

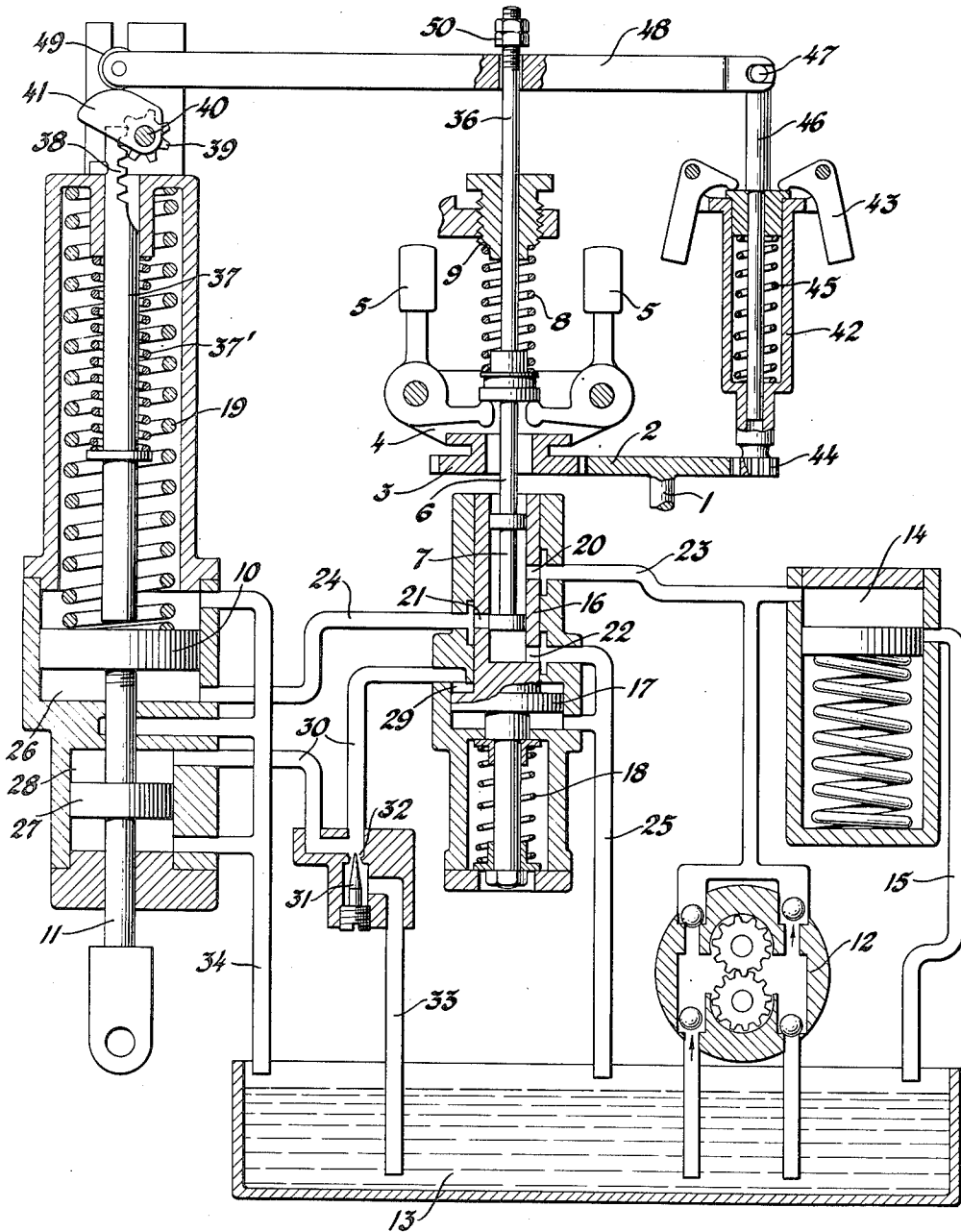
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K. O. KEEL ET AL

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LOAD LIMITING GOVERNOR

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Inventors
Knut Olav Keel &
Charles Harold Eike

By *Blackman, Spencer & Flint*
Attorneys

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LOAD LIMITING GOVERNOR

Knut Olav Keel and Charles Harold Fike, Cleveland, Ohio, assignors to General Motors Corporation, Detroit, Mich., a corporation of Delaware

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This invention relates to a controlling device for internal combustion engines.

More particularly it relates to a load limiting governor for an internal combustion engine.

