Jan. 3, 1933. E. H. TARTRAIS 1,893,457

SPRAYING AND INJECTING DEVICE FOR INTERNAL COMBUSTION ENGINES EMPLOYING LIQUID FUEL

Filed Nov. 26, 1929

Fig. 1

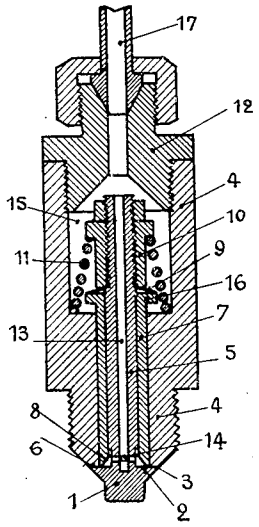


Fig. 2

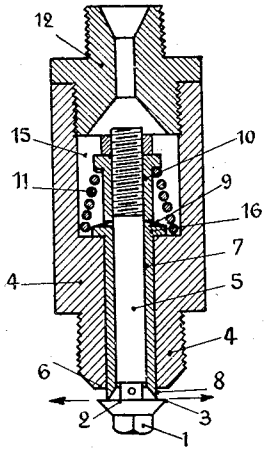


Fig. 3

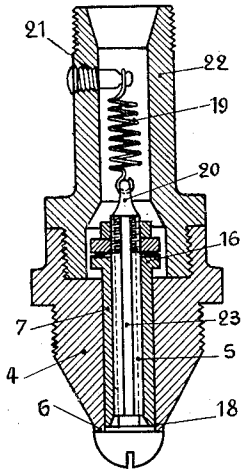


Fig. 4

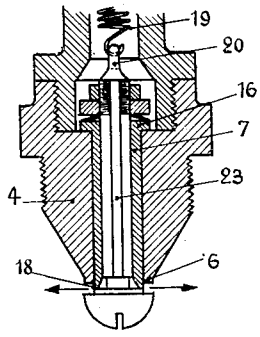


Fig. 5

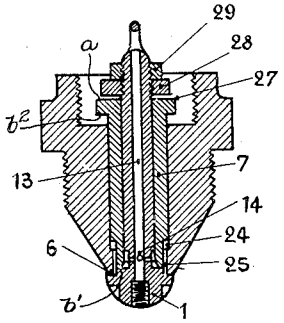


Fig. 6

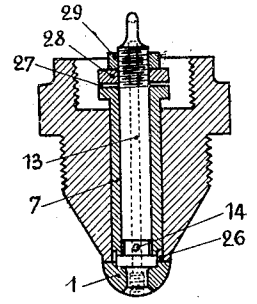


Fig. 7

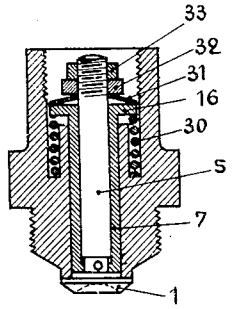


Fig. 8

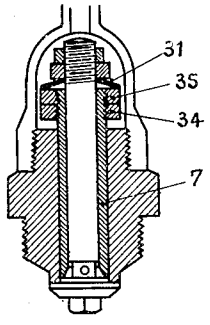
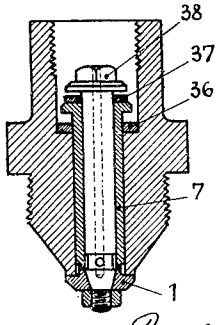


Fig. 9



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UNITED STATES PATENT OFFICE

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SPRAYING AND INJECTING DEVICE FOR INTERNAL COMBUSTION ENGINES EMPLOYING LIQUID FUEL

Application filed November 26, 1929, Serial No. 409,891, and in France November 26, 1928.

The present invention relates to spraying devices adapted to be used in connection with internal combustion engines provided with means for the injection of liquid fuel, in which the injection is controlled by the injection pump itself, according to the principle of "solid injection", that is, without the use of compressed air. These devices essentially comprise a valve adapted for automatic opening by the pressure of the fuel which is delivered by the pump, in such manner that the fuel will escape with great force in the form of a thin sheet of flat or tapered form which becomes broken up and subdivided when discharged against the compressed air contained in the cylinder head of the engine.

