July 23, 1935. F. STEPHAN 2,008,803

FUEL ATOMIZING AND IGNITING MEANS

Filed April 18, 1932 2 Sheets-Sheet 1

Fig: 1

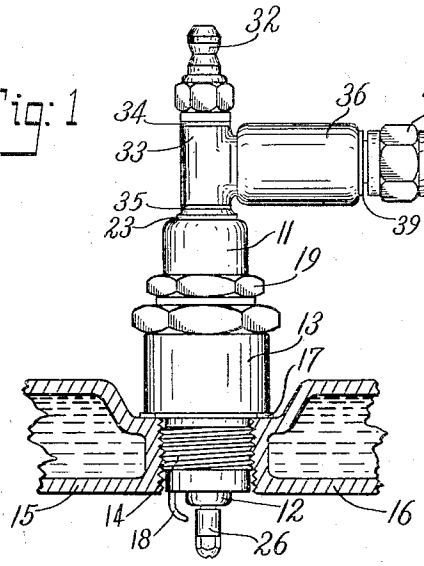

Fig: 2

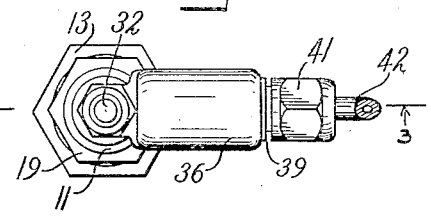

Fig: 5

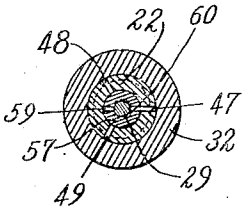

Fig: 3

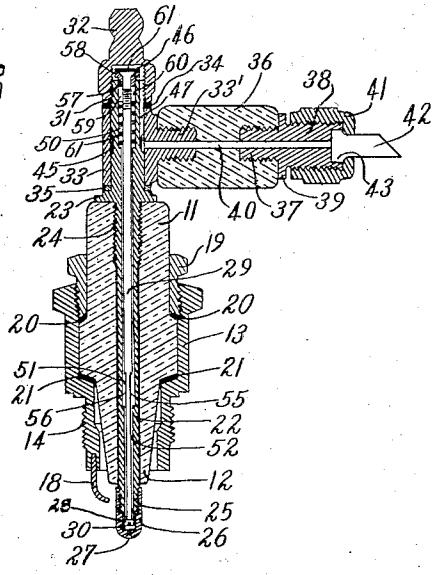

Fig: 6

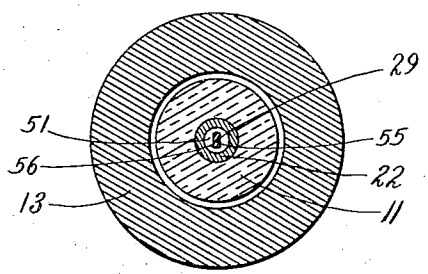

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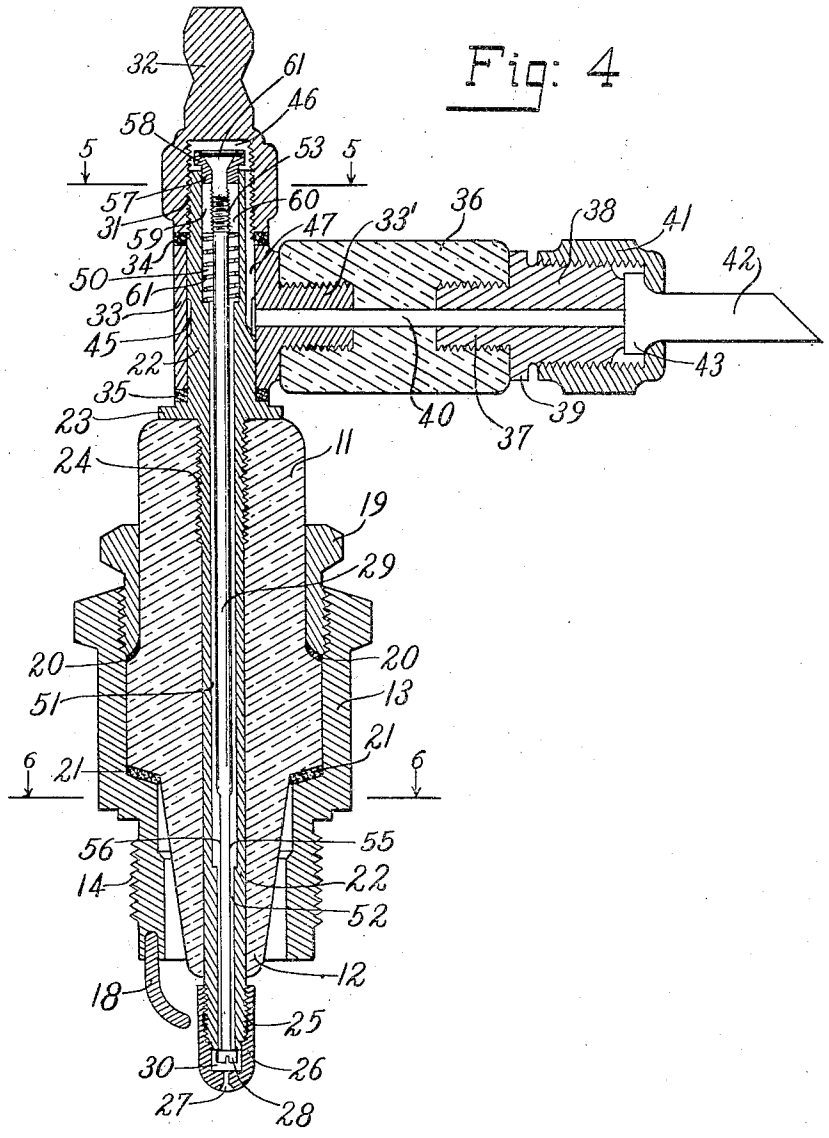
Fig: 4



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Patented July 23, 1935

2,008,803

UNITED STATES PATENT OFFICE

2,008,803

FUEL ATOMIZING AND IGNITING MEANS

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Application April 18, 1932, Serial No. 605,938

5 Claims. (Cl. 123—169)

This invention relates to a device for atomizing and for igniting fuel and may be considered a further development over the device shown in my copending application Serial No. 532,529, filed April 24, 1931.

The device has been developed and designed for positively vaporizing and atomizing liquid fuel, such as fuel oil or the like, for ejecting the atomized fuel in the form of a fine mist or spray into the combustion chamber of an engine cylinder where the fuel is intermixed with air, and for igniting the fuel mixture for the purpose of furnishing the motive power for the engine.

The problem of fuel atomization arises in connection with a great variety of engines, such as the Diesel engine and other internal combustion engines. The elimination of air bubbles from the various conduits and ducts through which the fuel is delivered, and the problem of preventing the dripping of liquid fuel into the cylinder of such an engine might be mentioned as examples of the difficulties experienced with atomizing devices heretofore developed. There are several other problems that need not be mentioned specifically.

My invention presents an improved atomizing device by means of which the drawbacks of prior devices of this character are overcome. The fuel charges can be positively injected into the engine cylinders in metered and measured quantities in accordance with the cycle of the engine, in the form of a fine mist or spray which will readily intermix with air to provide the required fuel mixture for all operating conditions. Another feature which distinguishes my invention from what is known in the art resides in combining the atomizing device with the spark plug, in such a manner, that the fuel mixture will be suitably ignited within the cylinders.

