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TRANSPORTATION SYSTEM FOR VISCOUS LIQUIDS

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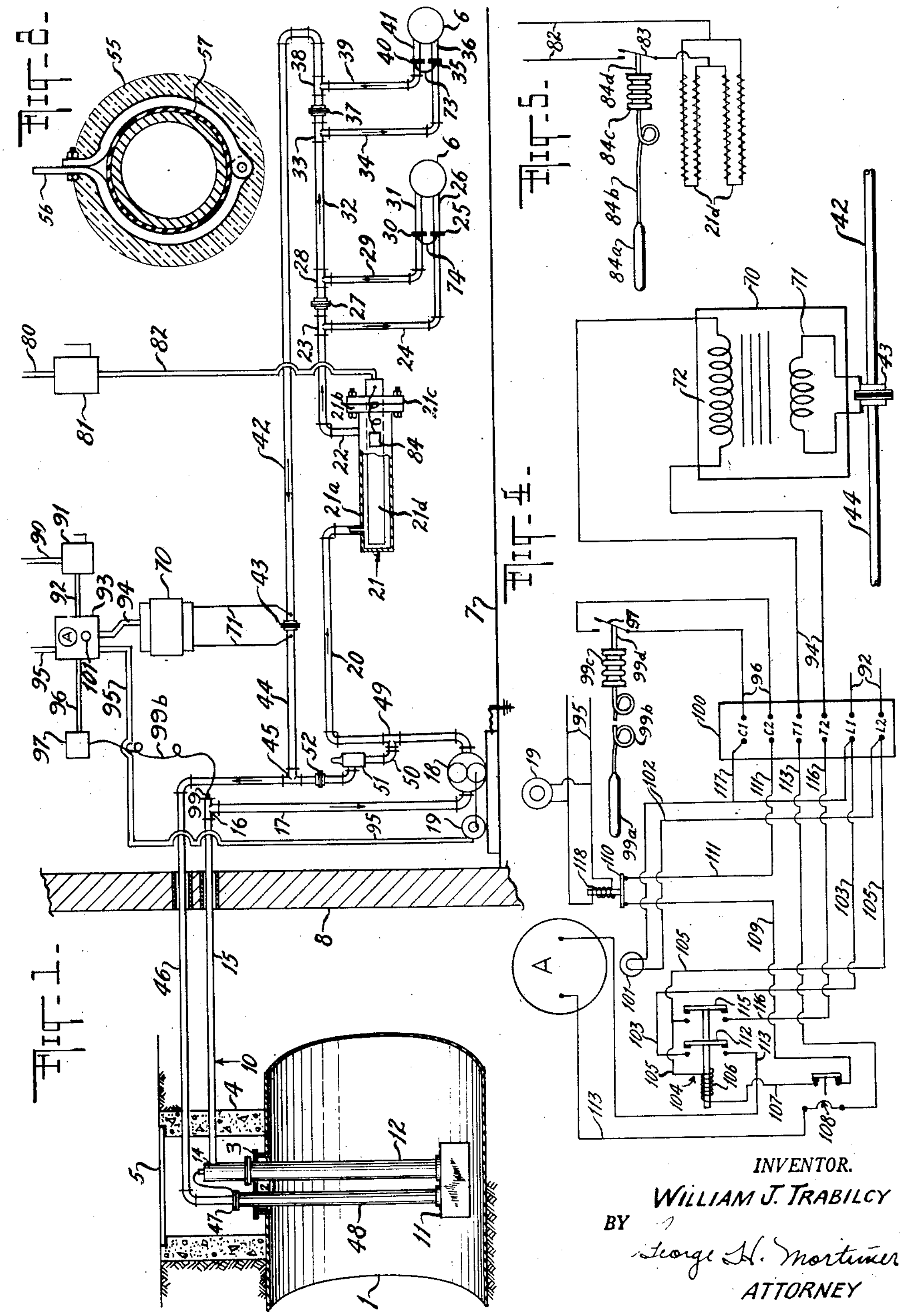

