May 10, 1938. E. SCHIMANEK 2,117,105

DEVICE FOR REGULATING THE RUNNING OF INJECTION ENGINES AT DIFFERENT SPEEDS OF REVOLUTION

Filed April 23, 1935 2 Sheets-Sheet 1

Fig.1.

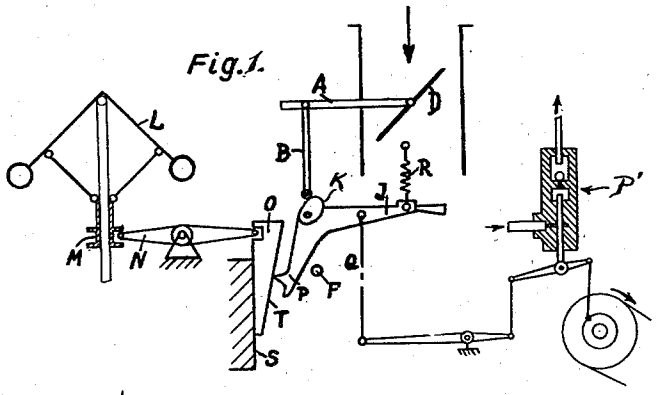
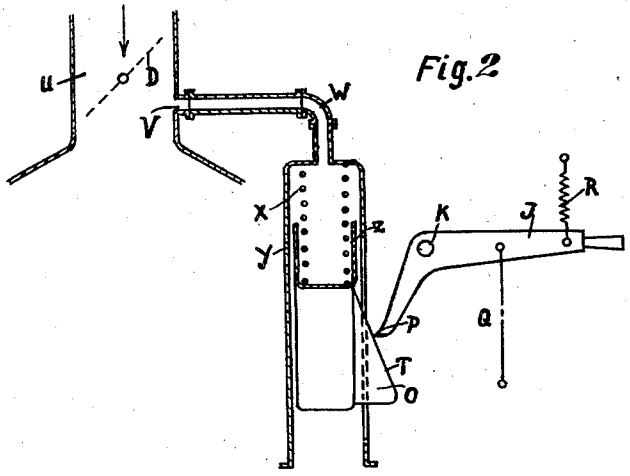


