April 29, 1924. 1,492,111

E. H. TARTRAIS

FUEL INJECTING DEVICE FOR INTERNAL COMBUSTION ENGINES

Filed July 14, 1921 2 Sheets-Sheet 1

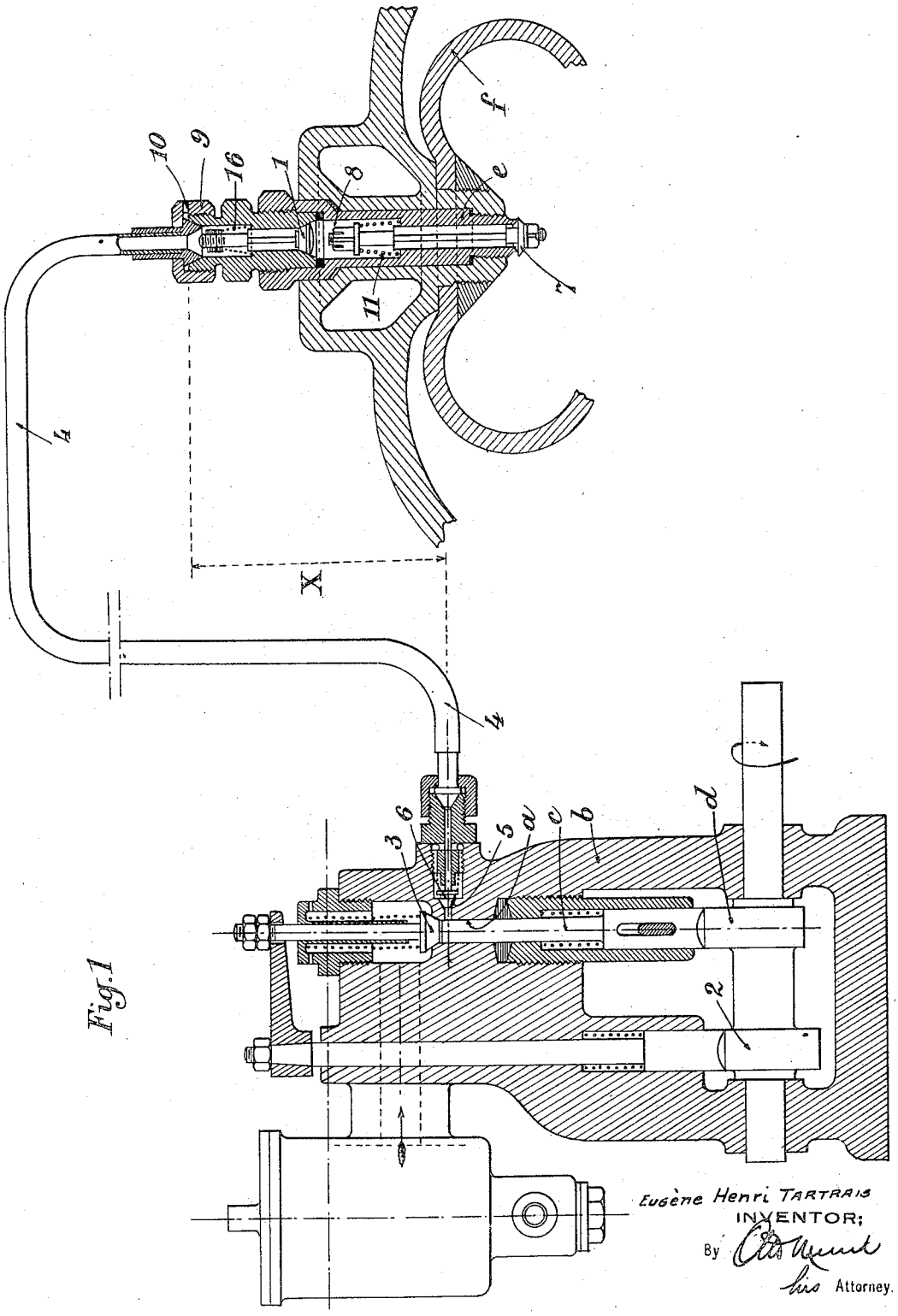


Fig. 1

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By
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Fig. 2