The physical structure of the device may be briefly described as comprising an elongated valve body enclosed in a suitable shell for securing the same to the cylinder of an engine in place of the ordinary spark plug. At the outer end of the device there is secured a fuel line, the attachment of the latter being in radially adjustable relation to the former. The fuel line is thus adjustable while the remainder of the atomizing device is rigidly attached to the cylinder. Within the fuel line is a duct through which fuel in liquid condition is delivered to the atomizing device under pressure and in variably metered and measured quantities. This fuel duct terminates in a plurality of restricted ducts provided on the exterior of the outer end of the valve body, where the fuel line is adjustably secured thereto, for diverting the flow of the fuel within the device for the purpose of achieving reliable fuel delivery and atomization. These restricted grooves or ducts terminate in a fuel chamber where the fuel is collected, the fuel chamber being adjacent to the outer end of the valve body and formed by a removable terminal cap. Within the valve body is a stem carrying a filter which projects into the fuel chamber. At the inner end of the valve stem is a head projecting beyond the valve body into the engine cylinder and closing the opening through which the fuel is finally ejected. Spring means are used for biasing the valve stem so that the opening on the valve body at the inner end thereof is normally closed. Now, when a fuel charge is delivered through the fuel line, the flow of the fuel will be diverted through the restricted ducts or grooves and will collect in the small chamber at the outer end of the valve body. The fuel charge will then rush through the filter and centrally through the valve body, around the valve stem, towards the opening at the inner end of the valve body. The pressure of the fuel charge will actuate the valve stem and the valve plug will be lifted, permitting the ejection of the fuel into the corresponding cylinder. The provision of the small restricted ducts which divert the flow of the fuel in a direction opposite to the direction of the ejection thereof causes a ready elimination of any relatively large air bubbles which might be present in the device upon the initiation of the operation of the engine or during the operation thereof. The ducts are very small and cause the breaking up of the air bubbles. It should be considered in this connection that the fuel charges are very small. Accordingly, a relatively large air bubble contained in the fuel and injected would disturb the smooth operation. A nozzle is secured to the inner end of the valve body covering the valve plug and the ejection opening. The ejection of the fuel is at a place disposed within the cylinder and the nozzle will be subjected to the hot gases while the valve itself enclosed by the nozzle will be cooled by the outflow of the atomized fuel. Secured to the shell body of the device within the cylinder and cooperating with the nozzle on the valve body is an electrode for producing the necessary spark. The nozzle can, of course, be combined with the valve body if desired. A terminal electrode is secured at the outer end of the valve body, holding the fuel line adjustably in place and serving as a terminal cap for attaching the corresponding electric conductor. The valve body serves thus as a current

conductor and represents the companion electrode cooperating with the first mentioned electrode within the cylinder. The invention is illustrated in the accompanying drawings in which

Figure 1 shows the device in elevation as attached to an engine cylinder, certain parts of the cylinder being shown diagrammatically and in cross section;

Figure 2 is a top view of the device;

Figure 3 is a longitudinal cross section taken along the lines 3—3 of Figure 2 and looking in the direction of the arrows;

Figure 4 is an enlarged cross section corresponding to the cross section shown in Figure 3;

Figure 5 is a transverse cross section taken along the lines 5—5 of Figure 4; and

Figure 6 is a transverse cross section taken along the lines 6—6 of Figure 4 and looking in the direction of the arrows.

Like parts are designated by like reference numerals throughout the drawings.

Referring now to the drawings, the device comprises the parts, and operates in the manner specifically described below:

An insulating body 11 having a tapering inner end 12 is disposed within a metallic shell 13 provided with a thread 14 for attachment to the cylinder of an engine such as indicated in cross section in Figure 1 and designated there by the numerals 15 and 16. A washer or gasket 17 may be disposed between the device and the cylinder in order to insure a tight seat. At the inner end of the shell 13 is provided an electrode 18. A tubular nut 19 holds the insulating body 11 in place within the shell 13 as shown. This nut is screwed into the upper portion of the shell 13 and gaskets such as indicated at 20 and 21 may be provided to secure a tight seat of the insulating body 11 within the shell 13, the center portion of the insulating body 11 being larger than the end portions, and furnishing suitable shoulders for the engagement of the gaskets.

An elongated valve housing or body 22 having a flange like enlargement 23 extends through the insulating body 11, being secured thereto by means of a thread 24 as shown. It is understood, of course, that the valve body may be cemented to the insulating bushing 11. The flange like enlargement 23 registers with the outer end of the insulating body 11 and the valve body itself projects beyond the tapering inner end 12 of the insulating body into the corresponding cylinder of the engine.

The inner end of the valve body 22 is provided with a thread 25 and secured thereto may be the nozzle 26. The nozzle has an opening 27 through which the atomized fuel is ejected into the combustion chamber of the cylinder. The nozzle covers the inner end of the valve body and also the valve plug 28 on the valve stem 29 which extends through the valve body 22. The electrode 18 cooperates with the nozzle 26 producing a spark for igniting the fuel mixture within the cylinder.

