

Jan. 13, 1942.

A. KRAVITS
ARRANGEMENT FOR REGULATING THE OUTPUT OF FUEL PUMPS
FOR INTERNAL COMBUSTION ENGINES
Filed March 7, 1939

2,270,127

FIG. 1

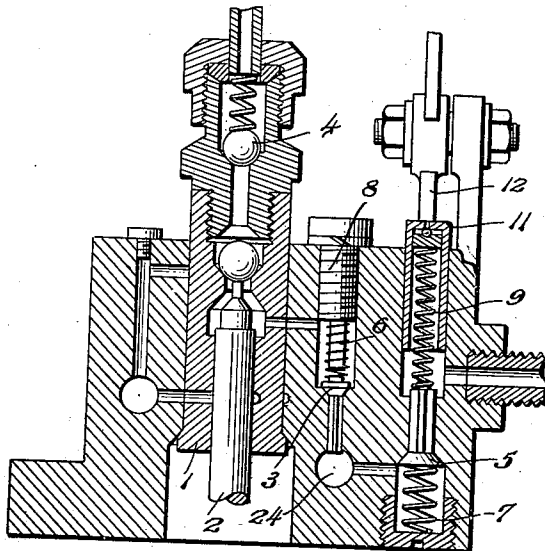


FIG. 2

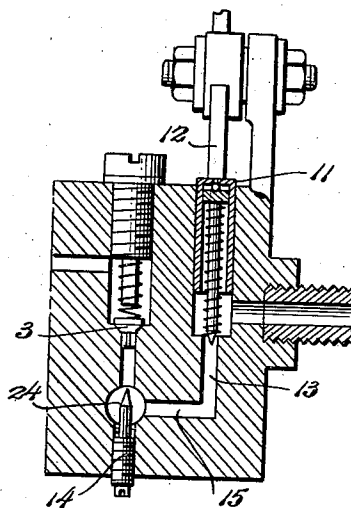


FIG. 5

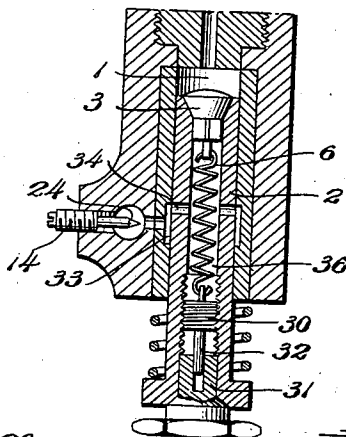


FIG. 3

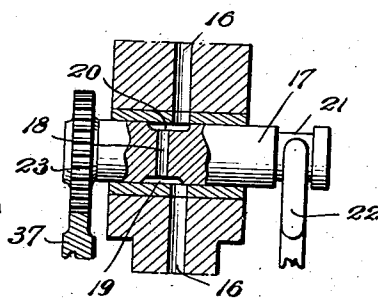
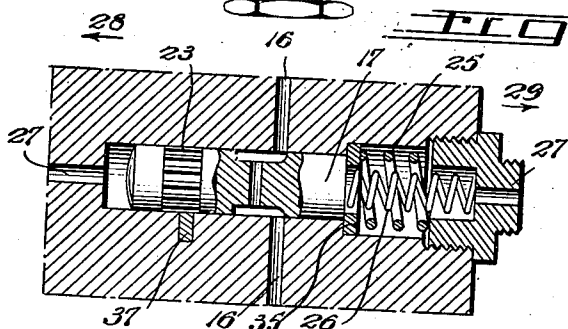


FIG. 4



Inventor
Arthur Kravits

by *Robert Henry Campbell*
Attys

UNITED STATES PATENT OFFICE

2,270,127

ARRANGEMENT FOR REGULATING THE
OUTPUT OF FUEL PUMPS FOR INTER-
NAL COMBUSTION ENGINESArthur Kravits, Budapest, Hungary, assignor of
one-half to Aurel Nemes, Budapest, Hung-
aryApplication March 7, 1939, Serial No. 260,256
In Germany March 29, 1938

3 Claims. (Cl. 103—37)

It has already been proposed to regulate the output of fuel pumps for internal combustion engines by variable throttling of the flow in the suction pipe of the fuel pump, whereby the intake resistance to the flow of the fuel into the cylinders of the pump may be increased to such an extent that during the whole of the time available for the intake, that is to say during the suction stroke, a larger or smaller fraction of the quantity of fuel corresponding to the displacement of the pump piston is able to enter the cylinder, according to the degree of throttling, while the remainder of the volume of the cylinder swept by the piston remains empty.

