

C. W. BAKER.
METHOD OF AND APPARATUS FOR DELIVERING LIQUID FUEL TO OIL ENGINES.
APPLICATION FILED MAR. 30, 1912.

1,149,321.

Patented Aug. 10, 1915.
2 SHEETS—SHEET 1.

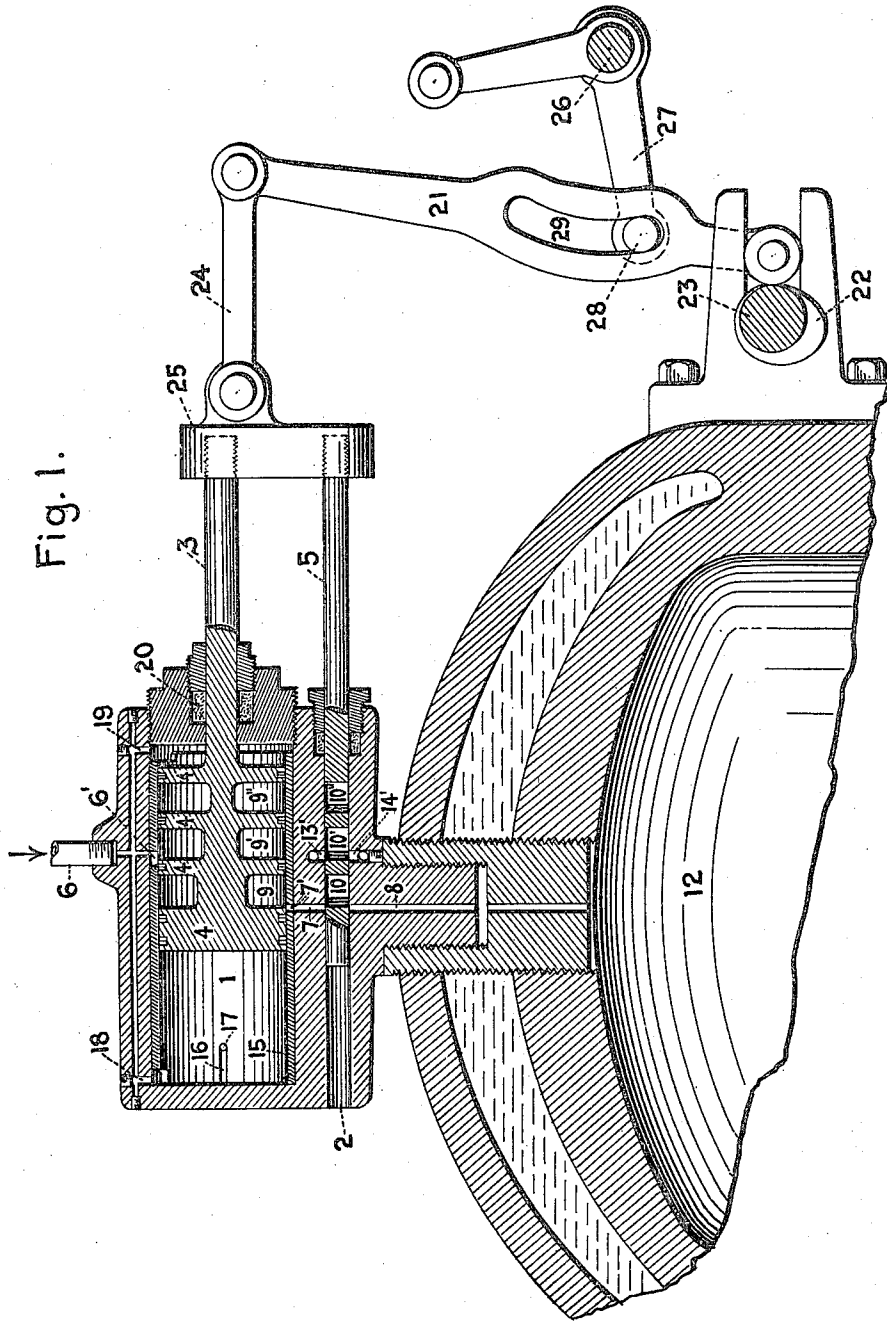


Fig. 1.

WITNESSES

Charles A. Spru...
W. A. Pauling

Charles Whiting Baker INVENTOR

BY *Giffers & Bull*
His ATTORNEYS

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Fig. 3.