The chief object of my invention is to provide an injection device of the type described whose operation may be safe and satisfactory.

Another object of my invention is to prevent, in a device of that type, the formation of carbon deposits at the orifice of injection of the device.

Still another object of my invention is to provide a device of that kind in which the injection valve is suddenly opened along its whole periphery so that the flow of the fuel may be suitably distributed along the whole periphery of said valve.

The spraying device according to my invention comprises: a main body provided with a cylindrical guide terminated at the end adjacent to the engine by a large valve seat; a sleeve which is fitted into said guide and is freely slidable therein, while operating in such manner as to prevent leaks with or without packing, which sleeve receives the spraying valve and comprises on the engine side a small seating for the said valve and on the pump side a shoulder adapted to make contact with the sprayer body; and finally a spraying valve cooperating with two seats the smaller of which constitutes a sprayer and the larger of which is in contact in the inoperative position with the body of the spraying device. Means can be provided by which said sleeve will be secured to the spraying valve during a part of their stroke, and by which the valve will be separated from the smaller seat only at the end of the said stroke. Other means can be employed to return the combination of the sleeve and valve to the original position after the fuel has been injected.

Preferred embodiments of my invention will be hereinafter described with reference to the accompanying drawing, given merely by way of example, and in which:

Fig. 1 is a vertical axial sectional view of a first embodiment of my invention, the device being at rest;

Fig. 2 is a corresponding view of the device according to my invention at the beginning of the operation thereof;

Figs. 3 and 4 are vertical axial sections, corresponding to Figs. 1 and 2 respectively, and illustrating another embodiment of my invention;

Figs. 5, 6, 7, 8 and 9 are vertical sectional views illustrating several other embodiments of my invention.

1 is a spraying valve which comprises a flat seat 2 and a sharp edge 3 (see French Patent 488,099). Said seat is in contact upon its whole surface with the main body of the sprayer 4 which is provided with a seat 6 for this purpose. Between the stem 5 of the valve and the body 4 is inserted a movable sleeve or ring 7 which is practically without lateral play in the said body and comprises a seat 8 having a knife-edge form; said sleeve is held in contact with the valve by a spring 9 which may have the form of a spring washer, and said spring rests upon a nut 10 which is screwed to said valve. Said nut is also subject to the pressure of a spring 11 which rests upon the body 4. The fuel is supplied through coupling plug 12 and reaches the spraying end through conduit 13 and holes 14, which latter may be replaced by grooves.

The operation is as follows:—It will be supposed that the injection pump comprises a known arrangement for by-passing fuel from the inlet conduit 13 between injections (see for instance French Patent 528,931) or any other arrangement serving the same purpose. When the pump starts delivering fuel, the pressure in the space 15 will then be either the atmospheric pressure or the slight pressure of a feed pump, if such a pump is used

to supply the injection pump. In all cases, owing to the force of spring 11 and also to the pressure of the gas acting upon the head of valve 1, said valve is closed, and is in the position shown in Figure 1. When the pump starts the delivery, there is at first no discharge, but only a displacement of valve 1 together with sleeve 7. These now have the position shown in Figure 2, since sleeve 7 is held against 1 by spring 9. The pump continuing to deliver liquid, and ring 7 being stopped by shoulder 16, valve 1 opens and the fuel is sprayed. After this has taken place, the discharging device of the fuel conduit now operates, and the whole of the compressed fuel contained in the spraying device will expand. The device then suddenly returns to the position of Figure 1.

Figures 3 and 4 show, in the inoperative and operative positions, respectively, a modification in which the valve with a special seat similar to that described in French Patent 488,099 is replaced by an ordinary valve having a seat 18 of a flat or a tapered shape, but which is preferably somewhat narrow. It is better adapted than the one shown in Figs. 1 and 2 for the purpose specified in the preamble, that is, to protect the spraying orifice against carbon deposits. This result is evidently obtained, as the orifice 18 is opened only for very short instants, and besides, there is no place for the carbon deposits to collect, as is clearly shown in the figures.

As shown in Figures 3 and 4 by way of example, the apparatus no longer employs a compression spring such as 11 (Figure 1) but comprises a draw spring 19 attached at one end to a ring 20 provided at the end of the valve, and at the other end to a stud 21 which is screwed and rivetted to cap 22; the valve stem is grooved at 23 to provide a passage for the flow of the fuel.

