April 9, 1946. E. J. SENNINGER 2,397,988

LIQUID FUEL BURNER

Filed Jan. 27, 1942 2 Sheets-Sheet 1

Fig. 1.

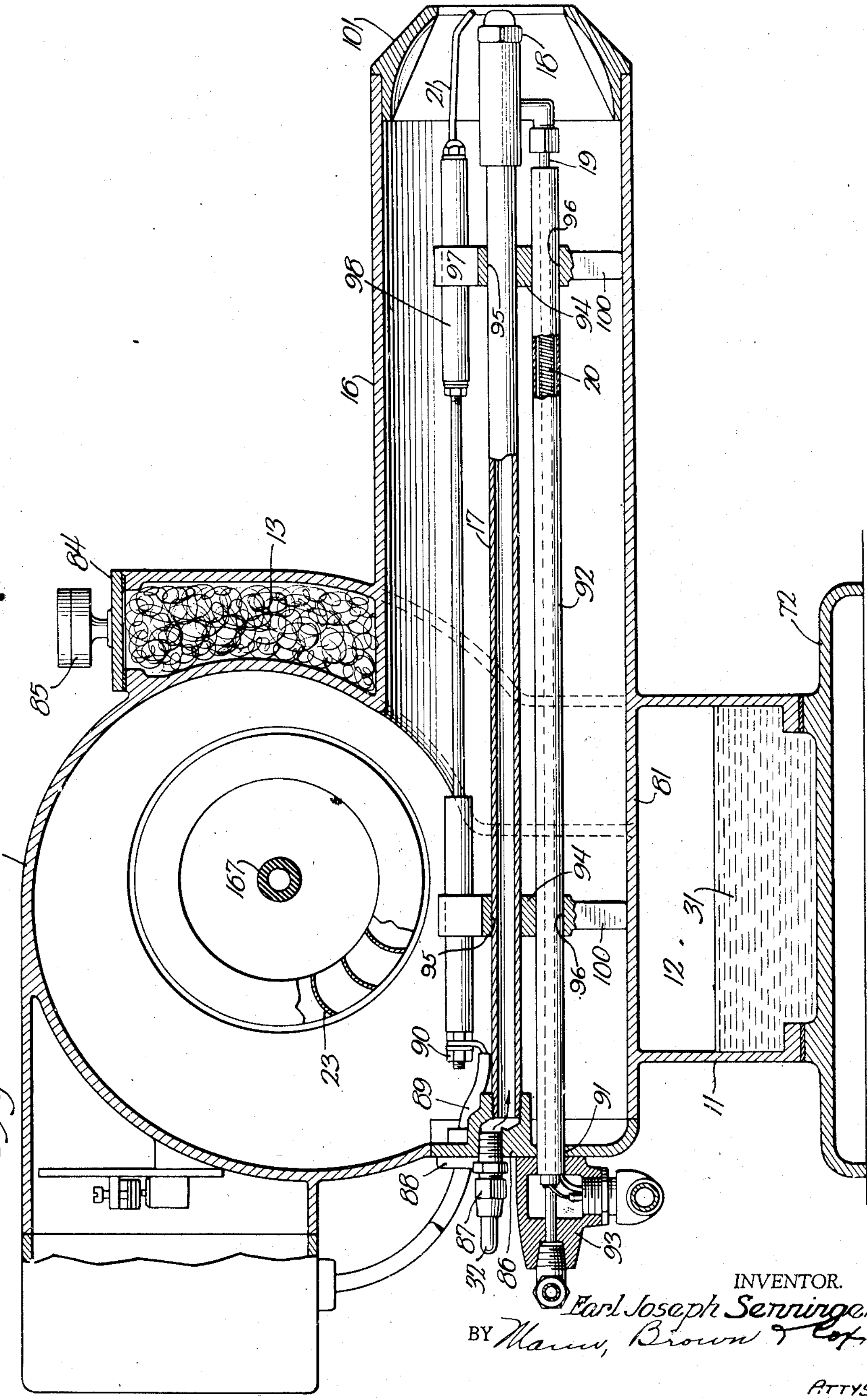

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Fig. 2.

