April 24, 1945. H. G. CAMNER 2,374,411

MEANS FOR CONTROLLING THE FUEL SUPPLY IN TWO-STROKE INTERNAL-COMBUSTION ENGINES

Filed Nov. 7, 1939 3 Sheets-Sheet 1

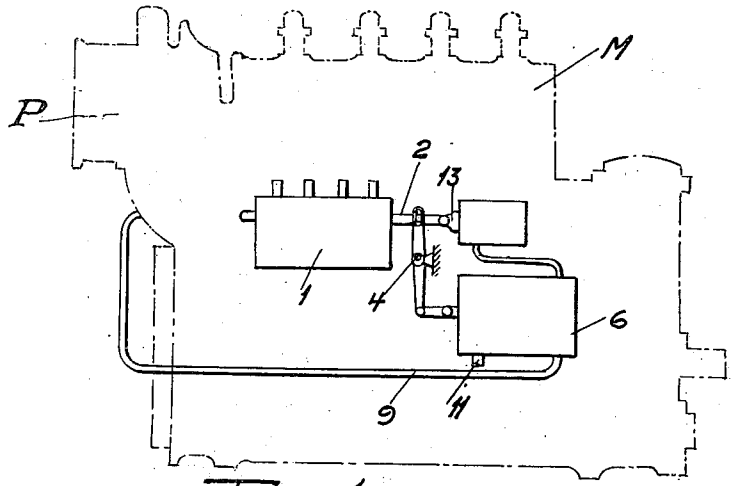


Fig. 1.

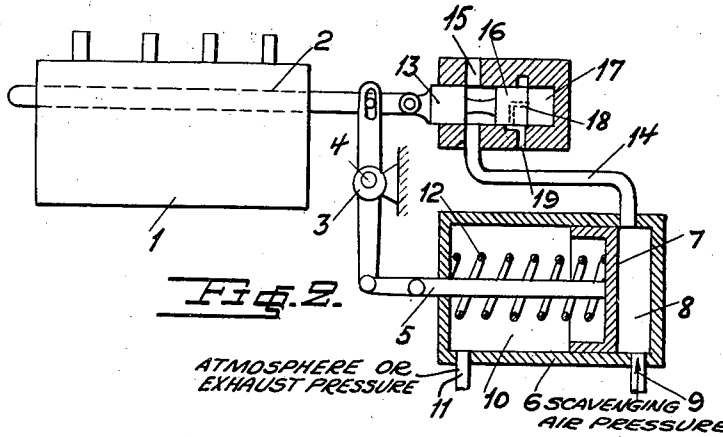


Fig. 2.

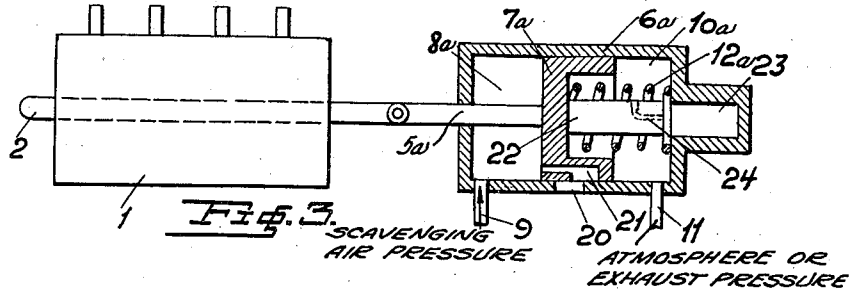


Fig. 3.

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Filed Nov. 7, 1939 3 Sheets-Sheet 2