As above stated, one of the chief advantages of my invention lies in the protection of the apparatus against carbon deposits. Other advantages although specified as accessory are still of an important nature.

With valves of the usual known types, whatever may be the form of its seating, it is extremely difficult to obtain a good spraying, as the valve opens to a very slight extent, and the frictions of the stream of liquid upon the walls of the spray discharge orifice have a great importance. For this reason, and also since it is very difficult to obtain a uniform opening around the seat, the spraying is defective, and often takes place only on a part of the circle. In the device, according to my invention, on the contrary it will be noted that when sleeve 7 is suddenly stopped by the contact of shoulder 16 with the body 4, valve 1, which has been put in action, is not at once stopped, and it thus opens abruptly and positively, and to a sufficient degree that the difference in the aforesaid sections, due to imperfect construction, may be negligible. If desired, the said lift can be limited by accurately regulating the amount of motion of said spring washer 9 or by any other means, and thus spring 9 need not be strong. For all these reasons, the amount of opening of valve 1 will be at once very large. The fuel compressed in the spraying device and its conduit will suddenly expand and will thus escape through this abruptly formed opening as if impelled by an explosion. Then the device is suddenly unbalanced and the pressure at 15 becomes too small for the force of spring 11, so that the device consisting of valve 1 and sleeve 7 will at once recede into its guide. Shoulder 16 is no longer in contact with the main body of the sprayer. The aforesaid actions must necessarily recommence while the pump still feeds in order that the valve 1 may again open, and it will open in the same conditions, that is with the same explosive effect. All such actions will occur several times during the course of the same injection, which will thus be subdivided into a series of partial injections whose force is much increased, and the efficiency of the device will thus be considerably increased. This action, which is very marked at slow speeds, becomes less sensible as the speed increases, due to the inertia of the masses, and will finally disappear, at high speeds.

The amplitude of the beats of the valve will depend upon numerous factors, such as masses, pressures, force of springs, compressed volume, and pump volume, and in certain constructions it may happen that the speeds of rotation which are sufficiently slow to permit several observed beats per injection, may be found useless in practice. However the abrupt opening of the valve and the resulting explosive effect of the compressed liquid will always take place at least once, and this is the essential feature.

To this advantage are to be added the following:

In the known single spraying valve, it is usually necessary to add to said valve a supplementary clack valve disposed before said first mentioned valve, since the spraying valve is not sufficiently leakless in itself, and it is necessary to prevent the gas from returning from the cylinder into the sprayer, and hence one valve is not sufficient, but the apparatus requires two valves or even three valves in series, for reasons of safety, since the said valves are subject to rapid wear. Such valves however enclose in the sprayer, after the end of the injection, a considerable amount of fuel at high pressure, and since it is impossible to count upon absolutely leakless conditions for the spraying valve, this fuel expands and issues through the said valve, chiefly during the relatively long period of the discharge of the gas from the cylinder. This loss is not

negligible, and it is entirely obviated by the present arrangement. No clack valve is used before the spraying valve, and the whole of the fuel thus expands towards the pump immediately after the end of the injection. Leakless conditions are assured by seat 6 alone, and the latter will be maintained in proper condition, since it is not subject to any wear produced by the liquid. Finally, taking due account of the elimination of the aforesaid accessories, the aforesaid apparatus is of a simpler nature and can be more readily constructed in an accurate manner; it is less affected by imperfections, and has a longer duration.

Figure 5 shows a modification of the apparatus. Herein the spring 9 between the sleeve and the valve is eliminated, and the apparatus comprises a sleeve 7 having two diameters, so that the force exercised upon the face a of said ring in the downward direction (according to Fig. 5) by the pressure of the liquid will exceed the pressure which is upwardly exercised upon the faces b^1 and b^2, the pressure upon b^1 being due to the fact that the seating of the spraying valve cannot be considered as perfectly leakless and subsequently a certain amount of liquid fuel may escape between the valve and its seating. In order to prevent all back-pressure at 24, which could result from compression of fluid enclosed therein one or two slots 25, leading from spaces 24 to the inner face of the seat 6, or a very slight play at this point allow the fluid that may be compressed in said spaces 24 to leak out into the cylinder when the pressure in the latter is at a minimum.