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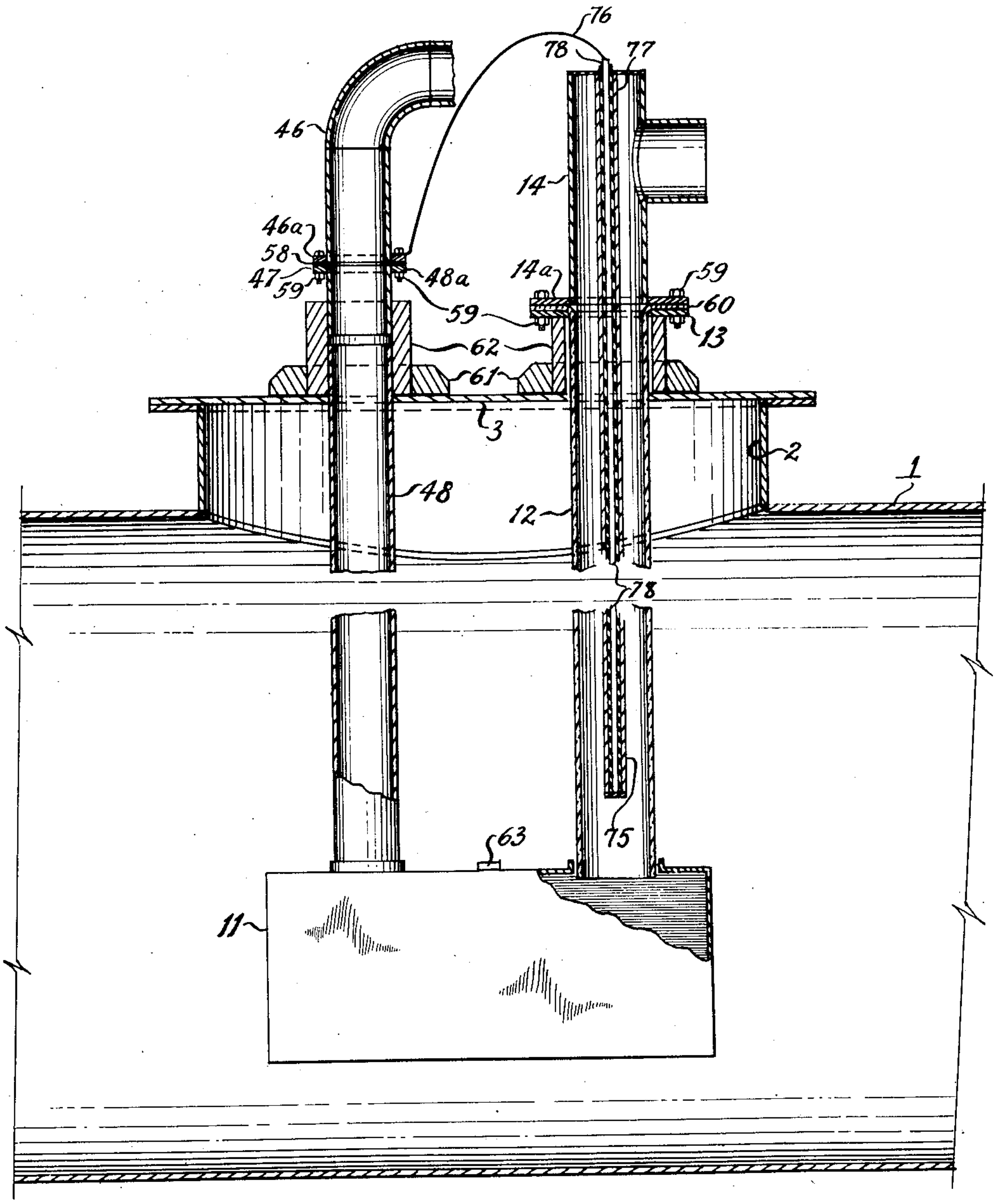
FIG. 3.



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TRANSPORTATION SYSTEM FOR VISCOUS LIQUIDS

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The present invention relates to a transportation system for viscous liquids and more particularly to a system for delivering heavy fuel oil from a supply tank to an oil burner at an elevated temperature.

Many liquids which have to be transported by pumping through conduits are so viscous at room temperature as to be non-pumpable by either vacuum or pressure pumping systems. Many systems have been proposed which have as their object the reduction in the viscosity of such liquids by raising their temperature and thereby making pumping practicable. Older systems utilized steam for this purpose. When electricity became commercially available it was early recognized that heating by electric current offered numerous advantages over steam, particularly with respect to temperature control, and systems employing electric heating of the conduits through external resistance heating elements as well as by passing current through the conduit itself have been proposed. One problem in such systems has been to provide heat economically to the viscous fluid throughout the pipe line from a position adjacent to its inlet near the bottom of a storage tank to the point of use. It has been proposed to solve this problem by including the portion of the supply line which extends into the storage tank in the electric circuit of the external conduit heating system and thereby heat the fluid adjacent thereto, the other conduit for the circuit being either a central core or a surrounding pipe forming part of the return system for excess heated oil.

One serious problem with systems which connect the inlet end of the supply line in the electric circuit is the danger of getting an electric spark in the tank, e. g., an accidental ground of the inlet end with the tank wall, a loose or broken connection between the supply pipe and the other pipe or core which completes the electric circuit for the supply line, and the like.

Another serious problem with fuel oil supply systems which utilize the conduit wall as the electric heating unit is the control of the heat of the oil delivered to the oil burner. The temperature required for pumping is not necessarily, and usually is not, the temperature best suited for delivery to the oil burner to obtain most efficient operation. Thus a heavy fuel oil which pumps properly at about 120° F. preferably is delivered to an oil burner at a temperature within the range of about 160° to 180° F. The oil in the entire supply line cannot be heated to the higher temperature desired for delivery to the burner because it becomes troublesome to draw oil from the tank at a temperature above about 120° F. while under vacuum due to vaporization of the more volatile portion of the oil and formation of a vapor lock which incapacitates the pump. On the other hand, if the oil is delivered to the burner at a lower temperature required for the pumping, the efficiency of the burner suffers.