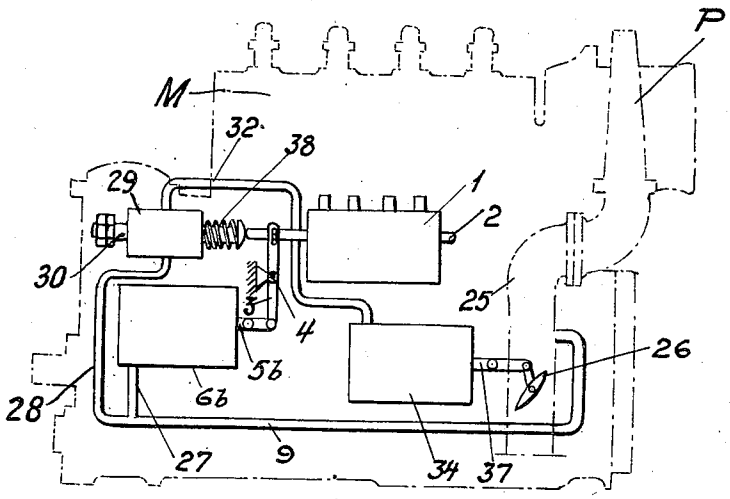


Fig. 4.

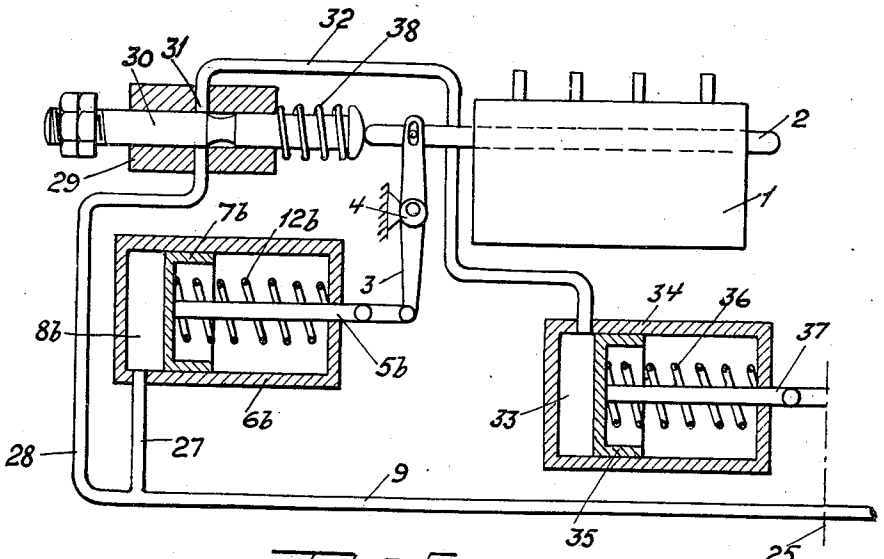


Fig. 5.

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Filed Nov. 7, 1939 3 Sheets-Sheet 3

Fig. 6.

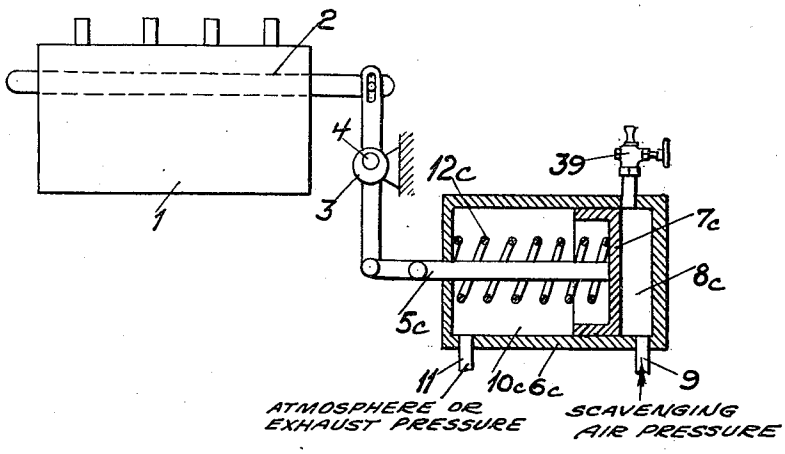
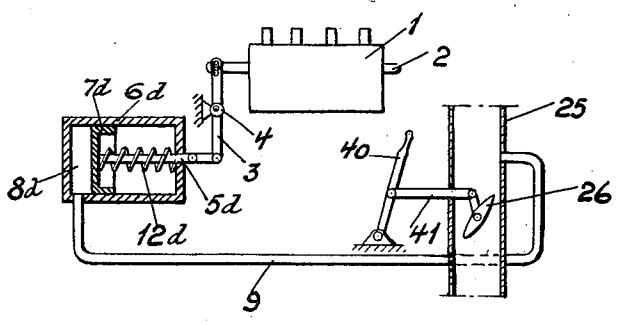


Fig. 7.