Specifically it relates to means for limiting the maximum brake mean effective pressure (B. M. E. P.) which can be developed in the engine cylinder or cylinders of a Diesel engine by varying the maximum quantity of fuel which can be supplied thereto, in accordance with the speed of the engine.

Still more specifically it relates to a device of the foregoing character, associated with conventional isochronous governing means for maintaining a constant engine speed with varying loads.

The volumetric and thermal efficiencies, fuel economy and heat stresses are factors varying with the speed of the engine, and for reasons such as these, as well as for safety, it is very desirable to be able to control the maximum amount of fuel which can be supplied to the engine, and hence the maximum B. M. E. P. and load which can be borne by the engine, at any given speed.

According to the invention, the maximum amount of fuel which can be supplied to the engine at a given speed is limited by means whose position is responsive to both the amount of fuel actually being supplied to the engine, and the engine speed.

The drawing shows the invention associated with an isochronous hydraulic relay governor of well known principle, in somewhat schematic form.

Describing first the isochronous hydraulic relay governor to which the invention has been applied:

As illustrated, 1 is a shaft driven by the engine, and provided with a gear wheel 2, through which the gear 3 on the engine governor head 4, having flyweights 5, is driven.

As the engine speed increases, the flyweights 5 move outwards under the influence of centrifugal force and lift the stem 6 of a pilot valve plunger 7 upwards against the resistance of a spring 8, the pressure of which can be varied by adjustment of the abutment 9 therefor, to set the engine speed.

The pilot valve plunger 7 controls the position of a servo-motor piston 10 which has a stem 11 to which the fuel control mechanism (not shown) is mechanically connected. A spring 19 resiliently urges the piston 10 downwards along with the stem 11, in a direction to reduce the fuel supply to the engine.

12 is a gear wheel pump which can be driven in either direction, to deliver oil from a sump 13

to a spring loaded pressure accumulator 14, from which there is a relief pipe return line 15 to the sump 13.

The pilot valve plunger 7 is a pressure balanced valve, and works within a pilot valve bushing 16, the lower end of which constitutes a receiving compensating plunger 17 through which the pilot valve bushing 16 may be moved upwards or downwards, against the centering action of a compensating spring 18.

Three ports 20, 21 and 22, in the pilot valve bushing, are at all times in communication with pipe lines 23, 24 and 25 connected respectively to the pressure accumulator 14, to the space 26 on the underside of the servo piston 10, and to the sump 13.

The pilot valve 7 and the bushing 16 are such that by their relative movement, the pipe line 24 may be closed off, or connected either to the pipe 23 or to the pipe 25.

On the stem 11 of the servo piston 10 is an actuating compensating piston 27, the space 28 above which, is connected with the space 29 above the compensating plunger 17, by a pipe 30.

In the pipe 30 is a compensating needle valve 31, controlling a port 32 connecting the pipe 30 with a pipe 33 from the sump 13.

A pipe 34 returns leakage past the pistons 10 and 27, back to the sump 13.

The operation of the parts of the hydraulic relay governor thus far described is as follows,—it being assumed that in the position of the parts as shown, the engine is running at normal speed, and carrying approximately half load.

The flyweights 5, the pilot valve plunger 7 and the pilot valve bushing 16 are centered, and the port 21 in the pilot valve bushing is exactly covered by the lower disc of the pilot valve plunger. The power servo piston 10 is stationary at a position corresponding to about half load on the engine.

If now the load on the engine is increased, the speed decreases—the flyweights 5 move inward—the speed adjusting spring 8 pushes the pilot valve plunger 7 downwards, uncovering the pilot valve bushing port 21—pressure oil from the accumulator 14 passes through the valve 7 into the space 26 and pushes the power piston 10 upwards against the downward pressure of the spring 19, increasing the fuel supply to the engine. The upward movement of the actuating compensating piston 27 along with the power piston 10 creates a pressure in the space 28 which forces the pilot valve bushing 16 downwards until the port 21 is again covered by the lower pilot valve plunger

disc—the power piston 10 stops at the exact position corresponding to the fuel required to sustain the increased load on the engine—the speed returns to normal, the flyweights 5 move outwards back to their original position, lifting the pilot valve plunger 7 upwards to its original centered position—the compensating spring 18 recenters the compensating receiving plunger 17 and pilot valve bushing 16 in exact unison with return of the speed to normal, by forcing oil out of space 29 through the compensating needle valve port 32 to the sump 13—the port 21 in the pilot valve bushing 16 is kept covered—the power piston 10 remains stationary,—and the completion of the cycle finds the flyweights 5, the pilot valve plunger 7, and the pilot valve bushing 16, centered in their original position with the power piston 10 in a new position, to hold the fuel control mechanism in a position providing the engine with an increased amount of fuel to carry the increased load at the same speed.