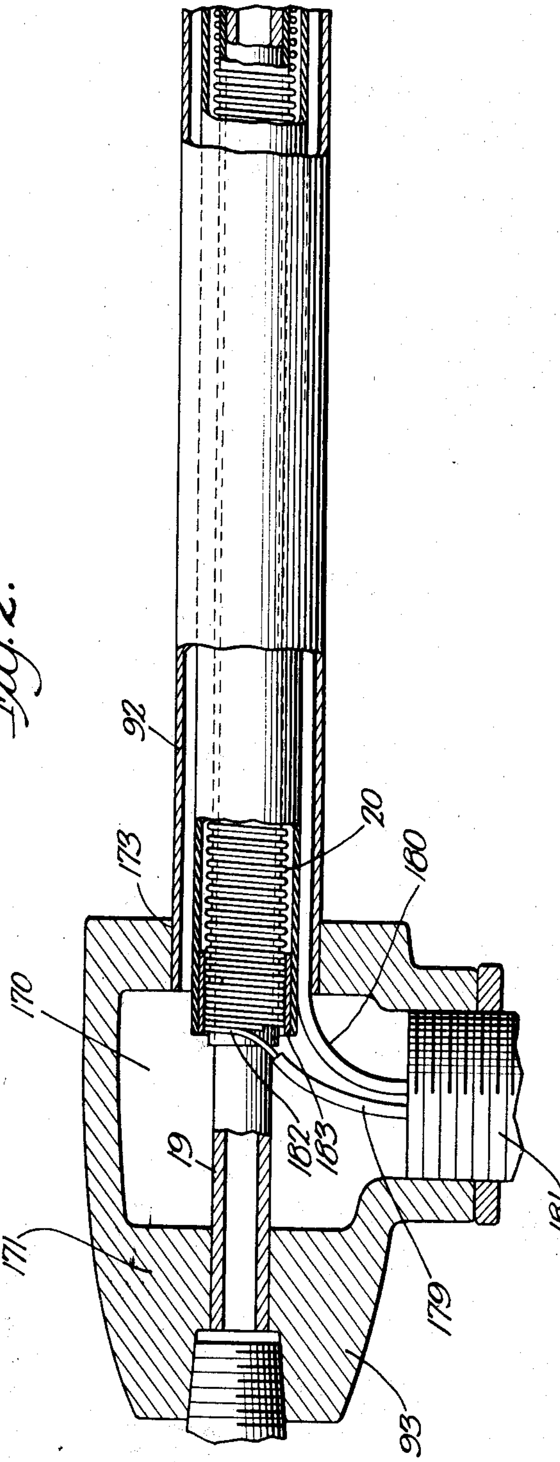
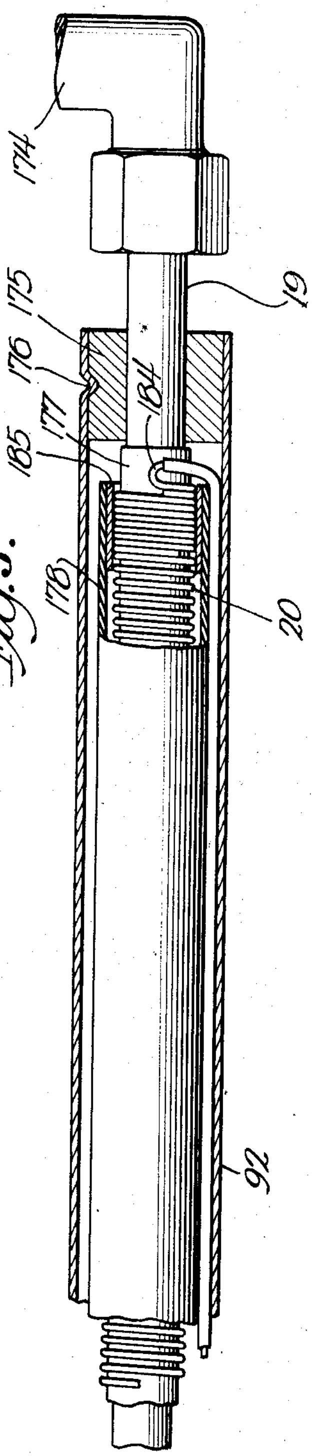


Fig. 3.