Fig.2



INVENTOR

Emil Schimanek

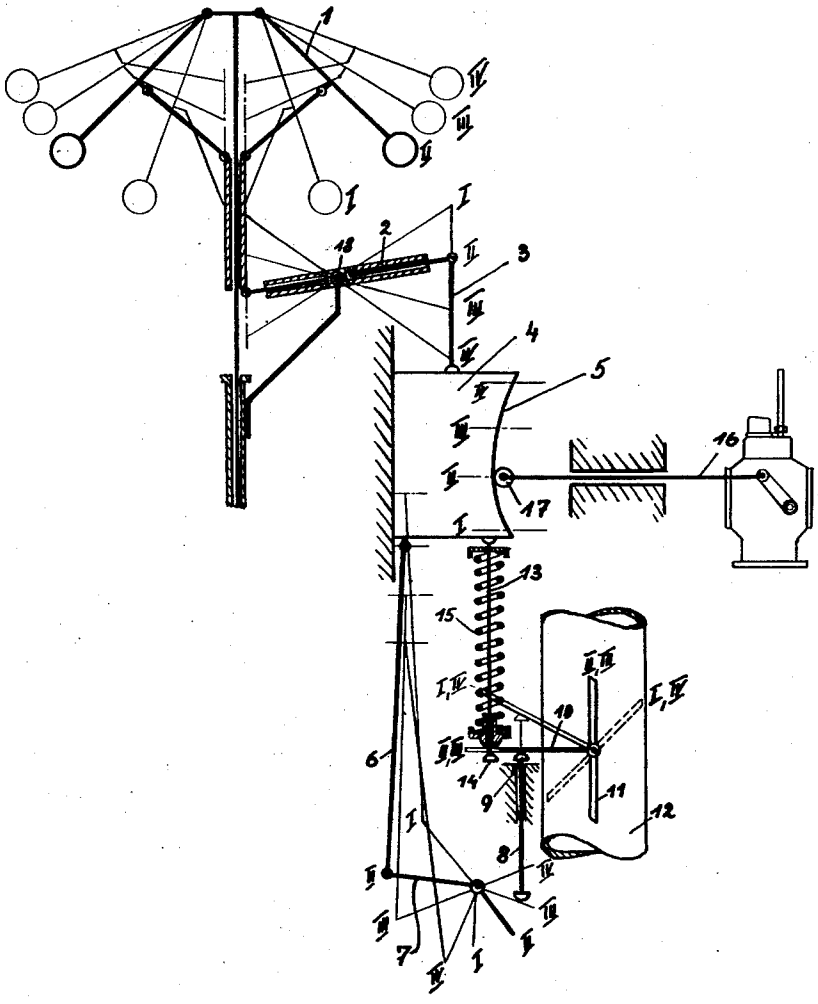
BY

May 10, 1938. E. SCHIMANEK 2,117,105

DEVICE FOR REGULATING THE RUNNING OF INJECTION ENGINES AT DIFFERENT SPEEDS OF REVOLUTION

Filed April 23, 1935 2 Sheets-Sheet 2

Fig. 3.



INVENTOR

Emil Schimanek

BY

Patented May 10, 1938 2,117,105

UNITED STATES PATENT OFFICE

2,117,105

DEVICE FOR REGULATING THE RUNNING OF INJECTION ENGINES AT DIFFERENT SPEEDS OF REVOLUTION

Emil Schimanek, Budapest, Hungary

Application April 23, 1935, Serial No. 17,758
In Austria July 13, 1934

2 Claims. (Cl. 123—140)

This invention relates generally to internal combustion engines.

It is known that in internal combustion engines the power is determined by the speed of revolution and by the quantity of fuel that can be burned in the cylinder during a power stroke. The quantity of fuel that can be burned at any one time in the cylinder is, however, limited by the quantity of air or the quantity of oxygen present in the cylinder. With engines operating with variable speeds of revolution, for instance vehicle engines, the quantity of air filling the cylinder is less at higher speeds of revolution than at lower speeds at a given throttle position.

In the case of explosion engines the quantity of fuel introduced into the cylinder is proportional to the quantity of air admitted to the cylinder, as in such engines a mixture of air and fuel is introduced or drawn by suction into the cylinder. Hence at lesser speeds of revolution, an increase in the quantity of air means a greater increase in the quantity of fuel entering the cylinder at each suction stroke or working cycle than at higher speeds.

In the case of injection engines, such for instance as Diesel engines, the fuel to be introduced in one stroke is delivered by the fuel pump independently of the quantity of air passing into the cylinder. In vehicle engines of this kind the regulation of the fuel delivery is mostly effected by hand. The greatest quantity of fuel which can be adjusted for by this hand regulation is however in the case of all Diesel engines limited by a stop or the like. In vehicle engines operating on the Diesel principle with fuel injection this stop and consequently also the quantity of fuel entering the cylinder at any one time is so adjusted that at the maximum speed of revolution, at which the cylinder takes in the minimum quantity of air, smokeless combustion will still be obtained.

In all hitherto known Diesel engines, the generic term "Diesel engine" comprises all those internal combustion engines, in which the fuel is introduced into the combustion air which is highly heated by compression. The maximum quantity of fuel which can be introduced in one stroke remains unchanged at all speeds of revolution and consequently the maximum torque also remains unchanged at all speeds of revolution. In the case of mixture engines, however, the maximum quantity of fuel used up in one stroke is not constant but changes proportionately to the quantity of air drawn in by suction with a fixed throttle position.

