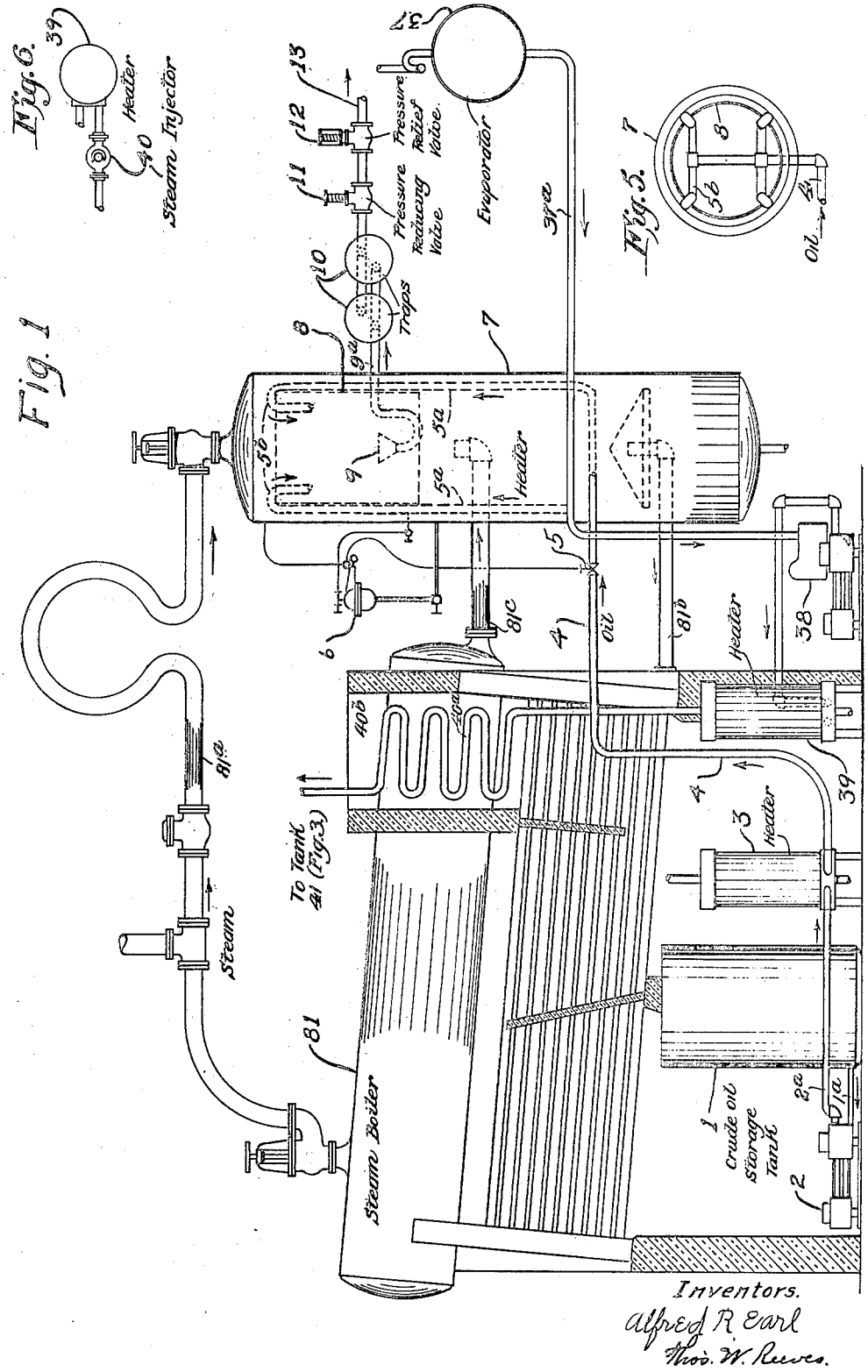
Dec. 29, 1925. 1,567,429

A. R. EARL ET AL

PROCESS FOR SERIES SEPARATION OF CRUDE PETROLEUM

Filed August 25, 1923 4 Sheets-Sheet 1