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Patented Apr. 9, 1946 2,397,988

UNITED STATES PATENT OFFICE

2,397,988

LIQUID FUEL BURNER

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Application January 27, 1942, Serial No. 428,392

4 Claims. (Cl. 158—36)

This invention relates to liquid fuel burners, especially adapted for heavy oils such as No. 5 fuel oil. It has for its principal object to provide sufficient preheating of the oil as it approaches the burner to insure proper atomizing while preventing carbonizing.

Generally speaking, this is accomplished by feeding the oil directly from a pump to the burner, preferably a positive displacement pump, and surrounding a suitable length of the oil supply pipe adjacent to the burner nozzle with a heating element whose wattage after starting drops below, and remains below, the capacity required to produce carbonizing temperatures in the oil.

Further objects and advantages of the invention will appear as the disclosure proceeds and the description is read in connection with the accompanying drawings in which

Fig. 1 is a vertical section through a commercial embodiment of the new oil burner;

Fig. 2 is a view, partly in longitudinal section and partly in side elevation, of a rearward portion of the preheater incorporated in the burner; and

Fig. 3 is a similar view of the forward portion of the preheater.

But these specific illustrations and the corresponding description are used for the purpose of disclosure only and are not intended to impose unnecessary limitations on the claims, or confine the patented invention to a particular use.

General description

In Fig. 1 a main housing, having a base 72, provides a tank or reservoir 11 for lubricating oil, a chamber 12 for primary or atomizing air above the oil tank, a suitable filter or cleaner and oil separator 13, and a secondary fan or blower casing 15, communicating with a horizontally directed draft tube 16, passing out through the chamber 12.

Within the draft tube 16 are a primary air line 17, a burner nozzle 18, an oil line 19 with its associated heater 20 for delivering heated oil to the nozzle 18, and a pair of electrodes 21 associated with the nozzle for igniting the mixture of oil and air when the burner is started. Only one of the electrodes is shown in Fig. 1.

The main housing also forms a support for a motor driven secondary air fan or blower 23, which delivers secondary air through the draft tube 16 around the mixture of oil and air discharged from the nozzle 18. A suitable primary or atomizing air pump (not shown) forces air through the chamber 12 and the filter 13, which filter is charged with bronze wool. In the chamber 12 the primary air passes over the supply of lubricating oil 31. The primary air is led from the chamber 12 through a pipe 32 to the air line 17. In fact, the air line 17, the chamber 12 and the pipe 32 may be considered as forming a single air line with a storage or pressure chamber in an intermediate position which insures an even flow to the nozzle and forms pressure for several other purposes.

An arrangement (not shown) for circulating lubricant continuously delivers air and oil foam to the filter 13, whereby the bronze wool in the filter is made to serve as an oil separator and an air cleaner, and the lubricating oil collected there drops down over the outside of the draft tube 16 and returns to the tank 11.

When a room thermostat or boiler control, or equivalent means, in the burner control system calls for heat, an electric circuit is closed automatically to allow current to flow to the oil heater 20. After a delayed action, for example, twenty-five seconds, a motor circuit will close to start the secondary air fan or blower 23, the primary or atomizing air pump for forcing air through the primary air line 17, and the oil pump for forcing air into the burner oil line 19. As the mixture of air and atomized heated oil is discharged from the nozzle 18, sparks from the electrodes 21 ignite it and the flame is further fed by the supply of secondary air delivered by the fan or blower 23 through the draft tube 16. The resistance of the heater element 20 increases with the rise in temperature and the wattage drops to the selected limit for the particular design. It will be understood that various automatic control systems may be used.