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MEANS FOR CONTROLLING THE FUEL SUPPLY IN TWO-STROKE INTERNAL-COMBUSTION ENGINES

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Application November 7, 1939, Serial No. 303,221
In Sweden February 18, 1938

7 Claims. (Cl. 123—140)

The present invention relates to two-stroke internal combustion engines having a servo-motor controlling the fuel injecting mechanism of the engine and acted on by the scavenging air to control the fuel supply.

The invention has for its object to eliminate that part of the speed difference which is related to and may be said to be represented by the change of the scavenging air pressure at varying torques of the engine and comprises essentially means for controlling the pressure in the servo-motor with relation to variations of the torque of the engine.

The annexed drawings illustrate diagrammatically some embodiments of a control device according to the invention. Fig. 1 is a side view showing the outlines of an engine having a control device according to one embodiment applied thereto. Fig. 2 is a detail view on an enlarged scale of the control device according to Fig. 1. Fig. 3 is a similar view of a somewhat modified control device. Fig. 4 is a side view showing the outlines of an engine having a control device according to a further modification applied thereto. Fig. 5 is a detail view on an enlarged scale of the control device according to Fig. 4. Figs. 6 and 7 show two embodiments of manually operable control devices.

Referring first to Figs. 1 and 2, M designates the engine proper and P the scavenging air pump thereof driven by the engine in any ordinary convenient manner. The fuel injecting mechanism, which is assumed to be of any known construction and for such reason need not be particularly described, is denoted by 1 and its control member by 2. Joined to the said control member is the one arm of a double-armed lever 3, the stationary fulcrum of which comprises an adjustable eccentric 4, and the other arm of which is pivotally connected to the piston rod 5 of a servo-motor comprising a cylinder 6 and a piston 7 movable therein. The space 8 within the cylinder at the right side of the piston 7, as viewed in Fig. 2, communicates through a pipe 9 with the scavenging air receiver of the engine or with any part of the scavenging air conduit, while the chamber 10 at the opposite side of the piston may communicate through a pipe 11 with the exhaust pipe of the engine at a place located between the engine and a throttling member in said pipe. The piston 7 is also acted on by a spring 12 counter-acting the pressure in the cylinder chamber 8.

Connected to the control member 2 of the fuel injecting mechanism is a piston-slide valve 13, the interior of the housing of which communicates with the cylinder chamber 8 through a pipe 14 and which is adapted to control an outlet 15 in the housing for the scavenging air in order to change the pressure in the said chamber 8, as will be described more particularly below. The piston valve 13 is connected to a damping piston 16 moving in a bore 17 in the valve housing and fitting either tightly in the said bore and having a small diameter channel 18 communicating with an outlet 19 in the valve housing, as shown, or having a certain clearance in the bore, in which case the channel 18 and the outlet 19 can be dispensed with.

Displacement of the control member 2 in the direction from the right towards the left in Figs. 1 and 2 is assumed to increase the fuel supply to the engine, whereas displacement of the said member in the opposite direction decreases the supply.

Based on the above assumption, the arrangement operates in the following manner.

If the engine be set for a certain speed and the torque of the engine decreases, the speed will increase, whereby the scavenging air pressure rises and the piston 7 moves the control member 2 towards the right, to thereby decrease the fuel supply, until said supply corresponds to the decreased torque. At an increased torque the speed of the engine and thus also the scavenging air pressure decreases, whereby the piston 7 under the action of the spring 12 moves the control member 2 to the left to thus increase the fuel supply, until an equilibrium occurs between the fuel supply and the torque.

By adjusting the eccentric 4 or by altering the initial tension of the spring 12, the speed of the engine can be altered.

However, it is characteristic of the operation of engines of the kind under consideration that the scavenging air pressure increases and decreases with increase and decrease, respectively, of torque even if the speed remains constant, due to the increase of exhaust back pressure with increase in charge needed to produce the same speed with increased torque.

Thus, it is not possible by the servo-motor alone to obtain a sufficiently accurate control under all conditions.