In accordance with the present invention these disadvantages of previously proposed systems are overcome by providing a number of novel features which cooperate

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to form a very efficient, safe and readily controllable system, all of which will become apparent from the following description of the best known mode of applying the principle of the invention, taken in conjunction with the drawings in which:

Fig. 1 is a schematic representation of a system embodying the present invention, with certain parts in section and other parts omitted for clarity;

Fig. 2 is a sectional view of a conduit and hanger with insulation in place;

Fig. 3 is a fragmentary sectional view on a larger scale of the supply tank with the inlet section of the supply line and the discharge section of the return line in section to show how they are mounted in and related to the tank;

Fig. 4 shows the wiring diagram for a control system for the pump and line heater; and

Fig. 5 shows the wiring diagram for a control system for the localized electric heater.

Generally speaking, the system of the present invention can be applied for transporting any viscous liquid which becomes pumpable at an elevated temperature such as molasses, heavy fuel oil, fats and the like from a supply tank to a receiver such as a processing device, an oil burner and the like. A fuel supply system for delivering a heavy fuel oil at proper temperature to an oil burner is a preferred embodiment of the invention and the best mode of applying the principle of the invention will now be described for this embodiment, but it is to be understood that this is for illustrative purposes only and the scope of the invention is to be ascertained from the appended claims.

Referring now to Fig. 1, reference numeral **1** represents a fuel tank having a manhole **2** and a manhole cover **3**. The tank **1** is shown buried in the earth with the manhole **2** at the top located in a cement or like manhole **4** provided with a manhole cover **5** at grade level, but it is not essential to the invention that the tank be buried.

The receiver for fuel oil comprises one or more oil burners **6** which are only schematically illustrated since the structure of the oil burner and its control are not part of the present invention. The burners are shown inside a building which could be the basement of a large apartment house, office building, school or the like, having a floor **7** and walls **8**.

A supply pipe line **10** connects the tank **1** with the burner or burners **6**. Beginning at the tank **1** the supply line comprises a bell or hood **11** adjacent to the bottom of the tank, a vertical pipe **12** made of non-conducting material extending from the bell **11** to which it is suitably secured to a flange **13** on the manhole cover **3**, a T **14**, a pipe **15** shown illustratively buried in the ground and extending into the building through a suitable opening in the wall **8**, a T **16**, a pipe **17** leading to a pump **18** driven by an electric motor **19**, a pipe **20** connecting the pump with a localized electric heater **21**, and a pipe **22**, a T **23**, a pipe **24**, an insulated coupling **25** and a pipe **26** connecting the heater to an oil burner **6**. T **23** is also connected through an insulated coupling **27** to a T **28**, a pipe **29**, an insulated coupling **30** and a pipe **31** to the same burner **6**. This same parallel type of pipe connection is provided for each additional burner, only one other burner being shown but it is obvious that any other number may be provided as required. Thus T **28** is shown connected by pipe **32** to T **33**, pipe **34**, insulated coupling **35** and pipe **36** to the second burner **6**, T **33** also being shown connected through insulated coupling **37**, T **38**, pipe **39**, insulated coupling **40** and pipe **41** to the second burner **6**.

The pump **18** may be the only pump in the oil burner system, or it may be used as an auxiliary to a pump at each burner, and of course a stand-by pump and suitable piping may be provided, if desired, to take over in the event of failure of pump 18. In any event, pump 18 (as well as any other pump upon which operation of the burner or burners 6 depends) is electrically connected in the control system for the burner (not shown) so that when this control system calls for oil to be pumped to the burner, an electric circuit to the motor 19 is closed, thereby causing it to rotate and drive pump 18.

The localized electric heater 21 may be of any suitable construction, the one illustrated being an effective type comprising a steel casing 21*a* having a flange 21*b* at one end and a cap plate 21*c* bolted to the flange. The cap plate carries electric resistance heating elements, e. g., two of them 21*d*, preferably of the metal encased type packed with electric-insulating heat-conducting material, which extend from the cap plate to a point near the other end of casing 21*a* so that oil flowing into the heater from pipe 20 near one end of the casing has good contact with the heating elements as it flows through the casing to pipe 22 at the other end thereof.

The return line to transport oil in excess of that used in the burner or burners 6 back to the supply tank 1 comprises a pipe 42 connected to T 38, an insulated coupling 43, a pipe 44, a T 45, a pipe 46 leading back to the manhole 4, e. g., underground, through a suitable opening in wall 8, an insulated coupling 47 and a discharge pipe or section 48 extending into tank 1 under bell 11 to which it is suitably secured.

Pipe 20 preferably is provided with a T 49 to connect the supply line near the high pressure side of the pump 18 through a pipe 50, a safety relief valve 51 and an insulated coupling 52 to the return line through T 45.

All of the pipes and fittings outside the tank are preferably made of steel or iron covered with thermal insulating material 55. For pipes indoors suitable hangers 56 may be used to support the pipes from the building, and these hangers are electrically insulated from the pipes by short lengths of electric insulation 57 inserted between the pipe and the hanger. See Fig. 2. The insulation is omitted from Fig. 1 for clarity.

