Jan. 17, 1961

S. MEURER

2,968,298

INTERNAL COMBUSTION ENGINE

Filed Jan. 12, 1959

2 Sheets-Sheet 1

Fig. 1.

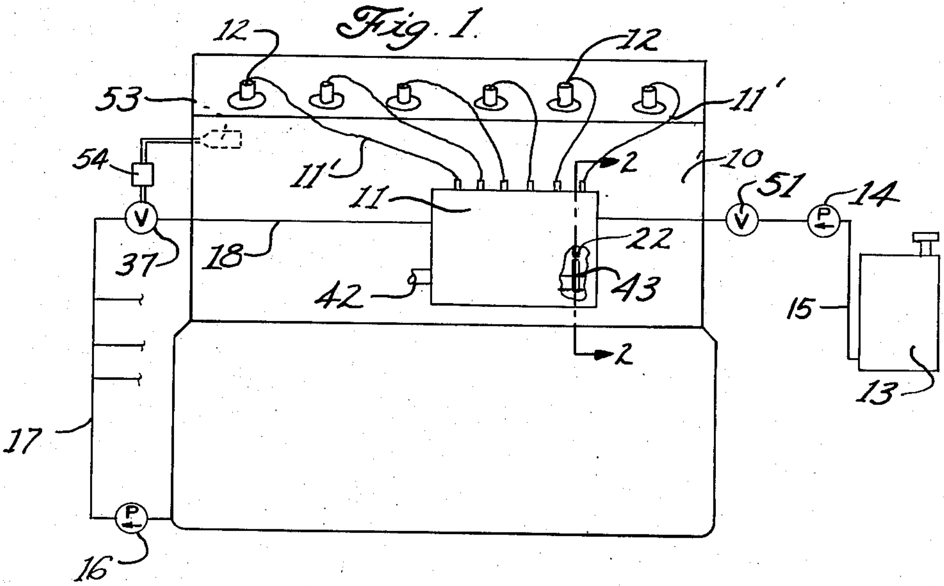


Fig. 2.

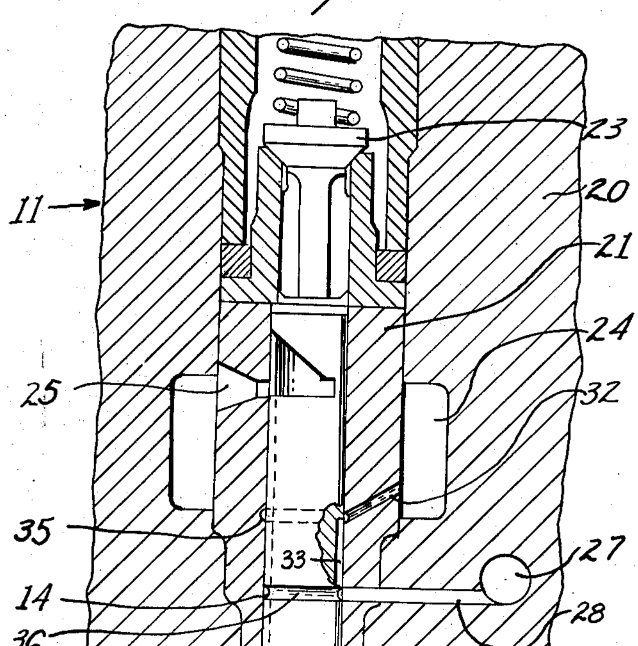


Fig. 3.

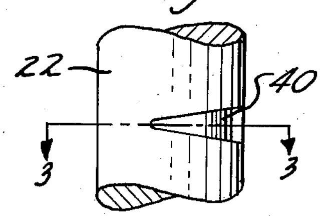
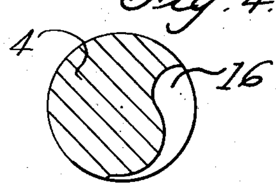


Fig. 4.



INVENTOR.

SIEGFRIED MEURER

BY [signature]

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Fig. 5.

