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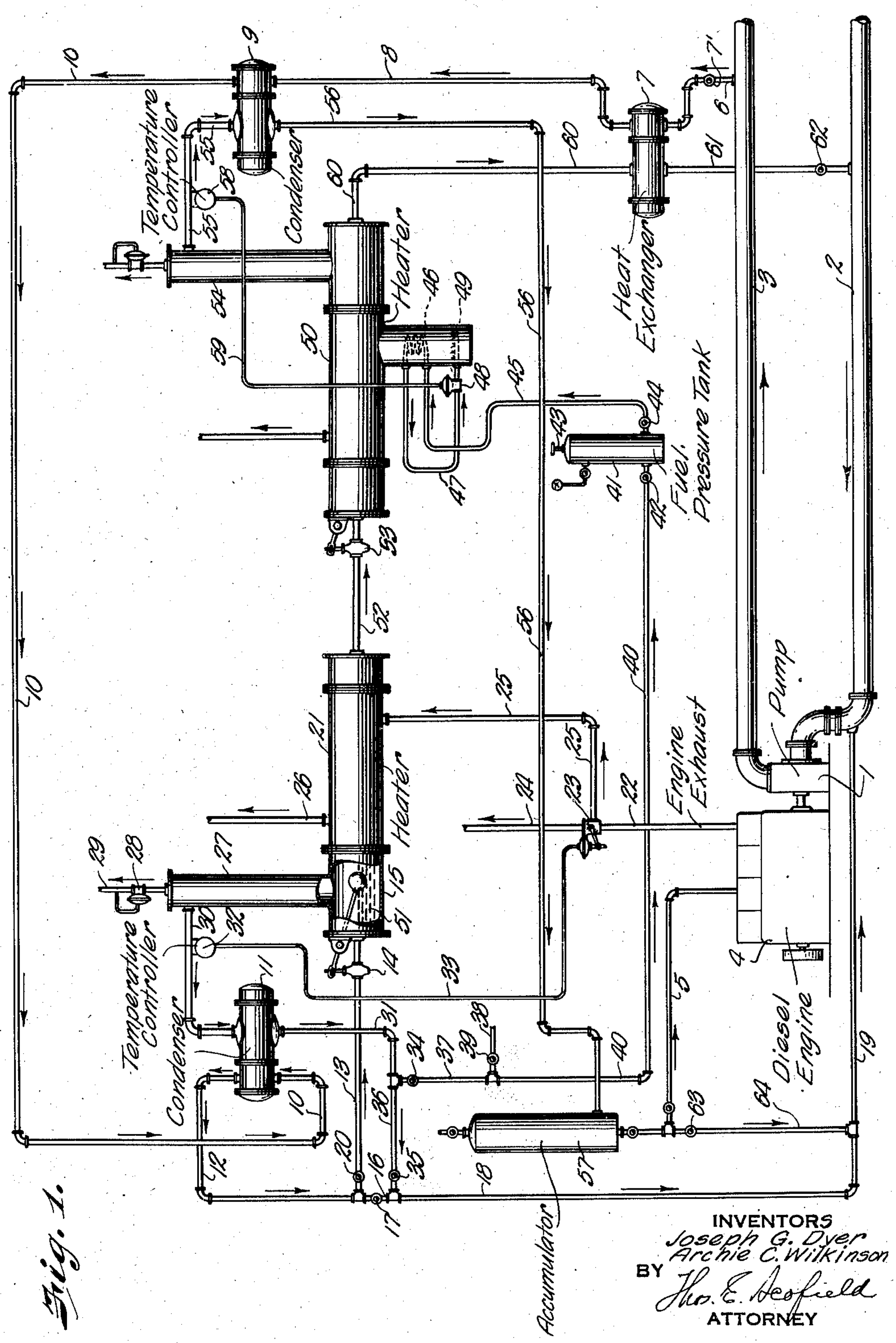

Fig. 1.