With multi-cylinder pumps for multi-cylinder engines there has hitherto been provided a common throttling member. It is however practically impossible to obtain absolute equality of resistance to flow in the paths leading from the common throttling member to the intakes of the individual pump cylinders, or to maintain this equality under working conditions, since this resistance is influenced by the angle of inclination of the engine, flow conditions within the fuel, shocks, accumulations of foreign matter in the fuel ducts and other factors. The resulting inequality affects the uniformity of the fuel supply to the individual cylinders of the engine, particularly at low admission.

According to the invention, in addition to an adjustable master throttling member provided in the suction pipe and common to all the pump cylinders, a separate throttling device consisting of a spring-loaded non-return secondary throttling valve is inserted between the said master throttling member and each cylinder of the pump.

The spring load on the non-return secondary throttling valves must be so great that the pressure requisite to overcome this force is so high, relatively to the fluctuations of pressure due to the varying conditions referred to, throughout the entire stroke of the valve, that the resulting fluctuations in the rate of flow do not exceed a practically admissible limit. In the case of fuel pumps for vehicle engines in order to compensate the fluctuations due to inclination of the engine to within the admissible limit of about 10%, the spring load on the non-return secondary throttling valves must be such as to counter-balance at least a fuel column of 300 mm., that is to say must not allow any fuel to pass until the fluid pressure thereof exceeds this limit.

If the load on all the non-return throttling valves is practically equal it follows that the

quantity of fuel supplied to each of the cylinders will be practically equal. Since the frictional resistance to the flow of the fuel increases with velocity of flow it is advisable for the purpose of compensating the fluctuations resulting from this cause to insert further adjustable means for varying the cross-sectional area of the flow between the master throttling member and each of the secondary non-return throttling valves.

Arbitrary controlling of the throttling action is effected by means of the variable master throttling member common to all the cylinders, which may consist for example of a simple adjustable needle valve or of a valve with variable spring loading.

An embodiment of the invention is illustrated by way of example in the accompanying drawing, in which:

Fig. 1 is a sectional view of one cylinder of a multi-cylinder fuel pump having an output regulating arrangement according to the invention.

Fig. 2 shows a modification of the master throttling valve,

Figs. 3 and 4 show two examples of a master throttling valve in the form of a slide valve adapted for arbitrary and automatic speed regulation, and

Fig. 5 shows a device for adjusting the loading springs of the non-return secondary throttling valves.

Referring to the drawing 1 denotes the cylinder of the fuel pump and 2 the piston which may be driven in any known manner.

5 denotes the master throttling valve which is common to all the pump cylinders connected to the common suction pipe 24, and which serves for the arbitrary regulation of the fuel supply, while 4 denotes the spring loaded delivery valve of the pump. Between the master throttling member 5 and each individual cylinder of the pump there is provided a non-return secondary throttling valve 3 which is loaded by a spring 6.

By adjustment of a screw 8 the tension of the spring 6 may be varied to obtain the required degree of throttling. The stroke of the valve 3 may if desired be limited by means of a suitable adjustable stop.

Given suitable adjustment of the spring load on the secondary throttling valve 3 the quantity of fuel entering the cylinder of the pump during the suction stroke will be automatically regulated in the manner described below.

The arbitrary regulation of the output of the fuel pump, which takes precedence over the automatic regulation, is effected by means of the

master throttling valve 5. This latter valve may be substantially similar to the secondary throttling valves 3, but is provided, in addition to the loading spring 7 which is of such strength as not to allow any fuel to pass, even at maximum suction of the pump, with a relief spring 9. The tension of the relief spring may be increased by depression of the piston 11, under the control, for instance, of a centrifugal governor or of the accelerator pedal 12 of a motor vehicle, to such an extent that the master throttling valve is opened to allow the required quantity of fuel to pass. This arrangement allows of accurate regulation even when the output of the pump is quite small and ensures smooth transition from one rate of fuel supply to another.