The cycle of operation for a decrease in load is just the reverse of that described for an increase in load. As the pilot valve plunger 7 is moved upward, uncovering the pilot valve bushing port 21, the spring 19 is able to push the power piston 10 downwards to reduce the amount of fuel supplied to the engine, and forces oil from the chamber 26 through the port 22 into the pipe 25 and thence to the sump 13. At the same time a vacuum is formed in the space 28, which draws the receiving compensating plunger 17 upwards against the centering action of the compensating spring 18. Simultaneously oil is being drawn from the sump 13 into the space 28 through the compensating needle valve port 32, to relieve the vacuum and allow the compensating spring 18 to recenter the receiving compensating plunger 17, as the governor parts return to their original position with the power piston 10 in a new position, to hold the fuel control mechanism in a position providing the engine with a lessened amount of fuel, sufficient to carry the lessened load at the same speed.

The passage through the needle valve port 32 is very small, and consequently the amount of oil moving therethrough does not have any great effect on the conditions in the spaces 28 and 29 while the power piston 10 is in motion, but has considerable effect immediately after the power piston 10 stops moving. Thus it is that the pilot valve bushing 16, at all times follows the pilot valve plunger 7, with sufficient lag to enable the necessary change in the position of the power piston 10 to be effected, but in exact unison with the pilot valve plunger as the speed returns to normal.

The engine will carry varying loads at a regulatable constant speed, and the position of the pilot valve plunger and the governor weights remains the same for that speed, while the position of the power servo piston and hence the quantity of fuel supplied to the engine is controlled in accordance with the actual load to be borne by the engine at that speed.

According to the invention an engine having an isochronous governor of the foregoing type, such that the governor returns to its normal position after effecting a change in the setting of the position of the fuel supply control mechanism to carry a changed load, is provided with load limiting means as follows.

An upward extension 36 is provided for the stem 6 of the pilot valve plunger.

A rack rod 37 is mounted above the power pis-

ton 10 to partake of the upper range of movement of the power piston. The rack rod is resiliently urged downwards by a spring 37', and is provided with teeth 38 engaging a pinion 39 on a shaft 40 to which a cam 41 is attached.

A speed responsive device 42, having flyweights 43, is conveniently driven from the gear wheel 2 on the engine driven shaft 1, by a pinion 44.

As shown, the speed responsive device 42 is driven at a greater speed than the engine governor head 4, and the flyweights 43 are so disposed, that as the engine speed increases, there is a downward thrust against the pressure of a spring 45 resiliently urging a rod 46 upwards. The arrangement is such that as the speed falls, the flyweights 43 permit the rod 46 to be lifted upwards by the pressure of the spring 45. The extent of this upward movement of the rod 46 depends of course on the extent to which the engine speed falls.

It will be noted that the spring 8 tends to move the pilot valve plunger 7 with its stem 6 and extension 36 downwards, whereas the spring 45 tends to move the rod 46 upwards, and that these tendencies are overcome by the governors 4 and 42 respectively as the engine speed rises.

Fulcrumed on a pin 47 at the upper end of the movable rod 46, is one end of a floating lever 48, having, at its other end, a roller 49 constituting a cam follower for the cam 41.

The cam 41, the extension rod 36 of the pilot valve plunger, and the rod 46, are conveniently arranged in the same plane, and the extension 36 is provided with nuts 50, through which it may be lifted by the lever 48, against the pressure of spring 8, upon sufficient upward movement of either or both ends of the lever 48.

It will be appreciated that the position of one end of the floating lever 48 is dependent through the cam 41 on the amount of fuel being supplied to the engine—when this exceeds a certain minimum, while the position of the other end of the lever is dependent on the engine speed, through the governor 43.

The springs 8 and 45 are such, that the moment of the force of spring 45, when this is permitted to act on the lever 48 about its fulcrum 49, is greater than the opposite moment of the force of spring 8 about the same fulcrum, when this spring is permitted to act on the lever 48.

