June 11, 1963 D. C. BAKER 3,093,126

ENGINE PREHEATER

Filed Dec. 7, 1960 2 Sheets-Sheet 1

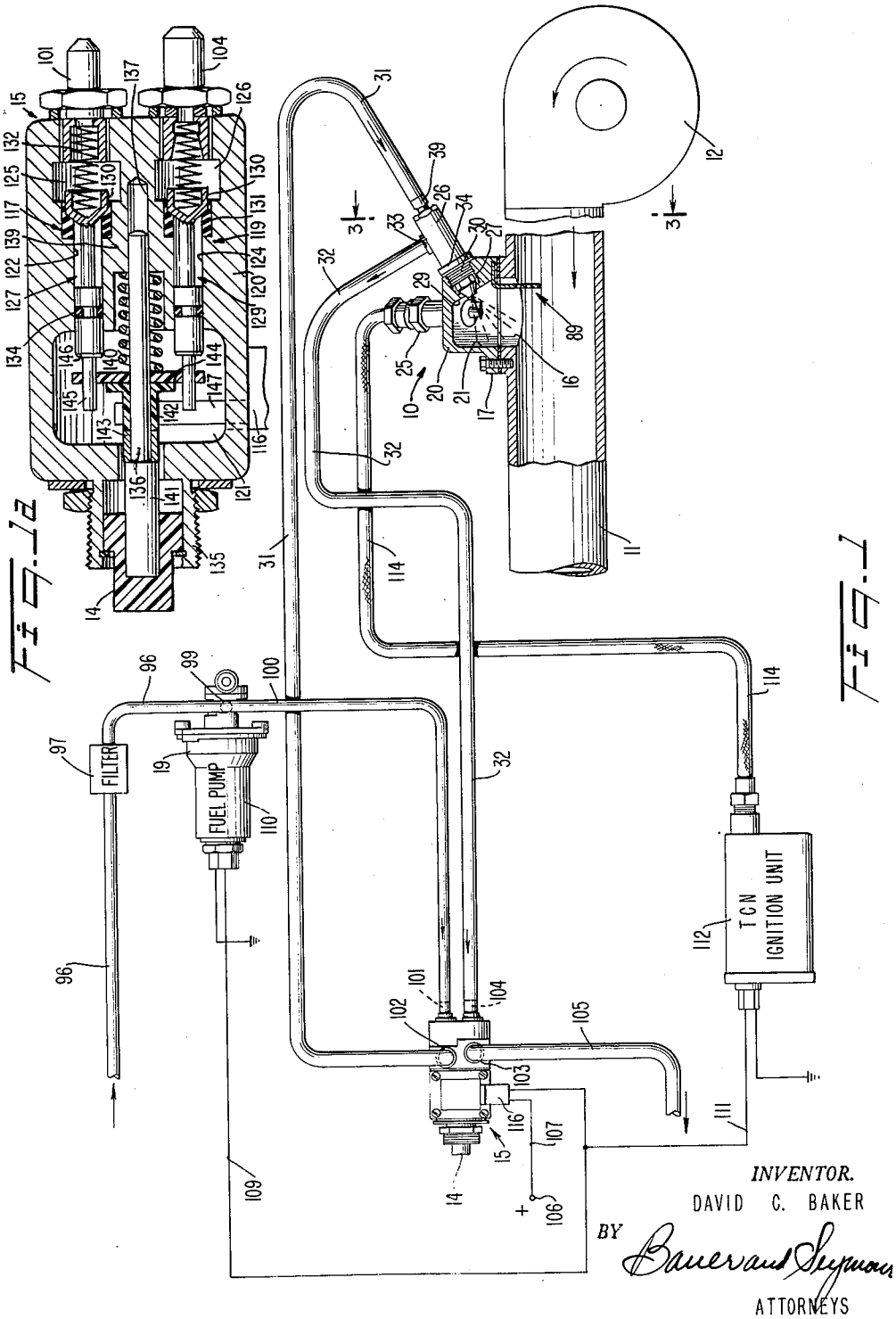


Fig. 1

Fig. 1a

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Fig. 2

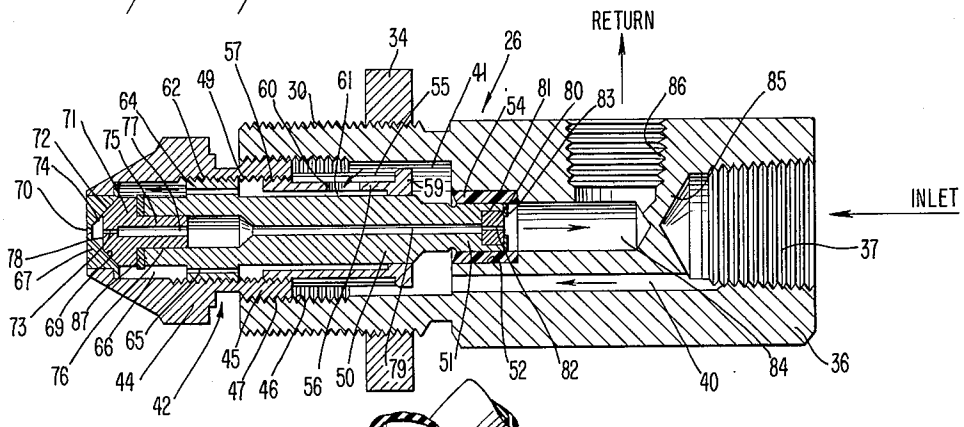


Fig. 3

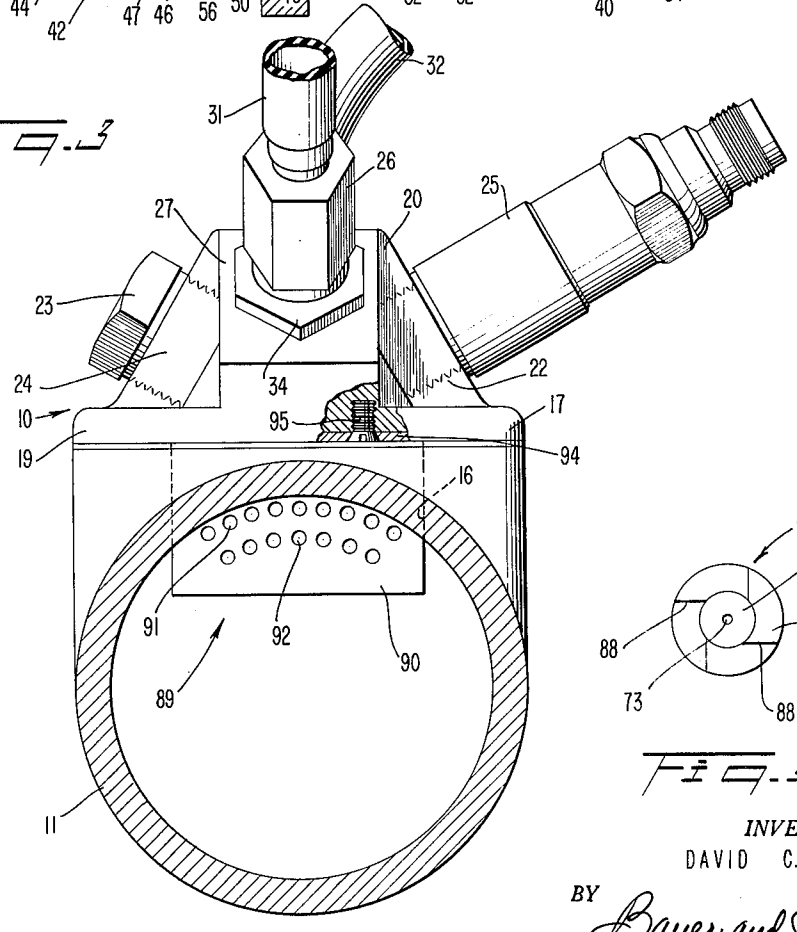


Fig. 4

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ENGINE PREHEATER

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9 Claims. (Cl. 123—142.5)

This invention relates to a preheater system for internal combustion engines. Such system is particularly useful with diesel engines used in cold climates.

In the Arctic or Antarctic regions, temperatures of —30° F. and —60° F. or below are not uncommon. Diesel engines employed under such conditions are difficult to start, because they depend solely upon the heat generated by compression of air to ignite the charge in the cylinder. When the intake air is too cold, the compression of such air is insufficient to ignite the air-fuel mixture. Consequently, the intake air must be preheated before it is introduced to the cylinders of the engine during the periods when the cold engine is being started.

The engine has among its objects the provision of a novel, simple and reliable preheater system for internal combustion engines.

