UNITED STATES PATENT OFFICE.

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PULVERIZER FOR OIL-ENGINES.

1,157,305.

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To all whom it may concern:

Be it known that I, WILLIAM H. FROST, a citizen of the United States, residing at Erie, county of Erie, State of Pennsylvania, have invented certain new and useful Improvements in Pulverizers for Oil-Engines, of which the following is a specification.

My present invention relates to pulverizers, injectors or atomizers for discharging fuel such as crude oil into the combustion space of an engine, and more especially to that type of engine which fires the fuel charge by the heat of compression.

The object of my invention is to provide a pulverizer, injector or atomizer of improved construction which is capable of finely dividing each fuel charge prior to its injection into the engine, is efficient in its action from no load to full load, and is simple and cheap to construct.

In a device of this character it is of fundamental importance first, to deliver the fuel to the combustion space of the engine in a very finely divided state, and second to discharge the fuel charge received from a measuring device such as a pump as completely as possible on each working stroke of the engine.

For a consideration of what I believe to be novel and my invention, attention is directed to the accompanying description and claims appended thereto.

In the accompanying drawing, which illustrates one of the embodiments of my invention, Figure 1 is a longitudinal section of a pulverizer embodying my invention; Fig. 2 is a perspective view of one of the interior portions of the pulverizers; Fig. 3 is a cross section taken on line 3—3 of Fig. 1; Fig. 4 is a cross section taken on line 4—4 of Fig. 1; Fig. 5 is a cross section taken on line 5—5 of Fig. 1, and Fig. 6 is a view in end elevation of an oil engine fitted with my improved pulverizer.

Referring to Fig. 6, 7 indicates the base of the engine and 8 the cylinder thereof. Located within the cylinder are pistons 9 and 10 which move in opposite directions and are connected by suitable rods with the main shaft. 11 indicates the pulverizer, injector or atomizer which discharges fuel into the combustion space 12 under the control of lever 13 and a cam 14, the latter being driven by the main shaft of the engine.

Referring to Fig. 1, 15 indicates the casing of the pulverizer that is chambered out to receive the parts to be hereinafter described. Located within the casing is a means which acts to break up the fuel into finely divided particles that are subsequently injected into the combustion space 12. This means comprises a plate 16 that is seated on an internal shoulder formed in the casing and a tubular member 17, the latter being seated on the plate. Between the end face of the tubular member and the adjacent face of the plate 16 are capillary ducts 18. These ducts may be formed in the plate or in the member 17, or partly in the plate and partly in said member. As shown, they are formed in the member and are arranged substantially tangential to its bore. This latter feature is advantageous in breaking up the fuel into small particles. Another advantage in the use of a large number of capillary ducts which are closely related resides in the fact that all of the air passing through the bore of said means is active in breaking up the fuel, as distinguished from a column of air acting on a few and rather widely separated fuel streams as would be the case with drilled holes. These capillary ducts should be numerous, and the aggregate cross sectional area thereof should be great enough to carry all of the fuel necessary for maximum load conditions during the interval of time that the needle valve is open to admit fuel to the engine. Making the ducts as described results in a material saving in the cost of manufacture over drilling, and at the same time permits of their being accurately made with ordinary machine tools at low cost. It also permits of their being made smaller than would be practical by drilling. The arrangement also has the advantage that said ducts can be readily cleaned, and due to their large number the liability of trouble due to stoppage thereof is materially reduced.

