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Henchel

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[54] **HEATER APPARATUS WITH CONTROLLED AIR AND FUEL INTAKE**

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[21] Appl. No.: **846,708**

[52] **U.S. Cl.** ..... **123/142.5 R,** 60/63, 431/201, 431/20, 431/336, 431/352, 431/121, 431/195

[51] **Int. Cl.** **F02n 17/02,** F23d 5/00, F23d 15/02

[58] **Field of Search** 123/142.5; 60/63; 431/201, 20, 336, 352, 121, 195

[56] **References Cited**

UNITED STATES PATENTS

795,409	7/1905	Nelson	431/121
982,141	1/1911	Keclar	431/121
1,329,224	1/1920	Brazic	431/195
2,357,454	9/1944	Brown	431/336
2,602,495	7/1952	Green	431/336
2,737,169	3/1956	Kimberlin	123/142.5
3,072,176	1/1963	Sunday	431/20
3,084,735	4/1963	Huston	431/201
3,158,192	11/1964	Mizer	123/142.5
3,234,928	2/1966	Smith	123/142.5
3,400,700	9/1968	Lindsey et al.	123/142.5

FOREIGN PATENTS OR APPLICATIONS

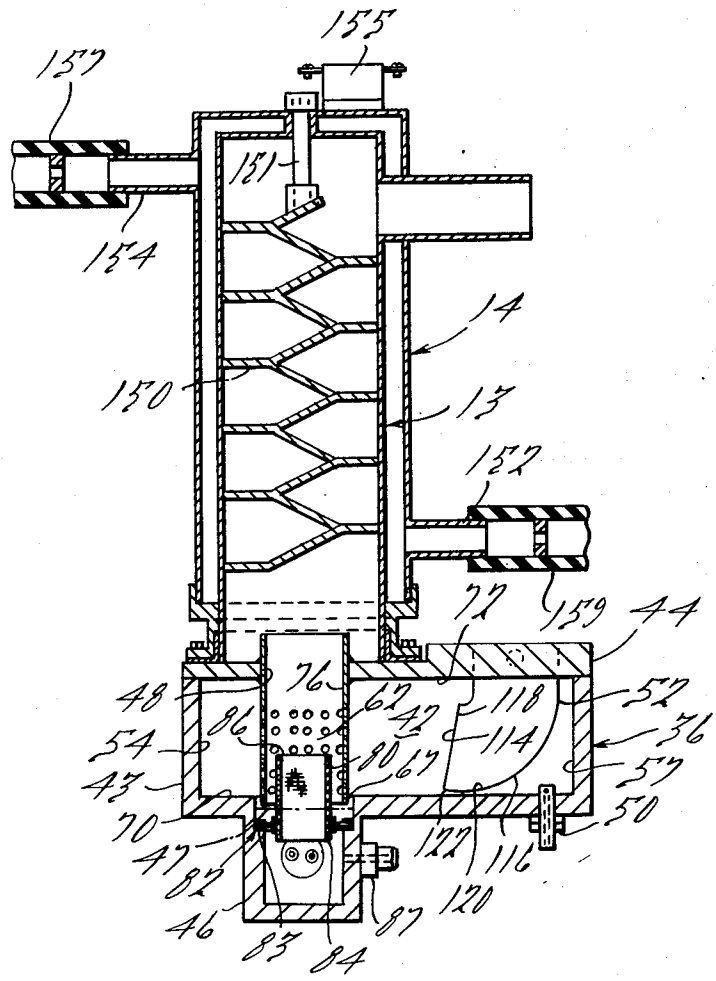
1,192,148	9/1959	France	431/336

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[57] **ABSTRACT**

An engine pre-heater comprising a pair of concentric screens mounted in one end of a pear-shaped swirl chamber and forming a combustion chamber in which diesel fuel vapors are mixed with forced air delivered from a fan through the swirl chamber and from which oil residues are forced along a flow path extending to the other end of the swirl chamber to a drain.