It is contemplated that the oil pump employed to force oil through the oil line 19 will have a positive displacement, and continuous delivery, the pump output for a given adjustment and speed being constant for all practical purposes. For that reason when it is used as a metering pump the apparatus can operate successfully on No. 5 oil.

The draft tube 16 intersects the main housing somewhat below the mid portion, and the lower wall 81 of the draft tube extends across the main housing above the lubricating oil tank 11 and, in effect, forms the upper portion of the chamber for primary or atomizing air.

The sides of the main housing are bulged to form passages upwardly around the draft tube and leading to the space for the filter 13, which space is closed at the top by a cap plate 84, secured in place by bolts and carrying an air pressure gauge 85. The bronze wool, which really forms the filtering and oil separating element of the filter 13, is in the space above the draft tube under the cap 84. Removing that cap permits access for cleaning the bronze wool, which should be done at suitable periods by removal and washing in kerosene or some similar solvent.

The upper portion of the draft tube 16 at the left in Fig. 1 opens into the secondary air fan or blower casing 15, which is generally eccentric with respect to the fan or blower 23 but affords direct and proper communication for air from the blower into and through the draft tube 16.

Just below the fan casing 15, and opposite to the draft tube, the main housing has an opening closed by a cap 86, into which the air tube 17 is fitted at the end opposite to that connected with the nozzle 18. The cap also carries an appropriate nipple, etc., 87, for connection with the air pipe 32, thus establishing the complete air line from the primary or atomizing air pump to the nozzle.

At each side of the nipple 87, and slightly above, are open insulated fittings 88 to admit wires 89, the inner ends of which are secured to the electrodes 21 by nuts 90.

Beneath the nipple 87 the cap 86 has an opening 91 to admit the heater tube 92 which surrounds the heater 20 and the oil line 19 leading to the nozzle 18. Suitable mounting for the electrical connections and the end of the oil pipe 19 are provided by a large cast fitting 93, secured to the cap 86.

Forked pedestals 94, formed with legs 100, have openings 95 and 96 to receive the air pipe 17 and the heater tube 92, respectively, and carry clamps 97 to receive the insulating tubes 98 for the electrodes 21. By removing the fastenings for the cap 86 this assembly (called in practice the drawer assembly) may be withdrawn as a unit from the draft tube. The delivery end of the draft tube is equipped with a suitable converging fitting 101 to direct the secondary air against the mixture of oil and primary air discharged from the nozzle 18. The detailed construction of the nozzle, its connection with the primary air pipe 17, the oil pipe 19 and its operation in use, will be sufficiently clear without specific description.

The size of the orifice, the spray angle, and such like will vary with conditions and personal preference.

The preheater

The large cast fitting 93, shown in Figs. 1 and 2, may well be called the base of the preheater, for it and associated parts form a unit that may be inserted and removed from the cap 86 of the drawer assembly. This base is made hollow to provide a chamber 170, the outer wall 171 of which has an opening wherein one end of the oil pipe 19 is fitted. The opposite wall has a larger opening 173 through which the pipe 19 projects with clearance and into which the inner end of the heater tube 92 is fitted. The otherwise free end of the oil pipe 19 is connected with the nozzle 18 by the elbow 174. Adjacent to the elbow the pipe 19 has a brass collar 175 pressed on it which is received in the adjacent end of the heater tube 92 and secured to it by crimping 176. The electrical resistance element 20 is wound upon a mica tube 177 fitted over the oil pipe 19, and, in turn, is enclosed within a second mica tube 178. Insulated lead wires 179 and 180 are brought into the chamber 170 through flexible hose connected to the base 93 by a nipple 181. One lead 179 is electrically connected with one end of the resistance element 20 by having a stripped portion 182 intertwined with it and made fast by a clamp 183. The other lead 180 passes along between the outer mica tube 178 and the heater tube 92, and has a stripped portion 184 intertwined with the opposite end of the resistance element 21 and made fast by a clamp 185.