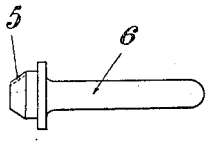


Fig. 3

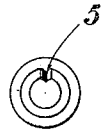


Fig. 5

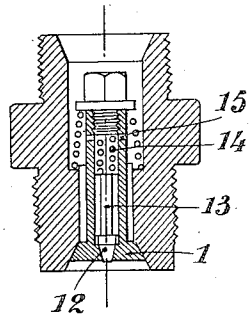
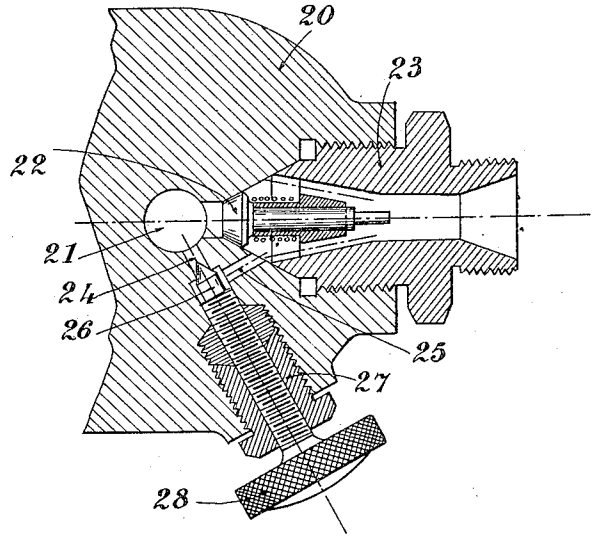


Fig. 4



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Patented Apr. 29, 1924. 1,492,111

UNITED STATES PATENT OFFICE.

EUGÈNE HENRI TARTRAIS, OF MAISONS-LAFFITTE, FRANCE.

FUEL-INJECTING DEVICE FOR INTERNAL-COMBUSTION ENGINES.

Application filed July 14, 1921. Serial No. 484,808.

To all whom it may concern:

Be it known that I, EUGÈNE HENRI TARTRAIS, citizen of the French Republic, residing at Maisons-Laffitte, Seine-et-Oise, in the Republic of France, have invented new and useful Improvements in Fuel-Injecting Devices for Internal-Combustion Engines, of which the following is a specification.

This invention relates to an internal combustion engine employing liquid fuel wherein the fuel is injected without requiring the use of compressed air, according to what is termed the solid injection method.

Apparatus are already known for effecting the injection of liquid fuel into these engines, such devices comprising a pump whose piston and admission valve are controlled by cams, the admission and exhaust valves opening outwardly, and a valved atomizer connected with the pump by a delivery passage.

This invention has for its object to obviate the various drawbacks arising in the operation of injection devices of this class, as will be set forth in detail hereunder.

The invention consists in providing a check valve opening towards the atomizer and disposed between the latter and the discharge valve of the pump, a very small orifice affording a constant communication between the pump and the delivery passage.

Other features of the invention will be further described.

The accompanying drawing shows by way of example various embodiments of this invention.

Fig. 1 is a sectional view of an injection pump and the upper part of the combustion chamber of an engine provided with the improvements according to the invention.

Figs. 2 and 3 are detail views in side and end elevation of the discharge valve provided with a groove according to the invention.

Fig. 4 is a horizontal section of the body of the pump on the axis of the discharge valve showing the use of a needle valve.

Fig. 5 is a sectional view of a modified form of the check valve disposed upon the atomizer.

a indicates the chamber of the fuel pump and *b* the frame thereof. As is well known in the case of this class of injecting devices for liquid fuel, when the motor piston is near the interior dead point, the piston *c* of the pump, which is acted upon by the cam *d* having a quick-motion ramp, will deliver the requisite quantity of fuel, and the latter is caused to pass through the discharge valve 6 of the pump and to lift the automatic valve 7 forming a part of the atomizer *e*. The fuel in the form of very fine drops thus enters the combustion chamber *f* of the engine cylinder wherein a high pressure prevails at this time.

Between the pump and the atomizer is necessarily provided a pipe of some length 4 having a considerable volume with reference to the volume of a charge of fuel. However small may be the compressibility of the liquid, this has nevertheless a value which is by no means negligible, by reason of this disproportion. Whence it will result that the injection will no longer take place completely at the stated moment, but it will be extended throughout the entire expansion stroke, inasmuch as the liquid which is compressed in the said pipe will expand when the pressure in the cylinder becomes reduced. The fuel which is introduced at the wrong time is therefore used under very defective conditions.

This drawback is obviated either as a whole or in part by the present invention, wherein a check valve 1 opening towards the atomizer is disposed between the latter and the discharge valve 6 of the pump and in immediate proximity to the atomizer, an orifice of very small size 5 (Figs. 1 to 3) being used to afford during the working of the engine a constant connection between the pump chamber *a* and the delivery pipe 4. This orifice 5 is preferably constituted by a small notch or groove formed in the valve 6 itself.