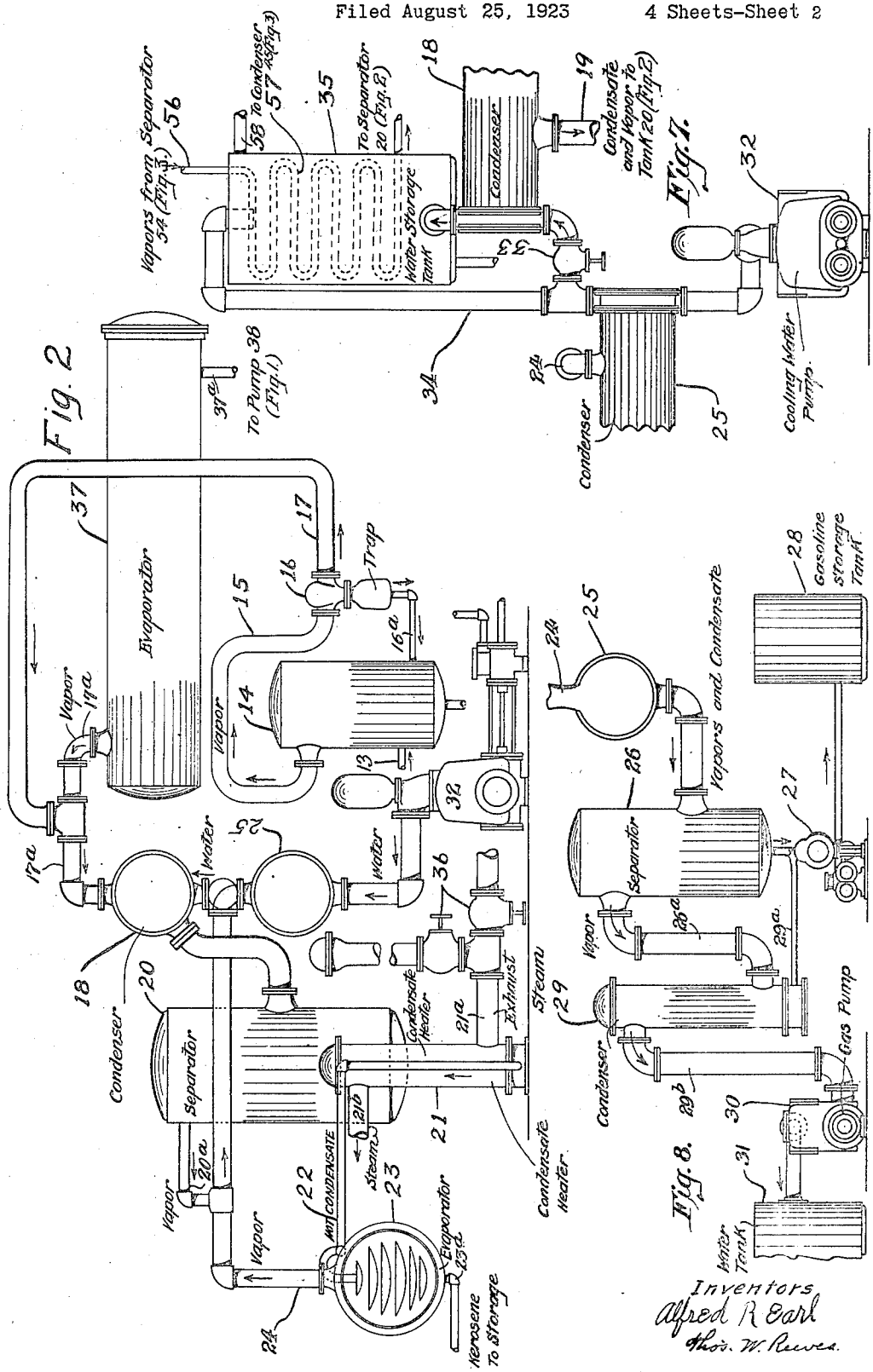
Inventors.
Alfred R. Earl
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PROCESS FOR SERIES SEPARATION OF CRUDE PETROLEUM

