Dec. 2, 1930. F. LANG 1,783,803

INTERNAL COMBUSTION ENGINE

Filed Dec. 24, 1926

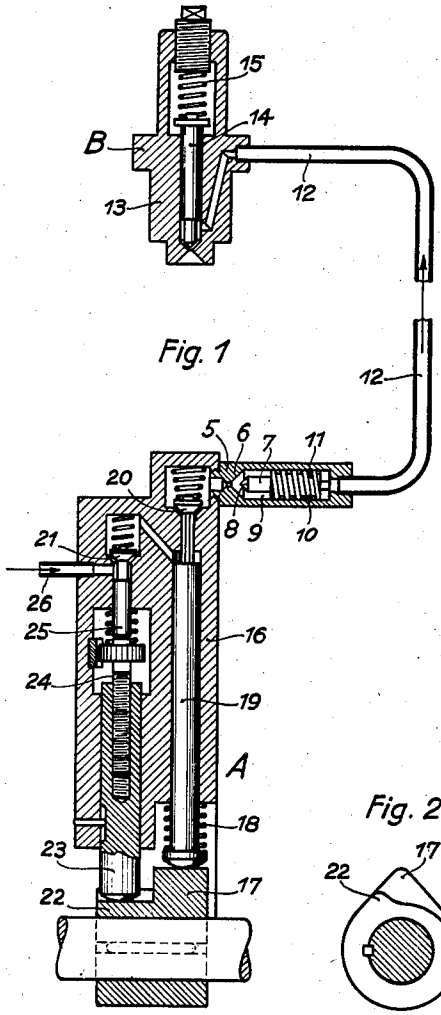
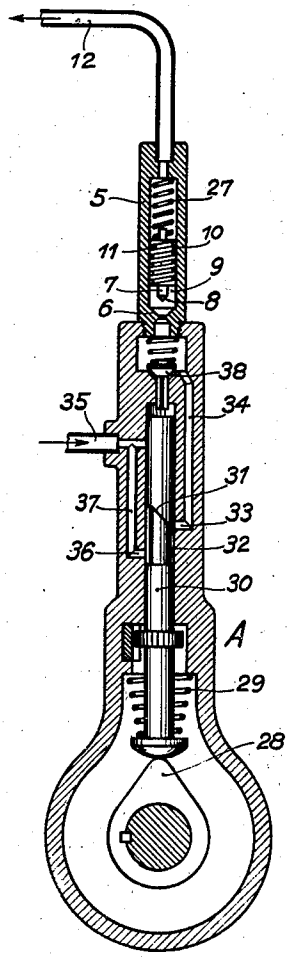


Fig. 1

Fig. 2

Fig. 3



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Patented Dec. 2, 1930 1,783,803

UNITED STATES PATENT OFFICE

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INTERNAL-COMBUSTION ENGINE

Application filed December 24, 1926, Serial No. 156,960, and in Germany October 8, 1926.

This invention relates to the arrangement of a non-return valve in the pipe extending from the fuel pump of an internal combustion engine to the injection nozzle of the same, it being understood that the engine is of the air-less injection type. With internal combustion engines of this type when the nozzle in closed position becomes leaky from any reason, compressed air and gases still present in the cylinder may find access into the delivery pipe extending from the fuel pump to the injection nozzle especially after the engine has been stopped, and may displace the fuel from said pipe. When the engine is started again, the fuel pipe must first be filled with fuel before the engine can run. That may, under some circumstances, require very considerable time. Further, air may remain in the fuel pipe and cause the engine to run irregularly.

Troubles and difficulties similar to those mentioned above may also occur in regular service if the fuel pump is of that type in which a certain portion of the fuel contained in the delivery pipe is permitted to flow back after every delivery stroke in order to relieve the pressure in this pipe temporarily and to prevent the troublesome trickling of the fuel from the nozzle. If the fuel pump stops, for instance, in that position in which the pressure in the delivery pipe is relieved, this pipe may be blown empty, particularly if the nozzle is leaky.

In order to obviate these and similar difficulties and disadvantages it has already been proposed to insert into the delivery pipe any one of the generally known non-return valves which close automatically instantly a reversal of the direction of flow of the respective fluid or liquid takes place. It is true that the disadvantages stated can be obviated thereby but this favorable effect is compensated by the unfavorable one that the portion of the pipe located between the valve and the nozzle cannot be relieved of pressure after every delivery stroke.

Now, to prevent also this latter disadvantage I have designed an improved non-return valve just suited for the particular purposes in view. This valve is so designed that it lets flow back only that portion of the fuel which will ordinarily flow back to relieve the pressure in the delivery pipe.

In order to make the invention clearer, reference is made to the accompanying drawing in which

Figure 1 is a longitudinal section through the novel non-return valve and pump employed in connection therewith;

Figure 2 is an end view of the pump cams, and

Figure 3 is a longitudinal section through a modification.