However, the construction of a sprayer body with a guide having two diameters for said sleeve 7 offers various difficulties, considering the very accurate adjustment which is required. For this reason it may be preferable to employ the arrangement shown in Figure 6 which serves the same purpose, but in which sleeve 7 alone has two diameters.

In the two embodiments shown in Figures 5 and 6, the spring 9 is eliminated, and the amount of opening of the valve is limited by the play 27 which can be regulated by nuts and lock nuts 28—29. The figures do not show the principal spring, which has the form represented at 19 in Figure 3, nor the upper part of the sprayer. Figure 6 shows another embodiment, comprising a separate valve head 1 secured to stem 5.

In a modification which is shown in Figure 7, the return spring 30 of the valve no longer acts upon the valve 1 but upon sleeve 7. It is obvious that in this case the spring 31 disposed between sleeve 7 and the nuts 32—33 on the stem 5 of the valve must have such force relatively to the spring 30 that it will not act before the shoulder 16 makes contact with the main body of the sprayer.

It has been already stated that when the spraying valve opens suddenly there is produced a sudden discharge due to the expansion of the fuel compressed in the spraying device, but this is not the only cause, another being the momentum (vis viva) of the fuel in movement in the tube—usually long and narrow—which connects the pump to the spraying device. The momentum of the fuel may be the only factor relied upon to produce said sudden discharge, and in that case it will readily be understood that the whole of sleeve 7 and valve 1 needs oppose so great a resistance to its being displaced towards the inside of the cylinder, that spring 30 of Figure 7 (or the springs 19 or 11 of Figures 3 and 1) may be dispensed with. Such an arrangement is shown by way of example in Figure 8. Only the spring 31 is retained, but, of course, it is rather weak. As shown in Fig. 9 this spring may also be eliminated by the use of the device shown in Figures 5 and 6 comprising a sleeve 7 of two different diameters. In these last two examples Figs. 8 and 9 the gas pressure in the cylinder returns the device to the position of complete closing. It is obvious that under these conditions the discharge conduit leading from the pump to the spraying device, and the spraying device itself, are sufficiently by-passed between two injections, as stated, to make only during this time, the pressure of the fuel in said conduit always below the pressure of the gas in the cylinder.

In the embodiments of Figs. 8 and 9, the operation is as follows: Upon the injection pump starting to deliver fuel, the pressure of the fuel in the spraying device increases until it is equal to the pressure in the cylinder. At that moment, the whole of sleeve 7 and stem 5 is set in motion and valve 1 is separated from seat 6 in the manner above described concerning the embodiment of Fig. 1. At that time the momentum (vis viva) of the fuel has become great enough to ensure a sudden discharge of said fuel into the cylinder.

The last two figures also represent by way of example various methods of regulating the stroke of sleeve 7 and of valve stem 5; in an engine having several cylinders, this stroke of sleeve 7 must be exactly the same for all of the cylinders, since it affects the volume of the injected fuel. In Figure 8, the regulating is effected by a nut and a lock nut 34—35 which may be adjusted in position along a threaded part of sleeve 7, so as to vary the distance between the lower nut 34 and the shoulder of the main body. In Figure 9, the same result is obtained by means of a washer 36 of suitable thickness and 37 is a washer for the adjustment of the lift of the spraying valve. The valve 1 is mounted at an end of its stem which is provided, at the other end, with a head 38 which receives the shock. Obviously, the said arrangements may be combined with those

already described. It is impossible to represent all such combinations, and in general, all modified constructions, as the invention is not limited to the strict use of the said mechanical devices which serve solely to indicate the principle of the invention. It may however be stated, without figures, that the accurate adjustment of sleeve 7 in its guide may be obviated by the use of any of the known leakless packing devices of a metallic or a plastic nature.

What I claim is:—

1. An injecting and spraying device of the type described comprising in combination, a casing provided with a cylindrical hole, means for conveying fuel into said casing, a sleeve adapted to slide in said hole, means for limiting the outward displacement of said sleeve, a stem adapted to slide within said sleeve, a valve head integral with the outer end of said stem and normally applied against the correspnoding extremities of said sleeve and of said casing, said stem being so shaped as to provide a fluid connection between the interior of said casing and the space between said valve head and the corresponding extremity of the sleeve, and means for limiting the outward displacement of said stem within said sleeve.

