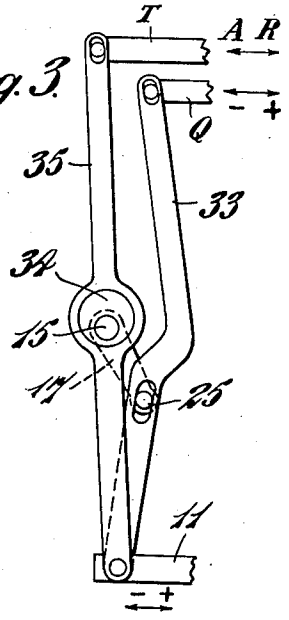


Fig. 2.

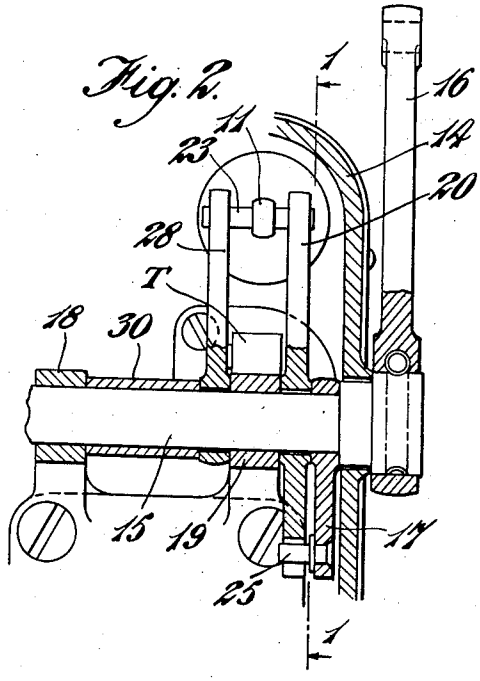
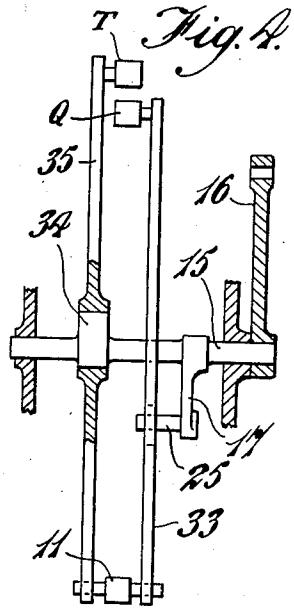


Fig. 4.



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GOVERNING MEANS FOR INJECTION PUMPS

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5 Claims. (Cl. 123—140)

This invention relates to governing means for the fuel injection pumps of internal combustion engines. It is well-known to provide in injection pumps which are directly connected to an engine or other mechanism, means whereby the quantity of liquid injected at each stroke of the pump can be varied, and also means whereby the timing of such injection can be adjusted in relation to the movements of the engine or equivalent.

It is the object of the present invention to provide an improved form of mechanism for use with pumps having these two independent controlling means, a hand lever or other manual controlling member being provided to serve as the main control of the engine or equivalent, the governing means thereafter automatically adjusting the timing and quantity of the injection to suit the load and speed of the engine.

It is a further object of the invention to provide an extremely simple and compact form of governor which can be readily embodied in the fuel injection pump unit and which operates in a light and sensitive manner.

The invention further seeks to provide a governor mechanism which coordinates the timing and quantity control members of a fuel injection pump in such a manner that the timing is at all times adjusted to correspond with the actual prevailing speed of the engine and not merely to the setting of the manual control member.

It will be appreciated that in this specification the term "quantity of fuel injected" means the quantity of fuel which is forced into one or each of the engine cylinders for each injection operation, said quantity being, of course, varied by any known or suitable means, such for example as by altering the beginning or the end of the period during which the injection takes place. This, of course, will depend upon the type and design of injection pump used, as in practice there are numerous ways in which the quantity of fuel injected is ordinarily varied. The term "timing" of the injection on the other hand refers solely to the relation of the injection period with regard to the usual engine cycle, and it follows therefore that to change the timing of the injection, the beginning and the end of such injection must be altered simultaneously and to the same extent so that the quantity of fuel for each injection remains the same as before. Fuel injection pumps are now available in which two separate control members are provided, one for altering the quantity of fuel delivered for each injection, and the other for altering the timing of the injection in respect to the cam shaft of the pump, and it is to this form of injection pump that the control mechanism according to the present invention can most readily be applied.