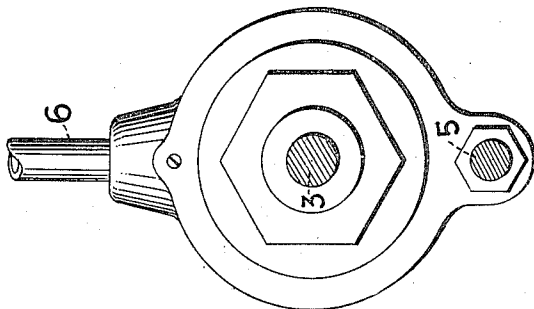


Fig. 4.

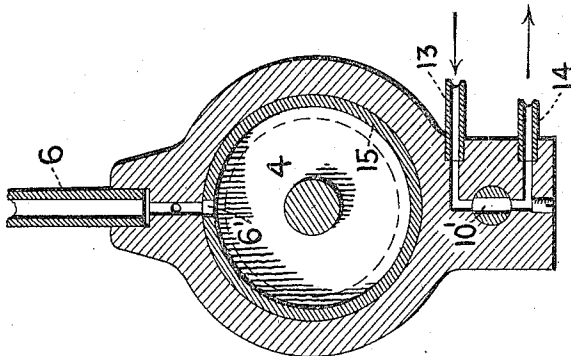
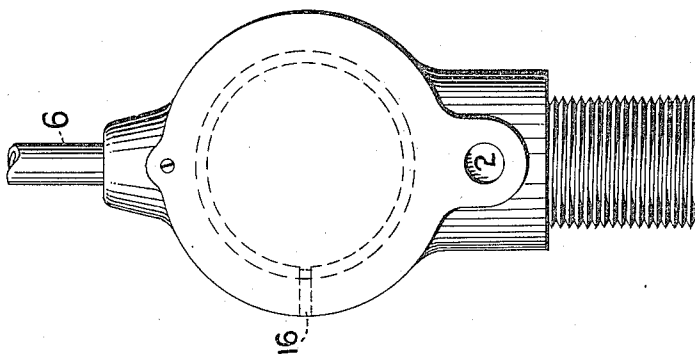


Fig. 2.



WITNESSES

Charles S. Jones
W. A. Pauling

INVENTOR

Charles Whiting Baker
BY *Lyfford H. Bull*
ATTORNEYS

UNITED STATES PATENT OFFICE.

CHARLES WHITING BAKER, OF MONTCLAIR, NEW JERSEY.

METHOD OF AND APPARATUS FOR DELIVERING LIQUID FUEL TO OIL-ENGINES.

1,149,321.

Specification of Letters Patent.

Patented Aug. 10, 1915.

Application filed March 30, 1912. Serial No. 687,310.

To all whom it may concern:

Be it known that I, CHARLES WHITING BAKER, a citizen of the United States, residing at Montclair, in the county of Essex and State of New Jersey, have invented certain new and useful Improvements in Methods of and Apparatus for Delivering Liquid Fuel to Oil-Engines, of which the following is a specification.

In oil engines of the Diesel type, the liquid fuel is sprayed into the cylinder by a jet of air which has been previously compressed to a density several hundred pounds per square inch above that of the air compressed in the clearance space of the cylinder. This highly compressed air, before its passage through a nozzle into the cylinder, picks up oil which has been previously deposited in its path by a pump, carries it past a series of obstructing surfaces by which the globules of oil are broken up into small particles and finally discharges it in the cylinder as a fine mist. It is desirable that the amount of this high-pressure air discharged into the cylinder be closely regulated. If too much is admitted, the loss of power in the high-pressure air compressor becomes large. If too little is admitted, the oil is imperfectly sprayed. Further, if the right amount of air is admitted when the engine is fully loaded and the full amount of oil has to be atomized, too much air will be admitted when the engine is run under small load and the blast of high-pressure air may blow out the flame from the small quantity of oil then used. It is necessary, therefore, to vary the pressure of the air used for spraying as the load on the engine varies. Again the aim of Diesel engine designers is to approach as nearly as possible to "constant pressure" during combustion, that is to have combustion proceed, as the piston moves forward, just rapidly enough to maintain but not exceed the maximum pressure attained at the end of the compression stroke. But this end can only be roughly approximated by the ordinary method of admitting the high-pressure air for spraying through an orifice governed by a needle valve. In Diesel engine operation at present, the high-pressure air used for spraying the oil has to be compressed 300 to 500 lbs. per square inch above the pressure in the engine cylinder. This high pressure is required because the air for spraying picks up a mass of oil previously delivered in its path and many obstructions

have to be placed in its further path against which the mass of oil may be broken up. If, however, the oil and air could meet in a simultaneous stream, fewer obstructions would be necessary for atomization, and a lower pressure would suffice for the spraying air. It is necessary in Diesel engine operation that a measured quantity of oil, proportionate to the load on the engine, shall be delivered to the cylinder at each stroke. But the quantity of oil required per stroke is so small, especially at light loads and in small size engines, that the oil-feeding pump and its parts are of extremely small size and require the greatest perfection of workmanship and highly skilled operators for their adjustment and repair.