A further object of the invention resides in the provision of a preheater system which is particularly useful with diesel engines, and may be employed to advantage with multi-fuel diesel engines.

Yet another object of the invention lies in the provision of an engine preheater system which makes use of the sources of the electrical power and fuel for the engine.

A further object of the invention lies in the provision of an improved, simplified and efficient combustion heater unit for the preheater system of the engine.

Still another object of the invention lies in the provision of a preheater system of the type described which eliminates the necessity for the provision of a source of compressed air for operating the combustion heater unit.

The present invention is an improvement upon that disclosed and claimed in the application of David C. Baker, Serial No. 760,386, filed September 11, 1958, assigned to the assignee of the present application, now Patent No. 3,024,777, issued March 13, 1962.

The above and further objects and novel features of the invention will more fully appear from the following description when the same is read in connection with the accompanying drawings. It is to be expressely understood, however, that the drawings are for the purpose of illustration only, and are not intended as a definition of the limits of the invention.

In the drawings, wherein like reference characters refer to like parts throughout the several views,

FIG. 1 is a fragmentary somewhat schematic view of an engine preheater system made in accordance with the invention, a fragmentarily shown air intake manifold of the engine being shown partially in section;

FIG. 1*a* is an enlarged view in horizontal axial section through the control unit **15** of FIG. 1, the switch portion of the control unit being omitted for simplicity of illustration;

FIG. 2 is a view in longitudinal axial section through the spray nozzle employed with the combustion heater unit of the system of FIG. 1;

FIG. 3 is a view in vertical transverse section through the air intake manifold of the engine immediately in advance of the combustion heater unit, the section being taken generally along the line **3**—**3** of FIG. 1; and

FIG. 4 is an enlarged view in end elevation of the forward end of the inner assembly of the spray nozzle.

The illustrative embodiment of preheater system includes a combustion unit **10** which is shown in FIGS. 1 and 3. Unit **10**, which will be described in detail hereinafter, provides for combustion of fuel derived from the fuel source for the engine, the products of such combustion being discharged into the intake manifold **11** of the engine at a position between in intake air turbo-compresser **12**, shown schematically in FIG. 1, and the engine (not shown). Such products of combustion, mixing with the cold air from the turbo-compresser, raise the temperature of the resulting mixture sufficiently for such gaseous mixture, when mixed with fuel injected into the cylinders of the engine, to ignite it by engine compression.

After the engine has started, the operation of unit **10** may be discontinued. Unit **10** may, however, be operated, if desired, during periods of idling of the engine. The periods of operation of unit **10** are under the control of the operator, combustion and unit **10** being initiated by depressing a button **14** of a control unit **15**, and being stopped by releasing such button. The construction of a control unit **15**, which governs the operation of the combustion unit **10**, and the manner of operation of control unit **15**, will be described hereinafter.

Combustion unit **10** is secured to manifold **11** so that the interior of the combustion unit communicates with an opening **16** in the manifold. Unit **10** has a flange **17** on the bottom thereof which is secured by studs to a hollow boss on the manifold surrounding opening **16**, the unit being sealed to the boss by an interposed gasket, as shown. In the embodiment shown, the preheater unit **10** is supplied with liquid fuel which may be that normally supplied to the engine, and in the case of a diesel engine may be kerosene, diesel fuel, gasoline, or that known as JP4. The preheater system shown, including the combustion unit **10**, control unit **15**, and a fuel pump **19**, to be described, may be used without adjustment with any of such fuels. Consequently, the preheater system of the invention is particularly advantageous for use with multi-fuel diesel engines.

The combustion preheater **10** has a hollow body **20** presenting a space **21** therewithin. Space **21** is defined by a radially disposed forward wall of body **20**, by two oppositely sloping sidewalls **22** and **24**, and by a sloping rear wall **29**. As shown in FIG. 3, a spark plug **25** is threaded into an opening in wall **22**; wall **24** is provided with a similar threaded opening in which the spark plug may be alternatively mounted. The unused opening in the walls **22**, **24**, is closed by a plug **23**. A spray nozzle **26**, through which the fuel to be burned in space **21** enters, is provided with screw threads **30** by which it is mounted in a threaded opening in the rear wall **27** of body **20**. After being screwed into such opening, the spray nozzle **26** is turned to the desired angle about its axis and is retained in such position by tightening a nut **34** on threads **30** into engagement with the outer face of wall **27**. Fuel under pressure is led to the spray nozzle through a pipe **31** which is connected to the rear end of the nozzle by a fitting **39**. Fuel which is in excess of that required by the nozzle is returned to the fuel supply sump by a pipe **32** which is connected to the spray nozzle by a fitting **33**.