As a matter of fact, the speed difference at full load and in idling will be relatively great.

If, for instance, the engine runs at full load at a certain speed and the torque is then decreased to zero, the speed of the engine must increase to such an extent that the scavenging air

pressure obtains the same value as at full torque, and, besides, a further increase in speed must occur in order to raise the scavenging air pressure sufficiently to move the piston 7 to the idling position.

That part of the speed difference, which is related to the variation of the scavenging pressure at varying torques, is unavoidable in the arrangement with the servo-motor only. The second part of the speed difference is defined by the dimension of the spring 12.

In order to eliminate that part of the speed difference, which is related to the variation of the scavending air pressure at variations of the torque, or in other words to keep the speed constant independent of such variations, the piston-slide valve 13 is provided. The said valve is so adjusted as to be more or less open, when the engine runs for instance at full torque. By the discharge of the air through the outlet 15 in the valve housing a lower pressure exists in the cylinder chamber 8 than in the scavenging air receiver or conduit proper, since a certain resistance, which restricts the air supply from the receiver to the chamber 8, occurs in the pipe 9 leading from the receiver. If desired, any throttling means may be provided in the pipe 9 to increase the resistance. At a decrease of the torque, for instance to zero, the piston valve 13 will move towards its closed position, whereby the air discharge will decrease or wholly cease.

Then, the pressure in the cylinder chamber 8 will approach or be equal to the pressure in the scavenging air receiver. From the above it is apparent that it is rendered possible, by suitably dimensioning the piston-slide valve 13 and the cross-sectional area of the pipe 9 between the scavenging air receiver and the cylinder chamber 8, to maintain the same or even a lower pressure in the said cylinder chamber under conditions of large torque than under conditions of small torque, in spite of the pressure in the receiver being higher at the larger torque than at the smaller one.

As mentioned, in order to change the speed of the engine the initial tension of the spring 12 can be altered. In variable speed engines it is suitable to have the spring 12 actuate the piston 7 or the control member 2 from the outside, whereby the spring tension can be altered by means of a manually operated lever or the like.

In order to prevent oscillations, particularly in idling and at low loads, the damping piston 16 moving in the bore 17 is used, whereby either the channel 18 or, if such channel is not provided, the clearance between the piston and the bore preferably is so chosen that the air in the bore will check quick control movements only.

The embodiment according to Fig. 3 differs from the one according to Figs. 1 and 2 in that the piston rod 5^a of the servo-motor is connected directly to the control member 2 of the fuel injecting mechanism 1, necessitating a reversed location of the cylinder chambers 8^a and 10^a. Besides, the separate control valve 13 according to Figs. 1 and 2 is replaced by an arrangement in the servo-motor proper. The cylinder wall is provided wtih a port 20, controlled by the servo-motor piston 7^a, in which a channel 21 is made, which communicates with the cylinder chamber 8^a and the port 20 in certain positions.

At small torques or in idling the piston 7^a covers the port 20 substantially or wholly, in which case the pressure in the cylinder chamber 8^a will be substantially or wholly equal to the pressure in the scavenging air receiver. When the torque increases, the piston 7^a will move towards the left, and the port 20 is uncovered more and more and will be wholly opened, for instance at the maximum torque, which results in a decrease of pressure in the cylinder chamber 8^a in accordance with the action of the piston-slide valve 13 according to Figs. 1 and 2.

In order to prevent oscillations a damping piston 22 is connected directly to the servo-motor piston 7^a, said damping piston having either a certain clearance in a cylinder 23 at the outer end of the servo-motor cylinder 6^a or fitting tightly in said cylinder 23 and being provided with a small channel 24, as shown, which forms a communication between the damping cylinder 23 and the cylinder chamber 10 in the servo-motor.

Otherwise, the action of the device according to Fig. 3 is the same as that one described above in connection with the embodiment according to Figs. 1 and 2.

The damping means shown also can be located at any other place of the control device than shown, for instance at the free end of the control member 2.

According to the embodiments above described, their action is based on the principle that the full load scavenging air pressure is lowered towards, or lower than, the idling pressure.

However, in order to eliminate the speed difference as above described it is also possible to increase the idling pressure towards the full load pressure.

