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2,022,611

MEANS FOR REGULATING INTERNAL COMBUSTION ENGINES

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2 Sheets-Sheet 1

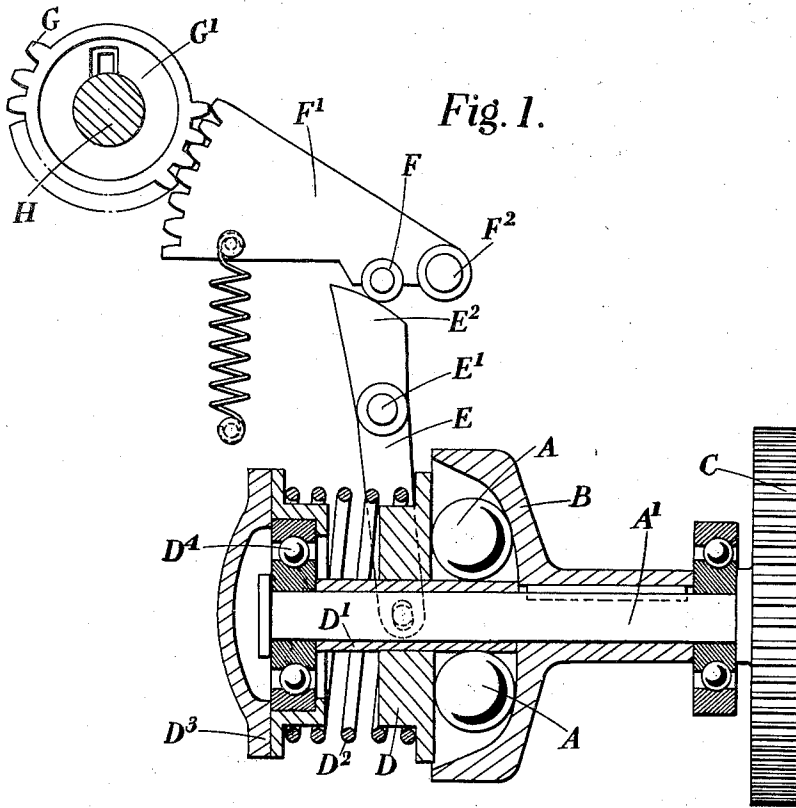
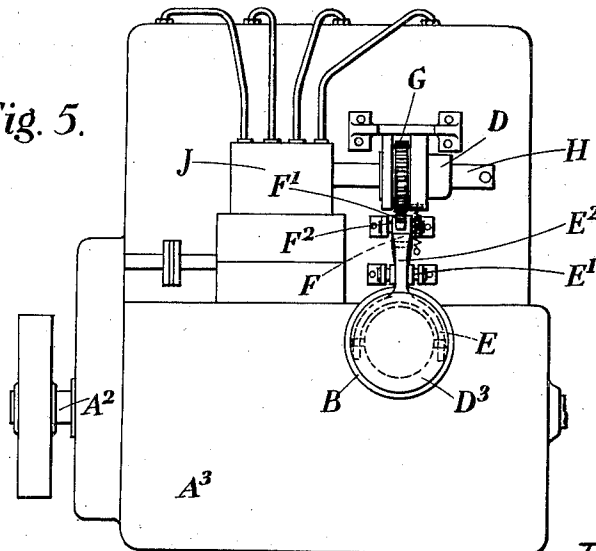


Fig. 5.



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2 Sheets-Sheet 2

Fig. 3.

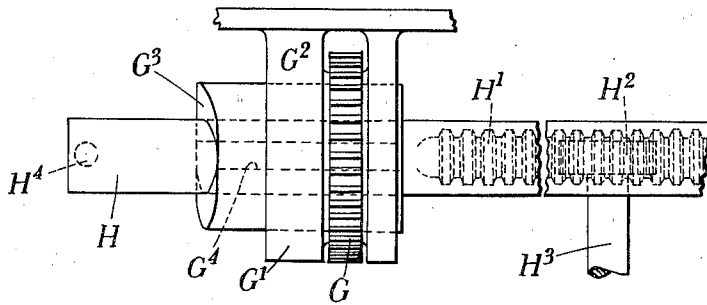


Fig. 2.