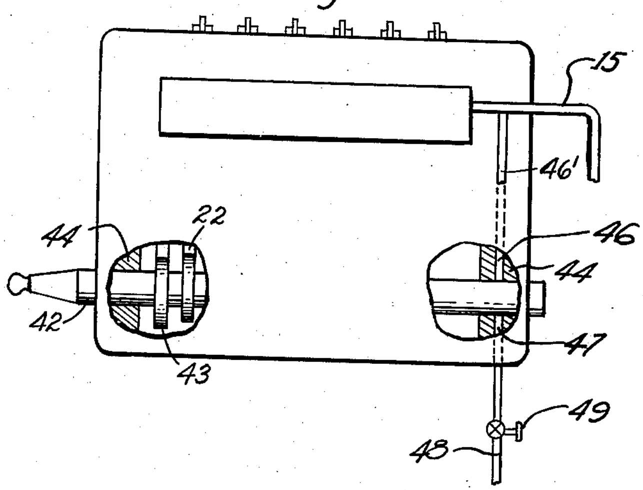


Fig. 6.

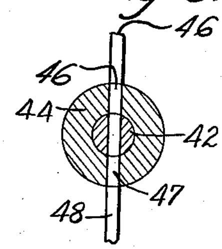
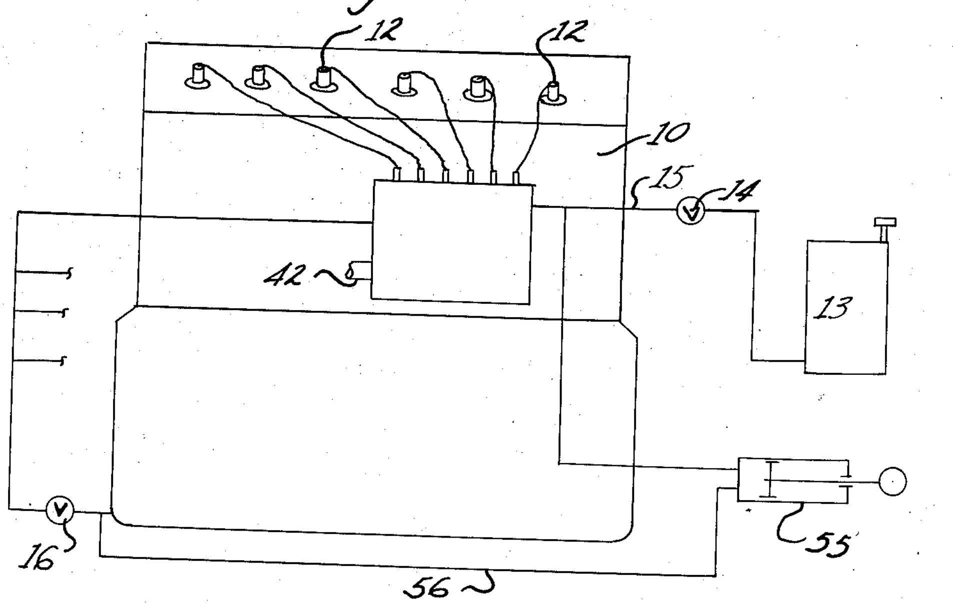


Fig. 7.



INVENTOR.
SIEGFRIED MEURER
BY
[signature]
ATTORNEYS

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INTERNAL COMBUSTION ENGINE

Siegfried Meurer, Heisterstrasse 37, Nurnberg, Germany

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11 Claims. (Cl. 123—139)

This invention relates to internal combustion engines of the fuel-injection type, and more particularly to engines in which the injected material comprises a mixture of two different liquids. The injection of a mixture of liquids into the cylinders of an internal combustion engine is most commonly employed in diesel engines where, during starting and warm-up, the delay in ignition of ordinary diesel-engine fuels results in poor performance. It has therefore been proposed to add an ignition-accelerator to a diesel fuel, at least during starting and warming up of the engine, thereby effecting a substantial improvement in the starting and warm-up characteristics.

I have discovered that ordinary lubricating oil of the type used in the lubricating system of internal combustion engines has ignition-accelerating properties. This invention therefore contemplates the provision of means for adding to the ordinary engine fuel a small, controlled proportion of lubricating oil. The means employed to accomplish that end may take different forms, but in the most desirable arrangements the lubricating oil for addition to the fuel is drawn from the lubricating system of the engine. In the preferred arrangement, means are provided for effecting a temporary connection between the lubricating system of the fuel-injection pump and the inlet of such pump, so that during each cycle of operation a small quantity of lubricating oil will be added to the conventional fuel.

Pursuing further this general idea of tapping small amounts of lubricating oil from the lubricating system of an injection type internal combustion engine and delivering it into the fuel injection system it is proposed to inject lubricating oil not only during starting as ignition accelerator but also during regular operation of the engine, the amount so added being varied to suit any particuler type of fuel out of the range burnt in multi-fuel engines (gas oil, gasolines, alcohol).