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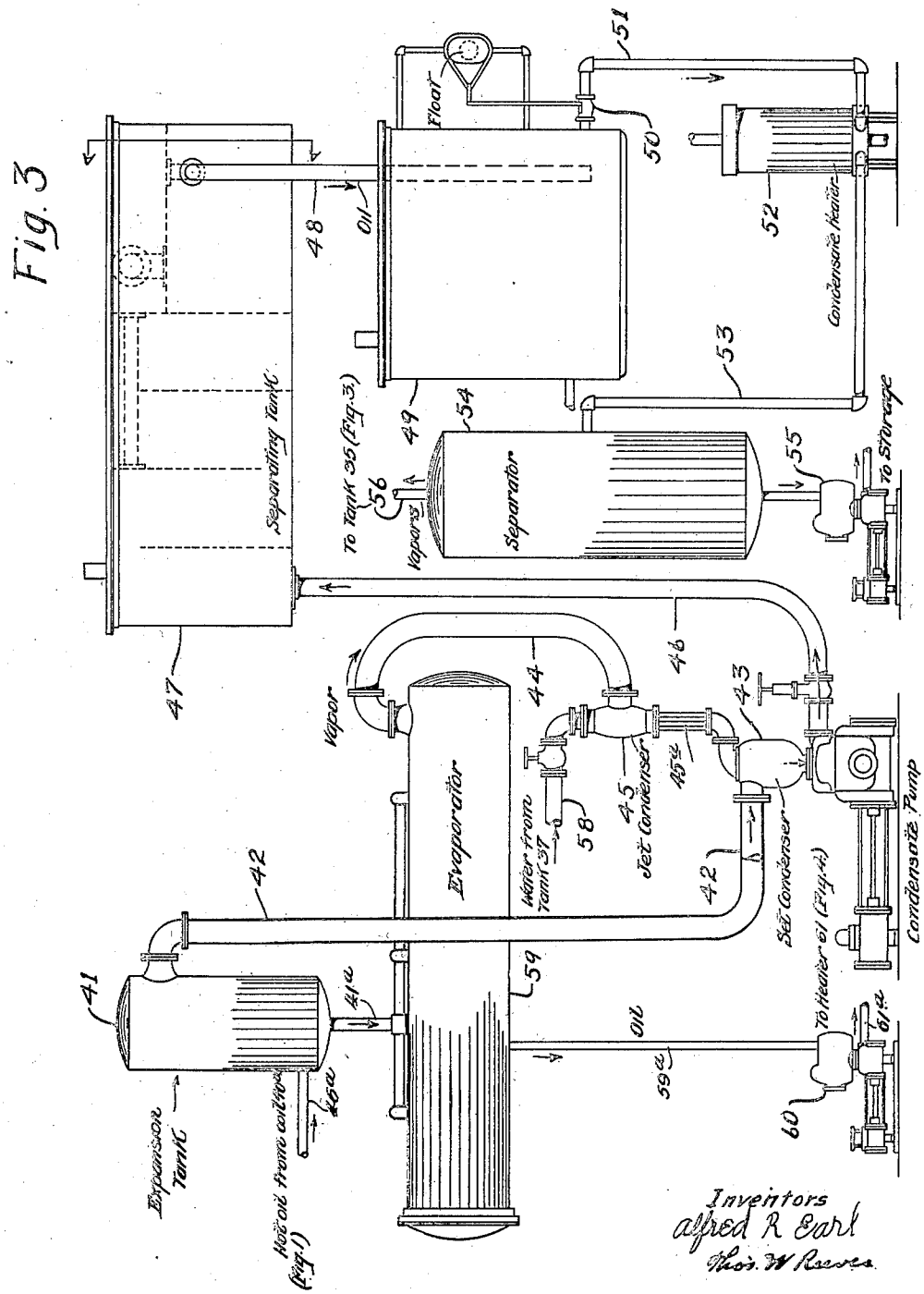
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A. R. EARL ET AL

PROCESS FOR SERIES SEPARATION OF CRUDE PETROLEUM

Filed August 25, 1923 4 Sheets-Sheet 3

Fig. 3



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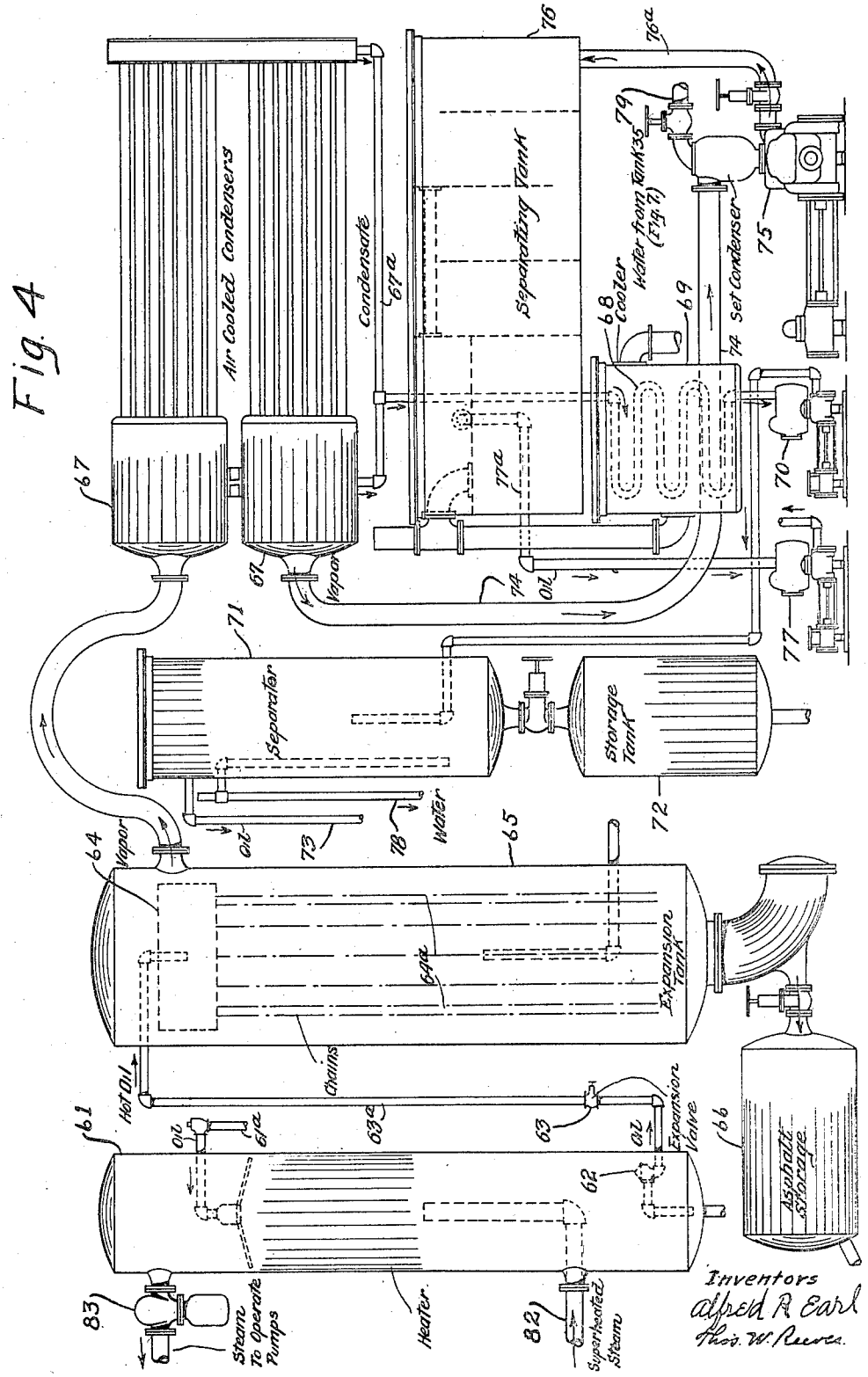
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A. R. EARL ET AL