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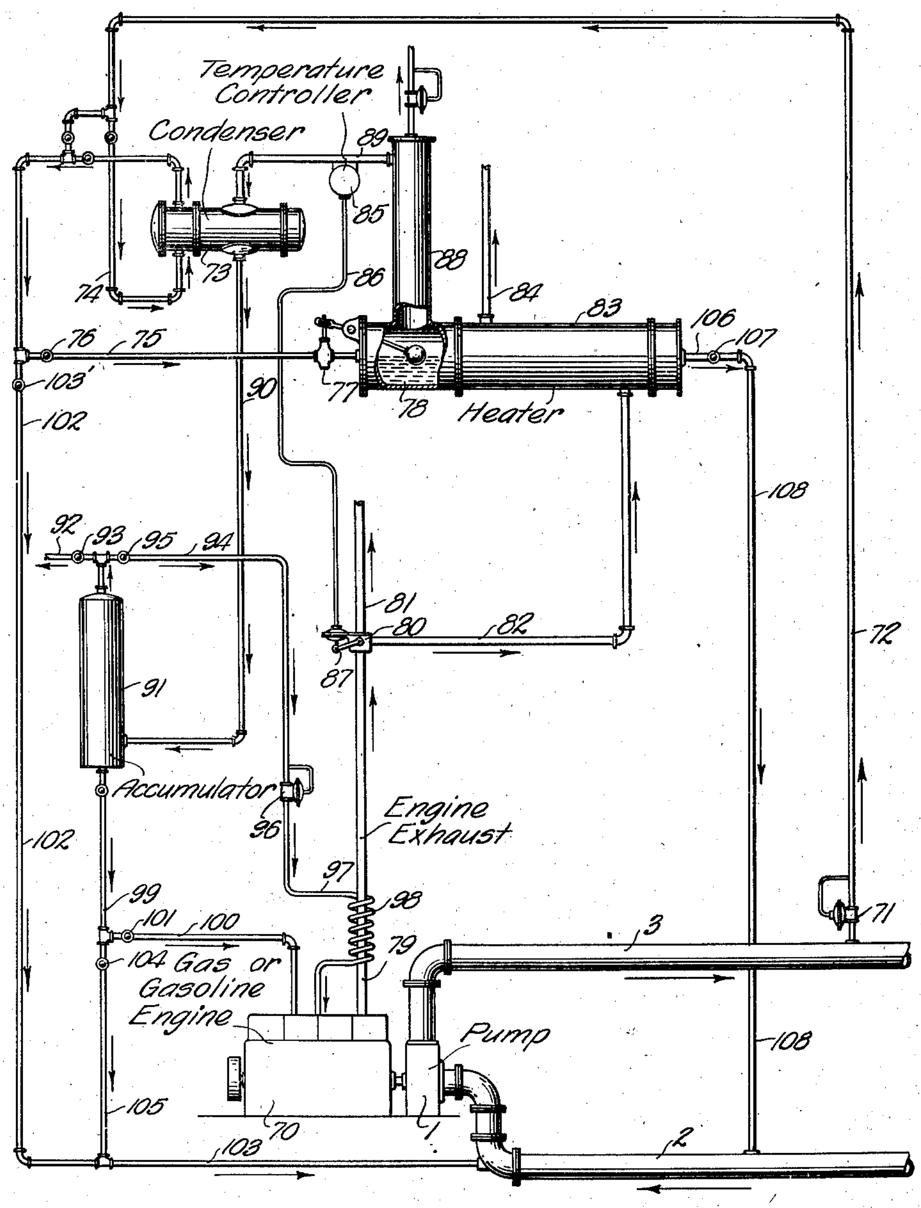

Fig. 2.

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APPARATUS FOR TRANSPORTING OIL THROUGH PIPE LINES

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3 Claims. (Cl. 123—3)

Our invention relates to a method and apparatus for transporting oil through a pipe line.

In long pipe lines for transporting oil across country, it is necessary to construct pump stations in isolated localities. This makes it difficult to secure fuel at reasonable costs. In the case of an oil pipe line, a portion of this oil can be used as fuel to furnish power for pumping. The oil, however, is such that it can be used only in heavy duty, slow speed Diesel engines which are very expensive, costing from two to three times as much as modern high speed Diesel engines. The modern Diesel engine, however, cannot operate upon the crude oil being pumped, and requires a special Diesel fuel.

Certain installations utilize gas or gasoline engines as a prime mover for pumping. In this case, as in the case of a modern high speed Diesel, it is necessary to haul or pipe the fuel required to the pumping station, frequently over long distances and under adverse conditions, as well as at high cost.

One object of our invention is to provide a method and apparatus for pumping crude oil or petroleum in which a portion of the crude oil being pumped is bled from the pipe line and converted into a fuel for the prime mover.