It is known that the contamination of the lubricating oil by soot or acid products of combustion differs for the various types of fuel. Whereas in the case of diesel fuels the contamination by solid impurities is relatively high, there is little contamination by acids. If the same engine is operated on gasolines the deterioration of the lubricating oil will be greater and mainly by acid dilution. If then the inherent lubricating oil consumption of an engine is small it will take quite some time before it becomes necessary to top up the oil level and thus to add a sufficient amount of fresh oil and restore the cleansing action of the oil (fresh additives). Therefore the engine is liable to suffer from the effects of sludge formation and the resulting clogging of the piston rings, excessive wear of the bearings, etc., although the lubricating oil level is within the prescribed limits. It is not possible to rely on the operator's judgement in deciding on how the interval between oil changes should be varied to allow for the different effects of various fuels on the lubricating oil. For this reason it is desirable that the oil consumption of the engine should be in proportion to the deterioration of the fuel used in a multi-fuel engine at a particular time.

In this invention the oil consumption of the engine is therefore caused to vary in accordance with the degree to which the quality of the lubricating oil is affected by the particular fuel used and the operator can maintain the quality of the lubricating oil simply by keeping the oil level within the prescribed limits while the interval between oil changes can be left unchanged. The variation of this controlled oil consumption is practically so small that the economy of the engine is not affected. On the contrary, the oil injected is not lost but burnt as a fuel and converted into power in the engine.

Mechanically this is achieved by retaining the said connection between the lubricating system of the fuel injection pump and the inlet of such pump throughout the operation of the engine. This connection is effected by a groove-and-port arrangement involving the pump plunger, pump barrel and the sleeve of the injection pump.

The amount of lubricating oil tapped from the lubricating oil system of the injection pump need be but very small, the best proportion being of the order of 1% of the amount of fuel injected. This results in a low-rate lubricating oil consumption which provides the operator with an indication of the oil deterioration and enables him to maintain the necessary oil quality over a scheduled mileage between oil changes so that the intervals between oil changes remain the same no matter whether highly volatile fuels (gasolines) or gas oil was used. Since when using highly volatile fuels of low viscosity the injection pump usually requires additional means of lubrication, the abovementioned lubricating arrangement for the injection pump plunger may be considered standard equipment for such applications so that the device covered by this invention requires but little extra cost. The lubricating arrangement on the pump plunger at the same time acts as an oil-packed gland preventing fuel from penetrating into the camshaft space.

Other features of the invention will become apparent from the following more detailed description and from the accompanying drawings in which:

Fig. 1 is a side elevation, largely diagrammatic in character, of an internal combustion engine embodying my invention;

Fig. 2 is a fragmental section on the line 2—2 of Fig. 1 showing details of an injection pump;

Fig. 3 is a fragmental side elevation of a modified form of pump-plunger;

Fig. 4 is a transverse section on the line 4—4 of Fig. 3;

Fig. 5 is a fragmental view of a fuel pump, in partial section, showing a modified arrangement for effecting temporary connection of the lubricating system to the inlet side of the pump;

Fig. 6 is a fragmental section on the line 6—6 of Fig. 5; and

Fig. 7 is a view similar to Fig. 1 showing still another embodiment of the invention.

In Fig. 1, I have indicated a six-cylinder diesel engine **10** having the usual fuel pump **11** which forces the fuel in timed sequence through conduits **11'** to the injection nozzles **12** of the several cylinders. The fuel pump **11** is supplied with fuel from any appropriate container **13** by a feed pump **14** discharging through a conduit **15**. The engine is provided with a lubricating system including a pump **16** which withdraws lubricating oil from an appropriate source, such as the crank case of the engine, and discharges it through a conduit **17** provided with branches leading to the various points of the engine requiring lubrication. One of such branches, indicated at **18**, extends to the fuel pump **11** for lubricating the running parts thereof.

In the construction shown in Fig. 2, the fuel pump **11** comprises a body **20** in which a series of sleeves **21**, corresponding in number to the injection nozzles **12**, are mounted in parallel relation. The interior of each sleeve **21** constitutes a cylinder which receives a reciprocable plunger **22** and which communicates at its upper end with one of the conduits **11'** past the usual spring-loaded check-valve **23**. Extending longitudinally of the body **20** is a passage or chamber **24** connected in any convenient manner to the fuel supply line **15**. Each of the sleeves **21** extends vertically through the passage **24** and is provided within the limits thereof with an inlet port **25** adapted to be alternately covered and uncovered in the reciprocation of the plunger **22**.