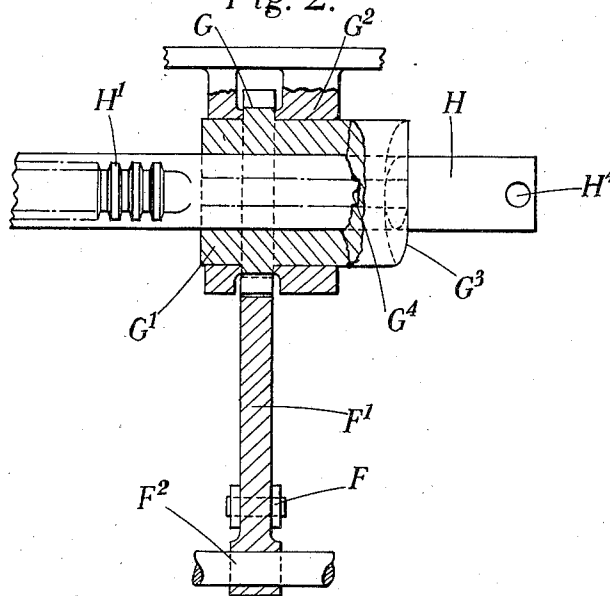
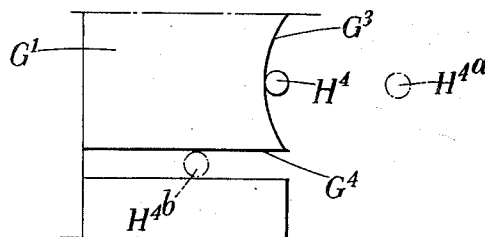


Fig. 4.



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# UNITED STATES PATENT OFFICE

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## MEANS FOR REGULATING INTERNAL COMBUSTION ENGINES

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Application November 14, 1933, Serial No. 698,001  
In Great Britain December 2, 1932

2 Claims. (Cl. 123—140)

The present invention relates to internal combustion engines which are intended to operate over a considerable range of speeds and is particularly but not exclusively applicable to engines of the liquid fuel injection compression ignition type.

The object of the invention is to reduce or prevent the risk of an engine operating under conditions of torque in relation to its speed which are undesirable.

To this end according to the present invention an internal combustion engine having a control member whereby the quantity of fuel or combustible charge delivered during each cycle can be varied is provided with a governor responsive to variations in the speed of the engine and means controlled by the governor whereby the maximum quantity of fuel or combustible charge which can be delivered is limited to an amount which is different at different engine speeds.

As stated, the invention is particularly applicable to engines of the liquid fuel injection compression ignition type and when applied to such engines the speed-responsive governor acts through suitable mechanism to limit the movement of the member for varying the quantity of fuel delivered on each delivery stroke of the fuel pump in such a manner that the maximum quantity of fuel which can be delivered at each delivery stroke is limited but is different at different engine speeds.

In certain circumstances it is desirable that an engine which has to work over a considerable range of speeds should not be capable of giving such a high maximum torque at certain speeds as at others the torque given being capable of being varied however at all speeds to suit different load conditions and it will be seen that with the present invention it is possible to ensure that the maximum torque at any speed cannot exceed that desirable for such speed without however limiting unnecessarily the maximum torque at speeds where a high maximum torque is desirable.

In a convenient arrangement according to the invention an adjustable stop member, conveniently in the form of a cam, serving to limit the movement of the fuel pump control member in a direction to increase the quantity of fuel injected is actuated directly or indirectly by the governor so as to limit the movement of the control member to an extent which depends on and varies with the engine speed whereby the maximum load carried by or the maximum torque exerted by the engine can be limited to a value which for each

speed is the maximum which is desirable at that speed.

For example in one known form of fuel injection pump the quantity of liquid fuel delivered by the pump on each delivery stroke is controlled by a longitudinally movable member and when the invention is applied to such a fuel pump the mechanism for limiting the movement of this member may comprise a face cam which is rotatable by the governor and forms an adjustable stop against which the control member or a part formed or rigidly mounted thereon comes into contact when this control member is moved in a direction to increase the quantity of fuel delivered.