The tubular member 17 is held in place by a retaining element 19; said element being provided with a cylindrical part 20 which is arranged to slip over the member 17 and be separated therefrom by one or more capillary spaces 21, which space may be annular in form or it may be composed of a large number of longitudinal passages separated by ribs or projections that serve
to center the parts with respect to each other. Owing to its capillary nature it prevents the free entrance of oil into the air passages 24 and chamber 27 but at the same time permits a portion of the air blast to directly assist in forcing fuel into the engine. The left hand end of said element is separated from the plate 16 by an annular capillary passage 22 occupying a plane perpendicular to the axis of the pulverizer. This capillary passage conveys oil from the supply chamber to all the capillary ducts 18 and space or spaces 21. From Fig. 2 it will be seen that the tubular member 17 has rear projections 23 formed thereon with passages between, and the retaining element 19 engages these projections and forces the member 17 against the plate 16. It will also be seen that these projections act as means to hold the left hand end of the retaining element away from the plate 16 and form the capillary passage 22. The retaining element is provided with a plurality of angularly disposed holes 24 as best shown in Fig. 1. The purpose of these holes is to permit high pressure air from the blast receiver to force oil through the capillary space or spaces and capillary ducts into the engine. The parts previously described are held in position within the casing by a follower 25 which is screwed thread at its right hand end into the casing. This follower is provided with centering projections 26 as best shown in Fig. 5, and between these projections are air passages communicating with the blast air chamber 27, the latter receiving air from the conduit 28 which is connected to a blast receiver or air compressor. 30 indicates a needle valve which passes through the center of the casing and engages a beveled seat formed near the left hand end thereof. This valve controls the passages of fuel and compressed air into the engine through the flame plate 31, said flame plate being provided with one or more suitably shaped discharge orifices 32 and the valve stem is guided at its right hand end by a nut 33 which is chambered out to receive a packing 34. The packing is placed under compression by a gland and nut 35. The intermediate portion of the valve stem is guided by the element 19 and the follower 23. It is important from an operative standpoint to guide the stem as fully as possible to prevent it from getting out of alignment, and also to prevent it from wearing out its guides.

It will be noted that the plate 16 and tubular member 17 are provided with a central open ended bore forming a nozzle through which the needle valve extends, there being a relatively small annular air space 36 between the valve stem and the wall of the bore. It will also be noted that the nozzle passage is large in cross section at the right hand end and gradually decreases to about the plane of the discharge ends of the capillary ducts 18 and hence gradually enlarges, thus forming a Venturi tube or device. The object of this arrangement is to accelerate the blast air and cause a lower pressure at the discharge ends of said capillary ducts 18 than exists in the blast chamber 27. It is to be further noted that the ducts 18 instead of being perpendicular to the axis of the needle valve are inclined in the direction of flow of the fluid through the pulverizer. The object of this arrangement is to increase the pulverizing and suction effect of the blast air on the fuel as it flows toward the engine.

Surrounding the retaining element 19 is a fuel containing supply chamber 37 which communicates with the capillary passage 22 and ducts 18. Fuel is forced into the supply chamber from the conduit 38 by a suitable pump driven by the engine or otherwise. The pump should be so constructed and arranged as to maintain the supply chamber 37 full of fuel at all times. On each discharge stroke of the pump fuel will be forced from the chamber 37 through the capillary passage 22 into the capillary space or spaces 21 and ducts 18. It will be seen that the capillary passage 22 feeds fuel to the capillary ducts 18 and to the capillary space or spaces 21 in multiple thereby avoiding excessive friction, the amount passing into the space being determined by the amount discharged from the supply chamber. One advantage in providing the capillary passage 22 and placing it between the supply chamber 37 and the capillary space 21 resides in the fact that in addition to keeping the supply chamber 37 filled it prevents the compressed air from working into it.

When the needle valve is opened by the lever 13 against the action of its closing spring, the air rushes through the conduit 28, chamber 27, holes 34 and through the chamber 36 around the needle valve, a substantial drop in pressure taking place as it flows through said space. Air at substantially admission pressure acts on the oil contained in the capillary space or spaces 21. By reason of the suction effect of air passing through the nozzle and its drop in pressure the direct pressure of the air acting on the oil in the capillary space or spaces 21, an amount of oil corresponding to that delivered by the measuring device or pump on a given stroke will be forced through the flame plate 32 into the combustion chamber 12. In practice the needle valve is only open for a very brief interval of time, for example, from one-fortieth to one-fiftieth of a second, and during the closed period the pump or measuring device forces oil into the relatively large annular chamber 37 causing the same 129.
amount to be forced through the capillary passage 22, into space or spaces 21 and ducts 18. Owing to the fact that the passages 18 and space or spaces 21 are capillary in form, 5 oil is prevented from working out of them so long as the needle valve 30 is closed. By 10 capillary passage, space, or duct, is meant one whose walls are so close together at some point, giving due consideration to the vis- 15 cosity of the fuel, that they serve to prevent the fuel from flowing by gravity from a source of supply to a region beyond.