The main throttling valve may also be in the form of a needle valve as shown at 13 in Fig. 2 operated, for instance, by means of the piston 11 under the control of the accelerator rod 12. This figure also shows a set-screw 14 inserted between the master throttling member 13 and each non-return secondary throttling valve 3, with the aid of which screw the cross-sectional area of the supply duct 15 leading to the secondary throttling valve 3 may be reduced to a desired extent.

The mode of operation of the described output regulating arrangement is as follows:

At starting of the engine, in the present instance a vehicle engine is contemplated, the master throttling valve is set for maximum throttling action, corresponding to no-load running of the engine. At the slow speed of the engine at starting the time available for the suction stroke of the fuel pump is sufficiently long to allow the cylinder of the fuel pump to become filled to such an extent that the engine rapidly accelerates to the no-load or idle running speed. When this speed is reached the force of the loading spring 6 of the secondary throttling valve 3 counterbalances the relatively higher pressure prevailing behind this valve, this pressure being already very greatly reduced owing to the throttling action of the master throttling valve. In this condition the lift of the secondary throttling valve is merely sufficient to allow the fuel to pass at the rate necessary to keep the engine at no-load running speed. This speed is automatically maintained since an increase of speed would mean shortening the duration of the suction stroke and reducing the admission to the cylinder of the pump to such an extent that such increase in speed can not in fact occur. On the other hand a drop in speed would mean an increase in the duration of the suction stroke and in the admission to the cylinder of the pump, which in its turn would increase the speed of the engine again.

Depression of the accelerator pedal causes the master throttling valve to be opened wider with the result that the relatively higher pressure prevailing in the suction pipe before this valve increases, which in its turn results in a proportionate increase in the lift of this valve and in the admission to the cylinder of the pump. Consequently, the torque and the speed of the engine increases.

By means of the master throttling valve the pressure in the suction pipe in front of the secondary throttling valve, and with it the admission to the fuel pump, may be adjusted as required. The spring-loaded secondary throttling valves 3 have the effect of ensuring that the individual cylinders of the pump receive equal sup-

plies of fuel from the common suction pipe according to the extent to which the pipe is throttled by the master throttling valve, while any fluctuations due to change in the position of the pump relatively to the master throttling valve or to variations in the resistance to flow offered by the connections in the supply system are eliminated or reduced to within limits of tolerance.

If the piston of the pump is allowed to carry out its pressure stroke by the relieving of a previously tensioned spring, the idle portion of the delivery stroke will take place, in the absence of the injection resistance, with very considerably greater velocity than the succeeding portion of the delivery stroke, with the result that the alteration of the timing of the injection which occurs at reduced charging is diminished.

On alteration of the load the fuel feed throttling arrangement according to the invention effects to a certain extent an automatic regulation of speed. The sensitiveness of this automatic regulation may be enhanced by arranging for the master throttling member to be automatically controlled by a speed governor, in addition to the arbitrary control of this member. In order to ensure that the alteration of pressure in the suction pipe occurring on alteration of the throttling action shall not interfere with the automatic adjusting of the master throttling member, and that on arbitrary adjustment of the same no reaction on the automatic adjustment shall take place there is used as the master throttling member in accordance with the invention a member, for example a rotary slide valve, which is not subjected to the pressure prevailing in the suction pipe, and which is also slidable in an axial direction. Referring to Fig. 3 there is inserted in the suction pipe 16 of the fuel pump, as the master throttling member, a rotary slide valve 17 which is also capable of being moved in an axial direction. Recesses 19 and 20 adjoining the transverse port 18 in this slide valve coact with the orifices of the suction pipe 16 in such a manner that the effective aperture of these orifices is altered both by rotation and by axial displacement of the slide valve 17. In an annular groove 21 in the slide valve 17 there engages a fork 22 which is operatively coupled with the speed governor of the internal combustion engine. This governor may be any type of revolving governor or a governor responsive to a pressure depending on the speed of the engine, for instance, the pressure in the induction pipe of the engine or in the suction or delivery pipe of a pump inserted in the front of the fuel pump. This governor may be arranged to operate either over the whole range of speed of the engine or only when the speed of the engine exceeds or falls short of a certain range.