The fact that in a Diesel engine the maximum torque is invariable has great disadvantages when such injection engines are used as vehicle engines. Such engines lack the elasticity which is characteristic of the mixture engines. In measuring the elasticity of an engine the product of two factors is controlling. The first factor is determined by the amount of change, which the maximum torque shows when the speed of revolution changes; and the second factor is determined by the ratio between the greatest and the smallest speed of revolution at which the engine can still be operated properly. Measured in this way, however, the elasticity of Diesel engines is equal to zero, because the first factor is equal to zero.

The present invention is based on the fact that even with injection engines, such as Diesel engines, an elasticity can be obtained which is equal to that obtainable with mixture engines, if the two factors which determine the elasticity, when changing the speed of revolution, are changed in the same manner as in mixture engines. Thus, a change of the torque in injection engines, which corresponds to the change of the torque when changing the speed of revolution, can be obtained by regulating the maximum quantity of fuel introduced per stroke or per cycle into the power cylinder at the different speeds of revolution in dependence on the quantity of air introduced into the motor cylinder at the speed of revolution at any particular time. In such a manner the maximum quantity of fuel at smaller speeds of revolution is increased to correspond to the greater quantity of air entering the cylinder during a cycle and vice versa. In other words, the maximum quantity of fuel introduced per stroke into the cylinder is varied each time in accordance with the change of the volumetric efficiency, that is, in each case in accordance with the change in the quantity of air drawn in, as for instance by a suction stroke.

Such a method, which is based substantially on a regulation of the maximum power of the engine at smaller speeds of revolution, also enables (this forming a further feature of the invention) the second of the factors mentioned above to be correspondingly enlarged in considerably reducing the smaller speed of revolution at which the engine can still be operated. The result is that as a vehicle engine the Diesel engine is at least equivalent to the mixture engine as to its elasticity. The minimum speed of revolution

of a motor is limited in that it must in any case be so great that the live force stored in the fly-wheel can overcome the work of compression without the motor experiencing a drop in the speed of revolution of the engine, which would detrimentally affect the proper running of the engine. Now as the work of compression depends on the final compression pressure, this final pressure is determined in the case of Diesel engines by the requirement of the self-ignition of the introduced fuel, and, therefore, amounts to a multiple of the final compression pressure of the mixture motors. The fly-wheel must also be made several times larger and heavier than that of mixture motors, if the smallest speed of revolution, at which the engine can still be operated, is to be the same. With the known Diesel engines for vehicles, a separate centrifugal governor is mostly provided, which prevents a drop below the speed of revolution determined by the mass of the fly-wheel and the work of compression.

An object of the present invention is to reduce this minimum speed of revolution, at which the engine can still operate properly. The invention makes use of the fact that by diminishing the quantity of air entering the cylinder (for instance by throttling) the work of compression in the cylinder can be reduced without the final temperature of the compression being lowered, so that such a diminution of the quantity of air is also a means for reducing the speed of revolution at which the engine can still operate properly. The compression temperature is dependent both on the initial temperature (temperature before the compression) and on the degree of compression. Now, as is known, a throttling in no way influences the initial temperature. The initial temperature of the compression thus remains the same and, as the degree of compression (that is to say, the ratio of the stroke volume to the volume of the compression space) remains the same, the compression temperature corresponding to normal operation is also reached at the compression pressure reduced by throttling. Hence according to the invention at loads or at powers lying below the maximum powers the quantity of air also is reduced in accordance with the quantity of fuel reduced in accordance with the smaller power, with the result that the final pressure of the compression can be reduced to nearly the final pressure of the mixture motors and thereby also the speed of revolution, at which the engine can still operate properly can be reduced in the same ratio.

Thus, according to the invention the elasticity of Diesel engines is raised on the one hand by increasing the maximum power at smaller speeds of revolution, this being effected by increasing the maximum fuel supply at smaller speeds of revolution in dependence on the excess of air at the smaller speeds of revolution and on the other hand by reducing the minimum speed of revolution at which the engine can still operate, in reducing, at the smaller powers which are obtained by reducing the quantity of fuel, the quantity of air along with the quantity of fuel.

In the drawings, Fig. 1 is a view of a device showing the improvements in accordance with the invention for raising the maximum torque and reducing the minimum speed of revolution.