It may be observed at this point of the description that a small chamber 30 is formed within the nozzle and between the end of the valve body and the valve plug 28. This chamber 30 permits the movement of the valve plug 28 and also contributes towards preventing and eliminating the dripping of fuel into the engine cylinder after injection of the atomized charge. The structure of the valve stem and the operation of the entire valve mechanism will be presently described in detail.

Examining now the outer end of the valve body 22, it will be seen that this outer end is larger than the portion extending through the insulating body 11 and that it is provided with a thread 31. Secured to this thread is the terminal cap member 32 employed for attaching the corresponding electric conductor to the device. The current will thus flow from the terminal 32 through the valve body 22 and a spark will occur within the cylinder at the inner end of the device due to the cooperation of the electrode 18 which is grounded at the engine since the shell 13 is directly attached to the cylinder.

Secured to the outer end of the device intermediate of the enlargement 23 of the valve body and the terminal cap member 32 is the fuel line or fuel delivery member 33. This is a tubular part having a threaded extension 33', the tubular portion thereof fitting slidably over the enlarged outer portion 22 of the valve body. Gaskets such as 34 and 35 are interposed between the tubular part 33 and the shoulder on the valve body 22 and the terminal cap 32, respectively. Secured to the extension 33' is an insulating body 36 engaging the thread on the extension as shown particularly in Figures 3 and 4, and attached to the insulating member 36 by means of a threaded extension 37, is the connecting member 38 having a shoulder or flange 39 which registers with the insulating member 36. The insulating member 36 may be cemented to the corresponding part of the device. The extension 33' on the tubular member 33, the insulating member 36, and the connector 38 form a continuous duct 40 through which the fuel charges are delivered under pressure to the device, to be atomized therein, and to be ejected at the nozzle opening 27 disposed within the engine cylinder. The connector 38 is externally threaded for receiving a tubular nut 41 which secures the fuel line 42 in place by means of the flange 43. It will thus be seen that the fuel line is radially adjustable relative to the atomizer body which is rigidly secured to the corresponding engine cylinder, the radial adjustability being secured by means of the tubular member 33 which is held in engagement with the upper portion of the valve body by means of the terminal cap member 32.

The fuel duct 40 registers with an annular groove 45 on the outer portion of the valve body 22. A plurality of small ducts or notches are provided exteriorly on the outer portion of the valve body 22 and extending from the annular groove 45 longitudinally to the valve body 22 and to the outer end thereof. They terminate in the chamber 46 which chamber is a result of the attachment of the termial cap 32 on the valve body 22. One of these small ducts or notches is shown in Figures 3 and 4 and designated there by the reference numeral 47. If it is assumed that three such longitudinal ducts or notches are provided, extending from the annular groove 45 to the outer end of the valve body 22, the remaining two notches are not visible in the Figures 3 and 4 but have been indicated in the transverse cross section in Figure 5 and appear there designated by the reference numerals 48 and 49. The flow of the fuel charge rushing into the device under pressure through the duct 40 in the adjustable fuel line will thus be diverted angularly toward the outer end of the valve body, flowing through the small ducts or notches 47, 48 and 49 into the chamber 46. Air bubbles which might be present in the device

or in the fuel upon the initiation of the operation or during the operation will be broken up thoroughly as the fuel is forced through these small ducts, eliminating the handicaps and troubles which would result if the air bubbles would be fed to the cylinders.

Let us consider now the structure of the valve disposed within and cooperating with the valve body 22.

The outer, enlarged end of the valve body 22 is provided with a boring 50, merging into a smaller boring 51 which extends through the valve body for an appreciable distance, and finally narrowing down to a boring 52 which continues through the valve body to the extreme inner end thereof. The use of the terms "outer" and "inner" is understood to be relative to the cylinder of the engine. Thus, I designate as the inner end that end of the device which is within the cylinder while the outer end thereof is the end outside of the cylinder. Disposed within the progressively narrowing boring of the valve body is the valve stem 29. This valve stem terminates in the upward direction (as shown in the drawings) in the threaded outer end 53 to which is threaded the member 57 carrying the filter 61, the connection being such as to furnish a free space between the end of the valve stem and the filter for the free flow of the fuel supplied thru the filter. This free space between the filter and the end of the threaded portion 53 of the valve stem is particularly indicated in Fig. 4. The structure and the function of the filter carrying member 57 will be explained presently. The sides of this valve stem 29 are flattened near its inner end as is indicated by the reference numerals 55 and 56. This will be more apparent from a consideration of Figure 6 which is a transverse section along the lines 6—6 of Figure 4. It will be seen that the valve stem 29 is flattened on two opposite sides at its lower end. The tubular valve housing 22 is disposed within the insulating body 11 which in turn is disposed within the shell 13 as previously discussed.