An embodiment having such an action is shown in Figs. 4 and 5, in which similar parts are indicated by the same reference numerals as in Figs. 1 and 2, but with the suffix "b".

According to Figs. 4 and 5 the pipe 9 communicates with the scavenging air conduit 25 leading from the pump P at a place between the pump and a butterfly valve 26 in said conduit. Further, the said pipe 9 has two branches 27 and 28, the branch 27 of which leads to the cylinder chamber 8^b of the servo-motor, which operates the control member 2 of the fuel injecting mechanism 1, as described above, whereas the branch 28 leads to a valve housing 29 having a piston-slide valve 30 movable therein, which controls an outlet 31, from which leads a pipe 32 to the working chamber 33 of a second servo-motor comprising a cylinder 34 and a piston 35 movable therein. The piston 35 is acted on by a spring 36, which counter-acts the pressure in the chamber 33 and the piston rod 37 of which is connected to and operates the valve 26 in the scavenging air conduit 25, as seen in Fig. 4. The piston-slide valve 30 abuts against the end of the control member 2 and is operated together with said member, the contact between the valve and the control member being maintained by the aid of a spring 38, which also serves to move the valve 30 to the position in which it closes the outlet 31.

In the above embodiment a displacement of the control member 2 in the direction from the left towards the right is assumed to increase the fuel supply, whereas a displacement in the opposite direction decreases the fuel supply.

Now, if the engine is set for a certain speed and the torque of the engine tends to decrease, the speed of the engine will increase, whereby the scavenging air pressure also increases. As a consequence, the pressure in the cylinder chamber 8^b of the servo-motor 6^b, 7^b increases, and the piston 7^b will be moved towards the right causing a displacement of the control member 2 towards the

left, so as to decrease the fuel supply, until an equilibrium is obtained between the pressure in the chamber 8^b and the pressure of the spring 12^b.

Now, in order to eliminate that part of the speed difference, which is related to the change of the scavenging air pressure at variations of the torque the valve 29, 30 and the servo-motor 34, 35 are provided.

When moving the control member 2 towards the left, as mentioned, the piston-slide valve 30 will be moved in the same direction. As a consequence, the outlet 31 will be opened more or less, and the scavenging air supplied through the pipe 9 and its branch 28 passes through the pipe 32 to the cylinder chamber 33 of the servo-motor 34, 35. The piston 35 is moved towards the right and causes the valve 26 to close more or less. As a consequence, the pressure in the conduit 25, at a place between the air pump and the flap valve will increase correspondingly and, thus, also the pressure in the cylinder chamber 8^b of the servo-motor 6^b, 7^b, so that the piston 7 will be further moved towards the right causing a further decrease in the fuel supply and thus a reduction in speed, which will now correspond substantially or wholly to the initial speed at the greater torque.

If contrary to the above, the engine is set for a certain speed and the torque of the engine tends to increase, the action of the device described will be reversed causing an increased fuel supply, first by the servo-motor 6^b, 7^b and second by the servo-motor 34, 35, the tension of the springs 12^b and 36, respectively, now overcoming the decreasing scavenging air pressure.

The embodiment according to Fig. 6 differs from that one shown in Figs. 1 and 2 only in that the automatic valve device 16 is replaced by a manually operated outlet valve 39, by which the pressure in the servo-motor chamber 8^c can be controlled. Thus, at a decreasing torque the valve 39 has to be moved towards its closing position and vice versa.

Similarly, the embodiment according to Fig. 7 differs from that one according to Figs. 4 and 5 only in that the automatic valve 29, 30 and the servo-motor 34, 35 controlled thereby is replaced by a manually operated lever 40 connected to the valve 26 by a linkage 41. Thus, at a decreasing torque the lever 40 has to be swung towards the right to more or less close the valve 26 and vice versa.

According to the above described embodiments the control devices have been shown in combination with a fuel injecting mechanism, wherein the fuel quantity supplied to the engine is varied by displacement of the control member 2. It is evident that the invention is applicable also to a fuel injecting pump, wherein the controlling of the fuel quantity is effected by means of an eccentric device or by changing the stroke of the pump plunger or the like. Besides, the motion transmitting means between the servo-motor and the control member of the fuel injecting mechanism may be of any type. This is true also to the servo-motor, which may work with a membrane or the like instead of with a piston.