Another object of our invention is to provide a method of obtaining a usable fuel fraction from the crude oil being pumped by means of utilizing only the heat in the exhaustion of the internal combustion engine, or by utilizing in combination with engine exhaust heat additional heat generated from the combustion of a portion of the oil being pumped.

Another object of our invention is to provide a contact pumping unit which may be readily installed at an isolated pumping station and under some conditions it is an object to provide a compact and portable or transferable pumping unit.

Still another object of our invention is to provide a method and apparatus for obtaining different types of fuel fractions from crude oil or petroleum being pumped. The types are:

a. Gaseous; involving separation of those hydrocarbons that are gaseous at usual temperatures (atmospheric or otherwise) from those hydrocarbons in the crude that are not gaseous.

b. Gasoline; involving the separation of the hydrocarbons boiling in the gasoline from the high boiling hydrocarbons. The gaseous hydrocarbons may or may not be removed.

c. Diesel; involving different types of fuel but usually characterized by a controlled volatility for initial boiling point and final boiling point.

d. Fuel oil, a topped crude with front end volatility corrected.

Obviously, the above fuels may be blended if necessary, to meet certain engine requirements. The method and apparatus of our invention is flexible and may be used either in single or combination units to obtain these various types of fuels.

Other and further objects of our invention will appear from the following description.

In the accompanying drawings which form part of the instant specification and are to be read in conjunction therewith and in which like reference numerals are used to indicate like parts in the various views:

Figure 1 is a diagrammatic view of a section of a crude oil pipe line pump station showing an assembly embodying one form of our invention and capable of carrying out the method of our invention, in which the prime mover is a Diesel engine.

Figure 2 is a diagrammatic view of another embodiment of our invention, showing the arrangement in which the prime mover is a gasoline or gas engine.

More particularly referring now to Figure 1, a booster pump 1 is interposed in a pipe line and is adapted to take suction from branch 2 and discharge through branch 3 of the main line. The pump is actuated by a Diesel engine 4 which is supplied fuel through pipe 5. For this example, it will be assumed that the preferred fuel for this particular Diesel engine is of a volatility between 400° F. and 600° F. It will also be assumed that the crude being pumped is a normal one of say 125° F. initial boiling point and 15% to 25% of material boiling above 600° F. A bleeder pipe 6, controlled by a pressure reducing valve 7', is adapted to bleed a portion of the oil being pumped through a heat exchanger 7, for passage through pipe 8, heat exchanger 9, pipe 10, condenser 11, pipe 12, pipe 13, past float controlled valve 14, into a still 15. The heat exchange requirements may be such that a greater quantity of oil than can be employed in the still 15 must be bled. In such case, a portion of the bled oil passes through pipe 16 controlled by valve 17, pipe 18, and pipe 19, into the branch 2 of the main pipe line which is connected to the suction side of the pump 1. The amount of oil passing back to the pipe line and passing through pipe 13 can be controlled by adjustment of valves 17 and 20. The oil thus preheated is subjected to distillation in a heater 21 communicating with the oil in the still.

The heat exchange medium may be the exhaust gases of the Diesel engine. If desired, independent heating means such as a gas burner or the like may be employed for supplying heat to still 21 such as shown in connection with the heating of still 50. These leave the engine through pipe 22 and are controlled by a valve 23 which is adapted to by-pass a portion of the exhaust gases through pipe 24 to the atmosphere and deliver a portion of the exhaust gases through pipe 25 to the heat exchange tubes within the heater 21, from which the exhaust gases escape through pipe 26 to the atmosphere. A column 27 forms part of the still. This column may be filled with the usual fractionating trays or may be packed, if desired. The pressure within the still is controlled by a back pressure valve 28 connected to a pipe 29, venting to the atmosphere. The vapors leave the column 27 through a pipe 30 and pass into condenser 11, for condensation. The condensate is withdrawn from the condenser through pipe 31. A temperature controlled device 32 acting by fluid pressure through pipe 33 is adapted to control valve 23. The temperature controlled device 32, it will be understood by those skilled in the art, may be made to control a valve in line 13 governing the amount of crude going into the heater 21 and carrying a constant heat without the use of valve 23. In this case, valve 14 would be used in line 60 and valve 23 would be omitted.

If the temperature of the vapors passing overhead through pipe 30 is too high, the temperature control device operates to move valve 23 so that a greater proportion of the exhaust gases will be vented through pipe 24 to the atmosphere. If the temperature of the vapors passing overhead is too low, temperature control device 32 operates to pass a greater proportion of the hot exhaust gases through pipe 25 and thence through the heater 21.