Fig. 2 is a view partly in section and partly in diagram of a device embodying another form of improvements for raising the maximum torque.

Fig. 3 is a view partly in section and partly in elevation and in diagram of a device embodying another form of improvements for raising the maximum torque and reducing the minimum speed of revolution.

According to Fig. 1 a centrifugal governor is used for regulating the quantity of fuel for increasing the maximum power at smaller speeds of revolution. Member J is a lever which can be swung downwards by hand or by pedal and which is arranged to pivot about the fixed shaft K and is connected by means of a rod Q to the member for regulating the fuel pump indicated generally at P'. A suitable means for raising and lowering the rod B, such as the cam or eccentric is shown. The lever J, which is a bell crank, is influenced by the spring R which draws the lever upwards, the arrangement being such that, when the lever under the action of the spring R bears against the stop F, the fuel pump delivers the minimum quantity of fuel. The maximum quantity delivered by the fuel pump is limited by the contact surface T of a wedge O, against which the stop P of the lever J strikes. The wedge O is guided in a guide S, but so as to be capable of moving freely upwards and downwards.

In Fig. 1 the wedge is shown approximately in its middle position. The position of the wedge O is determined by the centrifugal governor L, to which it is connected by the lever N.

As the speed of revolution increases the sleeve M of the governor moves upwards and the wedge O downwards, the maximum quantity of fuel thus being reduced. With the motion in the opposite direction the maximum quantity of fuel which can be delivered by the pump is increased. The back T of the wedge is so shaped that the regulation of the maximum quantity of fuel corresponds to the quantity of air drawn by suction in each case at this position of the regulator or at this speed of revolution. This quantity of air can be determined for each speed of revolution by a single test for each type of engine, for instance by measuring the final pressure of the suction or the compression.

In the constructional example of the invention shown in Fig. 2, the regulation is effected by the vacuum created in the suction pipe. At greater speeds of revolution the air flows through the suction pipe at greater velocity and therefore produces a greater vacuum in the same. By transmitting this vacuum to the member for limiting the maximum quantity of fuel an automatic regulation of the limiting is obtained.

In Fig. 2 J is the lever which is acted on by a tension spring R and according to its position regulates the output of the fuel pump P'. The wedge O is in this case connected to the piston Z which is capable of moving freely upwards and downwards in the cylinder Y. The piston Z is forced downwards by the spring X. The cylinder Y is connected through the pipe W with the suction pipe U at V. This point V should be as near the cylinder as possible. As the speed of revolution of the engine increases the vacuum at V becomes greater. By this means the piston Z is moved upwards in opposition to the spring X and the limiting of the lever motion and with it the maximum fuel pump output is altered.

This mode of regulation is particularly suitable in cases in which, when regulating the maximum power of the Diesel engine for the different speeds of revolution, at the same time at smaller powers the quantity of air is also varied in accordance with the quantity of fuel introduced in each case.

For enabling both regulations to be effected

simultaneously, the arrangement may be made such, when a centrifugal governor in accordance with Fig. 1 is employed, that the member which serves the purpose of displacing the throttle for the purpose of reducing the power displaces the limiting of the stop for the lever J, for instance, through the fulcrum K of this lever being moved upwards when throttling, as is indicated in Fig. 1 by broken lines, the quantity of air thus being regulated with the quantity of fuel. The throttle D is moved by means of the lever A which is connected by the rod B to the fulcrum K, which latter can move freely upwards and downwards in a guide (not shown).

In the constructional example shown in Fig. 2, the connection of the pipe W must lie at a point V of the suction pipe, lying behind the throttle D which is shown in broken lines.