Taking into consideration the moment when the injection has just been completed, it is observed that the check valve 1 is about to close under the action of the spring 16. At a given moment, taking account of the time occupied in this closing—representing a few degrees of rotation of the crankshaft since the valve has a very light weight—the cam 2 will begin to open the admission valve 3 of the pump. Thereupon the fuel compressed in the pipe 4 will expand, and the quantity corresponding to this expansion will pass through the groove 5 of the discharge valve 6 and will return to the suction end.

The portion of the passage 8 situated between the check valve 1 and the atomizer valve 7 will thus remain under pressure as is necessary to prevent the formation of vapor under the action of the heat transmitted by the engine. The fuel contained in the pipe 4 being out of contact with the heated portions need not be maintained under pressure. By reason of the pressure remaining in the space 8, it is observed that the drawback arising from a prolonged injection is not entirely overcome, but it will be remarked that the volume 8 is or may be very small. In practice it will be given the tenth or the twentieth part of the volume of the pipe 4. In this manner, a considerable improvement will now have been made. However, means adapted to obviate the slight remaining drawback will be set forth hereunder.

The groove 5 has a very small cross-section, and for this reason it is found preferable to make use of a groove in the valve in preference to an orifice which is subject to clogging. The said groove is made of small size for two reasons, firstly, it is required to oppose as much as possible the output of fuel in back movement in order to prevent an impact or ram action which might set up cavities or pockets therein, and secondly, it is especially required to be able to effect the priming of the pump. To carry out this latter operation, the coupling member 9 is unscrewed by several turns to permit the air and then the fuel to escape freely through orifices such as 10. The pump is actuated by any suitable means, for instance by hand operation of the motor with the relief cock open. By reason of the small size of the groove 5 compared with that of the admission valve 3, the pump may be operated without any other pressure than what is represented by the height X of the liquid, in spite of the presence of the groove 5. When all the air has been expelled and the liquid fuel is seen to spout freely from the apertures 10, the coupling member 9 is screwed tight without stopping the engine, and the entire installation is now in working order.

It has already been remarked that the pump return orifice 5 should have an extremely small size chiefly in order to enable the priming operation to be effected by the use of the perforated nut 9, and that it is preferable in this case to form a groove upon the valve 6 rather than an aperture in the said valve or in the pump body, for it would be a very difficult matter to form such an aperture under these conditions.

This consideration will however no longer hold good in the case of the modified form shown in Fig. 4 wherein 20 indicates the body of the pump, 21 the pump chamber proper, 22 the valve, 23 the guide piece for the valve forming a delivery coupler, 24 and 25 two small orifices which are made as small as practical conditions of construction will permit and afford a communication between the pump and the delivery pipe, the orifice 25 opening rearwardly of the valve 22; 26 a screw needle valve for stopping the orifice 24; 27 a small packing member for the fluid-tight working of the member 26, and 28 the milled head for operating the said needle valve.

The above-mentioned device is operated in the following manner. The apertures nut 9 disposed on the atomizer remains closed, and as concerns the present purpose it has now no longer any reason to be provided with such aperture as 10 (Fig. 1). The needle valve 26 is closed. The pump may now be actuated by hand or other means, and it will operate as if the orifices 24, 25 did not exist. The engine may be started under these conditions, the needle valve being opened only after a few moments' running, in order to be assured that all the air has been expelled from the pipe 4. It should be observed that the needle valve 26 is used not only for opening and closing the passage 24, 25, but also for an experimental adjustment of the flow section which should be sufficiently small for the reason above stated and likewise for the following reason. At the moment of the opening of the admission valve 3 which takes place mechanically in the upward direction or outwardly of the body of the pump, the movement of the head of the valve produces a slight vacuum in the said body of the pump, and this may give rise to gas bubbles, but these latter, should any such occur, are then expelled by reason of the closing movement of the valve. To carry this out, it is necessary that they should be situated at the upper part, and therefore no such gas bubbles should be formed in the piping. The means of communication is made small either by the use of the groove 5 or the needle valve 26, whereby the said piping is not affected by the said vacuum, and should any cavities or pockets be produced these will be limited to the place wherein the variation in volume shall occur, that is, to the region situated upon the valve head 3 itself.

It might be supposed that the above-mentioned effect could no longer be produced, since in fact during the lift of the valve 3, the fuel arriving from the piping is caused to flow towards the pump body while expanding. This is only true to a certain extent, for the expansion of the fuel is extremely rapid and only occupies the very first moments of the phase of the valve lifting, or perhaps one-twentieth of the total lift, even at the highest running speeds, this being given as an approximate order of magnitude. The benefit obtained is there-

fore substantially negligible for the present purpose, but for another purpose this is not altogether true. The formation of cavities may result not only from the vacuum itself but also from the shock upon the valve at the moment of opening. It is not possible to open a valve in any practical mechanism except by a slight shock, even though this may be reduced by the proper design of the cam profile. This shock will produce a pocket, but at this precise moment the back flow of the fuel will no doubt aid in opposing its formation.