21 Claims, 6 Drawing Figures



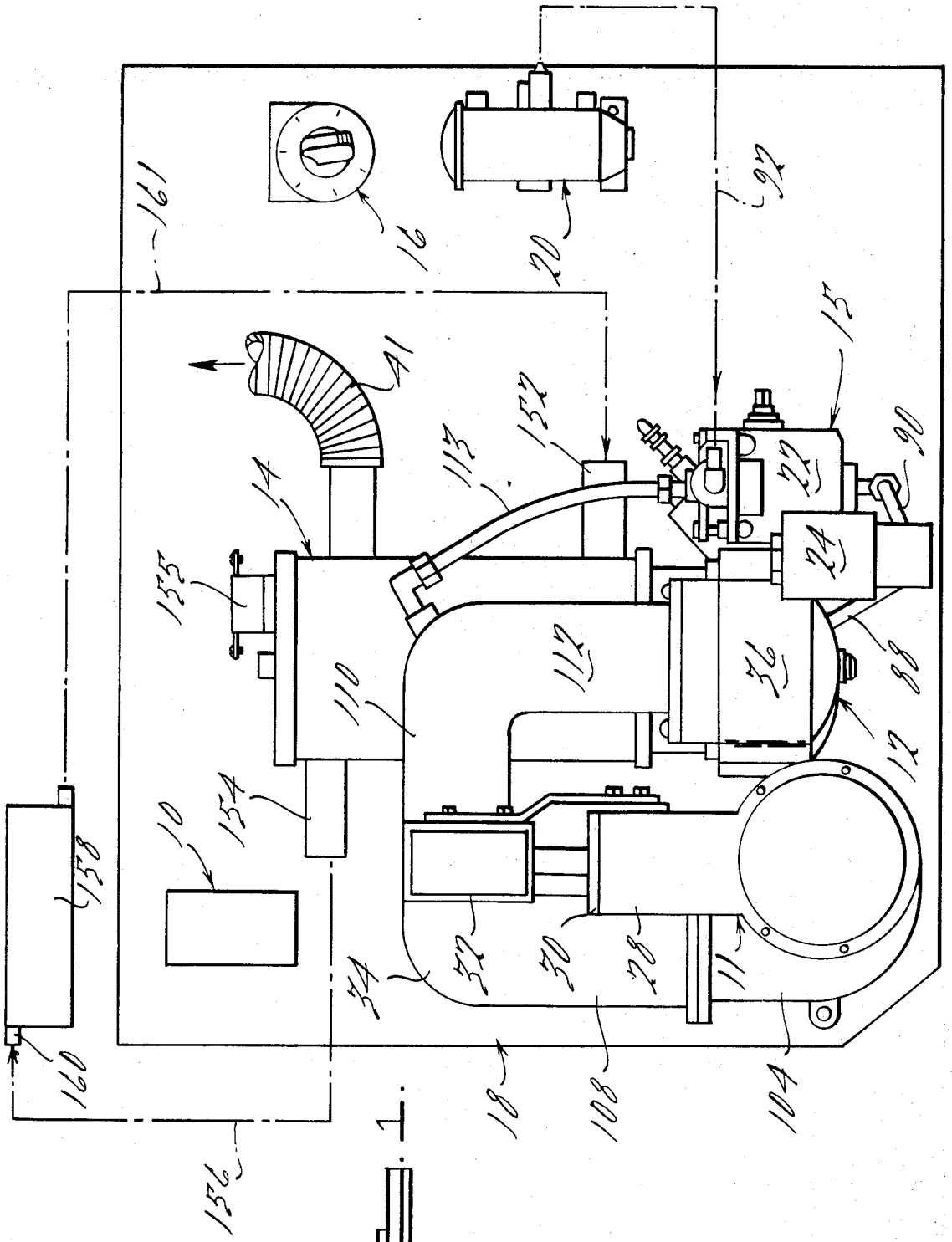


FIG. 1

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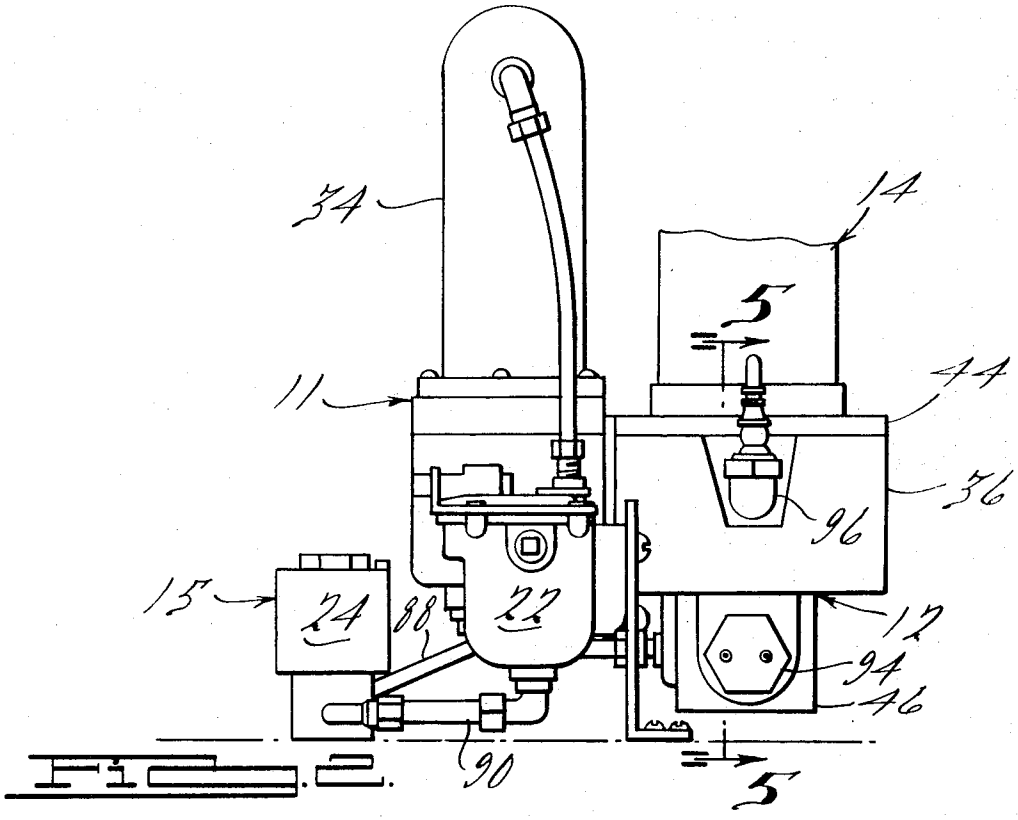


FIG. 2.

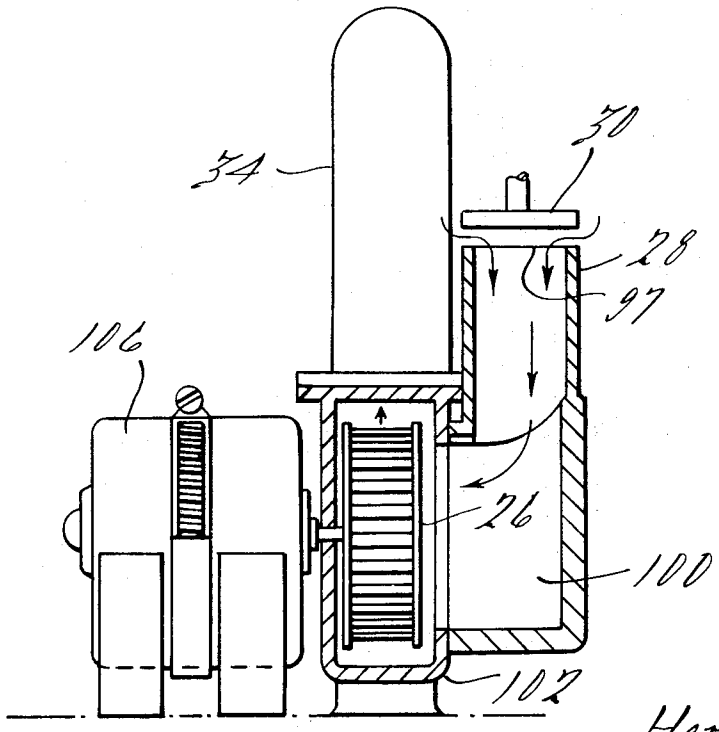


FIG. 3.