Preferably the arrangement is such that the maximum quantity of fuel which can be delivered at very low speeds corresponding to starting conditions is substantially greater than that which can be delivered at higher speeds corresponding to running conditions since for starting purposes large quantities of fuel may be required. For example, where a cam constituting a stop is employed, as described above, a very steep surface or slot on the cam face may be provided to permit movement of the fuel pump control member considerably beyond its normal maximum load position when the cam occupies the starting position. Thus the injection into the cylinder of the excess fuel which is desired during starting is permitted whereas as soon as the engine is running the maximum quantity of fuel which can be delivered is reduced to the normal.

The maximum quantity of fuel which can be injected may be arranged to vary with the speed in accordance with any desired curve or law according to the characteristics of the engine to which the invention is applied and the purpose for which it is intended.

The invention is particularly but not exclusively applicable to engines of the kind in question for motor road vehicles and one form of the invention applicable to an engine having a fuel pump in which the amount of fuel delivered on each delivery stroke is controlled either by rotating the pump plunger which acts also as a spill valve or by rotating a separate spill valve by means of a longitudinally movable rack is illustrated somewhat diagrammatically by way of example in the accompanying drawings, in which

Figure 1 is a side elevation, partly in section, of the governor and the apparatus controlled thereby,

Figure 2 is a plan view, also partly in section, of part of the construction shown in Figure 1,

Figure 3 is an inverted plan view of the mechanism shown in Figure 2,

Figure 4 is a development of the cam shown in Figures 2 and 3, and

5 Figure 5 is a view, on a reduced scale, of an engine to which the apparatus shown in Figures 1, 2, 3 and 4 is applied.

In the construction illustrated the apparatus comprises a centrifugal governor driven by the engine and having weights in the form of balls A resting in radial grooves or tracks on the inner surface of a rotating cup C mounted on a shaft A<sup>1</sup> which is driven by suitable gearing from the crankshaft A<sup>2</sup> of the engine A<sup>3</sup>, for example through a gear wheel C. The balls A are held in their tracks by the pressure of the face of a disc D which is mounted so that it can slide axially on a sleeve D<sup>1</sup> surrounding the shaft A<sup>1</sup> and is urged towards the balls A by one end of a spring D<sup>2</sup> the other end of which bears on a thrust member D<sup>3</sup> connected to the shaft A<sup>1</sup> by a thrust bearing D<sup>4</sup>. The disc D is connected to one arm E of a lever pivoted at E<sup>1</sup> so that axial movement of the disc D causes the lever E to rock about the pivot E<sup>1</sup>. The other arm E<sup>2</sup> of the pivoted lever is formed as a cam on which bears a follower F in the form of a roller connected to a rack member F<sup>1</sup> pivoted at F<sup>2</sup> and acted upon by a spring F<sup>3</sup> tending to maintain the follower F always in contact with the face of the cam E<sup>2</sup>. The teeth of the rack F<sup>1</sup> mesh with a gear wheel G formed or rigidly mounted on a sleeve G<sup>1</sup> rotatably supported in a bearing G<sup>2</sup>. Passing freely through the bore of the sleeve G<sup>1</sup> is the end portion of a longitudinally movable rod H constituting the member controlling the quantity of fuel delivered by a fuel pump J, this control being effected, for example, in known manner by a rack H<sup>1</sup> formed on the member H engaging a gear wheel H<sup>2</sup> on the end of a member H<sup>3</sup> which constitutes or is connected to the spill valve of the fuel pump, this pump being constructed in known manner so that rotation of the spill valve varies the quantity of fuel delivered.

45 Formed on one end of the sleeve G<sup>1</sup> is a cam surface G<sup>3</sup> which is adapted to cooperate with a pin H<sup>4</sup> on the rod H so as to limit the movement of this rod in a direction to increase the quantity of fuel delivered by the fuel pump. The face cam G<sup>3</sup> has the general form shown in development in Figure 4 and is provided with a groove which at one rotary position of the sleeve G<sup>1</sup> receives the pin H<sup>4</sup> and thereby permits movement of the rod H to increase the quantity of fuel delivered by the pump beyond the normal maximum.