The valve stem carries the plug or head 28 at its inner end which projects from the end of the valve body 22 into the engine cylinder, normally closing the boring 52 which opens into the chamber 30 within the nozzle 26. As intimated above, secured to the outer threaded end 53 of the valve stem 29 is the member 57 having a flange like head 58. The smaller shank portion of the member 57 fits slidingly into the boring 59 at the outer end of the valve body and is provided with longitudinal notches designated by the numerals 59 and 60 and with an internal thread for attachment to the threaded end 53 of the valve stem 29. The member 57 is secured on the end 53 of the valve stem so as to leave a free space between the end of the valve stem and the filter 61. The relative position of the end of the valve stem and the filter is indicated in Fig. 4 by the space between these parts. It will be seen from Fig. 4 that the valve stem stops or terminates somewhat below the line indicated by the reference numerals 5—5. A spring 61 is disposed within the boring 50 of the valve body, resting against the notched shank of the member 57. The force of the spring normally positions the valve stem as shown in Figures 3 and 4, with the valve plug or head 28 closing the valve seat at the inner end of the valve body. The flanged head of the member 57 is provided with a screen 61.

The charge of liquid fuel is delivered in measured quantity through the tubing 42 and rushes under pressure through the duct 40 which registers with the annular groove 45 on the outer portion of the valve body. The flow of the fuel charge is then diverted through the exteriorly disposed grooves or ducts 47, 48 and 49, outwardly into the chamber 46. The pressure of the fuel causes now the operation of the valve stem, that is to say, the valve stem will move in the direction of the ejection of the fuel, the flange like head 58 of the member 57 will be forced against the outer end of the valve body and the fuel will enter through the screen 61 into the member 57 and from there through the grooves or slots 59 and 60 in the shank of this member and over and around the threaded portion 53 of the valve stem 29 into the boring 59 in the valve body. There is no obstruction for the flow of the fuel in the upper portion of the valve body where the spring 61 is disposed. The fuel charge rushes then through the longitudinal boring 51, surrounding the valve stem 29, until it comes to the restricted boring 52 of the valve body. The corresponding inner portion of the valve stem fits slidingly in the boring portion 52. However, the valve stem is flattened on two opposite sides, as indicated at 55 and 56, and the fuel can therefore flow without obstruction through the inner portion of the valve body, and, since the plug or head 28 is at this moment removed from the valve seat, the fuel will rush out into the chamber 30 of the nozzle and will be sprayed into the cylinder through the nozzle opening 27.

When the above described operation is considered in detail, it will be seen that the small notches for diverting the flow of the fuel serve the purpose of breaking up any air bubbles contained in the fuel, thus eliminating this important handicap standing in the way of a proper operation. The size of the various grooves and ducts is chosen large enough to provide for a free and easy flow of the fuel and small enough to effect an elimination of relatively large air bubbles. Any minute particles of dirt will be caught by the screen 61 and deposited in the chamber 46. It is understood, of course, that the nozzle which I have shown secured to the inner end of the valve body has been shown only for the purpose of illustration. Another type of nozzle may be substituted if it is desired, or may be directly combined with the valve body. The function of the nozzle is to eject the fuel in atomized condition, to assist atomization of the fuel, and to prevent the dripping of liquid fuel into the engine cylinder. The nozzle is directly subjected to the heat of the gases within the cylinder and will therefore become quite hot. The nozzle will in this condition obviously assist in the complete atomization and vaporization of the fuel. The valve plug 28 is disposed at the extreme inner end of the device so that a controlled and governed ejection of the fuel is positively effected within the cylinder. The valve plug and the valve seat will be washed by the cool fuel and will therefore remain cool during the operation of the engine in spite of the fact that they are located within the cylinder.