The function of the cam 41 is to change the ratio of movement of the end 49 of lever 48 in relation to the movement of the piston 10 in its upper range of movement corresponding to the larger amounts of fuel supply, as may be required in order that the lever 48 may be just in contact with the nuts 50,—at any position of the end 47 of lever 48 corresponding to a given engine speed,—when the position of piston 10 and hence the quantity of fuel being supplied, is the maximum desired for that speed. Whenever the load on the engine and hence the quantity of fuel being supplied is less than the desired maximum for the given engine speed there will be clearance between the lever 48 and the nuts 50 which will permit of downward movement of extension 36 of the stem 6 of the pilot valve plunger 7 to increase the quantity of fuel supplied.

It will be obvious that by suitably shaping the cam contour, any desired limit on the maximum B. M. E. P. for a given speed, may be obtained.

Assuming now that the engine is running at the speed set through the spring 8 by adjustment of the abutment 9 and with the maximum permissible B. M. E. P. for that speed, and that the

nuts 50 on the extension 36 of the pilot valve plunger have been adjusted so that they are just in contact with the lever 48, then, if more load is put on the engine, its speed falls, the governor weights 5 move inwards, and the spring 8 tends to move the pilot valve plunger with its extension 36 downwards, to increase the fuel supply.

Downward movement of the pilot valve plunger is prevented however by the lever 48, while at the same time, the weights 43 of the governor 42 move inwards, permitting the spring 45 to raise the lever 48 upwards about its fulcrum 49. In moving the lever 48 upwards, the spring 45 overcomes the spring 8, and the pilot valve plunger 7 is raised through its extension 36, actually reducing the amount of fuel supplied to the engine, when otherwise the governor 4 would increase the amount of fuel supplied.

It will be seen, that a structure has been provided, in which a load limiting governor overcomes the engine governor and reduces the amount of fuel supplied, whenever the B. M. E. P. for a given speed is exceeded; that until the engine load is less than the permissible maximum for the lower speed the amount of fuel cannot be increased again; and furthermore that if the load is greater than the limit set for any lower speed, the supply of fuel and the B. M. E. P. developed by the engine will automatically be reduced to zero.

We claim:

1. In combination with isochronous governing means for an internal combustion engine to maintain a constant normal speed with varying loads, said governing means including a speed responsive controlling member operative to control and reposition a fuel quantity control member on any change in speed due to changes in load, said speed responsive controlling member having a normal speed position which remains constant irrespective of the load, load limiting means to prevent movement of the fuel supply controlling member in a direction to increase the quantity of fuel supplied beyond a desired maximum for any given speed, said means comprising a stop member whose position is controlled differentially by two means, one of which is responsive to the engine speed and the other of which is responsive to the position of the fuel quantity control member.

2. The combination according to claim 1, in which the means responsive to the engine speed and the position of the fuel quantity control member, to control the position of the stop mem-

ber, includes a cam, having a contour such that when the fuel quantity control member is in a position corresponding to the desired maximum quantity of fuel for any speed at which the engine may be running, said stop member is in a position to prevent any movement of the speed responsive controlling member from its normal position in a direction to increase the quantity of fuel supplied.

3. The combination according to claim 1, in which the means responsive to the engine speed for controlling the position of the stop member is operative to move the speed responsive controlling member in a direction to reduce the quantity of fuel supplied to the engine, as the speed thereof falls due to an increase in load beyond that which can be supported by the desired maximum quantity of fuel for a given speed.

4. The combination according to claim 1, in which the speed responsive controlling member is a pilot valve controlling hydraulic power servo means for positioning the fuel quantity control member.

5. The combination according to claim 1, in which the stop member is a floating lever, the position of which is differentially controlled by a centrifugal speed responsive device driven by the engine and separate from the speed responsive controlling member and a cam whose position is dependent on the position of the power servo actuated fuel quantity control member.

6. On an internal combustion engine, in combination with isochronous power relay governing means capable of being set to maintain the engine at any desired constant normal speed with varying loads, said governing means including a speed responsive controlling member operative to control and reposition a power servo actuated fuel quantity control member on any change in speed due to changes in load, and said speed responsive controlling member having a normal speed position which remains constant irrespective of the speed setting or the load at that speed, a stop member to prevent the movement of the speed responsive controlling member in a direction to increase the quantity of fuel supplied beyond a desired maximum for a given speed, the position of said stop member being differentially controlled by a speed responsive device and a cam whose position is dependent on the position of the power servo actuated fuel quantity control member.

KNUT OLAV KEEL.
CHARLES HAROLD FIKE.