What I claim is:

1. In a two-stroke internal combustion engine, a scavenging air pump driven by the engine, fuel injector mechanism including a control member, a servo-motor including an element movable in response to fluid pressure changes, means for subjecting said element to air supplied by said pump and varying in pressure with variations in scavenging air pressure, resilient means resisting the movement of said element, means connecting said element to said control member, and valve means shiftable in response to movement of said element for modifying the pressure of the air acting on said element sufficiently to compensate for the variation of scavenging air pressure resulting from variations in the torque developed by said engine.

2. In a two-stroke internal combustion engine, a scavenging air pump driven by the engine, fuel injector mechanism including a control member, a servo-member including an element movable in response to fluid pressure changes, means for subjecting said element to air supplied by said pump and varying in pressure with variations in scavenging air pressure, resilient means resisting the movement of said element, means connecting said element to said control member, said servo-motor having a passage for bleeding air to the atmosphere to thereby reduce the air pressure to which said element is subjected, and valve means shiftable in response to movement of said element for varying flow through said bleed passage sufficiently to compensate for the variations of scavenging air pressure resulting from variations in the torque developed by said engine.

3. In a two-stroke internal combustion engine, a scavenging air pump driven by the engine, fuel injector mechanism including a control member, a servo-motor including a pressure chamber, a movable element acted on by the pressure of air in said chamber and resilient means resisting movement of said element caused by increased pressure in said chamber, conduit means for connecting said chamber with said air pump, means connecting said element to said control member, said servo-motor having a passage for bleeding air from said chamber to the atmosphere to thereby reduce the air pressure acting on said element, and valve means shiftable in response to movement of said element for varying flow through said bleed passage sufficiently to compensate for the variations of scavenging air pressure resulting from variations in the torque developed by said engine.

4. In a two-stroke internal combustion engine, a scavenging air pump driven by the engine, fuel injector mechanism including a control member, a servo-motor including a pressure chamber, a movable element acted on by the pressure of air in said chamber and resilient means resisting movement of said element caused by increased pressure in said chamber, conduit means for connecting said chamber with said air pump, means connecting said element to said control member, and valve means shiftable in response to movement of said element for modifying the pressure of the air in said chamber sufficiently to compensate for the variations of scavenging air pressure resulting from variations in the torque developed by said engine.

5. In a two-stroke internal combustion engine, a scavenging air pump driven by the engine, fuel injection mechanism including a control member, a servo-motor including a cylinder and a piston movable in said cylinder, resilient means resisting the movement of said piston, conduit means for connecting said cylinder with said air pump, means connecting said piston with said control member, and valve means including a port in the wall of said cylinder in communication with the atmosphere and controlled by movement of said piston for modifying the pressure of the air acting on said piston sufficiently to compen-

sate for the variation of scavenging air pressure resulting from variations in the torque developed by said engine.

6. In a two-stroke internal combustion engine, a scavenging air pump driven by the engine, fuel injector mechanism including a control member, a servo-motor including an element movable in response to fluid pressure changes, means for subjecting said element to air supplied by said pump and varying in pressure with variations in scavenging air pressure, resilient means resisting movement of said element, means connecting said element to said control member, valve means shiftable in response to movement of said element for modifying the pressure of the air acting on said element sufficiently to compensate for the variations of scavenging air pressure resulting from variations in the torque developed by said engine, and damping means for preventing oscillation of said control member.

7. In a two-stroke internal combustion engine, a scavenging air pump driven by the engine, fuel injector mechanism including a control member, a servo-motor including a pressure chamber, a movable element acted on by the pressure of air in said chamber and resilient means resisting movement of said element caused by increased pressure in said chamber, conduit means for connecting said chamber with said air pump, means connecting said element to said control member, said servo-motor having a passage for bleeding air from said chamber to the atmosphere to thereby reduce the air pressure acting on said element, a valve member for controlling flow through said passage, means connecting said valve member to said element for shifting the valve member in response to movement of said element for varying flow through said bleed passage sufficiently to compensate for variations of scavenging air pressure resulting from variations in torque developed by said engine.

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