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Brille et al.

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[54] FUMIGATION DEVICES FOR SUPERCHARGED DIESEL ENGINES

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[51] **Int. Cl.** **F02b 37/04**

[58] **Field of Search** ..... 123/119 C, 119 CB, 131

[56] **References Cited**

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Primary Examiner—Carlton R. Croyle
Assistant Examiner—Warren Olsen
Attorney—Stevens, Davis, Miller & Mosher

[57] **ABSTRACT**

Device for the permanent atomization of liquid fuel into Diesel engines comprising a volumetric pump interposed in the engine air induction pipe, whereby pipes for delivering liquid fuels and additives, such as oil, open through jets into said air induction pipe, upstream of the volumetric gear pump operated simultaneously as a pump and as an atomizer.

6 Claims, 2 Drawing Figures

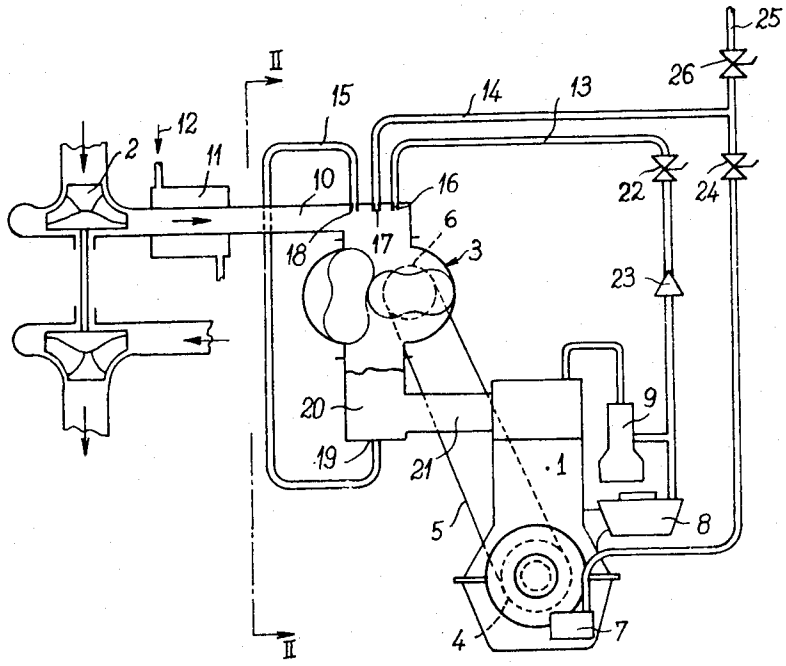

Fig - 1

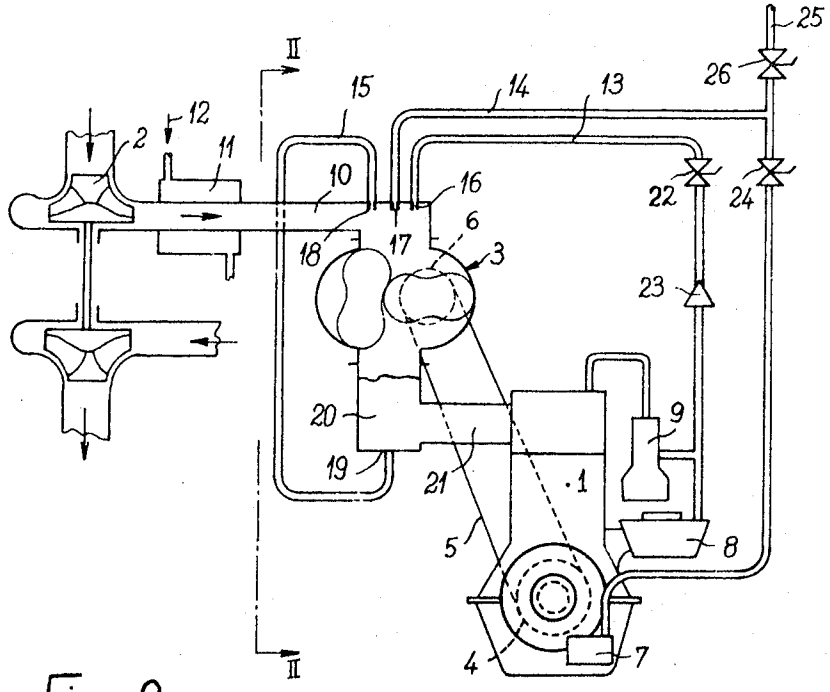
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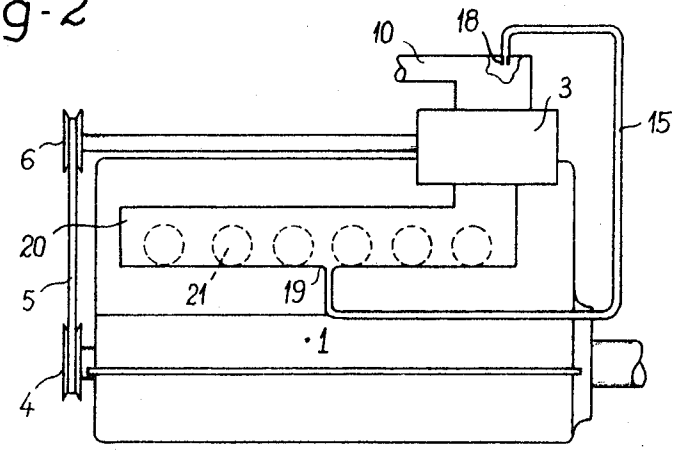
Fig - 2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FUMIGATION DEVICES FOR SUPERCHARGED DIESEL ENGINES

