May 21, 1935. A. BAJ 2,002,134

FUEL SPRAY INJECTION FOR INTERNAL COMBUSTION ENGINES

Filed Dec. 8, 1932

Fig. 1.

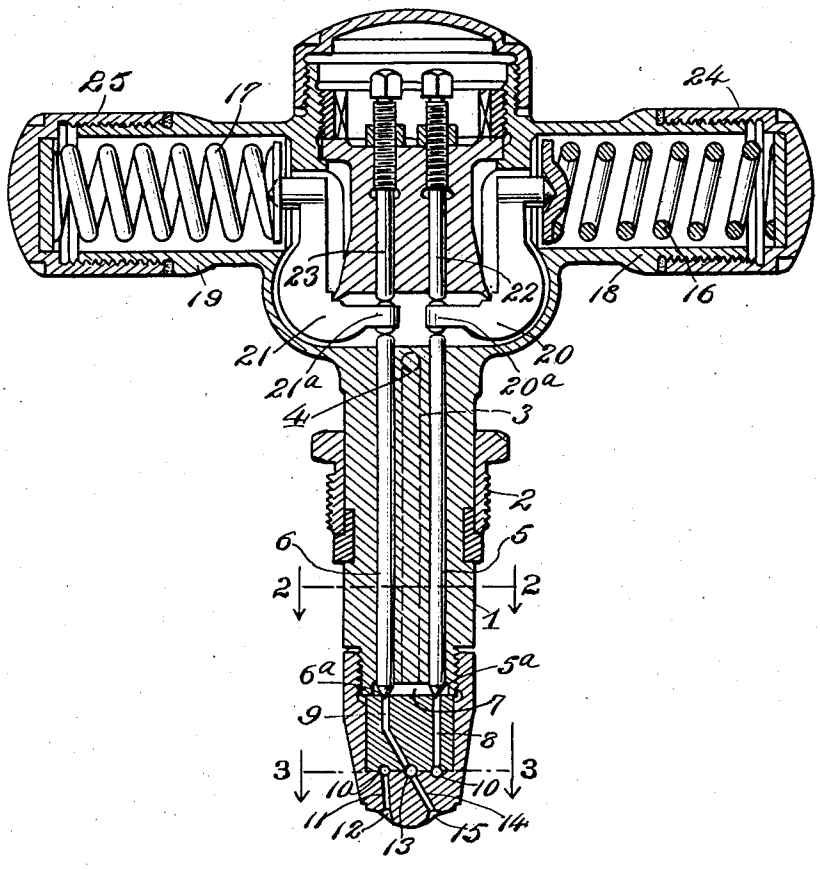


Fig. 2.

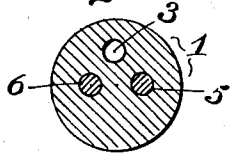


Fig. 3.

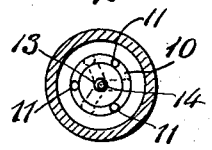
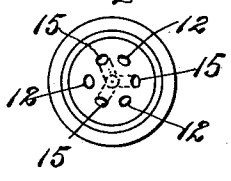


Fig. 4.



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FUEL SPRAY INJECTION FOR INTERNAL COMBUSTION ENGINES

Alessandro Baj, Milan, Italy

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In Italy December 9, 1931

1 Claim. (Cl. 299—107.5)

The present invention is a novel apparatus or device for reducing fuel to spray in internal combustion engines working by injection.

In general, it can be said that, in internal combustion engines, for every speed and load, there corresponds a type of fuel spray which gives the maximum result.

The type of spray depends on the duration of the injection, on the diameter of the minute drops of the sprayed fuel and on their velocity.

As a first approximation, the load, the duration of the injection (computed as the angle of movement of the lever) and the quantity of the fuel injected, are directly related to each other; having then, established a rule governing the introduction of the fuel at different speeds the diameter of the drops and their velocity would depend on the speed and on the manner in which the reduction to spray is performed.

In fact, the best result depends on the smallness of the diameter of the drops, if one considers that the time taken by the drops to burn depends on their size; but this time depends also on their velocity, (that is on the quantity of air through which they travel and with which they come in contact) therefore the time and also the speed with the time, are related to the diameter and the velocity of the drops.

When the reduction to spray is obtained by making the fuel pass through fine holes, the diameter of the drops of spray depends on the pressure and on the diameter of the holes, while their velocity depends on the diameter and number of the holes and on the quantity of fuel injected per cycle; that is, on the fuel load.

From the need of efficiency, the diameter and velocity of the drops depend on the speed, therefore it clearly follows that the best combustion and, with that, the efficiency of the engine at various speeds and loads, depend directly on the type of reduction to spray, and this type of reduction depends on the diameter and number of holes in use, and, for a given angular setting, and a given quantity of fuel injected it depends on the pressure of the injected fluid.