A lubricating oil passage **27** extends longitudinally of the pump body **20** and is connected at one end to the lubricant-supply line **18**. Individual oil passages **28** conduct oil from the passage **27** to the interiors of the several sleeves **21**, opening thereinto below the chamber **24**. The oil passages **28** normally serve to provide a lubricating-oil film **30** between the opposed surfaces of each plunger **22** and its associated sleeve **21**. As the consumption of lubricating oil at this point is low, it is not customary to provide for any oil return.

In adapting a fuel pump of the type shown in Fig. 2 for incorporation of my invention, I provide means for effecting a temporary interconnection of the lubricant passage **27** and the fuel chamber **24**. In the form shown, this interconnection includes a port **32** provided in the wall of a sleeve **21** to effect a connection between the chamber **24** and the interior of the sleeve. In addition, the plunger **22** is provided with a longitudinally extended groove **33** which, for a limited portion of the stroke of the plunger **22**, affords an interconnection between the lubricant passage **28** and the port **32**. During the interval in which the groove **33** provides a connection between the lubricant passage **28** and the chamber **24** lubricant will be discharged from the lubricating system of the engine into the chamber **24** where, mixed with the fuel therein, it will be supplied through the port **25** to the interior of the sleeve **21** and injected into the cylinder on the working stroke of the plunger.

In order that interconnection of the passage **28** and port **32** through the groove **33** may be independent of the angular disposition of the plunger **22** about its axis, the sleeve **21** is shown as provided interiorly and in the plane of the port **32** with an annular groove **35** and the plunger **22** is shown as provided with an annular groove **36** communicating with the lower end of the longitudinal groove **33**. Many fuel injection pumps are so constructed that the amount of fuel injected at each stroke of each plunger can be varied by adjusting the plunger about its axis. The annular grooves **35** and **36** shown in Fig. 2 permit such adjustment to be made without interfering with the delivery of lubricating oil to the chamber **24** through the port **32**, groove **33**, and passage **28**.

The amount of lubricating oil delivered to the chamber **24** at each stroke of the plunger will be a function of the length of the time interval during which the passage **28** and port **32** are interconnected. The duration of that time interval will depend on two factors—viz., on the effective length of the groove **33** relative to the spacing between the port **32** and passage **28** and on the position of the plunger during the interval in which such port and passage are interconnected. If, as indicated in Fig. 2, the plunger is at or near one end of its stroke while the groove **33** is interconnecting the passage **28** and port **32**, the plunger will be moving slowly and a relatively large amount of lubricating oil will be delivered to the chamber **24**. On the other hand, if the plunger is nearer the mid-point of its stroke when the port **32** and passage **28** are interconnected, the plunger will be moving rapidly and a small amount of lubricating oil will be delivered to the chamber **24**. Other factors affecting the rate at which lubricating oil is supplied to the fuel are the cross-sectional areas of the passages **28**, **33**, and **32**, the number of plungers provided with the grooves **33**, and the effective lubricating-oil pressure, which can be controlled by a valve **37** in the conduit-branch **18**.

Instead of employing in the plunger **22** a groove **36** which is of uniform cross-sectional area through the entire circumference of the plunger, I may provide the plunger with a groove of varying cross-sectional area, as indicated at **40** in Figs. 3 and 4. As there shown, the groove has a maximum cross-sectional area at one end and decreases in both width and depth toward the other end. By adjusting about its axis a plunger provided with a groove **40**, the amount of lubricating oil delivered to the fuel system at each stroke of the plunger can be varied as desired. In fuel pumps wherein the plungers are rotatable about their axes to vary fuel delivery, the grooves **40** can be positioned and shaped to maintain any desired ratio between the rates of fuel and lubricating-oil delivery to the nozzles **12**.

Another method of maintaining a desired ratio between the rates of fuel and lubricating-oil supply involves the use, in the fuel-line **15**, of a restriction which will create a pressure-drop that varies with the rate of fuel delivery. Such a restriction may be an adjustable valve such as indicated at **51** in Fig. 1, but it is not necessarily adjustable. At the higher engine speeds, such a constriction reduces the pressure in the chamber **24** below what it would otherwise be, thus resulting in increasing the amount of lubricating oil delivered to such chamber through the passage **33** at each stroke of the pump plunger **22**.