In both constructional forms, A denotes the fuel pump and 5 a branch or casing attached to said pump just between it and the delivery pipe 12 which conducts the fuel to the nozzle B (Fig. 1). In the casing 5 is a seat 6 for a cone 8 forming the free end of an axially movable member 7. The other end of this member is inserted into a piston-like member 10, reciprocable in the bore 9 of the casing 5 and provided on its circumferential surface with a flat thread 11.

The nozzle B may be used in connection with the pump shown in Fig. 3, as well as with the pump shown in Fig. 1 and it consists of a body 13, a so-called needle 14, and a helical compression spring 15.

Both pumps (Figs. 1 and 3) are shown in that position in which the piston is just about to arrive at its inner dead-center position and the delivery is just about to cease. The nozzle needle 14 has not yet seated but will do so almost immediately, say in the next second, and the fuel delivered can, therefore, still pass through the nozzle.

With the pump shown in Fig. 1 the piston 19 is lifted by a cam 17 and depressed by a spring 18. The piston is enclosed in the casing 16, and is so positioned therein that its upper end engages the stem of the delivery valve 20 in such a manner that the latter is opened and kept open during the last portion of every delivery stroke and during the first portion of every suction stroke. At the beginning of the latter stroke a part of the fuel under pressure in the delivery pipe will follow the receding piston either until the pres-

sure has fallen to zero or until the delivery valve can close.

The length of travel and the time of operation of the suction valve are controlled and may be varied so as to vary thereby the amount of fuel delivered. The suction valve is controlled by a cam 22 through the intermediary of a shiftable member comprising a body member 23 and a screw 24 having threaded engagement therewith so that the total length of the combination member 23/24 can be varied. The cam 22 and said member 23/24 are shown in that position in which the suction valve is just being opened. 26 denotes the suction pipe.

When the internal combustion engine runs at high speed, the united members 7 and 10 are and remain shifted to the right (Fig. 1) so that the small amount of liquid fuel flowing back from the delivery pipe can pass through the helical groove of the thread 11 without producing a pressure of sufficient strength to move the member 7 against the seat 6. But, if the nozzle B should have become leaky, the pressure existing in the cylinder of the internal combustion engine could drive the fuel back when the pump is in that position in which the suction pipe and the delivery pipe are temporarily in indirect communication with each other. Such an occurrence is, however, prevented by the non-return valve which closes the communication instantly when the liquid fuel forced back out of the pipe 12 cannot pass quickly enough through the grooves of the thread to avoid the creation of pressure on the right-hand end of the member 10 sufficient to press the member 7 upon the seat 6. It is true that the non-return valve is again opened at the next delivery stroke of the pump, but it is also true that it is closed again if the nozzle should be still leaky.

The modification shown in Fig. 3 is distinguished from that shown in Fig. 1 chiefly by the branch or casing 5 being arranged vertically instead of laterally, and by the member 10, or the members 10/7 respectively, being subjected to the pressure of a compression spring 27.

In the form of construction shown in Figure 3, the piston is reciprocated with a fixed stroke by a cam 28 and a helical spring 29. The amount of liquid fuel delivered by the pump is effected by turning the piston about its axis. The piston is formed with a circumferential recess 32 having an oblique edge 31 which controls the point at which communication is established or interrupted between the passages 33, 34 on the one side and the passages 36, 37 on the other side. By turning the piston the point in the stroke of the latter at which such communication is established or interrupted may be varied so that the amount of fuel delivered by the pump may be adjusted accordingly. The circumferential recess 32 is at certain times only in communication with the passage 33 but is always in communication with the passages 36 and 37 so that the latter can always conduct liquid fuel delivered to such recess back to the suction pipe 35.

The load upon the member 7/8/10/11 relatively to its shape and weight is such that its movement towards the seat 6 is retarded at least for such a length of time as is required for the flowing back of the fluid to relieve the pressure in the delivery pipe. If care is taken that the retardation lasts only as long as the pressure relieving time, or just a little longer, then the pressure existing in the cylinder cannot, in the case the nozzle having become leaky, drive back the fuel.

The invention can be used advantageously also with motors operating with open nozzles where there is a normal non-return valve built in behind the nozzle. Further, the invention can be employed also in connection with motors having mechanically controlled nozzles.

Instead of helical grooves or screw threads, as at 11 in Figs. 1 and 3, fine longitudinal grooves or other grooves allowing communication between the spaces at the two ends of the member 10 can be used. In fact, any constructional shape permitting such communication can be made use of. The drawing shows merely two examples.

I claim:

In combination with an internal combustion engine, a fuel supply pump, an injection nozzle, a conduit connecting the discharge side of said pump with said nozzle, means for relieving the pressure in said conduit near the end of the pressure stroke of said pump, and a non-return valve in said conduit operable to allow fuel to flow in said conduit toward said pump when the pressure in said conduit does not exceed a predetermined pressure, said valve preventing flow of fuel in said conduit when the pressure exceeds said predetermined pressure.

In testimony whereof I have hereunto affixed my signature.

FRANZ LANG.