It is the object of my invention to overcome these various difficulties in the construction and operation of Diesel engines and further to provide means whereby, as hereafter explained, any type of engine using liquid fuel, as, for example, ordinary automobile engines, may have their fuel sprayed into the cylinder at the end of the compression stroke instead of impregnating the entering air with it by means of a carbureter as now practised.

I attain these objects by substituting for the present method of fuel spraying, a method whereby a measured quantity of high-pressure air is delivered to the cylinder at each stroke, such quantity being proportioned to the quantity of oil delivered, the oil being likewise measured and fed into the stream of entering air, and the quantity of both oil and air being varied according to the load on the engine.

The apparatus by which I apply this method of oil and air feeding to liquid fuel engines is illustrated in the accompanying drawings, in which—

Figure 1 is a section of the cylinder head of an oil engine having my oil and air feeding device attached, the latter being also shown in section. Figs. 2 and 3 are end views of the oil and air feeding device. Fig. 4 is a cross-section of Fig. 1 through the air inlet pipe 6.

As shown in Fig. 1, the apparatus consists in general of two parallel cylinders in one casing, the upper and larger cylinder 1 being the air measuring cylinder and the smaller oil measuring cylinder 2 lying below it. In the air cylinder 1 there is a rod 3 carrying a series of connected pistons 4 which closely

fit the cylinder, the spaces between these pistons forming closed chambers. In the oil cylinder 2 there is likewise a series of connected pistons in the form of a closely fitting rod 5 having chambers which may be in the form of slots through the rod and which chambers correspond in spacing to the chambers between the pistons of the air cylinder and proportioned to the capacities of the air chambers. These two rods are adapted to reciprocate in their respective cylinders and are moved in unison with each other. A pipe 6 delivers high pressure air to the air cylinder 1; a passage 7 leads from the air cylinder 1 to the oil cylinder 2; and a passage 8, preferably in alinement with passage 7, leads from the oil cylinder 2 to the combustion space 12.

At the proper period in the engine cycle, the air rod 3 and oil rod 5 are moved to the left. As the successive air chambers 9, 9', 9'' are brought over the passage 7 they discharge their contents of air through this passage and through the slots 10, 10', 10'' in the oil rod 5 into the passage 8, the air carrying with it the oil held in the slots. It will be seen that the oil in each slot is fed into the current of high pressure air from the passage 7 as the oil rod 5 moves forward, so that atomization is effected by the "planing off" of successive particles of oil from the advancing mass by the swiftly moving air current. It becomes necessary, therefore, to impose very few obstructing surfaces in the passage 8 to effect the final atomization of the oil necessary for its complete combustion. These obstructing surfaces are not shown in the drawing as they may be of any desired design.

The distance between the inlet port 6' and the outlet port 7 measured along the axis of the air cylinder 1 is somewhat greater than the distance apart of the pistons 4, 4 which separate the air chambers 9, 9', 9'' so that, as the rod 3 moves to the left, the admission of air to a chamber from the port 6' is cut off before the outlet passage 7 is opened. The oil inlet 13' is similarly spaced with reference to the exit passage 8.

The air and oil rods having made their delivery stroke to the left and the air having blown out of the chambers 9, 9', 9'' carrying with it into the cylinder the oil lying in the slots 10, 10', 10'', the air and oil rods 3 and 5 make a return stroke to their original position, and as they do so the air chambers are successively refilled as they pass under the air inlet 6'. The oil slots, however, are filled with air, at a pressure corresponding to that in the cylinder combustion space 12. In order to drive out this air and completely fill the oil slots with oil, two oil pipes are used, the first 13 delivering the oil under pressure and the second 14 re-

turning the oil to a reservoir. These pipes are connected to passages communicating with opposite sides of the oil cylinder 2. The oil rod 5 opens communication between these pressure and return oil pipes as successive slots 10 in the rod pass between the passages 13' and 14' during the return stroke. Thus both air chambers and oil slots being filled on the return stroke, the apparatus is ready for the delivery stroke.