The insulated couplings shown schematically in Fig. 1 may have any suitable structure. The coupling 47 illustrated in Fig. 3 is a satisfactory type and it comprises a flange 46*a* secured to the end of pipe 46 and a flange 48*a* secured to the adjacent end of pipe 48, e. g., by screw threads, welding, or the like, an insulating annulus 58 and bolts 59 insulated from the flanges securing the coupling together in fluid tight relation for the liquid to flow freely from pipe 46 into pipe 48 but with the two pipes and flanges electrically insulated from each other. Any other structure which electrically insulates the two halves of the coupling while permitting liquid to flow from one pipe to the other may be used in place of the structure shown.

The non-conducting pipe 12 forming the inlet section of the supply line 10 is preferably expanded at the upper end into an annulus which itself serves as the insulating member 60 between flange 13 and a similar flange 14*a* threaded or welded to T 14 and secured by insulated bolts 59 to flange 13, as shown in Fig. 3. Both the inlet section 12 of the supply line and the discharge section 48 of the return line are secured to manhole cover 3, preferably in fluid tight relation, e. g., by welding a flange 61 and nipple 62 to the cover 3 around an opening of suitable size, flange 13 being secured by threads, welding or the like directly to its nipple 62 whereas the nipple for pipe 48 may be double tapped internally to receive externally threaded ends of sections of pipe 48. This assembly comprising manhole cover 3, inlet section 12, T 14, discharge section 48 and hood or bell 11 forms a unit which may be assembled outside the tank and installed simply by bolting the cover 3 to the manhole 2.

The bell 11 may be any desired shape and size, a convenient shape being an open bottomed cylinder with a vertical wall and a flat top having openings in which

pipes 12 and 48 are secured and a vent 63 to permit gas and/or air to escape from the bell.

With oil at a suitable temperature for pumping, the system operates as follows when motor 19 drives pump 18: Pressure in lines 12, 15 and 17 is reduced by pump action so that oil is forced by the pressure in tank 1, which need be and usually is only atmospheric pressure, to flow up from bell 11 into and through pipes 12, 15 and 17 to pump 18 and from there through pipe 20, heater casing 21*a*, pipes 22, 24 and 26 to the first burner 6. Similarly oil is supplied by pipes 32, 34 and 36 to the other burner 6. This system delivers oil to each burner at a definite pressure, the burners taking as much only as they can use efficiently and the balance being returned by the return line to the bell 11. The bell 11 serves two important functions. One is to limit the heat loss by confining the returned hot oil within the bell. The other is to serve as a mixing or blending chamber where the returned heated oil is mixed with colder oil flowing into the bottom of the bell to replace the oil consumed by the burner operation. In this way the contents of the tank 1 outside the bell remain at substantially the temperature prevailing outside the tank while the liquid in the bell is at an elevated temperature suitable for pumping. The proportion of returned hot oil to cold oil in the bell is adjusted by regulating the rate of flow produced by pump 18 with the amount of oil consumed by the burners and the temperature of the returning oil so as to give the oil blend in the bell the desired temperature for pumping. As long as the pump 18 continues to operate, the electric heater 21 supplies all the heat required to bring the oil flowing to the burners up to the desired temperature, e. g. about 160° to 180° F., and all the heat required to bring cold oil from the tank flowing into the bell 11 up to the desired temperature for pumping, e. g., about 120° F. During periods when the pump 18 is not operating, however, the supply and return lines may be used to keep the oil warm enough to be pumpable by the electrical system now to be described.

A transformer 70 has one end of its secondary winding 71 electrically connected to one side of the insulated coupling 43 and the other end to the other side thereof, as shown in Figs. 1 and 4. While insulated coupling 43 is shown in line 42, it is not essential that it be there since the system would work the same if it were in line 20, or in line 22, or any other convenient place in the supply line or the return pipes. When the primary winding 72 of the transformer 70 is connected to a source of alternating current the potential across the ends of the secondary winding causes current to flow through the portion of the piping system comprising pipe 42, T 38, pipe 39, a jumper 73 connecting the "hot" sides of insulated couplings 40 and 35, pipe 34, T 33, pipe 32, T 28, pipe 29, a jumper 74 connecting the hot sides of insulated coupling 30 and 25, pipe 24, T 23, pipe 22, the casing of heater 21, pipe 20, T 49, pump 18, pipe 17, T 16, pipe 15, T 14, a heater element 75 extending from T 14 through pipe 12 approximately to the bell 11, a jumper 76 connecting the element 75 with the hot side of insulated coupling 47, pipe 46, T 45 and pipe 44. The element 75 comprises a long tubular member 77 electrically connected at the top to one of the arms of T 14 by a fluid tight connection, and at the bottom to the end of a conductor, e. g., a solid rod 78, which extends axially through and beyond tube 77 from which it is otherwise insulated throughout its length, e. g., by a packing of electric-insulating heat-conducting material, or by a plurality of insulating mica rings. The upper end of conductor 78 is connected to jumper 76. See Fig. 3.