These light hydrocarbons are chiefly within the gasoline boiling range and are condensed in condenser 11. Normally, when obtaining fuel for a Diesel engine, they are returned to the pipe line. This is accomplished by closing valve 34 and opening valve 35, permitting the condensate comprising hydrocarbons boiling below 400° F. to pass through pipe 36 and thence into pipes 18 and 19 for return to the pipe line branch 2. If desired, valve 35 may be wholly closed and a portion of the gasolinelike hydrocarbons withdrawn from the pipe 37 through pipe 38 by opening valve 39. A portion of the gasolinelike hydrocarbons will always pass through pipe 37 in the form shown in Figure 1 and thence through pipe 40 into a fuel pressure tank 41. When the fuel pressure tank is filled, valve 42 will be closed and the tank placed under pressure by means of pump 43. Valve 44 will then be opened, allowing the fuel to pass through pipe 45 and thence through heating coil 46, pipe 47, past temperature controlled valve 48 to the burner 49 which supplies heat to a heater 50. The unvaporized oil 51 in the still 15 will flow therefrom through pipe 52, past float controlled valve 53 into a second heater and still 50. The still is provided with a column 54 through which vapors distilled from the liquid oil are adapted to pass. The vapors are withdrawn from the column 54 through pipe 55 for passage through a condenser 9. The condensate leaves the condenser 9 through pipe 56 and passes into an accumulator 57. The valve 48 which controls the fuel to the burner 49 is controlled by the temperatures of the vapors leaving the still through pipe 55 by means of a temperature controller 58 which acts through pipe 59 to control valve 48. The arrangement is such that, if the temperature of the vapors leaving the column 54 is too high, the valve 48 will tend to close, reducing the fuel supply to the burner 49. If the temperature of the vapors leaving the column 54 is too low, then the temperature controller operates to open valve 48. Normally, in the example given above, where the desired boiling range of the high speed Diesel fuel is between 400° F. and 600° F. the temperatures of the vapors leaving pipe 55 will be in the vicinity of 600° F. The unvaporized liquid will leave the still or may be pumped through pipe 60 for passage through heat exchanger 7 and pipe 61, past valve 62 to the suction side of the pump 1. If the quantity of Diesel fuel made is too high, valve 63 may be opened to permit a portion of the Diesel fuel to pass through pipe 64 into pipe 19 for return to the oil being pumped.

It is believed that the operation of the embodiment shown in Figure 1 will be clear from the foregoing description. The light hydrocarbons are removed from the oil being pumped by means of heat supplied from the engine exhaust. An intermediate fraction of hydrocarbons is then distilled from the reduced crude and this fraction used as the Diesel fuel, the heavier fractions of the oil and, if desired, lighter fractions being returned to the oil being pumped.

As an example of the savings effected by our invention in a pumping assembly embodying our invention, a 350 horsepower, high speed Diesel engine was used for driving a pipe line pump. The engine consumed approximately 15 barrels of fuel a day. The cost of Diesel fuel, delivered at the pumping station, was six cents per gallon or \$2.52 per barrel. Crude oil costs \$1.10 per barrel. By means of our invention we were enabled to save, in one installation alone, \$21.32 per day, which represents a major economic advantage in the cost of transporting oil by pipe lines.

Referring now to Figure 2, we have shown another embodiment of our invention in which the engine 70 is a gas or gasoline engine. The pipe line pump 1 is adapted to take suction through branch 2 of the pipe line and deliver the oil being pumped to branch 3 of the pipe line. Valve 71 controls the bleeding of oil from the discharge branch 3 into a pipe 72 from which the bled oil passes through a condenser 73 in heat exchange with the hot gasoline vapors. The condenser may be by-passed as shown in Figure 2 in case gas is being used as fuel for the engine instead of gasoline. In this case, a separate cooling means for the condenser would be used, as readily understood by those skilled in the art, and gas formed by cracking would be removed from the accumulator 91 to supply the engine. The preheated oil leaves the condenser and passes through pipe 75 controlled by valve 76, past float controlled valve 77 into a still 78 in which the oil is subjected to distillation by heat furnished from the exhaust gases of the internal combustion engine 70. The gases are withdrawn from the engine through pipe 79, the outlet of which is controlled by a temperature controlled valve 80 to divide the exhaust gases between exhaust pipe 81 and pipe 82, leading to a heat exchanger

83 from which the gases are discharged through pipe 84 to the atmosphere.