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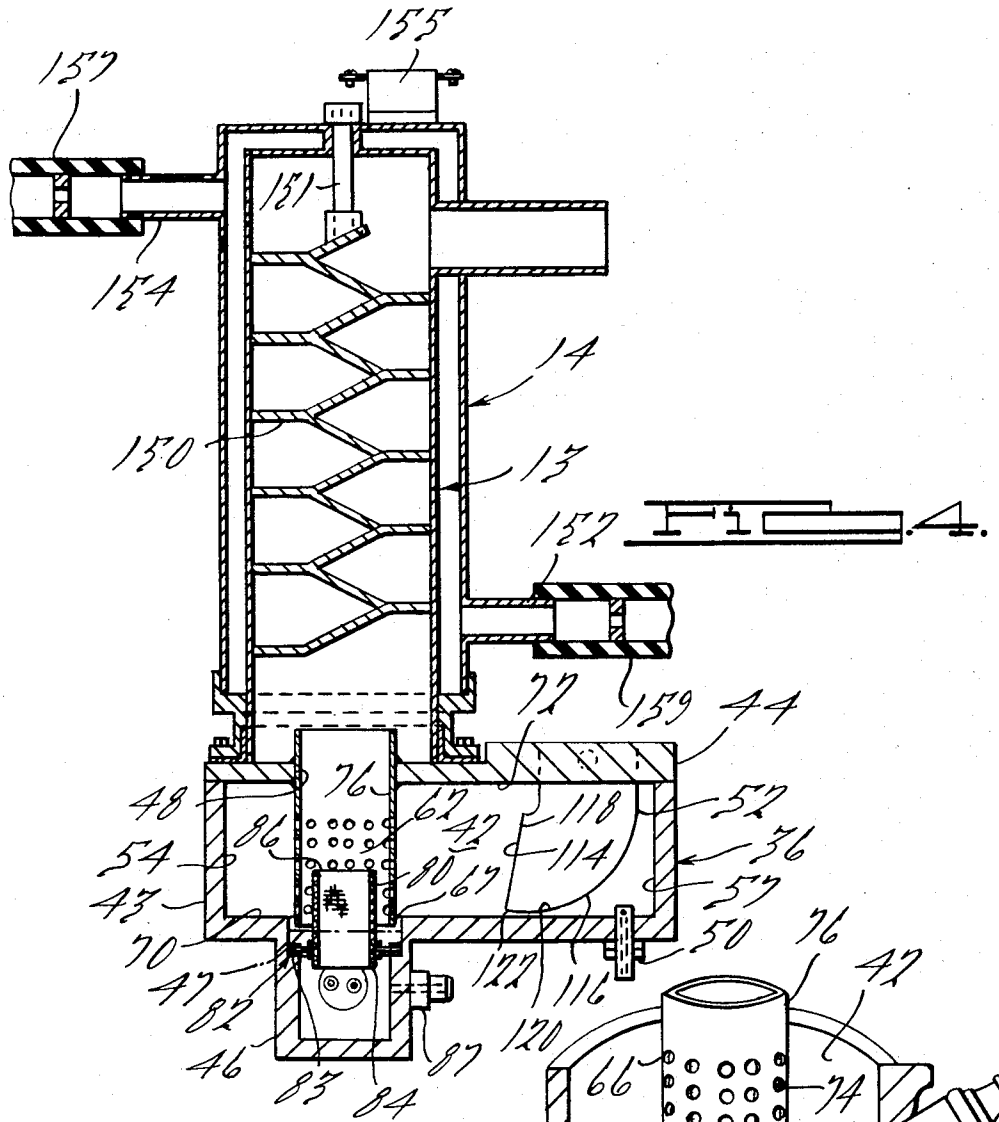


FIG. 4.

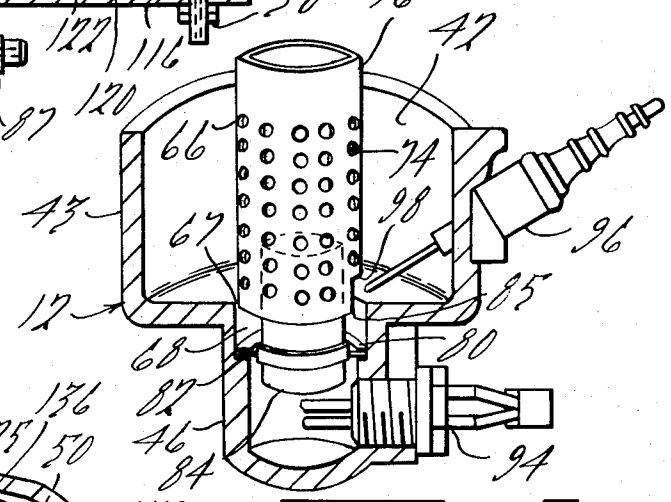


FIG. 5.

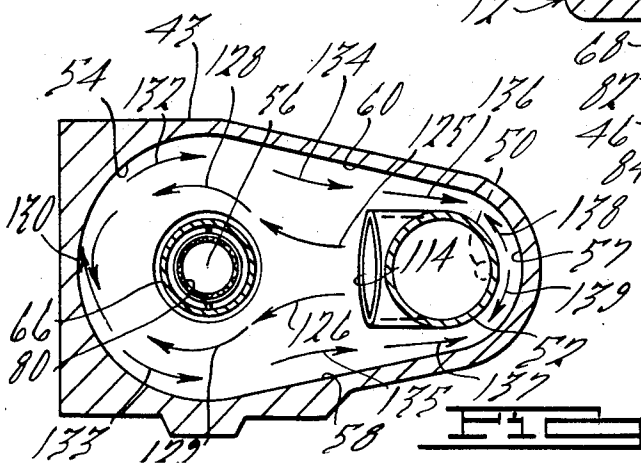


FIG. 6.