By way of a specific example that has been found satisfactory in heavy oil burners for No. 5 fuel oil consuming from one-quarter of a gallon an hour to seven gallons an hour, the following details are added.

The oil pipe 19 is steel tubing one-quarter inch outside diameter and approximately three-sixteenths inch inside diameter. The resistance element is composed of No. 35 pure nickel wire, fourteen (14) turns per inch, for approximately nineteen (19) inches of the length of the tube 19. It has approximately 40 ohms resistance cold; that is, at a room temperature of around 70°; and it draws 300 watts on 110 volts A. C., but, due to the peculiarities of the metal, the wattage drops to 150 when the heating element is hot, i. e., at normal operating temperatures.

Of course, other materials can be used. Nickel wire containing a small proportion of chromium, cobalt, or other metals will approximate the same results.

Preferably the control system turns on the heater as soon as there is a call for heat and approximately one-half minute before the air flow and oil flow are started. During this interval the preheater will condition the oil remaining in the oil tube 19 after the last stop. This insures that the oil pipe 19, with its contained oil and associated parts, will be appropriately warmed up by the time oil flow starts to the burner. For the values of resistance given, and using a half minute time delay, the relationship is such that the oil in the fuel line immediately adjacent to the nozzle is heated to a temperature of around 190° F., which is not far below the flash point of the oil and hence provides for quick ignition. As soon as the fuel valve is opened so that there is a flow of oil through the pipe 19 to the nozzle, the temperature of the heater drops because of the more rapid heat transfer and the wattage input settles to a value of approximately 150 watts, fifty per cent less than the wattage input when the heater is cold. With oil flowing through the pipe 19 and the heater operating at 150 watts, the oil is heated to a temperature of around 105° F., which is well below the temperature at which oil carbonizing will take place but which is sufficiently high to give the oil proper viscosity characteristics for atomization of fuel at the nozzle. As the temperature rises the resistance in the coil 20 will rise and the wattage will drop accordingly.

The considerable length of oil pipe 19 enclosed within the preheater insures appropriate preheating, and the close proximity of the end of the coil to the nozzle insures the delivery of properly conditioned oil to the orifice.

By this arrangement the appropriate preheating is accomplished with very small current consumption as compared with prior devices. The automatic drop in wattage as the resistance increases eliminates the necessity or even expediency for including a make and break thermostat. The temperature at which the heating coil or resistance element 20 tends to hover under any given operating conditions involves an equilibrium of several factors, among which are the specific heat of the fuel oil, the rate of flow of the fuel oil, the resistivity of the heating coil, and the temperature coefficient of resistance. The outstanding advantage of substantially pure nickel as the resistance material is that it provides a particular combination of resistivity and temperature coefficient of resistance that causes the equilibrium to occur and to vary in a manner essential to proper functioning of the burner. In other words, the properties of pure nickel cause a certain inherent automatic regulation of the oil-heating coil, regulation that would ordinarily require auxiliary automatic controls.

One aspect of the automatic regulation is the above mentioned drop from an initial 300 watts heat input to a normal heat input of 150 watts as normal oil flow is established, the normal level of heat input attributable to peculiar properties of nickel being moderate enough to be continued indefinitely without overheating the oil.

Another aspect of the automatic regulation is that any tendency of the heating coil to be cooled is offset by the relatively large increase in wattage brought about by any drop in temperature of the resistance. In other words, pure nickel minimizes the drop in temperature of the heating coil that occurs whenever the oil flow is increased above normal to meet an increased demand for fuel consumption.