A temperature controlled device 85 acting by fluid pressure through pipe 86 operates control arm 87 of the valve 80. The still 78 is fitted with a column 88 which may be a fractionating column, if desired. The vapors which are distilled off from the hydrocarbon oil charged to the still are withdrawn from the column 88 through pipe 89. The temperature controller is such that the vapors passing overhead will be at the desired temperature for the boiling range of the fuel to be used in the internal combustion engine 7. The vapors are condensed in condenser 73 by heat exchange with the incoming crude and the condensate and incondensable gases withdrawn from the condenser through pipe 90 for passage into an accumulator 91, controlled by valve 93. A portion of the gases may, if desired, pass through pipe 94 controlled by valve 95, through a back pressure controlled valve 96, through pipe 97, through heat exchanger 98 for use in the internal combustion engine as a portion of the fuel. The liquid gasoline fractions are withdrawn from the accumulator through pipe 99 and pass through pipe 100 controlled by valve 101 to the carburetor of the internal combustion engine 70. Since it may be necessary to circulate a greater quantity of oil than can be subjected to distillation we provide pipe 102 controlled by valve 103' so that a portion of the oil passing in heat exchange with the hot vapors in condenser 73 may pass through pipes 102 and 103 into the suction side of the pump 1 for commingling with the oil being transported.

If the crude oil contains a greater quantity of gasoline-like fractions than can be used in the internal combustion engine, valve 104 may be opened, permitting a portion of the gasoline-like hydrocarbons to return to the pipe line through pipe 105 and pipe 103. The unvaporized oil comprising the heavier fractions thereof, is withdrawn from the still through pipe 106 controlled by valve 107, for passage through pipe 108 to the suction side of the pump.

From Figures 1 and 2 and the examples given to show how the method and apparatus may be employed to produce a Diesel fuel of assumed characteristics and a gasoline fuel, it is obvious, without additional drawings, how a strictly gaseous fuel may be made for a gas engine. For this purpose the equipment and method outlined in connection with description of Figure 2 would be employed. In this event a lower heat would be maintained on still 78 and the high boiling undesirable hydrocarbons not vaporized through fractionator 88. As in the production of Diesel fuel and gasoline fuel the method and apparatus of our invention may be varied over reasonably wide limits, as required depending upon the crude being pumped and the specifications of the fuel required with the various types of prime movers, to give a fuel satisfactory for use.

For prime movers that will satisfactorily operate on a topped or residual crude oil it is obvious that the oil returned to the pipe line through line 60 of Figure 1 and line 108 of Figure 2 may be used, or if necessary, the method and apparatus as above described may be altered slightly to meet fuel specification requirements.

With the above simple, flexible method and apparatus which may be installed as a single unit as in Figure 2, or a multiple unit, as shown in Figure 1, it is possible for us to economically and satisfactorily produce various types of fuels as required.

The character of crude oil being pumped from various crude oil producing fields will vary over wide limits, and in view of this the method and apparatus of our invention must be varied, depending again upon the type of prime mover, to produce a satisfactory fuel. Some crude oil will not contain any so-called gaseous hydrocarbons, while other crudes may be devoid, or substantially devoid of gaseous hydrocarbons and hydrocarbons boiling in the gasoline boiling range. In these instances it would be obvious that a Diesel type prime mover would be used and a fuel for such would be made along the line of the example given in connection with the discussion of Figure 1.

For different prime movers we may produce the various types of fuels. For example:

1. A gaseous fuel consisting of methane, ethane, propane, and butane.
2. A gaseous type fuel including the hydrocarbons mentioned in 1 and in addition some of the pentanes, hexanes, and heptanes, or in fact the fraction of hydrocarbons included in the lower boiling portion of gasoline. It may be necessary to heat such fuel for vaporization prior to delivering it to the prime mover bust such is not an objectionable feature. This fuel may have a boiling point starting with the boiling point of methane and having a maximum boiling point of 150° F. to 200° F.
3. A gasoline type fuel may be of varying volatility specification; for example 80° F. to 150° F. initial boiling point up to 350 to 500° F. final boiling point.
4. Diesel type fuels of the following volatility specifications are contemplated in our invention.