Instead of employing reciprocation of fuel-injection plungers to effect a temporary interconnection of the lubricating and fuel-supply systems, I may employ rotation of one of the engine shafts. Such an arrangement is indicated in Fig. 5. Here, the shaft **42** which carries the cams **43** that operate the several plungers **22** is shown as supported in bearings **44**. In the plane of one of such bearings, the shaft **42** is provided with a transverse passage **45** adapted to register at each half-revolution of the shaft **42** with diametrically opposite passages **46** and **47** in the bearing. One of such passages, shown as the passage **46** is connected to the fuel-supply line **15** by a conduit **46'** while the other passage is connected to a branch **48** of the lubricant-conduit **17**. With such an arrangement, whenever the passage **45** in the shaft registers with the passages **46** and **47** a small quantity of lubricating oil will be added to the fuel supplied to the pump **11**. The quantity of lubricating oil so added to the fuel can be controlled by means of an adjustable valve **49** in the branch conduit **48**.

In the operation of the devices so far described, the valve **37** or **49** in the line from the lubricating system is opened prior to starting the engine. The lubricating oil added to the fuel serves as an ignition accelerator during engine starting and warm-up. When the engine attains normal operating temperature and an ignition accelerator is no longer needed, the valve **37** (or **49**) is closed to terminate the supply of lubricant. As indicated in the case of the valve **37** in Fig. 1, the valve controlling the supply of lubricating oil to the fuel system may be automatically operated under the control of a temperature-responsive element **53** responsive to engine temperature and operative through any appropriate form of motor **54** to close the valve when a predetermined engine temperature is attained.

The arrangement of Fig. 7 is similar to that of Fig. 1 except that the supply of lubricant to the fuel system is effected manually. In such an arrangement I employ a manually operated pump **55** having a suction line **56** communicating with the lubricant sump of the engine and a delivery line **57** communicating with the fuel line **15**. Through operation of the manual pump **55**, lubricant can be withdrawn from the lubricant system and delivered to the fuel system during the starting and warm-up of the engine.

This application is a continuation-in-part of each of my prior copending applications Serial No. 567,397, filed February 23, 1956, and Serial No. 684,244, filed September 16, 1957, both of which are now abandoned in favor of this application.

I claim as my invention:

1. In a compression-ignition internal combustion engine having a combustion chamber, means for injecting liquid fuel into said combustion chamber, and a lubricating system through which lubricating oil is circulated; means for withdrawing small quantities of the lubricating oil from said lubricating system and supplying them to said fuel-injection means.

2. The invention of claim 1 with the addition that said last named means is driven by the engine and receives lubricating oil through a conduit communicating with said lubricating system.

3. The invention of claim 2 with the addition of a valve in said conduit, and means responsive to the temperature of the engine for controlling said valve to terminate the supply of lubricating oil to the fuel-injection means.

4. The invention of claim 2 with the addition of a valve in said conduit, and means responsive to the temperature of the engine for controlling said valve.

5. The invention of claim 2 with the addition of a valve in said conduit.

6. The invention of claim 1 with the addition of means responsive to the temperature of the engine for controlling the supply of lubricating oil to said fuel-injection means.

7. The invention of claim 1 with the addition that said last named means is engine driven and includes provisions for establishing a controlled short-time connection between the lubricating system and said fuel-injection means.

8. An apparatus for controlling the lubrication oil consumption of a fuel injection internal combustion engine comprising a fuel injection pump having a cylinder, a fuel plunger reciprocable therein, and a fuel intake suction chamber in controlled communication with said cylinder, an engine connected lubricating system having a lubricating oil line joined to said pump, and pump actuated means for establishing a controlled short time communication between said oil line and said suction chamber during operation of said pump.

9. In combination with a high speed diesel engine having a fuel supply system, a fuel-injection nozzle, and a lubricating system, means for feeding lubricant in controlled quantities from said lubricating system to said fuel supply system at a point therein anterior to said nozzle for admixture and simultaneous injection with the fuel.

10. The combination of claim 9 with the addition that said lubricating system is a circulating system having a pressure side, said feeding means comprising a connection between the pressure side of the lubricating system and the fuel-supply system.

11. The combination of claim 9 with the addition that said feeding means is a manually operated pump having an inlet connected to said lubricating system and an outlet connected to said fuel supply system.

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