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HEATER APPARATUS WITH CONTROLLED AIR AND FUEL INTAKE

BACKGROUND AND SUMMARY OF INVENTION

This invention relates to an engine pre-heater for use with internal combustion liquid-cooled engines (diesel or gasoline), which are used by vehicles operating on the highways, off-the-road earth-moving and stationary equipment. The function of the heater is to pre-heat the engine coolant, making normal engine-starting possible in cold weather. The engine pre-heater also eliminates the need for conventional engine warm-up periods during which engine efficiency is quite low and thereby acts as an anti-pollution control as well as reducing fuel costs. Furthermore, the pre-heater itself is extremely clean burning and produces no substantial amounts of carbon or other residue. The invention involves improvements in heater apparatus of the type disclosed in U.S. Pats. No. 3,072,176 and No. 3,234,928, the disclosures of which are incorporated herein by reference.

While the pre-heater of the present invention may be used with other types of fuel (e.g., gasoline), one of the primary advantages of the present invention is the provision of engine pre-heater apparatus which is able to vaporize any grade of diesel fuel and burn vaporized diesel fuel containing substantial amounts (e.g., 20 percent) of oil ordinarily provided in commercial diesel fuels for lubrication of engine cylinder walls. It has been discovered that in order to successfully burn such diesel fuel, it is necessary to vaporize the liquid fuel and to separate and remove the oil. This oil, which those skilled in the art refer to as the "back-end," is heavier than the balance of the fuel and does not burn or vaporize. Therefore, means must be provided to separate and remove the oil to prevent accumulation in the heater apparatus in sufficient quantities to terminate combustion.

In order to more completely vaporize the liquid fuel, the burner apparatus is arranged to concentrate the heat of combustion in the fuel burning area and to create turbulence in the burning area by use of temperature differentials and shock waves and a high degree of molecular activity. As a result, in the burning area, there is explosion-like activity indicating high energy molecular movement which causes vaporization and complete burning of all but the distillation residue back-ends which collect as residue on the bottom of the combustion chamber and which are constantly removed therefrom jacket heater operation. jacket.

The pre-heater apparatus is associated with the engine cooling system in a new and improved manner providing a thermosiphon system for circulating the coolant through the engine water jacket. The heater apparatus includes a vertically extending coolant jacket with a coolant outlet at the top of the jacket located somewhat lower (e.g., at least approximately one-half inch) than the engine block coolant inlet and with a coolant inlet at the bottom of the jacket. The system includes means to hold coolant in the coolant hacket to maximize heating of the coolant by delaying the circulation of the coolant through the coolant ja ket. In the preferred embodiment, the heater apparatus is formed as a self-contained portable unit which may be mounted closely adjacent the engine or spaced some distance therefrom.

The size, shape and position of the burner housing and combustion chamber apparatus is extremely important. The burner includes an elongated swirl chamber, having a somewhat pear-shape configuration in the presently preferred embodiment, to which combustion air is delivered under pressure and caused to move therewithin in a particular flow pattern. To this end, a new and improved air delivery system is provided by the present invention.

The burner housing includes a fuel pot having a relatively small size in which a relatively small amount of fuel is maintained as compared with prior art devices. For example, approximately 20 cc of fuel are kept in the heater fuel pot in the present invention, whereas fuel pots having a capacity of approximately 60 cc of fuel or more have been utilized in prior art devices. Furthermore, in the present invention, the fuel delivery system and the shut-off apparatus are arranged to maintain a full fuel pot both during and after heater operation. To this end, new and improved means of terminating heater operation are provided.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** is a somewhat schematic side elevational view of illustrative apparatus embodying the principles of the invention;

FIG. **2** is another side elevational view of a portion of the apparatus shown in FIG. **1**;

FIG. **3** is still another side elevational view of a portion of the apparatus shown in FIG. **1**;

FIG. **4** is an exploded view, partly in section, of a portion of the apparatus shown in FIG. **1**;

FIG. **5** is a perspective view in cross section of a portion of the apparatus taken generally along the line **5—5** in FIG. **2**; and

FIG. **6** is a plan view of the apparatus shown in FIG. **4** taken along the line **6—6.**

DETAILED DESCRIPTION

Referring now to FIG. **1,** in general, the pre-heater apparatus is shown to comprise electrical means **10,** an air delivery system **11,** burner apparatus **12,** chimney-heat exchanger apparatus **13,** coolant jacket apparatus **14,** a fuel system **15,** and timer means **16,** all of which are mounted on suitable support means **18.** In the presently preferred arrangement, the pre-heater apparatus is enclosed as a unit in a metal case measuring 13 ½ inches high by 10 inches wide by 7 ¾ inches deep with external connections for inlet and outlet hoses, battery and fuel pump wires. The pre-heater fuel system **15** comprises fuel pump means **20,** float bowl means **22,** and shut-off valve means **24.** The air system comprises a radially discharging impeller type blower fan means **26,** FIG. **3,** restricted air inlet means **28,** air inlet control valve means **30,** air inlet control valve actuating means in the form of a solenoid **32,** and an air delivery conduit means **34.** The burner apparatus, FIG. **4,** comprises a burner housing **36** on which chimney means **13** is mounted. Coolant heating jacket apparatus **14** is mounted circumjacent the chimney means which is provided with a suitable exhaust conduit.