Two embodiments of the invention will now be described with reference to the accompanying digrammatic drawing in which

Figure 1 is a fragmentary side elevation partly in section on the line 1—1 of Figure 2 showing an arrangement in which the timing of the injection is only dependent upon the speed of the engine;

Figure 2 is an end elevation corresponding to Figure 1;

Figure 3 is a side elevation of a modified arrangement in which the timing is automatically changed for different loads as well as speeds; and

Figure 4 is an end elevation also in section showing more clearly the relationship of the parts included in Figure 3.

In the mechanism shown in Figures 1 aind 2 a fuel injection pump, a part of which is indicated at 10, is fitted in the known manner with a pair of sliding control bars T and Q, the first of which regulates the timing of the injection while the latter serves to modify the quantity of fuel delivered during each injection. The pump is further provided with a speed-sensitive member 11 which may be actuated by any suitable mechanism (not shown) such for example as a centrifugal governor or a governing device according to my co-pending application Serial No. 95,947, filed August 13, 1936. In this example the member 11 is arranged to move to the right as the speed increases and to the left as it diminishes, this being indicated by the double-headed arrow 13.

Passing through a casing 14 of the governor is a spindle 15 which carries at its outer end a control lever 16 serving as the manually set member, while a crank arm 17 within the casing is attached to said spindle, which latter is mounted for angular movement within a pair of bearings 18 and 19 securely fixed to the body of the injection pump.

A quantity control lever 20, the shape of which will be seen more clearly from Figure 1, is slotted at 21 to fit over the spindle 15, and is formed at its upper end with a notch 22 engaging a transverse pin 23 carried by the member 11. Its lower end is similarly notched at 24 to fit a pin 25 carried by the crank arm 17, while a lateral extension 26 is slotted for co-operation with a pin 27 carried by the control bar Q. Thus angular movement of the manually set member 16

shifts the position of the pin **25**, and this in turn alters the setting of the control bar Q in relation to the speed-sensitive member **11**. The pin **25** serves normally as the pivot of the lever **20**, and it will be appreciated, therefore, that movement of the member **11** to the right, as for example would take place when the speed increases on account of a reduction in the load on the engine, will have the effect of moving the bar Q to the right, which reduces the quantity of fuel injected, while movement to the left has the opposite effect.

A bell crank lever having arms **28** and **29** is pivoted upon the spindle **15**, endwise movement being prevented by a sleeve **30**. The upper end of the arm **28** is notched for engagement with the pin **23**, while the outer part of the arm **29** is formed with a cam slot **31** engaging with a pin **32** carried by the control bar T, the arrangement being such that as the speed-sensitive member **11** moves to the right on account of increase in speed the control bar T is also moved to the right, thus advancing the injection with regard to the engine cycle without varying the quantity of fuel injected. The timing of the injection is in this case purely dependent upon the speed, and is unaffected by the position of the manually set member **16** i. e. is not automatically regulated for different engine loads.

By adopting the general form of governor shown in Figures 3 and 4, however, the relation between the speed of the engine and the timing of injection can be modified in accordance with the load on the engine, as well as the speed thereof, and in this particular embodiment the quantity control bar Q of the pump is connected by means of a lever **33** with the speed-sensitive member **11**, said lever **33** having as a fulcrum a pin **25** carried upon the crank arm **17** as before. Thus as the manually set member **16** is moved angularly the relationship of the control bar Q is changed with respect to the speed-sensitive member **11**. The position of the timing control bar T is in this case automatically adjusted by the position of the manually set member **16** as well as by the speed-sensitive member **11**, and for this purpose an eccentric **34** is provided upon the spindle **15** and serves as the fulcrum of a connecting lever **35** joined at its upper end to the control bar T and its lower end to the speed-sensitive member **11**.