The heating element 75 is preferably made of permanently connected parts 77 and 78 of suitable conductivity which cannot work loose or corrode so as to cause an electric spark in the tank 1. Copper is suitable where the pipe lines are carbon steel. Being located inside the non-conducting pipe 12 it is impossible for accidental contact of **75** and **12** to cause an electric spark and pipe **12** positively prevents contact of **75** with any part of the tank so that no electric spark can be caused by accidental contact of **75** with the tank. Pipe **48** and bell **11** are electrically insulated from the return line **46** and from element **75** by insulated coupling **47**. The tank unit comprised of manhole cover **3**, bell **11**, pipe **12**, T **14**, heater **75** and pipe **48** thus provides an absolutely safe installation as well as one which is easy to install and easy to remove for cleaning, inspection and the like.

Means are preferably provided for automatically controlling the operation of the pump **18**, the electric heater **21** and the electrical system just described. Referring to Figs. 1, 4 and 5, a power line **80** connected to a suitable source of electric power leads to a manually operated disconnect switch **81** connected by an electric circuit **82** to the electric resistance heating elements **21*d*** in the heater **21** from which they are electrically insulated, through a switch **83** controlled by a thermostat **84** suitably mounted on cap plate **21*c***. Any effective thermostat can be used, the one illustrated being a satisfactory type comprising a bulb **84*a*** located inside heater **21** where it senses the oil temperature, a capillary tube **84*b*** and a bellows **84*c*** having a link **84*d*** connected to switch **83**. The bulb, capillary tube and bellows are gas filled so that the length of the bellows responds to the pressure on the gas enclosed therein which in turn is a function of the temperature of the oil in heater **21**. Thus when the disconnect switch **81** is turned on, electric current flows to the heating elements **21*d*** in heater **21** to heat the oil flowing through the heater until it reaches a predetermined temperature for which thermostat **84** is set (e. g., about 160° to 180° F.) and the thermostat **84** thereafter turns the current off or on as required to maintain this temperature.

A power line **90** connected to a suitable source of electric power leads to a manual disconnect switch **91** connected by an electric circuit **92** to a control panel **93**, described in detail below, which in turn is connected by electric circuit **94** to the primary **72** of transformer **70**. An electric circuit **95** connecting the control system of the oil burners (not shown) to the oil pump motor **19** passes through the control panel for a purpose to be described. Electric circuit **96** leads to a switch **97** operated by a thermostat **99** in the oil supply line, e. g., in the underground line **15** where heat loss is greatest and which can be reached through T **16**. The thermostat **99** may be of the same type as thermostat **84**, comprising a bulb **99*a***, a capillary tube **99*b*** long enough to reach from the bulb placed in line **15** outside the building through T **16** to switch **97**, a bellows **99*c*** and a link **99*d*** connected to said switch **97**, as shown in Fig. 4.

The thermostats **84** and **99** independently control the switches **83** and **97** and may be set for optimum temperatures for the burner feed and pumping, respectively. Thus the thermostat **84** for the electric heater **21** is preferably set for a relatively high temperature (e. g., 160° to 180° F.) which is optimum for the oil burner while the thermostat **99** is preferably set for a relatively lower temperature (e. g., 120° F.) which is optimum for standby conditions in the pipe line. The bulb **99*a*** being in the normally coolest place in the line assures at least this temperature throughout the heated line.

When the pump **18** (or any other pump in the system which operates to pump oil automatically when the oil burner needs it) is operating there is no need for the line heating system to operate since the heater **21** provides all the heat necessary. The thermostatically controlled system just described, if properly regulated and correlated with other factors, will generally cause switch **83** to close the circuit through the heater elements **21*d*** practically as soon as the pump begins to bring new oil into heater **21** and to break this circuit when the pump stops. It will operate only as often as required to maintain the oil temperature in heater **21** at the predetermined temperature, and as long as disconnect switch **81** is closed a body of hot oil is maintained in heater **21** whether motor **18** is running or not. Similarly thermostat **99** will normally cause switch **97** to open the circuit to the transformer **70** as soon after pump **18** begins to operate as the blend of hot oil from the return line with other oil from the tank **1** flows through pipe **15** over the bulb **99*a***, and to close the circuit to said transformer **70** shortly after the motor **19** stops driving pump **18**. In some installations it may be preferable, however, to provide an interlock between the circuit to the motor **19** and the circuit to the transformer **70** so that they cannot operate simultaneously but only sequentially or alternately. Fig. 4 shows a suitable control circuit for this purpose.

The control panel **93** includes a terminal board **100** having six pairs of terminals or binding posts designated L_1, L_2, T_1, T_2, C_1 and C_2, one terminal of each pair being electrically connected to the other. Terminals L_1 and L_2 are respectively connected to the two wires of power line **92** which bring electric current into the control panel. A lamp **101** is connected in parallel by line **102** across terminals L_1 and L_2 so that it glows whenever switch **91** is closed. Terminal L_1 is also connected by wire **103** to one terminal of a double pole solenoid switch **104** which is biased to open position as shown, while terminal L_2 is connected to the other terminal of switch **104** by wire **105**. Terminal L_2 is further connected through line **105** with solenoid **106** of switch **104**, line **107**, overload protecting switch **108** which is normally closed as shown, line **109**, solenoid switch **110** (single pole) which is biased to closed position as shown, and line **111** to terminal C_2. When the solenoid **106** is energized and closes switch **104**, a blade **112** connects line **103** to a line **113** to terminal T_1 through an ammeter A and the heating element of overload protector **108**. Simultaneously a blade **115** connects line **105** through a line **116** to terminal T_2. Terminals T_1 and T_2 are connected to the two wires **94** which supply power to the primary **72** of transformer **70**. Terminal C_1 is connected to L_1 by a wire **117**. Terminals C_1 and C_2 are connected by wires **96** to the two terminals of switch **97**. The solenoid switch **110** has its solenoid **118** connected in parallel in line **95** which supplies power to motor **19** so that whenever motor **19** is running switch **110** is open but when the power to motor **19** is cut off, switch **110** closes.