2. An injection and spraying device of the type described comprising in combination, a casing provided with a cylindrical hole, means for conveying fuel into said casing, a valve seat at one extremity of said casing, a sleeve adapted to slide in said hole, means for limiting the outward displacement of said sleeve, a stem adapted to slide within said sleeve, a valve head integral with the outer end of said stem, and normally applied against said valve seat and the extremity of said sleeve, said stem being provided with a longitudinal conduit opening at one end into said casing and at the other end into the space existing between said valve seat and said extremity of the sleeve, and means for limiting the outward displacement of said stem within said sleeve.

3. An injecting and spraying device of the type described comprising in combination, a casing provided with a cylindrical hole, means for conveying fuel into said casing, a valve seat at one extremity of said casing, a sleeve having a sharp edged extremity normally in the same plane as said valve seat, said sleeve being so fitted in said hole as to be capable of sliding therein, means for limiting the outward displacement of said sleeve, a stem adapted to slide within said sleeve, a valve head integral with the outer end of said stem so as to be located outside said casing, said stem being provided with a longitudinal conduit opening at one end into said casing and with a transverse passage connected with said conduit and extending throughout said stem close to the active surface of said valve head, and means for braking the outward displacement of said stem within said sleeve.

4. A device according to claim 3 further comprising elastic means for applying the valve head against said seat.

5. A device according to claim 3 further comprising a spring for applying the valve head against the valve seat.

6. A device according to claim 3 further comprising an elastic connection between said sleeve and said stem for applying said valve head upon said sharp edged extremity of said sleeve.

7. A device according to claim 3 in which the means for limiting the outward displacement of the sleeve comprise a shoulder on said sleeve adapted to cooperate with the bottom of said casing.

8. A device according to claim 3 in which the extremities of the sleeve have different diameters so as to produce a differential action.

9. An injecting and spraying device of the type described comprising in combination, a casing provided with a cylindrical hole, means for conveying fuel into said casing, a valve seat provided on the outer end face of said casing, a sleeve having a sharp edged extremity, a shoulder at the other extremity of said sleeve adapted to cooperate with the bottom of said casing so as to limit the outward displacement of said sleeve in said hole, a stem adapted to slide within said sleeve, a valve head integral with the outer end of said stem so as to be located outside said casing, said stem being provided with a longitudinal conduit opening at one end into said casing and with a transverse passage connected with said conduit and extending throughout said stem close to the active surface of said valve head, a nut screwed upon the inner end of said stem, a spring washer interposed between said nut and the above mentioned shoulder of the sleeve, a shoulder on said nut, and a spring interposed between said shoulder and the bottom of said casing for limiting the outward displacement of said stem within said sleeve.

10. An injecting and spraying device of the type described comprising in combination, a casing provided with a cylindrical hole, means for conveying fuel into said casing, a valve seat provided on the outer end face of said casing, a sleeve having a sharp edged extremity adapted to slide in said hole, a shoulder at the other extremity of said sleeve adapted to cooperate with the bottom of said casing so as to limit the outward displacement of said sleeve in said hole, a stem adapted to slide within said sleeve, a valve head integral with the outer end of said stem so as to be located outside said casing, said stem being provided with a longitudinal conduit opening at one end into said casing and

with a transverse passage connected to said conduit and extending throughout said stem close to the active surface of said valve head, a nut screwed upon the inner end of said stem, a spring washer interposed between said nut and the above mentioned shoulder of the sleeve, a spring secured to the inner end of said stem and to said casing for braking the outward displacement of said stem within said sleeve.

11. A device according to claim 3 in which the means for limiting the outward displacement of said stem within said sleeve are adjustable so as to make it possible to vary said displacement.

12. A device according to claim 3 in which the means for limiting the outward displacement of said stem within said sleeve comprise a nut screwed to the inner end of said sleeve, a lock nut for fixing said nut in the desired position, and a stop provided on the inner end of said stem and adapted to cooperate with said nuts.

In testimony whereof I have signed this specification.

EUGÈNE HENRI TARTRAIS.