The compressed air acts on the fuel at two points—first, at admission pressure to push 20 the fuel ahead of it out of the space 21; and second, at a lower pressure and higher velocity as it passes the ends of the ducts 18 at or near the throat of the Venturi device where is acts to minutely divide the fuel 25 charge as the numerous small jets or streams of fuel issue from said ducts. A somewhat analogous action taken from the mechanical arts would be that of a rapidly moving file acting to cut off small particles of the work as it moves forward.

As will be seen, the capillary passage 22 forms the important feature of my invention since without it the fuel could freely flow from the supply chamber 37 by force of gravity and vibration of the engine to other parts of the pulverizer where the same would accumulate. An additional important feature resides in the capillary space or spaces 21 which are open directly to the blast air in the chamber 37, and further in the capillary ducts 18 which prevent fuel in said space or spaces from flowing by gravity into the chamber 36. Owing to the fact that the capillary passage retains the fuel I can operate the pulverizer in a vertical or horizontal position, which is of great advantage because the same type of pulverizer can then be used on horizontal or vertical types of engines with equal facility. No attempt has been made to show the exact size of the capillary passages, ducts and space or spaces owing to the small scale of the drawing. I have endeavored to show them clearly and have therefore made them considerably larger than in actual practice. Furthermore their size would naturally vary somewhat with the kind of fuel used.

Owing to the peculiar nature of the parts of the pulverizer to the fact that they are completely inclosed when in operation, to the exceedingly brief interval of operation per engine stroke and to the further fact that the blast pressure is very high, pressures from 600 to 1000 pounds per square inch are not being uncommon, it is impossible to state with exactness how much of the pulverizing effect is due to the reduction in air pressure in the throat of the Venturi device, to the suction effect caused by the blast air rushing past the ends of the capillary ducts and to the direct pressure of the blast air on the fuel in capillary space 21, but they all contribute to the final result.

In accordance with the provisions of the patent statutes, I have described the principle of operation of my invention, together with the apparatus which I now consider to represent the best embodiment thereof; but I desire to have it understood that the apparatus shown is only illustrative, and that the invention can be carried out by other means.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. In a fuel pulverizer, the combination 80 of a casing having a discharge opening, means located therein containing an orifice and also a capillary passage for the fuel, the latter communicating with the orifice, an annular supply chamber which supplies fuel to the capillary passage, said passage acting to prevent the flow of fuel by gravity from the chamber, a conduit for supplying fuel under pressure and in suitable quantities to the chamber, means supplying an elastic fluid under pressure to the orifice, and a valve which passes through the means and controls the passage of elastic fluid and fuel from the casing.

2. In a fuel pulverizer, the combination of a casing having a discharge opening, a means located therein which contains an open ended bore and a plurality of capillary ducts opening into the bore, a supply chamber which is common to the ducts and supplies fuel thereto, said ducts acting to prevent the flow of fuel by gravity into the bore, a means adapted to supply fuel under pressure to the chamber in measured quantities, a means adapted to supply elastic fluid under pressure to said bore so that in flowing therethrough it passes the discharge ends of said capillary ducts, and a controlling valve that extends through said member.

3. In a fuel pulverizer, the combination of a casing having a discharge opening, a hollow means located therein which contains a plurality of ducts opening into its bore, there being a capillary space or spaces communicating with said ducts, a chamber for supplying fuel under pressure to the said capillary space and ducts, said space or spaces acting to prevent the flow of fuel by gravity, a controlling valve, and means for supplying an elastic fluid under pressure to the bore of said member and to one end of the capillary space or spaces.