The operation of the control system is readily understood from the wiring diagram. Assuming the circuit **95** has just been opened by the furnace control system (not shown), solenoid **118** is simultaneously deenergized due to its connection in line **95** which permits switch **110** to close at once due to the action of the biasing means. The motor **19** stops with the result that the oil cools down to the temperature at which thermostat **99** closes switch **97**, thus completing the circuit from line **92** through terminal L_2, line **105**, solenoid **106**, line **107**, overload protector **108**, line **109**, switch **110**, line **111**, terminal C_2, circuit **96**, switch **97**, terminal C_1, line **117** and back to line **92** through terminal L_1. The energization of solenoid **106** closes switch **104** and completes the circuit from line **92** through the transformer primary **72** via terminal L_1, line **103**, blade **112**, line **113** with ammeter A and overload heating device **108**, terminal T_1, line **94** with primary **72**, terminal T_2, line **116**, blade **115**, line **105** and terminal L_2. Transformer **70** then provides electric energy to the pipe system from the left terminal **71** in Fig. 1 through pipe **44**, T **45**, line **46**, the hot side of flange **47**, jumper **76**, rod **78**, tube **77**, T **14**, line **15**, T **16**, line **17**, pump **18**, line **20**, heater casing **21*a***, line **22**, T **23**, line **24**, jumper **74**, pipe **29**, T **28**, pipe **32**, T **33**, pipe **34**, jumper **73**, pipe **39**, T **38** and line **42** to the right terminal **71** of transformer **70**. Insulated flange connections **43**, **52**, **27**, and **37** prevent short circuiting of this circuit through the pipe system despite the fact that oil flows freely through these same flange couplings, Insulated couplings **13**, **47**, **25**, **30**, **35**, and **40** insulate the electrical circuit around through the piping system from grounding through the tank and burners. The flow of current continues until the temperature in line **15** reaches the upper limit for which thermostat **99** is set, whereupon switch **97** opens, deenergizing solenoid **106** and permitting the biasing means on switch **104** to open it and thereby break the circuit supplying electricity to the transformer primary **72**. As soon as the oil in line **15** cools to the lower limit for which the thermostat is set, switch **97** closes and reestablishes the circuit for transformer **70**. This alternate opening and closing of switch **97** continues during the standby period unless switch **91** is manually opened. At any time the circuit to motor **19** is closed by the furnace control system (not shown), switch **110** is immediately opened, thereby breaking the circuit through solenoid **106** of switch **104** and permitting it to open if it was closed when motor **19** is started or preventing it from closing upon closing switch **97** if it was open when motor **19** started. Switch **110** with its solenoid **118** is thus an electrical interlock which prevents the heating of the pipe line when pump **18** is operating but permits thermostat **99** to control the opening and closing of the transformer circuit when pump **18** is not operating. Overload protector **108** causes opening of the transformer circuit in the same way as switch **97** or switch **110** with which it is in series, in the event that the current flowing through line **113** exceeds the maximum safe value at which the protector **108** is designed or set to open. If the interlock **110** is not used, the thermostats **84** and **99** operate to control current flow to heater **21** and transformer **70** solely by the temperature of the oil in heater **21** and pipe **15**, respectively, but since these temperatures are related to operation of the pump **18**, as previously described, the time cycle for the supply of current to the transformer **70** in the absence of an interlock approximates the time cycle fixed by an interlock although lagging somewhat in cutting out transformer **70** when motor **19** starts. As long as motor **19** is driving pump **18** the oil flows in the manner described to the burners at the proper temperature controlled by thermostat **84**, sufficient excess oil being returned to bell **11** to heat oil in the tank in the vicinity thereof to bring it to pumpable temperature. As soon as the burners are inactivated, the system automatically is switched back to the condition at the sart of the description of the operation.

Although the invention has been described in connection with the best embodiment now known to me, it is obvious that modifications in structure and function can be made without departing from the scope of the invention as defined in the appended claims which cover the combination and such sub-combinations of elements thereof which have separate utility with or without other parts or elements of the complete combination described and illustrated.

Having thus described the invention and manner of its operation, what I claim as my invention is:

1. A transportation system for viscous liquids comprising a liquid supply tank, a receiver, a supply pipe line connecting said tank with said receiver, a pump in said pipe line for forcing liquid to flow therethrough from said tank to said receiver, heating means for raising the temperature of at least a portion of the viscous liquid in the supply tank high enough for ready flow, standby means for supplying heat to liquid in said pipe line, and control means for inactivating the standby means when the pump is operating and for activating the standby means when the pump is not operating.