(a) 100° F. initial boiling 600 to 700° F. end boiling point.

(b) 200° F. initial boiling point to 600° F. to 700° F. end boiling point.

(c) 300 initial boiling point to 600° F. to 700° F. end boiling point.

(d) 400 initial boiling point to 600° F. to 700° F. initial boiling point.

(e) 400° F. initial boiling point residual fuel that would have an end boiling point similar to that of the crude from which it was derived.

(f) Residual type fuels similar to (e) above but of a higher initial boiling character, such as 500° F. to 600° F. or a little higher.

It is understood that each type of fuel may be passed through a caustic scrubber or other type of scrubber to remove corrosive materials from the fuel. For example, hydrogen sulfide, low molecular weight mercaptans, hydrogen chloride etc. may be removed if required by any of the well known methods.

In Figure 1 a supplementary burner 49 is shown for heating still 50. It is obvious that if sufficient heat is feasibly available from the exhaust of the engine or if the character of the crude being pumped is such that supplementary heat is not required to obtain the desired fuel, another heating line from the engine exhaust will be used for heating heater 50.

Figure 2 shows a pressure unit throughout but it is understood that pump pressure on line 3 may be immediately reduced to atmospheric or substantially atmospheric in line 72. Our invention is in no way limited to pressure or lack of pressure on our equipment.

Various control and operating instruments are indicated in the drawings and descriptions but these are given by way of example only and any equivalent or better equipment either similar or dissimilar may be employed.

It will be seen that we have accomplished the objects of our invention. We have provided an installation for pumping oil in pipe lines and a method of operating pipe lines in which we are enabled to utilize modern, efficient, low cost, internal combustion engines, as prime movers for operating the pump. We are enabled to furnish fuel to the prime mover by extracting it from the oil being pumped, in a convenient and expeditious manner. Our units are simple in operation and rather inexpensive of installation, are compact, light in weight and are readily portable. The use of our method and apparatus enables us to operate a pipe line in a more expeditious and economical manner.

It will be understood that certain features and sub-combinations are of utility and may be employed without reference to other features and sub-combinations. This is contemplated by and is within the scope of our claims. It is further obvious that various changes may be made in details within the scope of our claims without departing from the spirit of our invention. It is, therefore, to be understood that our invention is not to be limited to the specific details shown and described.

Having thus described our invention, we claim:

1. An oil transport pipe line, including in combination a conduit, a pump for moving oil through said conduit, an internal combustion engine burning a selected fraction of oil for driving said pump, a first still, means for bleeding a portion of the oil from said conduit into said still, a heater for said still, a second still, means for removing vapors from said first still, means for passing unvaporized oil from said first still to said second still, means for heating said second still, means for removing vapors from said second still, means for passing unvaporized oil from said second still to said pipe line, a first condenser for condensing vapors from said first still, means for passing condensate from said first condenser back to said pipe line, means for burning uncondensed gases from said first condenser in one of said still heaters, means for passing exhaust gases from the internal combustion engine through the other of said still heaters, a second condenser, means for passing vapors from said second still to said second condenser and means for passing the condensate from said second condenser to said internal combustion engine, as fuel.

2. An oil distilling apparatus for supplying an intermediate fraction of a hydrocarbon oil to an internal combustion engine having a fuel inlet and an exhaust outlet for combustion gases comprising a source of crude oil supply, a first still, a second still, means for conducting crude oil from the source to said first still, means for conducting the exhaust gases of the engine to the said first still for heating the contents thereof to a predetermined temperature, means including a burner for heating the contents of said second still to a predetermined temperature, means for condensing the vapors from the first still and for conducting the uncondensed gases to the said heater whereby the uncondensed gases of the first still will constitute a source of fuel supply for the burner of the second still, means for passing unvaporized oil from the first still to the second still, and means for condensing vapors from the second still and for supplying the condensate to the said fuel inlet of the engine.

3. An oil distilling apparatus for supplying an intermediate fraction of a hydrocarbon oil to an internal combustion engine having a fuel inlet comprising a source of crude oil supply, a first still, a second still, heaters for the said stills, means for conducting crude oil from the source of supply to the said first still, means for condensing vapors from the first still and for supplying the uncondensed gases of the vapors to at least one of the said heaters, means for passing unvaporized oil from the first still to the second still, and means for condensing vapors from the second still and for conducting the condensate to the said fuel inlet of the engine.

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