The present invention relates to devices for atomizing fuel into the induction manifold of supercharged Diesel engines, which are generally referred to as "fumigating devices."

This invention is applicable more particularly to compression-ignition or Diesel engines comprising a crankcase containing engine lubricating oil circulated by an oil pump, a feed pump supplying liquid fuel to an injection pump, and a volumetric pump having its input orifice connected to a direct air supply pipe or to the delivery pipe of a turbo-compressor driven from the engine exhaust gas and having its output orifice connected to an engine air induction pipe.

The object of the atomization of fuel into the induction air pipe is to promote the starting of the combustions in Diesel or compression-ignition engines.

Fumigation devices are already known which supply about 20 percent of the necessary fuel by means of a carburetor disposed upstream of the air induction pipe of the engine and associated with a conventional injection system supplying the residual fuel in the proportion of about 80 percent.

This known system is objectionable in that the resulting air-fuel mixture is very poor, and also in that the fuel atomization at low or idling speeds is likewise very poor.

In a prior U.S. Pat. No. 3,595,013 a device has already been proposed which permits of injecting oil or fuel upstream of the gear-type supercharging compressor during the starting period of a Diesel engine, in order on the one hand to assist in improving the fluid-tightness of this compressor at low speeds and on the other hand to utilize fuel for facilitating the starting of the combustion proper. However, this device is characterized by the fact that it comprises members preventing the introduction of oil or fuel outside the starting period.

On the other hand, it was discovered that in certain cases it is advantageous to atomize in conjunction with the usual engine fuel certain other liquid such as a lubricant. Thus, the intermittent introduction of detergent oil drawn from the engine crankcase permits compensating the absence of oil seeping up through the piston rings to the valves, which characterizes supercharged engines. This leakage oil, notably in the case of inlet valves having a greater diameter and therefore more liable to undergo the known "rolling" effect by torsion on their seats, assists greatly in extending the useful life of the engine valves by lubricating and "damping out" their shocks against the cooperating bearing surfaces.

Therefore, since on the one hand a constant and properly proportioned atomization of fuel into the stream of induction air of Diesel engines will tend under all circumstances to improve the priming of the combustion and since on the other hand a permanent or intermittent atomization of certain additives has already been acknowledged as having a beneficial influence on the fuel ignition, it is the essential object of the present invention to provide a device for the permanent atomization of combustible liquid and for an at least intermittent atomization of additional or additive liquid into Diesel engines of the type specified at the beginning of this description and equipped with a volumetric pump.

This volumetric pump constitutes a correcting apparatus driven in a variable manner from the engine and acts now as a pressure-reducing device under high power-output conditions, now as a compressor under reduced engine load conditions, the reduction in the volumetric ratio permitting the use of very high supercharging rates. Engines of this character have been described in the U.S. Pat. No. 3,595,013 by the same applicants.