Fig. 4 shows an example of the last-mentioned type of governor. The slide valve 17 is in this case loaded by a more powerful spring 25 bearing against an abutment ring 35 and by a weaker spring 26 bearing against the middle portion of the end surface of the slide valve. The other end of the slide valve chamber communicates with the delivery pipe of the fuel feed pump, for instance by means of a passage 27. The springs 25 and 26 are so dimensioned that when the speed of the engine falls below a certain limit, and with it the pressure in the passage 27, the slide valve is moved by the spring 26 in the direction indicated by the arrow 28, while when a certain speed is exceeded the slide valve is moved against the

action of the spring 25 in the direction indicated by the arrow 29. If the slide valve is to be governed by the pressure prevailing in a suction pipe the connection to this suction pipe will be made at 27'.

Arbitrary regulation is in this case effected either indirectly, by influencing the speed governor, or directly, for instance by rotating the slide valve 17, e. g. with the aid of a rack 37 (Figs. 3 and 4) meshing with teeth 23 provided on the slide valve body.

Since for obtaining uniform feed to all the cylinders of the engine the force exerted by the loading spring 6 of the non-return secondary throttling valve 13 is of decisive importance it is essential to be able to adjust this force while the pump is at work. In view of the necessity for maintaining a tight joint, adjustment of this spring force with the aid of the screw 8 (Fig. 1) can only be effected in practice by changing the washer beneath this screw, that is to say only when the pump is not working. For this reason the arrangement shown in Fig. 5 is preferred. With this arrangement the loading spring 6 of the non-return secondary throttling valve 3 takes the form of a tension spring housed within the hollow piston 2 of the pump, and is attached on the one hand to the valve 3 and on the other hand to the screw 30 which engages, for the purposes of adjustment, in screw threading in the socket 36 of the piston. Adjustment is effected with the aid of a plug 31 which takes the form of a valve rotatably seated in the lower end of the piston of the pump and also adapted to engage a stem 32 on the screw 30 in the manner of a key or spanner. Under the action of the pump the fuel passes from the suction pipe 24 through passages 33 and ports 34 into the hollow space inside the piston and thence, as the piston descends, through the suction valve (secondary throttling valve) 3 into the cylinder 1 of the pump. 14 represents a throttling screw similar to that shown in Fig. 2.

What I claim is:

1. In a fuel feeding device comprising a plurality of fuel pump cylinders, a throttling member provided in the section of the fuel admission channel common to all the pump-cylinders and secondary throttling members consisting of spring loaded non-return valves inserted between said master throttling member and the admission apertures of said pump cylinders, the secondary throttling members being submitted to a spring load at least so large that the largest cross-sectional area of said secondary throttling members even in fully open state of the master throttling member be smaller than the smallest passage between said master throttling member and the several pump cylinders.

2. In a fuel feeding device comprising a plurality of fuel pump cylinders, a throttling member provided in the section of the fuel admission channel common to all the pump cylinders and secondary throttling members consisting of spring loaded non-return valves inserted between said master throttling member and the admission apertures of said pump cylinders, the secondary throttling members being submitted to a spring load at least so large that the cross-sectional area of said secondary throttling members be smaller than the smallest passage between said master throttling member and the several pump cylinders and having adjustable means for varying the tension of said loading springs.

3. In a fuel feeding device comprising a plurality of fuel pump-cylinders, a throttling member provided in the section of the fuel admission channel common to all the pump-cylinders and consisting of a spring-loaded non-return valve partly balanced by an adjustable spring, and secondary throttling members consisting of spring-loaded non-return valves inserted between said master throttling member and the admission apertures of said pump cylinders to limit automatically the part of the volume of the pump-cylinders to be filled by the fuel.

ARTHUR KRAVITS.