Referring now to FIGS. **4–6,** a swirl chamber **42** is provided within the burner housing **36** which comprises a box-like bottom member **43,** which may be in the form of an aluminum casting or the like, and a cover plate member **44.** The burner housing is elongated and a downwardly depending fuel pot **46** is provided in the bottom and adjacent one end thereof. The level of fuel maintained in the pot is indicated by line **47.** A com-

bustion chamber outlet opening **48** is provided in the cover plate **44** directly above the fuel pot **46.** Fuel residue outlet means **50,** in the form of a removable threaded plug member having a flow passage extending from the bottom of the burner housing to the bottom of the member, is provided at the bottom of the other end of the burner housing opposite the fuel pot. An air inlet means **52** extends into the burner housing through the top plate at the other end of the burner housing opposite the fuel pot.

Fuel pot **46** is of generally cylindrical cross-section configuration, FIG. **6,** and centrally spaced a substantial distance from the adjacent side wall **54** of the burner housing which is semi-cylindrical and concentric with the center of the pot at **56.** Side wall **57** of the other end of the housing is also semi-cylindrical, but of small diameter than side wall **54,** and is connected to side wall **54** by side walls **58, 60** which are outwardly diverging from the air inlet end of the housing to the fuel pot end of the housing.

A combustion chamber **62** is provided by an outer burner screen **66** fixedly mounted in the outlet opening **48** in cover plate **44** and depending from plate **44** into the burner housing above the fuel pot. Outer burner screen **66** is formed of sheet metal or the like and extends upwardly through and in sealing association with cover plate **44.** The outside diameter of burner screen **66** is slightly less than the diameter of the top portion of the fuel pot and the bottom of the burner screen **66** is located slightly (e.g. one-sixteenth inch) below and inwardly of the bottom of the burner housing to provide a residue flow gap **67** therebetween. Screen **66** is cylindrical and, in effect, except for the one-sixteenth inch gap, forms a continuation of the side wall **68** of pot **46** and defines the combustion chamber **62** thereabove. A portion of the screen **66,** intermediate the bottom surface **70** of the burner housing and the top surface **72** of the cover plate, is perforated by a number of substantially circular air inlet holes **74,** evenly distributed in horizontal and vertical rows. However, the top row of holes is spaced a substantial distance from the bottom of surface **72** so that there is a length **76,** FIG. **5,** of imperforate screen providing a deflecting surface for inlet air and defining the only discharge path from the combustion chamber for the escaping gases and other products of combustion. The bottom row of holes is also spaced above the bottom of surface **70** of the swirl chamber to provide a deflecting surface for the inlet air. In the presently preferred embodiment, there are a total of **96** air inlet openings of approximately one-eighth inch diameter located with approximately one-fourth inch spacing between centers. Each opening is believed to act as a Venturi and create a kind of shock-wave-explosive effect within the screen as relatively cool deflected swirling inlet air on the outside of the screen **66** enters the relatively hot combustion chamber **62** on the inside of the screen **66.** As a result, the temperature on the outside of the outer burner screen is substantially less than the temperature on the inside thereof.

A stainless steel wire mesh type generally cylindrical inner burner screen **80** is concentrically mounted inside the outer burner screen and is supported by pinring means **82** on a seat **83.** The bottom edge **84** of the inner screen is located substantially below the bottom edge **85** of the outer screen, FIG. **5,** and below the fuel level line **47** so as to be immersed in the fuel. The upper edge **86** of the inner screen terminates somewhat less than one-half the distance between the bottom **70** of the housing and the bottom **72** of the cover plate so as to be located in the burner flame and to concentrate the heat of combustion in the top center part of the fuel in the fuel pot.

A fuel pot inlet **87,** FIG. **4,** is connected by a line **88** to shut-off valve **24** and thence by a line **90** to the float bowl **22** and thence by a line **92** to fuel pump **20** which is connected to a suitable fuel supply as shown in FIG. **1.** The pre-heater operates independently from the associated engine, but uses the same fuel as the engine obtained directly from the main fuel tank of the engine through a separate fuel pump and fuel line. The arrangement is such that the pot **46** is normally always filled with fuel at or about the level **47.** When the pre-heater is turned off, as will be more fully described herein, shut-off valve **30** is also closed to smother the fire and trap a quantity of fuel in pot **46.**

For purposes of starting the pre-heater, an electric fuel heater means **94** is mounted in pot **46** to heat and vaporize the fuel therein until sufficient heat is obtained for self-sustaining operation. A fuel igniter means **96** is mounted on the burner housing **43** and extends through a slot **98** at the bottom of the outer screen **66** as shown in FIG. **5.**

The combustion air delivery system is provided with flow control means designed to promote particular flow characteristics in the burner housing. The flow control means includes vertical inlet conduit **28,** the opening **97** to which is opened and shut by valve **30** upon actuation of solenoid **32.** The size of the air inlet opening as defined by the space between the valve **30** and the top of the conduit **28** in the open position is adjusted to obtain the desired results in the combustion chamber. The heater is turned off by closing the inlet opening and stopping the supply of air which will snuff out the fire and leave the desired fuel supply in the pot **46** rather than allowing the fire to burn out as in prior art devices.

The fan air inlet conduit **28** communicates with an inlet chamber **100** mounted on the side of fan housing **102.** Fan wheel means **26,** in the form of a radial discharge squirrel cage impeller blade type, draws the air in centrally and axially from chamber **100** and discharges the air radially and circumferentially through an upwardly curved discharge elbow **104** and into the discharge conduit **34.** An electric fan motor **106** is drivingly connected to the fan in a suitable manner. Conduit **34** is substantially U-shaped in side elevation, FIG. **1,** and includes an upwardly extending leg portion **108,** a cross-over portion **110** and a downwardly extending leg portion **112.** Vapor lock prevention means are provided in the form of an air line **113** connecting air passage **112** to the float bowl **22.** The air inlet passages, openings and impeller fan are arranged to obtain a consistent smooth relatively non-turbulent air flow at the discharge opening **114,** FIG. **4,** of chute means **52.**

The curvature and position of the discharge chute are such as to provide a ring-like body of twisting incoming air generally directed toward the end wall **54** of the swirl chamber. Since the incoming air stays along the inside surface of the discharge chute, the front surface **118** of the discharge chute is positioned to direct the upper portion of the ring of air toward the upper portion of the screen **66** above the upper row of inlet holes and the bottom portion of the ring of air toward the bottom portion of the screen **66** below the bottom row

of inlet holes. This arrangement prevents the incoming air from immediately escaping from the swirl chamber and creates the desired turbulence.