The structure of the spray nozzle is shown most clearly in FIG. 2. The nozzle has an outer body **36** on the forward end portion of which the aforesaid screw threads **30** are located. At the rear end of body **36** there is a threaded inlet port **37** to which the inlet fitting **39** is secured. Displaced somewhat from the axis of body **36** are a plurality of longitudinally extending fuel inlet passages which are angularly spaced from each other about the longitudinal axis of body **36**; one of such passages is shown at **40** in FIG. 2. The forward ends of passages **40** communicate with a counterbore **41** in the forward, inner

end of body 36. Within counterbore 41 there is mounted an inner spray nozzle assembly 42, the assembly being connected to the body 36 by interfitting screw threads 47 and 46 on rear portion 45 of body 44 of the inner nozzle assembly and body 36, respectively. Body 44 of the nozzle is hollow and is internally threaded as shown at 49 throughout a substantial portion of its length from its rear end. The inner spray nozzle assembly 42 has an inner body portion 50 which has an annular flange 64 intermediate its length. Flange 64 is externally threaded at 62, threads 62 being engaged with threads 49 on body 44. The rear end of body 50 is provided with a portion 51 of reduced diameter which is received within a counterbore 52 at the inner end of chamber 44. An annular sealing member 54, which may be made of nylon or the like, is interposed between element 51 and the counterbore 52 so as to provide a seal therebetween. It will be understood that fuel under pressure enters port 37, travels through the passages 40 and thence into chamber 41. From chamber 41 the fuel is led under pressure to the spray orifice of the nozzle in the following manner.

An annular sleeve-like screen 55 is disposed about the rear or inner end of the inner spray nozzle assembly. Screen 55 is retained in the position shown by an inner, screen-retaining sleeve 56, the forward end of member 56 carrying threads 57 which mate with threads 49 on body 44. The rear end of member 56 has an annular radially projecting flange 59 thereon, such flange functioning to thrust screen 55 forwardly against the rear end of portion 45 of body 44. Member 56 has one or more radial holes 60 therethrough, such holes communicating with an annular, sleeve-like space 61 between members 56 and 50. Fuel under pressure thus travels radially inwardly through screen 55, through the one or more holes 60, and thence forwardly within space 61.

The mounting flange 64 on body 50 is provided with a plurality of longitudinally extending passages 65 therethrough so that the fuel travels from space 61 through passages 65 into a forward or inner annular chamber 66 adjacent the orifice of the spray nozzle. The nozzle has an outer hard metal insert 67 and an inner hard metal insert 71, the two inserts having mating frusto-conical faces. In the embodiment shown, the outer insert 67 is press-fitted into a bore at the forward end of body 44, and the insert 71 has a rearwardly extending stem 75 which somewhat loosely fits within a central longitudinal opening 76 in the forward end of body 50. A gasket or washer 87 seals insert 71 to member 50 when the insert and member are thrust against each other as shown in FIG. 2. Body 67 has a frusto-conical seat 69 therein, and the forward end of insert 71 has a complementary frusto-conical end surface 72. The frusto-conical surface 72 of insert 71 is provided with a plurality (four shown, FIG. 4) of narrow slots or grooves 88. Centrally inwardly of surface 72 the insert 67 is provided with a small frusto-conical chamber 74, bounded by a transverse surface 78 on insert 71, the chamber 74 communicating with the central spray orifice 70 in the insert 67. It will be apparent from the above that fuel which has traveled under pressure into chamber 66 flows forwardly through the narrow slots 88 in surface 72 and thence into chamber 74 from which it is sprayed outwardly through orifice 70.

With the spray nozzle shown, the fuel which flows into chamber 74 is in excess of that which can be discharged through orifice 70. Excess fuel is led from chamber 74 of the nozzle through a flow-metering orifice and thence to the fuel sump. The rate of fuel flow outwardly through orifice 70, with a given viscosity of fuel, is effectively determined by the fuel pressure, the total cross sectional area of slots 88, and the cross sectional area of the return flow-metering orifice.