It will be seen that with the arrangement described above movement of the disc D as a result of variations in the speed of the engine acts through the lever E, E<sup>2</sup> to produce movement of the rack F<sup>1</sup> and hence to cause rotary movement of the sleeve G<sup>1</sup>. Thus at different speeds different parts of the cam face G<sup>3</sup> lie opposite the pin H<sup>4</sup> so that the movement of the rod H to increase the quantity of fuel injected is limited to an extent which varies with variations in the speed of the engine.

The form of the cam face may vary but in the arrangement shown more particularly in Figure 4 the groove indicated by the reference letter G<sup>4</sup> is adapted to lie opposite the pin when the engine is at rest or is rotating at very slow speeds corresponding to starting speeds so that for this position of the sleeve G<sup>1</sup> the member H can be moved to increase the quantity of fuel delivered by the pump considerably above the maximum

normal quantity as is sometimes required for starting purposes. During normal running of the engine, however, the part of the cam face indicated by the letter G<sup>3</sup> comes opposite to the pin so that the movement of the rod H to increase the quantity of fuel delivered is limited to an extent which is determined by the speed of the engine. Thus, as the speed increases from low speeds to mean speeds, the maximum movement of the rod to increase the quantity of fuel increases, while as the speed increases still further from mean speeds towards the maximum speed, the maximum movement of the rod H to increase the quantity of fuel is again reduced. As an example in Figure 4 the maximum movement of the rod H at the mean speed of the engine from its maximum injection to its minimum injection position is indicated by the two positions for the pin H<sup>4</sup> indicated in Figure 4 respectively by the reference letters H<sup>4</sup> and H<sup>4a</sup> while the position which the pin may occupy at the very slow starting speed is indicated by the reference letter H<sup>4b</sup>.

It is to be understood that the form of the cam shown is only given by way of example and that the form may vary widely according to requirements. For example in one modified arrangement the cam may be so formed that the maximum quantity of fuel which can be delivered is greatest when the engine speed is at a maximum and is gradually reduced as the engine speed falls.

It will be understood that the governor conveniently functions throughout the whole speed range of the engine.

It is further to be understood that the governor, in addition to controlling the mechanism according to the present invention, may control mechanism for varying the timing of fuel injection or ignition in accordance with variations in speed as described in the present applicant's co-pending United States patent application No. 698,000, filed November 14, 1933.

What I claim as my invention and desire to secure by Letters Patent is:—

1. An internal combustion engine of the variable speed liquid fuel injection compression ignition type including in combination a fuel pump, a control member whereby the quantity of fuel delivered on each delivery stroke can be varied, a governor driven by the engine and responsive to variations in the speed of the engine, and an adjustable stop actuated by the governor and serving to limit the movement of the control member in a direction to increase the quantity of fuel delivered, this stop member having a cam surface thereon whereby the point in the movement of the control member at which the stop member prevents further movement thereof is determined by and varies with variations in the engine speed, the cam surface being so formed that at low speeds corresponding to starting conditions the control member can be moved into a position in which a quantity of fuel is delivered substantially greater than the maximum which is permitted at the higher speeds corresponding to running conditions.

2. For use with an internal combustion engine of the variable speed liquid fuel injection compression ignition type, a fuel pump including in combination a control member for varying the quantity of fuel delivered, an adjustable stop member adapted to be actuated by a governor and serving to limit the movement of the control member in a direction to increase the quantity of fuel delivered, this stop member having a cam

5 surface thereon whereby the point in the movement of the control member at which the stop member prevents further movement thereof is determined by and varies with movement of the stop, the formation of the cam surface being such that at the position the stop is intended to occupy at low speeds corresponding to starting

conditions the control member can be moved into a position in which a quantity of fuel is delivered substantially greater than the maximum which is permitted at higher speeds corresponding to running conditions.

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