It will be apparent that at the end of the delivery stroke of the pistons 4, the air left in the chambers 9, 9', 9'' will be still under a pressure corresponding approximately to that in the engine cylinder during combustion. During the return stroke, of the pistons 4 however, the pressure in the engine cylinder is being lowered by expansion, and if the passage 7 were left open there would be further delivery of air from the chambers 9, 9', 9'' during the return stroke carrying with it possibly some oil particles lodged on the obstructing surfaces in the passage 8. It is desirable to avoid this loss of air and fuel by closing the passage 7 before the return stroke is made. I provide means to effect this as follows: The air cylinder 1 is lined with a bushing 15 which is slightly shorter than the cylinder and is made an easy fit in the cylinder, so that the bushing 15 moves in the cylinder 1 with much less friction than the rod 3, carrying several pistons 4, moves in the bushing 15. Thus, as the air rod 3 starts to move in either direction it first moves the bushing 15 with it until the latter strikes the end of the cylinder 1. In the bushing 15 there is a port 7' which, when the bushing is moved to the left, registers with the passage 7 from the air cylinder to the oil cylinder. When the return stroke of air rod 3 is to be made, however, the bushing first moves to the right and closes the passage 7. A pin 17 engaging with a slot 16 in the bushing prevents the bushing from rotating.

Each end of the air cylinder 1 is in communication with the high-pressure air supply pipe 6 through the passages 18, 19. As the area of the piston 4 under pressure at the left end is greater than that of the piston 4 under pressure at the right end by the diameter of the rod 3 passing through the stuffing box 20, the return stroke of the rod 3 is made automatically.

To vary the delivery of oil to the combustion space 12 in proportion to the load on the engine, it is only necessary to vary the length of stroke of the air and oil rods 3 and 5. There are a variety of mechanisms by which this oil and air feeding apparatus may be driven from the engine so as to give the desired quick delivery stroke, slow return stroke and variable length of stroke. I illustrate such a mechanism in Fig. 1, where 21 is a lever the lower end of which

is moved by a cam 22 on a shaft 23 driven by the engine, and the upper end is joined by a connecting rod 24 to a block 25 operating the air and oil rods. The cam 22 has a sharp rise at one part to effect the quick working stroke and the remainder of the cam has an easy descent to permit the slow return stroke. The variable stroke of the rods 3 and 5 is obtained by giving the lever 21 a movable fulcrum. The rock shaft, 26, carries an arm 27 on which is a pin 28 forming the fulcrum of the lever 21. This lever 21 having the lower end guided to permit only horizontal motion, the movement of the fulcrum pin 28 in the slot 29 varies the relative length of the lever's arms and the throw of the oil and air rods 3 and 5 to which the upper end of the lever is attached may be varied by rotating the rock shaft 26, and the position of this may be controlled by the engine governor. The graduation of the engine for varied loads may be also aided by making the chambers 9, 9', 9'' of varying capacity, so that at lightest loads only a part of the contents of the smallest chamber 9 and of its corresponding oil slot 10 will be discharged. By proper location of the rock shaft 26 and of the slot 29, the working stroke of the oil and air rods 3, 5 may always begin with the rods at the extreme right hand position, whether the stroke is to be a full stroke or a partial stroke. By thus varying the capacity of the air and oil chambers, and by proper proportioning of the driving cam 22 it becomes possible to deliver the oil charged spray into the combustion space 12 in just the time required to produce the best results.

While I have referred above chiefly to the use of this apparatus with engines operated on the Diesel principle, I intend it to be applied also to engines using gasoline or kerosene and operated by other methods of ignition than the high temperature of the compressed air. It has been difficult hitherto to adopt compressed air fuel spraying on small size engines as the parts became too small and delicate, and it was difficult or impossible to graduate the minute quantities of air and of oil required for such small engines.

My improved method and apparatus above described, by reducing the amount and the pressure of the air required for effective atomization, by providing means for simply and accurately measuring the oil and air and graduating them in proportion to the load on the engine, and by the use of apparatus for dealing with these small quantities of oil and air which is not too microscopic and delicate to be operated and repaired by ordinary mechanics, makes possible the use of the compressed air spraying system on all classes of engines using liquid fuel.

The term "cylinder" is used as a convenient one for designating the air and oil measuring chambers of the form shown, but the term is to be understood as including any suitable form of casing adapted to receive a movable piston divided into chambers or compartments.

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

1. The method of operating liquid fuel engines consisting in measuring in separate closed chambers the quantity of liquid fuel required for one working stroke of the engine at full load and the quantity of compressed air required for atomizing it, and drawing from said chambers such a part of their contents as the load on the engine requires.

2. An engine cylinder having a fuel inlet passage, means for supplying liquid fuel thereto comprising a chamber for liquid fuel opening into said passage, a chamber for compressed air of a volume proportioned to the amount of oil in the oil chamber, a duct leading from the air chamber to the oil chamber and means for permitting the escape of the compressed air to the oil chamber at each cycle of the engine.