In the constructional example shown in Fig. 3, a governor is used which acts on the air throttling member and the fuel pump. In this arrangement it is also sought to reduce the compressing work required for starting the engine, without however thereby diminishing the compression temperature. Use is made, in this case, of the above mentioned fact that the compression temperature is dependent on the one hand on the initial temperature (temperature before compression) and on the other hand on the degree of compression, whereby the compression temperature corresponding to normal operation can be reached even at the compression pressures reduced by throttling. In the example shown in Fig. 3, by means of a starting regulator, which acts on the air throttling member and the fuel pump, the quantity of air drawn in by suction is first reduced during the starting period to such an extent that it is only slightly greater than the quantity of air corresponding to the quantity of fuel required for maintaining the idle running of the engine. At the same time, the fuel pump is adjusted so as to deliver a slightly greater quantity of fuel than the quantity of fuel required for idle running, the arrangement being such that, corresponding to the increasing acceleration of the engine, the regulating member constantly reduces the throttling of the suction air and alters the delivery of the fuel pump in the manner required for reaching the full speed of revolution of the engine. In the example shown in the drawings such a regulator serves in place of the regulator L shown in Fig. 1 and also serves the further purpose of regulating the maximum power at different speeds of revolution.

The governor 1 is connected by the lever 2, which is pivoted at the point 18, and the bar 3 to a regulating body 4 for the quantity of fuel, this regulating body acting through a profile 5 which is determined by experiment. The regulating body 4 is connected on the one hand by a bar 6 with a lever 7 and on the other hand by a bar 13 and a lever 10 with the throttle 11 disposed in the suction pipe 12. The arrangement is made such that the connection with the throttle 11 is established by means of a lever 10 to which the bar 13 is coupled by means of a head 14 in a yielding manner through the intermediary of a spring 15. A bar 8 which is adapted to move upwards and downwards freely in a guide and which is provided with a head 9 establishes the connection between the lever 7 and the throttle lever 10 in certain positions of the bell crank lever 7.

The profile 5 coacts with a roller 17 mounted on a bar 16, the bar 16 being connected in a manner not shown in the figure with the member regulating the output of the fuel pump.

This arrangement operates as follows:

When the engine is stationary the governor is in the position marked I. At the speed of revolution, at which the throttling action which is effective at starting ceases, that is, when the throttle is in its entirely open position (shown in the drawing by heavy lines), the governor is in the position marked II. (In this position all parts are shown in the drawing in heavy lines.) During the change of position from I to II the throttle valve is displaced from its closed position I, which corresponds to the smallest speed of revolution, by the bar 13 or the spring 15 into the entirely open position II.

For the better understanding of the invention let it be assumed that the engine is running at 1000 revolutions per minute. The position II is assumed as occuring for instance at 300 revolutions, that is, at that speed of revolution at which the fly-wheel already overcomes the entire compression work.

The position III of the governor corresponds to the maximum speed of revolution 1000.

While the governor is swinging from the position II into the position III only the regulating body 4 for the quantity of fuel is displaced and by means of the profile 5 the maximum quantity of fuel for the particular speed of revolution is correspondingly regulated.

The position II of the throttle valve coincides with the position III, when the lever 10 resting on the head 9 cannot be further displaced by the spring 15.

On the speed of revolution of the engine tending to increase because the load becomes smaller, the governor will swing from the position III towards the position IV and the fuel regulating body 4 will diminish the quantity of fuel, while the lever 7 displaces the bar 8 upwards and closes the throttle valve.

I claim:

1. A fuel regulating apparatus comprising a governor, a fuel pump, an air supply pipe with a throttle therein, a bar operatively connected to the governor, a movable member connected to the bar having a profile surface thereon, said profile surface being formed to vary the adjustment of the fuel pump, means connecting said surface to said pump and means of connection between said profile member and the throttle, said latter means consisting of a bar connected to the profile member, a bell crank lever connected to said bar, a second bar connected to said profile member, a lever connected to said second bar, said latter lever being operatively connected to the throttle and a floating bar interposed between said bell crank lever and said latter lever for actuating the same whereby the position of said throttle is simultaneously adjusted by said profile member.

2. A fuel regulating apparatus as claimed in claim 1 characterized by means for guiding the movement of the floating bar.

EMIL SCHIMANEK.