Insert 71 is provided with an axial passage 77 which communicates at its forward end with chamber 74 through a central passage 73. Body 50 is provided with an axially extending passage 79 which communicates with passage 77 as shown. A flow-metering insert 80, preferably made of hard metal, is disposed within a counterbore 81 in the rear end portion 51 of the body 50. Insert 80 is retained in place as by the spinning of the rear edge 83 of portion 51 over the rear edge of the insert. Insert 80 has a flow-metering orifice 82 through which the excess fuel flows into a central chamber 84 in body 36. Chamber 84 is separated from inlet port 37 by an integral partition 85, as shown. The rear end of chamber 84 communicates with an outlet port 86 to which is connected the above-mentioned fitting 33 to which the return pipe 32 is attached.

A short baffle 89 is disposed radially of the intake manifold 11 at the rear edge of the opening 16 thereinto. Such baffle is in the form of an L-shaped plate having an operative baffle portion 90 extending within manifold 11 and a horizontally disposed flange portion 94 which is located in an elongated groove in the bottom of wall 27 of body 20 and is attached thereto by screws of which one is shown at 95. Portion 90 of the baffle in the embodiment shown has two arcuate rows of holes 91 and 92 therethrough, the outer row 91 being positioned close to the inner surface of the intake manifold, and the inner row 92 being positioned somewhat radially inwardly of the first row. Inwardly of the holes 92 the baffle plate 90 is imperforate. The baffle functions to prevent the direct entry of air under pressure from blower 12 into the space 21, the holes 91 and 92 in the baffle, however, forming a plurality of eddy currents in the air flowing across the mouth of the combustion chamber in body 20. As a result, the finally dispersed fuel issuing from spray orifice 70 is discharged into rapidly moving turbulent air so as to be thoroughly mixed therewith by the time it burns.

The preheater system as a whole, and its manner of operation, will be more readily understood upon consideration of FIG. 1. A fuel supply line 96, fed by gravity from a sump (not shown) has a filter 97 interposed therein. Supply line 96 leads to an inlet port 99 of the fuel pump 19. The pump, which is driven by an electric motor 110, delivers fuel under pressure from its outlet port to a supply pipe 100 which leads to an inlet port 101 of the control unit 15.

Unit 15 includes two manually operated fluid control valves and a switch 116, the push button 14 controlling the positioning of such valves and also selectively energizing the motor 110 of the fuel pump and a high tension ignition unit 112. Fuel under pressure is delivered from the outlet port 102 of the first valve 117 of unit 15, when the latter is open, through the pipe 31 to the above-described spray nozzle 26. The fuel return pipe 32, which is connected to spray nozzle 26, is connected to a port 104 of unit 15 and thence flows through the second valve 119 of unit 15 and thence through port 103 and a pipe 105 to the fuel supply sump (not shown).

Control unit 15 has an elongated casing 120 which has a chamber 121 in the left-hand end thereof (FIGS. 1 and 1*a*). Two parallel, laterally spaced, longitudinally extending bores 122 and 124, forming parts of valves 117 and 119, respectively, extend from chamber 121 to two further, separate chambers 125 and 126, respectively, in the right-hand end of casing 120. Inlet port 101 communicates with chamber 125, and inlet port 104 communicates with chamber 126, as shown in FIG. 1*a*.

Reciprocably mounted in bores 122 and 124 are similar poppet valve elements 127 and 129, respectively. The right-hand end of each of elements 127 and 129 is enlarged to form a head designated 130, the head of each valve member sealingly cooperating with an annular valve seat 131 when the valve member is thrust to the left into the position shown in FIG. 1*a* by the respective spring 132. To the left of head 130 each of valve elements 127 and 129 has a stem portion which has a diameter markedly less than that of bores 122 and 124. The valve elements are enlarged at the left-hand end portions within the respective bores, the enlarged portions of the valve

elements accurately guidingly engaging the bores. An O-ring **134** is positioned in an annular groove in the enlarged portion of each valve element, whereby to provide a seal between each valve element and its bore. The port **102** extends through the wall of casing **120** into communication with the portion of bore **122** confronting the reduced-diameter stem of valve element **127**. The port **103** extends through the wall of casing **120** into communication with the portion of bore **124** confronting the reduced-diameter stem of valve element **129**. It will thus be seen that when valve elements **127** and **129** are thrust to the right against the action of springs **132**, communication is established between pipe **96** and port **101** and port **102**, and between pipe **32** and port **104** and port **103**.