As a second approximation, from the examination of the phenomenon of the reduction to spray of the fuel at various loads and speeds, it would appear that the various elements which determine the type of reduction are all more strictly related to each other than would appear from the first analyses made. It is however always true that if one wishes to regulate the type of reduction independently of the quantity of fuel injected, that is, of the load, one must be able to vary and regulate not only the pressure of the liquid but also the diameter and number of holes in use.

This is obtained through the use of the device according to this invention, which carries out the method indicated.

The device mentioned comprises a sprayer with many holes and with many needles having limited travel.

The needles work at different pressures since the counter forces or resilient means pressing on the needles are different. When the needles rise they allow the fuel to pass through the injection holes, reducing itself to fine spray; these holes may be one or more in number for each needle.

At the starting of each action the pressure of the fuel rises until it succeeds in raising the first needle, which has a limit to its rising movement. When the first needle has reached its maximum lift, the fuel pressure further rises until it makes the second needle work, this also being combined with a member limiting its travel, and so on to the last needle.

By suitably choosing the number of needles, the weights or resilient resistance on them, and their travel, as well as the number of spray holes, their diameter and disposition and their correspondence with the respective needles, it is possible to obtain various types of spray which, at given speeds and loads give the greatest efficiency.

Such inventive conceptions can, naturally, be realized in various ways of constructing and arranging the device according to the invention.

One of such forms, presenting some constructive features is shown in the attached drawing solely by way of example.

Fig. 1 is a longitudinal section of the spraying device.

Fig. 2 is a transverse section along line 2—2 of Fig. 1.

Fig. 3 is another transverse section along line 3—3 of Fig. 1.

Fig. 4 is a projection of the extremity of the actual true sprayer.

The device has the usual body 1, made to screw into the head of the engine cylinder by the threaded part 2.

Three longitudinal holes are bored in the body 1, of which one, 3, is designed to receive and conduct the fuel arriving by inlet opening 4 while the other two serve as ways for two needle-valves or rods 5 and 6. The channel 3 leads and delivers into the cavity or fuel chamber 7 from which take off the small channels 8 and 9

the inner ends of which constitute valve seats normally closed and controlled by the tapered ends 5a and 6a of the needle-valves 5 and 6.

The channel 8 opens into a small annular chamber 10 from which small channels 11 take off which lead to a given number of spray holes 12 (in the example given there are three). The channel 9 opens into another small chamber 13, shown as central, from which the small channels 14 take off to a separate set of spraying holes 15 (also three shown in the example).

The two needle-valves or rods 5 and 6 are differently loaded or pressed to their seats; in the example this pressing is by means of corresponding adjustable springs 16 and 17 set in hollow extensions 18 and 19 of the body 1. These springs act on the rods 5 and 6 through bell-crank levers 20 and 21 having central pivots, and inward and upward arms and whose contact ends or extremities 20a and 21a press on the upper extremities or contact ends of the needles. The bell crank inward arms and therefore the needles are controlled in the amount of their rise by stops or limiting members, these being in the example two adjustable screw bolts 22 and 23. The springs press upon the upward arms of the bell cranks, and screwed caps 24 and 25 serve to regulate, in an obvious manner, the compression or load on the springs and hence the resilient resistance or force pressing the needles 5 and 6 to a position closing the corresponding channels 8 and 9.

To load the needle-valves one may, instead of using springs, use other means, for example, a fluid under pressure.

Each valve may control many openings for the spraying of fuel.

The valve stop devices 22 and 23 may comprise springs or other cushioning means.

In general, the details of carrying out the invention, and those of constructing and applying the new device may undergo variations without departing from the scope of the improvement.

What I claim and desire to secure by United States Letters Patent is:

For internal combustion engines fuel spray injection apparatus of the kind comprising injection needle valves each normally closed by resilient or spring pressure but each adapted to be opened by increase of the liquid pressure of the fuel upon the valve and each delivering to the engine by one or more spray orifices; said injection apparatus characterized by a plurality of such injection valves consisting of separate needle rods spaced apart from each other to slide independently along spaced-apart ways to operate with independent actions, all of such valve needles being subject at all times to the same fuel pressure, but having their resilient closing means constructed differently to allow successive independent opening of the several valves as the fluid-fuel pressure increases, and the several spaced-apart valve needles having separate stop means limiting the successive openings of each of the valve needles to a very short movement adequate for injection purposes when open and thereby affording independent instantaneous closing of the respective valves upon decrease of fuel pressure, and means for finely and independently adjusting the stop means for each of the valve needles to limit minutely and accurately the extent of opening of each of the valves.

ALESSANDRO BAJ.