The electric conductor for conducting current to the device may be attached in the usual manner to the head of the terminal cap member 32. The current will be conducted from the terminal through the valve body to the nozzle and the spark will occur across the gap between

the nozzle, or between the end of the valve body and the grounded electrode 18.

Attention may be called to the fact that all parts of the device are adapted to mass production and that the structure of the device lends itself to being readily assembled without requiring any particular expert skill. The device may be readily produced; it is efficient in operation; it requires no adjustment after assembly; and it can be easily taken apart for the purpose of cleaning and inspection. It should also be obserbed that the device is not limited in its use to any particular type of engine, but that it may be employed in connection with several types of engines of the internal combustion class.

Changes may be devised in various details as well as in the mode of assembly without departing from the spirit of the invention. I, therefore, intend to utilized and to exploit the invention in all such modifications as might fall within the scope and meaning of the appended claims in which is stated what is believed to be new in the art.

I claim as my invention:

1. In a device of the class described, a member having a duct for feeding fuel therethrough, a fuel atomizing and igniting member, means for adjustably securing said first member on said second member, a plurality of fuel ducts for diverting the flow of fuel thru said first member to said second member, the flow of fuel thru said ducts being in a direction opposite to the direction of ejection of said fuel, a chamber for collecting the fuel thus fed to said second member, a duct for feeding said fuel thru said second member to the port of ejection thereof, a valve at said port for controlling said fuel ejection and electrode means for igniting said fuel upon ejection.

2. In a device of the class described, a member having a duct for feeding fuel therethru, an atomizing and igniting member, means for adjustably joining said members in a unitary structure, a plurality of ducts formed by said joined members for diverting the flow of said fuel first in an angle of ninety degrees and then in an angle of one hundred eighty degrees, a port on said second member for ejecting said fuel, a valve for controlling said port, a removable nozzle cooperating with said valve and said port, and electrode means cooperating with said nozzle for igniting fuel ejected thru said port.

3. A fuel atomizing and igniting device for attachment to the cylinder of an internal combustion engine adapted to inject predetermined fuel charges in atomized condition into said cylinder and to ignite the same for maintaining the continuous operation of said engine, comprising an elongated valve body projecting with its inner end into said cylinder, a boring within said body, the size of said boring decreasing progressively toward the inner end of said body, a stem disposed in said boring, said stem carrying a plug protruding from said inner end of said body into said cylinder adapted to close the opening thereat, part of said stem extending through said boring being flattened to permit the passage of fuel therethrough, a nozzle secured to the inner end of said body and covering said plug, means for delivering liquid fuel charges to said boring to be ejected through said nozzle, and means cooperating with said nozzle for igniting said fuel charges.

4. A fuel atomizing and igniting device for attachment to the cylinder of an internal combustion engine adapted to inject predetermined fuel charges in atomized condition into said cylinder and to ignite the same for maintaining the continuous operation of said engine, comprising an elongated valve body projecting with its inner end into said cylinder, a boring within said body, the size of said boring decreasing progressively toward the inner end of said body, a stem disposed in said boring, said stem carrying a plug protruding from said inner end of said body into said cylinder adapted to close the opening thereat, part of said stem extending through said boring being flattened to permit the passage of fuel therethrough, a nozzle secured to the inner end of said body and covering said plug, a member adjustably joined to the outer end of said body for delivering liquid fuel charges to said boring to be ejected through said nozzle, a plurality of duct means at the juncture of said member and said body for diverting the flow of fuel in a plurality of relatively minute streams to break up air bubbles contained in said fuel, and means cooperating with said nozzle for igniting said fuel charges.

5. In a device of the class described, an elongated atomizing and igniting member, a central boring in said member, the size of said boring decreasing progressively toward one end thereof, a stem disposed in said boring, part of said stem being flattened to permit the flow of fuel charges through said boring around said stem, a plug on said stem for closing the opening of said boring at one end of said body, means for biasing said stem to maintain said opening normally closed by said plug, a nozzle secured to said body and covering said plug, and means for delivering liquid fuel charges to said member and through said boring to said nozzle.

FRITZ STEPHAN.