Air discharge chute means **52,** FIG. **4,** directs the air into the burner housing swirl chamber **42** in a particular manner and is placed within the swirl chamber in a particular manner for purposes to be hereinafter described in detail. Referring again to FIG. **6,** the discharge opening **114** is centrally located between the adjacent side walls **58, 60** of the housing and faces the burner pot **46** and screens **66, 80.** The lower and rear surface **116,** FIG. **4,** of the discharge chute is formed on a relatively large radius to provide a relatively long smooth deflection surface. The front surface **118** of the discharge chute is slanted upwardly and away from the burner screens. In the presently preferred embodiment, the air discharge chute is mounted on the cover of the swirl chamber and held in place by a set screw (not shown) which permits adjustment of the position of the discharge opening. The chute is generally cylindrical copper material and has a 1 ½ inch outside diameter at the top and a 1 ¼ inch inside diameter at the bottom. The back of the chute at the cover is ⅜ inch from the adjacent housing wall so that the air can pass behind it. The top of the discharge opening **114** is 1 ¾ inch from the outer screen **66** and the bottom is 1 ⅝ inch from the outer screen and one-sixteenth inch from the bottom of the housing. With the heater started and the fan means **26** blowing air through discharge chute **52,** the air in the swirl chamber **42** is believed to have a flow pattern comprising a central flow path of the ring of incoming air indicated generally by arrows **125, 126** extending from the air discharge opening **114** toward the outer burner screen **66,** which causes the bottom and top portions of the ring of air to deflect therearound as indicated at **128, 129** and against the far wall **54** of the swirl chamber as at **130** which causes the air to deflect 180° therearound as at **132, 133.** The deflected air is driven rearwardly along the sides of the swirl chamber as at **134, 135, 136, 137** and onto the near wall **57** of the swirl chamber where the air is again deflected 180° as at **138, 139.** As a result, there is a swirling mass of air turning and twisting in many directions (i.e., turbulence), some of which is being forced through the air inlet openings **74** in the outer burner screen **66** to provide combustion air in the combustion chamber **62.** The turbulence prevents the intake air from escaping too fast, resulting in holding adequate air to supply two atoms of oxygen to one atom of carbon liberated to form carbon dioxide (CO_2). The air turbulence also counterbalances the electric motor R.P.M. drop due to lower battery strength. Another result is that there is a stream of air at the bottom of the swirl chamber moving first away from the fire pot toward the near wall **54** and then along the sides of the swirl chamber toward the far wall **57** in the direction of arrows **134, 135,** FIG. **6.**

In normal operation of the heater, the combustion chamber **62** is white hot with the heat of combustion centrally concentrated in and around and above the inner screen **80** which normally has a cherry red color and acts as heat transfer means maintaining a high temperature in the liquid fuel in the fuel pot and forming liquid particles and vapors that rise from the upper surface of the fuel. There is a substantial temperature and pressure differential along the inside and outside surfaces of the outer burner screen **66** which causes the swirling air to enter the combustion chamber at high velocity and to react in a kind of shock wave with the rising particles and vapor to burst the particles and completely vaporize the fuel in the combustion chamber. The swirl chamber disperses the relatively cold input air about the outer screen and the temperature differential between the combustion chamber and the incoming air causes violent motion of the fuel particles and vapors and agitates the remainder of the fuel in the fuel pot. As a result, some of the fuel in the pot attains such high velocity that it bursts through the surface film of the liquid fuel and escapes from the liquid as a gas. Some of the fuel is driven from the fuel surface in the form of small liquid particles which are vaporized as they rise into the combustion chamber. The fuel and the products of combustion are driven and drawn into the chimney **13** through the outlet opening **48** at the top of the outside burner screen, the swirl chamber **42** and combustion chamber **62** being otherwise sealed to prevent any significant escape of air along any other route.

In a pre-heater of this type, I have found that back end oil will not be vaporized and will float on the surface of the fuel and will eventually choke out the fire if not removed. The fuel oil back end cannot burn or vaporize because the boiling point required is higher than that obtained in the pre-heater. During fuel vaporization, velocity action forces the back end to the surface of the pot. One of the main advantages of the present invention resides in the provision of residue removal means in the form of a flow path extending along the bottom of the swirl chamber from the fuel pot to the bleeder means **50** whereat the back end residue is positively discharged from the burner housing. Velocity action in the pot pushes the residue into the pear-shaped swirl chamber through gap **67** against the near wall **54** where air turbulence forces it along the side walls **58, 60** to the rear wall **57.** Unexpectedly, it has been found that the residual removal means appears to work most advantageously when located some distance from the fire pot rather than closely adjacent thereto as might be ordinarily expected. In the illustrative form of the invention, the flow path from the fuel pot to the bleeder means is provided by gap **67** at the bottom of the outside burner and by the bottom surface **70** of the burner housing along which the back end residue is carried by the air in the swirl chamber in a path which extends from the fuel pot to the end wall **54** and then along the side walls **58, 60** to the end wall **57** where it accumulates about the bleeder means **50** and is removed by drainage therethrough. Diametrically opposed air holds the residue over the bleeder means where it drains free from the swirl chamber.