The operation of the mechanism will be clear from Figure 3, where the action of the parts is shown by double-headed arrows, the plus sign indicating increase in speed and quantity while A and R stand for advance and retard respectively. Let it be assumed that the engine is running light at 2,000 revolutions per minute, i. e., with no load. If now the full load of which the engine is capable is applied the engine would normally stall or its speed would at any rate drop to perhaps 500 revolutions per minute. It is the function of the governor to maintain the speed at as near the original figure as possible. No governing device is perfect since there must be a slight change of speed to cause it to operate, and in the example given, assuming the governor to be a sensitive one, the speed change might be from 2,000 to 1,950 revolutions per minute. The speed can now be brought back to exactly 2,000 revolutions per minute by operation of the manually set member **16** which causes the pin **25** to move the control bar Q, through member **33**. Under these new conditions the sensitive member **11** will have returned to its original position as this position is related only to speed; the control bar Q, however, will occupy a new position as a larger quantity of fuel is being injected to enable the engine to take the full load, and the timing control member T will also occupy a new position since movement of member **16** will have altered the position of the eccentric **34**, and the timing will thus have been altered in accordance with the changed load.

As shown in Figure 3, this movement would provide additional advance in the injection but by altering the relationship of the eccentric **34** with the crank **17** such movement may be made to retard the injection. Moreover the eccentric may be so adjusted that it will advance the injection with increase of load at low engine outputs, but retard it with increase of load at high outputs and vice versa. Further any desired load-speed-timing characteristic may be obtained by the use of cams, links or levers or the like for determining the fulcrum of the lever **35** for any particular setting of the member **16**.

In practice, of course, the manually set device usually comprises the main control member of the engine, and is connected to the accelerator pedal in the case of a motor vehicle or with the speed-setting lever of a stationary or marine engine, so that for any particular position of the manually set means the speed-sensitive governor and the quantity control are caused to cooperate and produce a state of equilibrium at which the desired speed is maintained substantially constant despite variations in the load upon the engine. The extent of speed change for any particular change of load will normally depend upon the prevailing engine speed and the characteristics of the governor.

If desired, means may be incorporated whereby the extent to which the injection timing is altered for changes of speed may be readily regulated with regard to extent and phase, so that the characteristics of the governor mechanism as a whole may be made to match those of the engine very closely.

What I claim is:

1. In a fuel injection pump having independent control means for changing the timing and the quantity of fuel injected respectively, a governing mechanism comprising a speed-sensitive member the position of which varies automatically according to the actual speed of the pump, a manually set member serving as a fulcrum, a lever pivoted on said fulcrum and connected to the speed-sensitive member and also to the quantity control means, a fixed fulcrum, a timing lever pivoted upon the fixed fulcrum and connected to the speed-sensitive member, a cam slot in said timing lever, and a pin carried by the timing control means and engaging in said slot whereby the timing of the fuel injection is regulated automatically as the speed of the pump changes.

2. In a fuel injection pump having independent control means for changing the timing and the quantity of fuel injected respectively, a governing mechanism comprising a speed-sensitive member the position of which varies automatically according to the actual speed of the pump, a manually set member, a quantity lever pivoted upon said manually set member and connected with the speed-sensitive member and with the quantity control means, a transverse spindle carrying the manually set member and supporting also the quantity lever, and a timing lever mounted pivotally upon said transverse spindle and connected with the speed-sensitive member

and with the timing control means whereby the latter is regulated automatically in accordance with the actual speed of the pump.

3. In a fuel injection pump having independent control means for changing the timing and quantity of fuel injected respectively, a governing mechanism comprising a speed-sensitive member the position of which varies automatically according to the actual speed of the pump, a quantity lever connecting the speed-sensitive member with the quantity control means of the injection pump, a fulcrum mounting for said quantity control lever, a timing control lever connecting the speed-sensitive member with the timing control of the pump, a fulcrum mounting for said timing control lever, and a manually set member which changes the fulcrum of the timing lever at the same time as the fulcrum of the quantity lever whereby the timing range will be varied according to the setting of the manually set member.

4. In a fuel injection pump having independent control means for changing the timing and quantity of fuel injected respectively, a governing mechanism comprising a speed-sensitive member the position of which varies automatically according to the actual speed of the pump, an angularly movable manually set member, a plurality of eccentric pivots carried thereby, a quantity lever fitted upon one of said pivots and having its ends connected respectively with the speed-sensitive member and the quantity control means, and a timing lever fitted upon the other of said pivots with its ends connected respectively to the speed-sensitive member and the timing control means whereby alteration in the setting of the manually set member changes the speed range of the engine and also the timing range.

5. A fuel injection pump according to claim 4, in which the spindle of the manually set member carries an eccentric upon which the timing lever is mounted, and a crank pin acting as the fulcrum of the quantity lever.

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