The device according to the present invention is characterized in that the pipes supplying liquid fuels and liquid additives to the engine open into the delivery pipe upstream of the volumetric pump, this volumetric pump being of the gear type and acting jointly as a pump and as an atomizer.

The gear compressor constitutes a very efficient atomizer capable of producing a liquid-air mixture and a mist sufficiently homogeneous to ensure a proper distribution thereof among the various cylinders of a multicylinder engine. The powerful and very efficient atomization at all engine speeds is attended by an incipient fuel oxidation promoting the ignition.

Due to the resulting reduction in the ignition time the possibilities of using different fuels in multi-fuel engines are greatly enhanced.

In contrast to carburetor-type fumigation systems, the device according to this invention operates under constant-output conditions. By resorting to a suitable setting or adjustment the engine operates at idling speeds simply by means of the fumigation mixture, by self-ignition, without resorting to its conventional injection system. In this manner, these engines operate at idling speeds with considerably reduced noise levels, which makes these engines as silent as gasoline engines.

However, under certain limit conditions a certain amount of liquid might be condensed in the induction manifold. According to another feature characterizing this invention, any liquid possibly deposited at the bottom of this manifold is collected and re-injected into the suction pipe of the gear-type compressor. Of course, if no liquid is collected or condensed (which is the most frequent case) this recovery path constitutes a by-pass corresponding to a slight leakage of the compressor. Therefore, the inlet or outlet passage of this by-pass is of nearly capillary size, thus reducing the air leak to a negligible value and promoting the flow of liquid therethrough when a condensation takes place.

This invention is also concerned with other characteristic features which will appear as the following description proceeds with reference to the accompanying drawing illustrating diagrammatically by way of examples a typical form of embodiment thereof. In the drawing:

FIG. 1 illustrates diagrammatically in cross-section a supercharged Diesel or compression-ignition engine equipped with a device according to this invention, and

FIG. 2 is a longitudinal view of the same engine, as seen in the direction of the arrows II—II of FIG. 1.

The Diesel engine **1** is supercharged by means of a turbo-compressor **2** scavenging air into the gear pump **3** driven at a variable speed from the pulley **4**, through an endless belt **5** and another pulley **6**.

The volumetric pump may be driven from the engine crankshaft via a variable-speed transmission causing the pump to produce an output to volume ratio now greater, now smaller, than the engine cylinder capacity.

The variable-speed drive is not illustrated, since it may consist of any suitable and known arrangement such as a V-belt drive, or a hydraulic pump and motor of the barrel-cylinder type, inter alia.

Conventionally, the engine is equipped with a lubricating oil pump **7**, a fuel feed pump **8** and an injection pump **9**. The delivery pipe **10** connects the turbo-compressor **2** to the gear pump **3** and extends through a heat exchanger **11** of which the other circuit receives water from the engine cooling system at a regulated temperature.

Pipes **13**, **14** and **15** provided at their outlet ends with jets **16**, **17** and **18** respectively, opening into said delivery pipe **10** very close to the inlet of pump **3**.

Pipe **13** is connected directly to the fuel feed pump **8** and pipe **14** is connected to the lubricating oil pump **7**. Pipe **15** of very small cross-sectional passage area is connected to the lower portion **19** of the general induction manifold **20** communicating with the cylinder head through pipes **21**.

Inserted in pipe **13** are a valve **22** and a non-return valve **23**. On the other hand a valve **24** and downstream thereof a branch pipe **25** equipped with a valve **26** are inserted in pipe **14**.

This arrangement operates as follows:

Immediately as the engine begins to revolve the fuel feed pump **8** delivers fuel under a pressure of about 35 psi, which in general is higher than the pressure prevailing in pipe **10**, notably when the engine loads and speeds are of medium or low values.

Thus, the fuel flows through the jet **16** into the compressor with a certain output and is delivered in a perfectly atomized condition into the manifold **20**.

The fuel mist just produced is distributed among the pipes **21** and facilitates the combustion by tending to reduce the ignition time. Of course, the normal injection takes place simultaneously through the conventional injectors (not shown) from the injection pump **9**.