2. A transportation system for viscous liquids as set forth in claim 1 in which the standby means includes means supplying heat locally to the liquid in the supply tank adjacent to the inlet to the pipe line.

3. A transportation system for viscous fuel oil comprising a liquid supply tank, an oil burner, a supply pipe line connecting said tank with said burner, a return pipe line connecting said supply pipe line with said tank and having a discharge outlet in said tank adjacent to the inlet to said supply line, a pump in said supply pipe line for forcing oil to flow through said supply line at a rate greater than it is consumed by said burner, a heater in said supply line beyond said pump for heating oil flowing through said heater to proper temperature for said burner, the portion of said heated oil in excess of the burner requirements flowing through said return line to said tank to raise the temperature of oil in said tank adjacent to said discharge outlet and supply line inlet high enough for ready flow, standby means for supplying heat to oil in said pipe lines, and control means for inactivating the standby means when the pump is operating and for activating the standby means when the pump is not operating.

4. A transportation system for viscous fuel oil as set forth in claim 3 in which said heater and the standby means are electric with separate electric circuits and the control means includes individual thermostats, one controlling the electric circuit for the heater set at a relatively high temperature suitable for burning and the other controlling the electric circuit for the standby means set at a relatively low temperature suitable for pumping.

5. A transportation system for viscous fuel oil as set forth in claim 4 in which said pump includes an electric motor having an electric circuit and an interlock which opens the electric circuit for said standby means when the electric circuit for said motor is closed and closes said electric circuit for said standby means when the electric circuit for said motor is opened.

6. A transportation system for viscous liquids comprising a liquid supply tank, a receiver, a supply pipe line connecting the tank to the receiver, a pump in said pipe line, a motor for driving said pump, a control for starting and stopping said motor, means for heating liquid in said tank at least adjacent to the inlet to said supply pipe line, separate means for supplying heat to liquid throughout the length of said supply pipe line, a control for activating and inactivating said separate heat supplying means, and an interlock between said controls for inactivating said separate heat supplying means when the motor is operating.

7. A transportation system for viscous liquids comprising a liquid supply tank, a receiver, a supply pipe line connecting the tank to the receiver, said pipe line from a point adjacent to said tank to a point adjacent to said receiver being made of electric conducting material, a pump in said pipe line, an electric motor for driving said pump, an electric circuit including said electric conducting portion of said pipe line, a switch in said electric circuit, an electric circuit for said motor, means including a solenoid in said motor circuit for opening said switch when the circuit for the motor is connected to a source of electric current and for closing said switch when the circuit for the motor is disconnected from said source of electric current, and separate means for heating liquid when said pump is operating.

8. A transportation system for viscous liquids comprising a tank, a receiver, a supply line connecting the tank to the receiver, said line including an inlet section made of non-conducting material extending from the top of the tank to a point adjacent to the bottom of the tank, the remainder of said line from said inlet section to a point adjacent to the receiver being made of conducting material, a pump in said line, an electric core heater in said inlet section, an electric circuit including said core heater and the conducting portion of said line, a switch in said electric circuit, means for closing said switch when said pump is inactive and for opening said switch when the pump is operating, and separate means for supplying heat to flowing liquid in said line when said pump is operating.

9. A transportation system as set forth in claim 8 in which the separate means is a localized electric heater in the conducting portion of said supply line.

10. A transportation system for fuel oil comprising an oil supply tank, at least one oil burner, a supply pipe line connecting the tank to the burner, a return pipe line connecting the supply pipe line adjacent to the burner to the supply tank, said supply line including an inlet section made of non-conducting material which extends from the top of the tank to a point adjacent to the bottom of the tank, said return line including a discharge section extending from the top of the tank to a point adjacent to the lower end of said inlet section, a pump for pumping liquid oil through the supply and return lines, means for heating oil in said lines from the inlet section to the discharge section, and an electric core heater in said inlet section for heating oil therein.

11. A transportation system for fuel oil as set forth in claim 10 in which said inlet section and said discharge section are mounted as a unit on a manhole cover for said tank.

12. A transportation system for fuel oil as set forth in claim 11 in which said inlet section and said discharge section are mounted in spaced substantially parallel relation on said manhole cover and a bell is secured to the lower ends of said sections into which hot oil from the discharge section is adapted to flow and from which oil from the tank blended with said hot oil is adapted to be drawn into said inlet section by said pump.

13. A transportation system for fuel oil or similar viscous liquid having a supply tank having a manhole in the top thereof, a supply line made of conducting material, an electric circuit including said supply line, and a pump for drawing liquid from said tank characterized by a manhole and cover covering said manhole having an opening, an inlet section of non-conducting material mounted in said opening and extending to a point adjacent to the bottom of the tank, means connecting the upper end of said inlet section to said supply line, an elongated tube made of electric conducting material electrically connected with said supply line and extending at least substantially through said inlet section, a conductor in said tube electrically connected with only the lower end of said tube, and means electrically connecting said conductor in the electric circuit for said supply line.