The hot exhaust gases are carried up the chimney **13** an over and around a vertically adjustable heat exchange baffle means **150** to an exhaust conduit **41.** Threaded adjustment means **151** permits necessary adjustment of the bottom of the baffle means relative to the flame which extends from screen **66.** Coolant in jacket **14** is heated thereby and tends to rise from the coolant inlet **152** at the bottom of the jacket to the coolant outlet **154** at the top of the jacket. A thermostat **155** is provided to sense the temperature of the coolant and provide means to control the apparatus. The coolant jacket outlet **154** is connected by a line **156** through restrictor means **157** to the engine cooling system **158.** A similar restrictor means **159** is associated with the coolant inlet to control flow of coolant

through the coolant jacket. The restrictor means **157, 159** act to delay passage of the coolant through the heater thereby maintaining higher coolant temperatures as well as higher heater temperatures. The inlet **160** to the engine cooling system is located about the coolant jacket outlet at an elevation sufficient to insure a thermosiphoning effect, e.g., a distance of one-half inch in the illustrative embodiment. The engine cooling system is directly openly connected to the heater coolant jacket inlet **152** by a line **161** without any intervening valves or the like except for the restrictor means so that the heater coolant jacket will be an integral part of the cooling system and effective immediately during start-up to cause a circulation of heated coolant through the cooling system.

In the presently preferred embodiment, the inside diameter of the inlet **152** and outlet **154** are the same (i.e. one-half inch) but the outlet restrictor **157** is larger (e.g., seven-sixteenths ID) than the inlet restrictor **159** (e.g. three-eighths ID). The difference in restrictor size helps prevent reverse flow as well as delay flow and increase pressure.

OPERATION

The pre-heater of the present invention is particularly adapted for use with engines used commercially in vehicles on and off-the-road and stationary equipment which use pure anti-freeze instead of water for coolant. Although ice may form whenever the ambient temperature drops below +35° due to condensation inside the heat exchanger and burner housing, the ignition system on the pre-heater always starts in the time allowed for ignition.

In operation, the heater may be automatically started by timer means **16** or by a manually operable start-up switch (not shown) which cause simultaneous or successive energization of the fuel valve solenoid **162,** the fuel pump **20,** the pot heater means **94,** the igniter means **96,** the air valve solenoid **32,** and blower fan means **26** by suitable circuitry (not shown) associated with the vehicle electrical system and energizer or with a separate electrical system and energizer. In the presently preferred arrangement, electric current for the heater is supplied by the vehicle or engine battery. The current is required for the following items: electric motor for the fan, air valve solenoid, sump fuel shut-off valve solenoid, fuel pump, vibrator coil for energizing the igniter plug and the heating unit. The igniter plug and heater operate for approximately 3 minutes at 0° and for approximately five to six minutes at <20°. The electric current consumption at −0° is approximately 2.325 (12v) and 1.162 (24v) ampere hours per hour. In any event, the pot heater means **94** heats the fuel in the pot and causes fuel vapors to rise into the combustion chamber **69** where they are ignited by the igniter means **96.** After a few minutes operation, sufficient heat will have been generated to make the combustion process self-sustaining at which time thermostat means **155** may be employed to shut off the pot heater means and the igniter means. At this time there is a continuous vaporization and burning of the fuel in the pot. The level of the fuel is maintained by the fuel system float bowl and combustion air is supplied under pressure as hereinbefore described. Coolant in the coolant jacket is heated and a thermosiphoning effect is begun with heated coolant rising from the coolant jacket outlet to the vehicle cooling system inlet and with coolant flowing from the vehicle cooling system outlet to the coolant jacket inlet. As the coolant circulates, the coolant is gradually heated until a substantially uniform vehicle cooling system temperature is reached. Then the heater apparatus is turned off either automatically by thermostatic control or manually by de-energizing the air valve solenoid to close the air valve and smother the pot fire. The fuel valve is also closed so as to trap a supply of fuel in the pot and the fuel pump is de-activated. It will be understood that the exact theory and/or manner of operation of the various components of the pre-heater may not be completely understood at this time and that the explanation herein given is intended to be illustrative of the results obtained rather than an exact theory of operation.

The heater apparatus is associated with a thermosiphon system for circulating the engine coolant through the cylinder block coolant jacket. The heater apparatus includes a 7 and ½ inch fire pot and coolant jacket. It is made with a 2 and ¾ inch I.D. inner tube and a 3 and ¼ inch O.D. outer tube. The coolant jacket is between these two tubes with a coolant capacity of one and one-quarter pints. The coolant outlet of the pre-heater needs only to be one-half inch lower than the engine block coolant inlet to obtain the thermosiphon function. The pre-heater can be installed several feet away from the engine.

The pre-heater output temperature rise is from approximately 0° to +205° in less than 10 minutes after ignition, and this temperature remains constant during the time required to heat the coolant in the engine block jacket to normal operating temperature. The time required depends on the engine coolant jacket capacity (which can be, e.g., 4 to 8 gallons) and the ambient air temperature, plus the velocity of the wind.

I claim:

1. A heater for an engine or the like comprising:
a fuel pot,
a combustion chamber formed above said fuel pot,
a closed swirl chamber having a side wall spaced from and surrounding said combustion chamber and said fuel pot,
forced air inlet means in said swirl chamber and spaced from said combustion chamber and said fuel pot and establishing a predetermined path of air flow to said combustion chamber including a path portion extending away from said fuel pot, and
fuel residue removal means in said swirl chamber and spaced from said fuel pot and located in said path portion whereby fuel residue is carried by the air flow along said path portion to said removal means.

2. The invention as defined in claim **1** and said fuel residue removal means being located closely adjacent said side wall beyond said forced air inlet means opposite said fuel pot and said combustion chamber.

3. The invention as defined in claim **1** and said swirl chamber being elongated and said fuel pot and said combustion chamber being located at one end of said swirl chamber and said air inlet means being located at the other end of said swirl chamber.