3. A device for delivering fuel to liquid fuel engines comprising a casing inclosing a fuel chamber with a delivery outlet therefrom, said casing having a series of connected pistons therein, which form with the casing a series of closed chambers, means for delivering compressed air to these chambers, a duct leading from the air casing to the fuel casing, and means for moving said pistons to open said chambers successively to the oil casing.

4. A device for delivering fuel to liquid fuel engines comprising a casing divided into two closed chambers one of which contains compressed air and the other a liquid fuel, a duct in the partition between said chambers, and means for opening said duct to deliver a measured quantity of compressed air to the oil casing at each cycle of the engine.

5. A device for delivering fuel to liquid fuel engines comprising a fuel-containing casing having a series of pistons therein and a delivery outlet, means for supplying fuel to the chambers between said pistons, a second casing having a series of pistons therein and means for supplying compressed air to the chambers between said last named pistons, a duct leading from the air casing to the oil casing, and means for moving said pistons to successively open the air chambers to the oil chambers.

6. An apparatus for spraying liquid fuel into an engine cylinder comprising a casing having a series of pistons and an outlet port, means for supplying compressed air to the chambers between said pistons, a

second casing into which said port opens having a series of pistons therein, means for supplying fuel to the chambers between said last named pistons, said second casing having a delivery passage to the engine cylinder, and means for moving said pistons to simultaneously open the said ports.

7. An apparatus for spraying liquid fuel into an engine cylinder comprising a series of measuring chambers for the fuel required per stroke, a series of measuring chambers for compressed air for spraying the fuel, and means for delivering the contents of these chambers in sequence to the combustion space of the engine cylinder.

8. An apparatus for spraying liquid fuel into an engine cylinder comprising a casing having a series of connecting pistons, means for admitting air to the chambers between said pistons, a second casing having a series of connected pistons, means for admitting fuel to the chambers between said last named pistons, means for admitting compressed air to the fuel chambers, and means for giving said pistons a variable movement in unison.

9. An apparatus for spraying liquid fuel into an engine cylinder comprising a casing having a series of connected pistons and an outlet port, means for admitting air to the chambers between said pistons, a second casing having a series of connected pistons, means for admitting fuel to the chambers between said last named pistons, said port connecting said casings, and means for moving said pistons in unison to bring corresponding air and oil chambers into communication with each other, and an outlet port from said second casing to deliver the mixed air and fuel into the engine cylinder.

10. An apparatus for delivering fuel to liquid fuel engines comprising a casing having a series of pistons therein, means for supplying oil to the chambers between said pistons, means for moving said pistons to bring them successively into communication with a delivery passage, and means for supplying a measured quantity of compressed air to each of said chambers as it is moved into communication with said passage.

11. An apparatus for spraying liquid fuel into an engine cylinder comprising a casing having a series of pistons and an outlet port, means for supplying fuel to the chambers between said pistons, a source of compressed air connected to said casing, means for mov-

ing said pistons to bring said chambers successively into communication with said outlet port, and means for delivering a measured quantity of compressed air to each of said chambers when it is in communication with said outlet port.

12. An apparatus for spraying liquid fuel into an engine cylinder comprising a casing having a series of pistons and an outlet port, means for supplying compressed air to the chambers between said pistons, a fuel-containing casing delivering into the engine cylinder and into which said port opens, and means for moving said pistons to bring the chambers between them successively into communication with the oil casing.

13. An apparatus for spraying liquid fuel into an engine cylinder comprising a casing having a series of pistons and an outlet port, means for supplying compressed air to the chambers between said pistons, means for moving said pistons to discharge said chambers successively through said port, and means for supplying a measured quantity of fuel to be sprayed upon each opening of said port.

14. An apparatus for spraying liquid fuel into an engine cylinder comprising a casing having a series of connected pistons and inlet and outlet ports, the distance between said inlet and outlet ports measured along the axis of the casing being greater than the distance apart of the said pistons, means for supplying compressed air to the chambers between said pistons, a casing containing oil with which said outlet port communicates and a passage from the oil casing to the cylinder.

15. In an apparatus for spraying liquid fuel into an engine cylinder by compressed air, the combination with an air measuring cylinder having inlet and outlet ports in the wall thereof and pistons therein forming an air measuring chamber or chambers, of a slidable bushing lining said cylinder and having a port adapted to register with the outlet port of said air measuring cylinder when the bushing is at one end of said cylinder.

In testimony whereof I have hereunto signed my name in the presence of two subscribing witnesses.

CHARLES WHITING BAKER.

Witnesses:

M. E. McNinch,

CHARLES S. JONES.