14. A tank unit for a transportation system for viscous liquids comprising a length of electrically non-conducting pipe, a three arm **T** made of conducting material, means connecting one arm of said **T** to one end of said pipe in fluid tight relation, an elongated tube made of conducting material connected adjacent to one end thereof to another arm of said **T** in fluid tight relation and passing in and substantially through the length of said non-conducting pipe, and a conductor in said tube connected with only the other end thereof whereby an electric circuit connected with the third arm of said **T** and with said conductor is adapted to cause current to flow through and heat said tube.

15. A tank unit for a transportation system for viscous liquids comprising a manhole cover having two openings, a first length of non-conducting pipe mounted adjacent to one end thereon on said manhole cover in one of said openings, a second length of pipe mounted adjacent to one end thereof in said manhole cover in the other of said openings in substantially parallel relation to said non-conducting pipe, said pipes adapted to extend from a manhole in the top of a tank to a point adjacent to the bottom of the tank, a bell comprising side and top walls, said top wall having two openings, means securing the ends of said pipes adapted to be adjacent to the bottom of the tank to said bell through said openings, a three arm **T** made of conducting material, means connecting one arm of said **T** to said one end of said non-conducting pipe in fluid tight relation, an elongated tube made of conducting material connected adjacent to one end thereof to another arm of said **T** in fluid tight relation and passing substantially through said non-conducting pipe, the third arm of said **T** being adapted for connecting to a supply pipe line of conducting material, a conductor in said tube connected with only the other end thereof, a coupling on said one end of said second length of pipe adapted to be connected with a conducting return pipe line, and means electrically connecting said coupling with said conductor whereby current flowing through the supply line and return line passes through the conductor and elongated tube and thereby heats the same.

16. A tank unit as set forth in claim 15 in which said second length of pipe is made of conducting material and said coupling is an insulated coupling which electrically insulates the second length of pipe and the manhole cover from the electric circuit.

17. A transportation system for supplying heavy fuel oil at elevated temperature to an oil burner comprising a supply tank, an inlet section of non-conducting material having its lower end adjacent to the bottom of said tank and the upper end outside said tank, a steel supply pipe connected at one end to the upper end of said inlet section and at the other end to an insulated coupling for said oil burner, an electric heater having an elongated steel casing connected adjacent to its ends in said supply pipe whereby oil flowing to said burner flows through said casing, electric resistance heating elements in but electrically insulated from said casing, a steel return pipe connected at one end with said supply pipe beyond said electric heater and at the other end with an insulated coupling adjacent to said tank, a discharge section connected at its upper end with said last mentioned insulated coupling extending to a point in said tank adjacent to the lower end of said inlet section, an elongated tube of higher electric conductivity than said steel pipe in said inlet section connected at its upper end to said supply pipe, a conductor connected to the lower end of said tube and to said return pipe adjacent to said discharge section, an insulated coupling in one of said steel pipes, an electric circuit connected at each side of said last mentioned insulated coupling whereby electric current may be caused to flow through said steel pipes and said elongated tube to heat them, a thermostatic control for said electric circuit responsive to temperature of oil in the supply line between the tank and the electric heater and set for a temperature at which said heavy oil is pumpable, an electric circuit for said electric resistance heating elements, a thermostatic control for said last mentioned electric circuit responsive to temperature of the oil leaving the electric heater and set for a higher temperature required to supply oil at said higher temperature to said burner, and means for pumping oil as required to said burner.

18. In a system for transporting and providing normally highly viscous fuel oil in condition for burning comprising in combination a burner assembly, a remote cool storage tank, means for withdrawing oil from said storage tank comprising a supply line adapted to extend between the tank and burner assembly and an excess oil return line extending from the burner assembly to the tank, said lines having pipe sections extending down into the tank oil, means for electrical resistance heating of the supply and return lines, means for electrically insulating the pipe sections extending within the tank from the electrically heated lines outside the tank so that no electric current is carried by the pipe sections within the tank, and an immersion heater in the supply line for controllably heating oil flowing therethrough at least to about 160° F., said returned hot excess oil being diffused with colder tank oil to provide a body of readily flowable intermediate temperature oil within the tank.

19. A transportation system for fuel oil comprising an oil tank, a receiver, a supply pipe line connecting the tank to the receiver, a localized oil heater in said supply line, a return pipe line connecting the supply line beyond the oil heater to said tank, a pump for delivering oil from the tank through the supply line to said receiver and through said return line to said tank, a pipe line heater for distributive heating of said supply and return lines,

a thermostatic control for said pipe line heater set at a temperature at which the fuel oil is pumpable and a separate thermostatic control for said oil heater set at a substantially higher temperature at which said fuel oil is deliverable to said receiver, the pipe lines from a point adjacent to the tank to a point adjacent to the receiver being made of electrically conductive material and the pipe line heater comprising an electric circuit including the electrically conductive portion of said pipe line, and an electric motor connected to drive said pump and having a circuit interlocked with a switch in the electric circuit of said pipe line heater so that said switch is open when the motor is energized and closed when the motor is deenergized.

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