Mention has already been made of a disposition for obviating the slight loss occasioned by the pressure remaining at the end of the injection in the space 8 comprised between the atomizer valve 7 and the check valve 1. This loss may be reduced in practice to ½ to 1% of the full load consumption. In the case of small engines, by reason of the difficulty in constructing the device to be described hereunder and likewise the small absolute value of the fuel lost, this approximate result may be considered as satisfactory. But this is not the same for high power engines, and in such cases the following device may be employed.

In this device a second valve 12, Fig. 5, connects the space 8 with the pipe 4, but this valve opens in the contrary sense to the valve 1 and is provided with a suitably calibrated spring which is proportionally weaker than the spring 11 of the valve 7 with reference to the size of the valve heads. In this manner the fuel under pressure at 8 is enabled to partially expand in the pipe 4 until a pressure is reached such that the valve 7 cannot be lifted even when the cylinder is entirely evacuated, but this pressure is still sufficient to prevent the formation of vapor, as has been herebefore indicated. The simplest method is to dispose this additional valve within the valve 1 as shown in Fig. 5, wherein the valve 1 contains the small additional valve 12 with a fluted guide piece 13 and a spring 14. The discharge takes place through the orifices 15.

It will be observed that if this device works in the proper manner, the valve 1 thus arranged may be disposed at any suitable point on the piping and not necessarily in immediate proximity to the atomizer. It may therefore be disposed upon the pump itself as a substitute for the discharge valve 6.

Having now described my invention, what I claim as new and desire to secure by Letters Patent is:

1. An apparatus for injecting liquid fuel into the cylinder of an internal combustion engine comprising a pump, an inlet valve and a piston for said pump, cams operating said inlet valve and piston, an automatic discharge valve, the inlet valve and outlet valve being adapted to open outwardly with respect to the pump barrel, a fuel atomizer having a valve adapted to open outwardly under the fuel pressure, a discharge pipe connecting the discharge valve to the atomizer and a check valve mounted in said discharge pipe, between the atomizer and the discharge valve and in close proximity to the atomizer, said check valve opening towards the atomizer, a small orifice being provided to afford a constant communication in operation between the pump barrel and the adjacent part of the discharge pipe.

2. An apparatus for injecting liquid fuel into the cylinder of an internal combustion engine comprising a pump, an inlet valve and a piston for said pump, cams operating said inlet valve and piston, an automatic discharge valve, the inlet valve and outlet valve being adapted to open outwardly with respect to the pump barrel, a fuel atomizer having a valve adapted to open outwardly under the fuel pressure, a discharge pipe connecting the discharge valve to the atomizer and a check valve mounted in said discharge pipe, between the atomizer and the discharge valve and in close proximity to the atomizer, said check valve opening towards the atomizer, a small orifice being provided to afford a constant communication in operation between the pump barrel and the adjacent part of the discharge pipe, a vent orifice opening to the atmosphere being provided on the discharge pipe and means for closing said orifice when desired.

3. An apparatus for injecting liquid fuel into the cylinder of an internal combustion engine comprising a pump, an inlet valve and a piston for said pump, cams operating said inlet valve and piston, an automatic discharge valve, the inlet valve and outlet valve being adapted to open outwardly with respect to the pump barrel, a fuel atomizer having a valve adapted to open outwardly under the fuel pressure, a discharge pipe connecting the discharge valve to the atomizer and a check valve mounted in said discharge pipe, between the atomizer and the discharge valve and in close proximity to the atomizer, said check valve opening towards the atomizer, a small orifice being provided in the pump body to afford a communication between the pump barrel and the adjacent part of the discharge pipe and means for controlling said small orifice.

4. An apparatus for injecting liquid fuel into the cylinder of an internal combustion engine comprising a pump, an inlet valve and a piston for said pump, cams operating said inlet valve and piston, an automatic discharge valve, the inlet valve and outlet valve being adapted to open outwardy with respect to the pump barrel, a fuel atomizer having a valve adapted to open outwardly under the fuel pressure, a discharge pipe

connecting the discharge valve to the atomizer and a check valve mounted in said discharge pipe, between the atomizer and the discharge valve and in close proximity to the atomizer said check valve opening towards the atomizer, a small auxiliary valve mounted in the check valve and opening in the opposite direction to the latter, a small orifice being provided to afford a constant communication between the pump barrel and the adjacent part of the discharge pipe.

In testimony whereof I have signed my name to this specification.

EUGÈNE HENRI TARTRAIS.