Both of these aspects obviously are intimately related to the temperature coefficient of resistance, since both aspects vary directly with the temperature coefficient. The temperature coefficient of pure nickel is approximately .005 per degree C. If this temperature coefficient is used as a basis for calculations, it is found that the resistance of the heating coils doubles when it is heated from room temperature to a value on the order of 400° F.; therefore the heating coil in the described apparatus normally is at this temperature when the heat input is at the normal rate of 150 watts.

In the preliminary heating period before oil flow exists to keep the heating coil cool, the heating coil reaches temporarily an exceedingly high temperature, as high, for example, as approximately 1000° F. with corresponding increase in resistance and drop in wattage. The input of the heating coil starts with 300 watts with the coil at room temperature, then drops to a minimum of, say, approximately 80 watts with the heating coil at around 1000° F., and finally climbs to the normal 150 watts after oil flow begins.

In considering the suitability of other metals or alloys as substitutes for pure nickel, two questions arise. First, is the resistivity of the proposed substitute close enough to the resistivity of pure nickel to make the dimensions of the substitute coil practical for the present purpose? As an extreme example, copper has a high temperature coefficient but has such low resistivity that it would be inconceivable to employ a coil big enough to give the required ohmic resistance. Second, is the temperature coefficient large enough to provide the automatic regulation to an extent adequate for the present purpose?

It is believed that any satisfactory substitute for pure nickel must have a temperature coefficient of resistance on the order of .003 per degree C., or higher, to introduce the required degree of inherent regulation into the described burner combination. Very few resistance materials meet both requirements of high resistivity and high coefficient of resistance. Resistance materials commonly used for elements to heat flowing oil, and the like, do not qualify. For example, nickel-chromium alloys widely in use have temperature coefficients that are less than 10% of the temperature coefficient of pure nickel, i. e., below .0003.

I claim:

1. In an oil burner of the type including a nozzle with fuel and primary air lines leading to the nozzle, the combination therewith of an electric heater for the fuel line located closely adjacent to the nozzle and characterized by having a sufficiently rapid rise in resistance with rising temperature to result in a wattage input at room temperature of 70° F. that is at least substantially twise as high as it is when the heater has reached its normal operating temperature, said latter temperature being such as to insure against carbonizing of the fuel.

2. In an oil burner of the type including a nozzle with fuel and primary air lines leading to the nozzle, the combination therewith of an electric heater for the fuel line located closely adjacent to the nozzle and characterized by having a resistance element having a temperature coefficient of resistivity on the order of .003 per degree C. or higher over the range of temperatures that it operates whereby the heater will heat rapidly but will automatically reduce the wattage input to a substantially lower value, said resistance element also being characterized by having a normal operating temperature when a minimum amount of fuel is being delivered to the nozzle for burner operation, that is low enough to insure against carbonizing of the fuel.

3. In an oil burner of the type including a nozzle with fuel and primary air lines leading to the nozzle, the combination therewith of an electric heater for the fuel line located closely adjacent to the nozzle and characterized by having a resistance element composed of wire having a sufficiently high nickel content to result in a temperature coefficient of resistivity on the order of .003 per degree C. or higher whereby the heater will heat rapidly but will automatically reduce the wattage input to a substantially lower value, said resistance element also being characterized by having a normal operating temperature when a minimum amount of fuel is being delivered to the nozzle for burner operation, that is low enough to insure against carbonizing of the fuel.

4. In an oil burner of the type including a nozzle with fuel and primary air lines leading to the nozzle, the combination therewith of an electric heater for the fuel line located closely adjacent to the nozzle and comprising an insulating tube telescoped over the fuel line, an electrical resistance element wound on the insulating tube, and a second insulating tube telescoped over the resistance element, said resistance element being characterized by having a temperature coefficient of resistivity on the order of .003 per degree C. or higher and having a wattage input when started at room temperature of 70° F. that is substantially 50% or more than it is when the heater has reached maximum temperature, said resistance element also being characterized by having a normal operating temperature when a minimum amount of fuel is being delivered to the nozzle for burner operation, that is low enough to insure against carbonizing of the fuel.

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