4. In a fuel pulverizer, the combination of a casing having a discharge opening, a means located therein having a central bore, a plurality of tangentially arranged capillary ducts which extend through the means to said bore, there being a capillary space or spaces that communicate with the ducts, an annular chamber which supplies fuel to the
capillary space or spaces and also to the ducts, said ducts acting to prevent the flow of fuel by gravity into the bore, a controlling valve, and means for supplying air under pressure to convey the fuel from said capillary ducts and capillary space or spaces into and through said bore.

5. In a fuel pulverizer, the combination of a casing having an opening, a means located therein comprising an end plate and tubular portion which contain capillary ducts extending toward the center, a retaining portion which surrounds a part of the tubular portion and is separated therefrom by one or more capillary spaces, a chamber supplying fuel to the capillary space and ducts, said capillary space or spaces acting to prevent the flow of fuel by gravity, a means supplying fuel to the chamber, a means for supplying elastic fluid to the capillary space and passages, and a controlling valve.

6. In a fuel pulverizer, the combination of a casing having an internal shoulder and a discharge opening, a plate seated on the shoulder, a tubular member that rests on the plate, there being capillary ducts between the plate and the end face of the member, an element that makes a snug fit in the casing, surrounds the tubular member and is separated therefrom by a capillary space, there being a capillary passage between one end of it and the plate, a follower for holding the parts within the casing, means for supplying fuel through the capillary passage to the space and ducts, a means for subjecting the fuel in said space and ducts to the effects of high pressure elastic fluid, and a controlling valve.

7. In a fuel pulverizer, the combination of a hollow casing having a discharge opening, a means seated in the casing, a member that engages said means, there being projections between said parts which maintain them in a fixed distance apart and form ducts for fuel, said means and member having a Venturi passage formed therein, means for holding the parts in position, means for supplying fuel to the ducts, means for supplying elastic fluid to convey fuel from the casing, and a controlling valve.

8. In a fuel pulverizer, the combination of a hollow casing having a discharge opening, a means seated in the casing, a member that engages said means, there being projections on one of said parts which maintain them in a fixed distance apart and form ducts for fuel, the said means and member having a bore which forms a nozzle that diverges toward its discharge end, said ducts opening into the throat region of the nozzle, a controlling valve that passes through the bore, a means for supplying liquid fuel to the ducts, and means for supplying elastic fluid to said bore to convey fuel in atomized condition from the casing.

9. In a fuel pulverizer, the combination of a casing having a discharge opening, a hollow means mounted therein having capillary ducts, said ducts opening into the interior of said means, a fuel supply means, means defining a capillary passage between the supply means and the ducts, said capillary passage acting to prevent the flow of fuel by gravity from said supply means, a means supplying elastic fluid under pressure to the hollow means to discharge the fuel from the casing as it issues from the ducts, and a valve controlling the passage of fuel and air through said discharge opening.

10. In a fuel pulverizer, the combination, with a casing having a discharge opening, a valve for controlling the passage of fuel therethrough, and a fuel supply chamber, of means defining a capillary passage which is interposed between the fuel supply chamber and the region surrounding the valve, said capillary passage acting to prevent the flow of fluid through it by gravity, and capillary means to receive and hold the fuel against the action of gravity after it leaves the passage and before entering the engine.

11. In a fuel pulverizer, the combination with a casing having a discharge opening, a valve for controlling the passage of fuel therethrough, and an annular fuel supply chamber, of capillary passages directly connecting the chamber to the region around the discharge opening, said capillary passage acting to prevent any flow of fuel from the chamber to the discharge opening by gravity.

12. In a fuel pulverizer, the combination of a casing having a discharge opening, means located therein having a bore arranged to form a Venturi device, a supply chamber that is adapted to be kept filled with fuel and from which it is discharged in measured quantities, ducts that receive fuel and feed it into the throat region of the Venturi device, capillary means which convey fuel from the supply chamber to the ducts and also act to prevent the flow of fuel by gravity from said supply chamber, conduit means admitting elastic fluid under pressure to the passages and also to the Venturi device, and a valve that controls the passage of the mixture of fuel and air through the discharge opening.