The valve elements **127** and **129** are simultaneously unseated, thereby to open valves **117** and **119**, by being thrust to the right by the pressing inwardly of button **14**. Button **14** is axially slidable in a central passage in an extension on casing **120**. Extending axially inwardly of the casing **120** from button **14** is a rod **136** made of electrically insulating material, the inner end of the rod being slidable in a bore **137** in a central member **139** integral with the casing and extending axially into the casing from the right-hand end thereof. The button **14** is constantly urged to the left toward its axially outer position by a coil compression spring **140** acting between a spring seat in member **139** and the button **14** through the medium of spacer members and a valve actuating member.

The rod **136** is connected to button **14** by an enlarged head **141** on the rod. Telescoped over rod **136** and abutting the head **141** thereof is an electrically conducting contact sleeve **143**. A transversely disposed electrically insulating plate **144** having a central hole therein is telescoped over rod **136** and interposed between the outer end of spring **140** and the flanged inner end of a sleeve **142**. Sleeve **142** is interposed between contact sleeve **143** and plate **144**. The left-hand ends of valve elements **127** and **129** have axial extensions **145** thereon, such extensions being slidable in holes in the outer edges of plate **144**. When the button **14** is fully retracted, as shown in FIG. 1*a*, the plate **144** lies spaced somewhat to the left of the shoulders **146** defined by the junction of extensions **145** and the main parts of valve members **127** and **129**. It will be apparent that the button may be pushed inwardly a short distance against the opposition of spring **140** without opening valves **117** and **119**. Only when plate **144** contacts shoulders **146**, upon movement of button **14** inwardly, do the valves **117** and **119** begin to open.

The switch **116** is secured to the casing **120** as shown in FIG. 1. Projecting inwardly into chamber **121** of casing **120** from the housing of switch **116** are two vertically spaced generally parallel leaf spring contacts insulated from each other and constantly urged into engagement with the insulating sleeve **142** and/or the contact sleeve **143**. When the button **14** is retracted as shown in FIG. 1*a*, the contacts, of which the bottom contact **147** is shown in FIG. 1*a*, engage only sleeve **142**, so that the circuit through the switch **116** is broken. When the button **14** is depressed somewhat, but before plate **144** engages shoulders **146** of the valve elements, the contact sleeve **143** completes the circuit between the leaf spring contacts, thereby energizing the fuel pump **110** and the ignition unit **112**. The apparatus is thus placed in condition immediately to initiate combustion in the heater upon the opening of valves **117** and **119** by continued inward travel of the button **14**.

Power for the control system is supplied through a suitable direct current source having a positive terminal **106** which is connected to the switch **116** by a wire **107**. The live side of the circuit issues from the switch **116** and is branched so that one supply wire **109** extends to fuel pump motor **110** and another supply wire **111** extends to ignition unit **112**. The ignition unit, which supplies a succession of high voltage discharge pulses when it is energized, is connected to spark plug **25** of the preheater through a high tension shielded lead **114**.

An engine provided with the above-described preheater system is started as follows: The engine is turned over by means of the engine starter. While the engine is turning over, the switch **116** is closed by the pushing of button **14** to cause spark discharges to occur at the spark plug **25**. Simultaneously therewith, the pushing of button **14** opens valves **117** and **119** so that fuel is led under pressure to the spray nozzle **26** and is discharged therefrom in the form of a spray through orifice **70**, excess fuel being returned through valve **119**. The turbo-blower **12** will, of course, have been started before or at least simultaneously with the closing of switch **116**. The mixture of dispersed fuel with air in the manifold **11** will ignite upon reaching the spark gap of the spark plug **25**. The products of combustion from chamber **21** enter the manifold **11** to mix with the air from the turbo-compressor **12** and thus to raise the temperature of the air drawn into the engine. The volume of such products of combustion relative to the air provided by the turbo-compressor is insufficient to prevent operation of the engine in a normal manner. After engine ignition has taken place, button **14** is released, thereby closing the fuel valves **117** and **119** in unit **15**, and opening switch **116** to deenergize the fuel pump motor **110** and to deenergize the ignition unit **112**.