The fuel output flowing through said jet **16** depends of course on the cross-sectional passage area thereof, and also on the pressure differential between the fuel pump **8** and pipe **10**; but not on the engine speed. As a consequence, the proportion of fuel caused to fumigate decreases with the engine speed and even with the engine load for the higher the load, the higher the pressure in pipe **10**. This is in conformity with the desired operating conditions. This fumigation device not only facilitates the normal operation of the engine with gasoil, but also permits a multi-fuel operation, it being understood that the heat exchanger **11** is adapted to regularize the air temperature upstream of compressor **3** at a value approximating that of the engine water regulation temperature.

Under full-load conditions it will happen that the pressure prevailing in pipe **10** will exceed the fuel feed pump **8**. In this case no atomization will take place, which is adequate, and the valve **23** will prevent the ingress of air into the fuel circuit.

It may also happen, when a vehicle is driven downhill, for example, that the driver may find it adequate to cut-off the fuel supply. To this end, independently of the normal operation of the injection pump **9**, the driver can close the valve **22**.

It may also be desirable to introduce upstream of the engine valves and in atomized form of small amount of engine oil in order to compensate the oil normally sucked up through the valve stem guides and which is no more drawn up due to the supercharging pressure. This compensation is provided by the jet **17** inserted in pipe **14**. As already explained in the foregoing, this intermittent supply of detergent oil is for compensating the absence of oil seeping through the piston rings and valve guides to the valves, this absence being a well-known effect in supercharged engines. This oil seeping, especially in the case of inlet valves which are larger than exhaust valves and therefore more exposed to the so-called "rolling" effect by torsion on their seat, assists greatly in extending the useful life of the engine valves by lubricating same and "damping out" the contact or shock with the bearing surfaces. The additional oil mist supplied intermittently through the means of this invention will ensure this desired function.

This intermittence is made possible by the extremely low amount of oil necessary therefor (of the order of 0.0035 ounce per HP), which eliminates the need for a continuous supply or feed.

The valve **24** may be used for controlling the time periods during which it is desired to obtain this intermittent supply of additional oil mist. Of course, an electrical or mechanical timing control system may be provided for operating this valve **24**.

Moreover, the same jet **17** may be used for introducing another type of oil or additive independent of the engine lubricating oil circuit, valve **24** being closed and valve **26** open in this case.

Finally, the pipe **15** may be used for returning to the jet **18** the liquid collected at the bottom of manifold **20**.

When the engine is operated under full-power conditions it may happen that the pressure prevailing in manifold **20** be slightly lower than that prevailing in pipe **10**. In this case a slight leakage through pipe **15** will be definitely negligible.

Although this invention has been described with reference to a specific form of embodiment thereof, it will readily occur to those conversant with the art that many modifications and variations may be brought thereto without departing from the basic principles of the invention as set forth in the appended claims.

What is claimed as new is:

1. A device for atomizing a liquid fuel and at least intermittently a liquid additive into Diesel engines comprising a crankcase containing engine lubricating oil which is circulated by means of a lubricating oil pump, a fuel feed pump delivering liquid fuel to an injection pump and a volumetric pump connected through its input orifice to an air supply pipe fed by a turbo-compressor driven from the engine exhaust gas, and through its output orifice to an engine air induction pipe, the device further comprising a plurality of separate jets opening into said air supply pipe upstream of said volumetric pump, and a plurality of pipes for supplying liquid fuel and additive through said jets, said volumetric pump being a gear pump operating simultaneously as a pump and as an atomizer.

2. A device according to claim **1**, characterized in that a pipe for returning any liquid condensed and accumulated in the bottom of the engine air induction pipe opens into the air supply pipe upstream of said volumetric pump, the cross-sectional passage area of at least one of the orifices of said return pipe being such that it provides a liquid output corresponding substantially to the maximum quantity of liquid likely to condense on the walls of said air induction pipe.

3. A device according to claim **1**, wherein one of said pipes is for supplying additive liquid and is connected to the lubricating oil pump, a first valve being interposed in said oil supply pipe.

4. A device according to claim **3**, wherein said valve is of intermittent and pre-adjusted opening type.

5. A device according to claim **3**, wherein a pipe for supplying an additional liquid additive is connected through a second valve to the oil supply pipe downstream of the first valve.

6. A device according to claim **1**, wherein one of said supply pipes is connected to a duct connecting the fuel feed pump to the injection pump, a stop valve and non-return valve are disposed in said pipe, said non-return valve being upstream of said stop valve, and the jet of said supply pipe has a specific cross-sectional passage area for providing a constant liquid output from said jet.

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