13. In a fuel pulverizer, the combination of a casing having a discharge opening, a means located therein having a central bore, a supply chamber, ducts in the means discharging fuel into said bore, capillary conduit means through which fuel from the chamber passes before entering the ducts and which acts to prevent the flow of fuel from the means by gravity, there being a space or spaces communicating with the capillary conduit means and receiving fuel therefrom and discharging into said ducts.
a valve for the discharge opening, and a conduit admitting elastic fluid to the space or spaces to force fuel therefrom into said ducts, and also to the bore in a manner to cause it to flow past the ends of said ducts when the valve is opened.

14. In a fuel pulverizer, the combination of a casing having a discharge opening, means located therein containing an orifice and also ducts for the fuel, said ducts opening into the orifice, a supply chamber, a capillary conduit means between the ducts and the chamber through which fuel is delivered in measured charges, said means acting to prevent flow of fuel from the chamber by gravity, a conduit supplying the chamber with fuel, a conduit supplying elastic fluid under pressure to the orifice and also to the ducts, and a valve which passes through said orifice and controls the passage of fuel and elastic fluid from the casing.

15. In a fuel pulverizer, the combination of a casing having a discharge opening, means located therein containing a central bore, a valve which extends through the bore and controls said opening, the wall of the bore being separated from the valve by a space, a supply chamber which is normally filled with fuel and to which it is admitted in measured quantities, a capillary conduit means through which fuel from the supply chamber passes, an axially extending chamber which communicates with the conduit means and receives and temporarily holds the fuel charges, ducts which receive fuel from the axially extending chamber and open into said bore, and means for supplying elastic fluid under pressure to the axially extending chamber for forcing fuel therefrom and also to said bore where it acts on the numerous fuel streams issuing from said ducts when the valve is opened.

16. In a fuel pulverizer, the combination of a casing having a discharge opening, a tubular member located therein having a central opening, a second member which surrounds the first, there being a fuel receiving chamber or space between them, ducts which communicate with the central opening at one end and with the fuel receiving chamber or space at the other, a supply chamber that normally contains fuel, capillary conduit means through which charges of fuel pass from the supply chamber to said receiving chamber or space, the capillary means acting to prevent the flow of fuel by gravity from the supply chamber, conduit means delivering elastic fluid under pressure to said fuel receiving space and also to said central opening, and a valve which controls the passage of fluid through said discharge opening.

17. In a fuel pulverizer, the combination of a casing having a discharge opening and a shoulder adjacent thereto, a plate that rests on the shoulder, a hollow tubular member that engages the plate at one end, projections between the plate and member that form fuel passages, a second member that surrounds the first, there being a fuel receiving chamber or space between them, one end of the second member cooperating with a part of said plate to form a capillary conduit which is in communication with said fuel receiving chamber or space, a supply chamber that normally contains fuel and communicates with the capillary conduit, the latter preventing the flow of fuel from the chamber by gravity, means for retaining the said members in place, a conduit supplying elastic fluid under pressure to the fuel receiving chamber or space and to the opening in the tubular member, and a valve which, when opened, permits the elastic fluid to force fuel from the receiving chamber or space through the discharge opening.

In witness whereof, I have hereunto set my hand this seventh day of October, 1912.

WILLIAM H. FROST.

Witnesses:

HEMMANN LEMP,

JOHN G. FARRAR.
It is hereby certified that in Letters Patent No. 1,157,305, granted October 19, 1915, upon the application of William H. Frost, of Erie, Pennsylvania, for an improvement in "Pulverizers for Oil-Engines," errors appear in the printed specification requiring correction as follows: Page 3, line 19, for the word "is" read "it; same page, line 59, for the numeral "100" read "1000." and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 9th day of November, A. D., 1915.

[seal.]

I. T. NEWTON,

Acting Commissioner of Patents.