Although only one embodiment of the invention has been illustrated in the accompanying drawings and described in the foregoing specification, it is to be especially understood that various changes, such as in the relative dimensions of the parts, materials used, and the like, as well as the suggested manner of use of the apparatus of the invention, may be made therein without departing from the spirit and scope of the invention as will now be apparent to those skilled in the art.

What is claimed is:

1. An engine intake air preheater unit comprising a combustion chamber-forming housing having an open inner delivery end and a closed outer end, the inner end of the housing being adapted for attachment to an air inlet conduit of an internal combustion engine at an opening in said conduit, a liquid fuel spray nozzle mounted on the wall of the housing for discharging fuel in comminuted form within the combustion chamber, the spray nozzle being inclined downwardly and forwardly in the direction of air flow to the engine so as to discharge its spray generally forwardly and through the opening in the conduit toward the axis of the conduit, and a spark discharge means disposed within the housing forwardly of the spray nozzle and in the path of fuel issuing from the nozzle.

2. A preheater unit as claimed in claim 1, comprising a baffle having a plate adapted to project transversely within the conduit at the rear of the opening in the conduit, said plate extending a substantial distance radially into the conduit, the plate having a plurality of spaced holes therethrough near the wall of the conduit adjacent the inner surface of the conduit.

3. A preheater unit as claimed in claim 1, wherein the spray nozzle is of the solid spray type, and comprising a source of fuel, means to supply the spray nozzle from said source with an excess of fuel under pressure, and means to return the excess fuel to the fuel source.

4. In an internal combustion engine having an air inlet conduit, the improvement which comprises an engine intake air preheater unit comprising a combustion chamber-forming housing having an open inner delivery end and a closed outer end, the inner end of the housing being attached to an air inlet conduit of the engine at an opening in said conduit, the inner surface of the rear wall of the housing being inclined in a direction forwardly and radially outwardly of the conduit, a liquid fuel

spray nozzle mounted on the rear wall of the housing with its axis generally normal to the inner surface of such rear wall so as to discharge its spray generally forwardly in the direction of air flow to the engine and toward the axis of the inlet conduit and partially within the combustion chamber and partially directly into the conduit, and a spark discharge means disposed within the housing forwardly of the spray nozzle.

5. Apparatus as claimed in claim 4, comprising a baffle having a plate adapted to project transversely within the conduit at the rear of the opening in the conduit, said plate extending a substantial distance radially into the conduit, the plate having a plurality of spaced holes therethrough near the wall of the conduit adjacent the inner surface of the conduit and aligned with the portion of the spray from the nozzle which penetrates directly into the conduit.

6. A preheater unit as claimed in claim 5, wherein the baffle is secured to the housing.

7. Apparatus as claimed in claim 6, wherein the baffle is L-shaped in end elevation and has a second plate portion disposed generally at right angles to the first recited plate, the second plate underlying and being secured to the rear edge of the housing at the open inner end thereof.

8. In an internal combustion engine having an air inlet conduit, the improvement which comprises an intake air preheater system for the engine, said system comprising an engine fuel-burning preheater unit having a combustion chamber and a spark ignition device within such chamber, said preheater unit being attached to the conduit to discharge heated gas thereinto through an opening in the conduit between the air inlet end thereof and the

engine, a solid injection liquid fuel spray nozzle mounted on the preheater unit so as to discharge fuel in comminuted form within the combustion chamber, the spray nozzle being disposed at such angle with respect to the conduit as to discharge its spray generally forwardly in the direction of air flow to the engine and toward the axis of the inlet conduit and partially within the combustion chamber and partially directly into the conduit, a source of fuel supply, means to supply liquid fuel under pressure to the spray nozzle, and means to return excess fuel from the nozzle to said source.

9. Apparatus as claimed in claim 8, comprising a baffle having a plate adapted to project transversely within the conduit at the rear of the opening in the conduit, said plate extending a substantial distance radially into the conduit, the plate having a plurality of spaced holes therethrough near the wall of the conduit adjacent the inner surface of the conduit and aligned with the portion of the spray from the nozzle which penetrates directly into the conduit.

References Cited in the file of this patent

UNITED STATES PATENTS

1,379,178	Good	May 24, 1921
1,395,399	Doble et al.	Nov. 1, 1921
1,473,136	Woolson	Nov. 6, 1923
1,613,000	Widdowson	Jan. 4, 1927
1,733,792	Good	Oct. 29, 1929

FOREIGN PATENTS

801,774	Great Britain	Sept. 24, 1958