4. An engine pre-heater comprising:
an elongated enclosed burner housing having a bottom wall, a top wall, and a side wall defining an air chamber,
a fuel pot at one end of said burner housing,

burner means at the one end of said housing defining a combustion chamber above said fuel pot,

air inlet passage means connected to said air chamber at the other end of said burner housing,

fan means connected to said air inlet passage means to force air through the air chamber to the combustion chamber,

and said inlet passage means including a first vertically extending portion connected to the atmosphere,

a second vertically extending portion spaced from said first vertically extending portion and being of equal length and connected to the air chamber through said top wall of said burner housing, and

an intermediate cross-over portion therebetween and defining a generally U-shaped flow path reducing turbulence of the air delivered to the air chamber.

5. The invention as defined in claim **4** and having a curved elbow connected to said second vertically extending portion and extending into said burner housing and having a discharge opening facing said fuel pot and burner means and directing the air toward the combustion chamber in a path generally transverse to the longitudinal axis of said fuel pot and said combustion chamber.

6. An engine pre-heater comprising:

an elongated burner housing having top, bottom, and side walls and being closed except for an outlet opening for products of combustion in the top wall at one end of the housing and an inlet opening for combustion air in the top wall at the other end of the housing,

a perforated outer cylindrical screen mounted in said outlet opening and extending into said burner housing and terminating closely adjacent the bottom of said burner housing,

a fuel pot located below said perforated cylindrical screen and connected to a source of fuel,

a perforated inner cylindrical screen mounted in said fuel pot and extending upwardly within said perforated outer cylindrical screen and terminating below the top of said burner housing,

a combustion chamber defined by said perforated outer cylindrical screen and said perforated inner cylindrical screen,

fan means connected to said air inlet opening to cause a flow of combustion air from the atmosphere through the housing, and

an elbow type conduit connected to the inlet opening and extending into the housing and directing combustion air from the one end of the housing to the other end of the housing onto and through said perforated outer cylindrical screen and into said combustion chamber and creating a zone of high molecular activity in the combustion chamber.

7. The invention as defined in claim **6** and the flow of air causing a flow of fuel residue from the fuel pot along the bottom of the burner housing, and residue removal means in said burner housing in the flow path of the fuel residue and located in spaced relationship to the fuel pot to receive and remove fuel residue from the fuel pot.

8. A heater adapted to burn a liquid fuel, such as diesel fuel, having a burnable constituent and an unburnable constituent during continuous self-sustaining operation and comprising:

pot means to hold a quantity of the liquid fuel with a free upper surface maintained at a predetermined level within the pot means,

burner means extending upwardly from the pot means and defining a combustion chamber located above the pot means and the free upper surface of the liquid fuel, heating means to heat and vaporize the burnable constituent of the fuel for delivery of fuel vapor to the combustion chamber,

an air chamber surrounding said pot means and said burner means to delivery combustion air to said combustion chamber, and

drainage means located in said air chamber beyond said pot means to continuously drain the unburnable constituent during continuous self-sustaining operation.

9. The invention as defined in claim **8** and having air delivery means to establish a flow path of air through said air chamber to said combustion chamber, said drainage means and said pot means being located in said flow path whereby the unburnable constituent is carried by the air from the pot means to the drainage means.

10. The invention as defined in claim **9** and wherein said air chamber being elongated and comprising:

a first side wall portion being located relatively closely adjacent said pot means,

a second side wall portion being spaced from said pot means a greater distance than and located opposite said first side wall portion, said air delivery means extending into said chamber between said pot means and said second side wall portion and having a discharge opening facing said pot means and said first side wall portion to establish an air flow extending from said pot means to said first side wall.

11. The invention as defined in claim **10** and said first side wall portion and said second side wall portion being arcuate and connected by generally tangentially extending side wall portions, said flow path extending from said first side wall portion along said tangentially extending side wall portions.

12. The invention as defined in claim **11** and said drainage means being located between said air delivery means and said second side wall portion.

13. The invention as defined in claim **12** and said drainage means comprising an opening in the bottom of said air chamber spaced inwardly from said second wall portion and centrally located on a line extending between the centers of the first wall portion and the second side wall portion.

14. The invention as defined in claim **13** and said air delivery means being spaced inwardly from said second side wall portion to facilitate flow of air from said first side wall portion along said tangentially extending side wall portions to said second side wall portion.

15. The invention as defined in claim **14** and the flow path of air in said air chamber being such as to establish a low pressure zone and to hold the unburnable constituent over said drainage means.

16. A heater adapted for continuous self-sustained burning of a vaporizable liquid fuel comprising:

fuel pot means for holding a quantity of the liquid fuel,

burner means extending above said fuel pot means and defining a combustion chamber thereabove receiving vaporized fuel therefrom,

an elongated air chamber extending laterally from said burner means for supplying air to said combustion chamber,

a first side wall portion of said air chamber being spaced closely adjacent said fuel pot means and said burner means, a second side wall portion of said air chamber opposite said first side wall portion being located more remotely from said fuel pot means and said burner means than said first side wall portion,

forced air supply means for supplying combustion air to said air chamber,

an air inlet conduit connected to said forced air supply means extending into said air chamber between said second side wall portion and said fuel pot means and said burner means and having an air inlet opening facing said first side wall portion and said fuel pot means and said burner means and directing incoming combustion air theretoward.

17. The invention as defined in claim **16** and wherein said fuel pot means and said burner means are generally cylindrical and are concentric, said first side wall portion being arcuate and concentric with said fuel pot means and said burner means.

18. The invention as defined in claim **17** and wherein said second side wall portion being arcuate and connected to said first side wall portion by tangentially extending side wall portions.

19. The invention as defined in claim **18** and wherein said air inlet conduit includes a cylindrical tubular portion extending parallel to said burner means and being concentric with said second side wall portion, an elbow portion curving toward said burner means, and an outlet portion extending toward said burner means.

20. The invention as defined in claim **19** and said air inlet conduit being spaced inwardly from said second side wall portion to provide an air flow passage therebetween.

21. The invention as defined in claim **20** and having a fuel residue drainage opening connected to said chamber and located between said air inlet conduit and said second side wall portion.

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