PROCESS FOR SERIES SEPARATION OF CRUDE PETROLEUM

Filed August 25, 1923 4 Sheets-Sheet 4

Fig. 4



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UNITED STATES PATENT OFFICE.

ALFRED R. EARL AND THOMAS W. REEVES, OF TOLEDO, OHIO.

PROCESS FOR SERIES SEPARATION OF CRUDE PETROLEUM.

Application filed August 25, 1923. Serial No. 659,363.

To all whom it may concern:

Be it known that we, ALFRED R. EARL and THOMAS W. REEVES, citizens of the United States, residing at Toledo, in the county of Lucas and State of Ohio, have invented certain new and useful Improvements in Processes for Series Separation of Crude Petroleum, of which the following is a specification.

Our invention relates to a method of distilling petroleum oil in a series of stages in a continuous manner, whereby the several distillates are obtained directly as commercial products without any further distillation treatments.

An object of this invention is to avoid overheating the oil while being distilled. This is done by not exposing the oil heating apparatus to the direct action of hot combustion products. In our process, the oil is heated by both saturated and superheated steam, either in direct or indirect contact with the oil. To further avoid the use of too great a degree of heat, we vaporize the oil under reduced pressure.

A further object of our invention is to reduce the cost of fuel used in distilling by utilizing the waste heat wherever possible.

Further objects of the invention will appear from the following detailed description of our process.

We attain these objects by the process carried out in the apparatus illustrated in the accompanying drawings in which—

Figure 1 is an elevation partly in section of the first part of the apparatus.

Figure 2 is a similar view of the second part of the apparatus.

Figure 3 is a similar view of the third part of the apparatus.

Figure 4 is a similar view of the fourth part of the apparatus.

Figure 5 is plan view of the heater 7 with the top removed showing the distributing pan and the heating pipes.

Figure 6 is a fragmentary view of a steam injector and heater.

Figure 7 is a side elevation of the condensing units shown in Figure 2.

Figure 8 is an elevational view of the condenser and separators associated with the apparatus shown in Figure 2.

It is to be understood that the apparatus shown in Figures 1, 2, 3 and 4, are joined together and that these figures are to be read as if they were placed consecutively end to end.

Referring to Figure 1 of the drawing 1 is a storage tank for the crude petroleum that is to be distilled. The oil is drawn from the tank 1 through the pipe 1^a by the pump 2 which forces it through the pipe 2^a to the heater 3 where the oil is heated in any suitable manner. From the heater 3 the oil is conducted by the line 4 through the valve 5, which is controlled by the thermally responsive regulator 6 to the heater 7. In the heater 7, the oil passes upwardly through a series of pipes 5^a and the down turned sections 5^b (see Figure 5) into the inner pan or distributor 8. From the distributor 8 the heated oil is discharged into the funnel-shaped opening 9 of the pipe 9^a into the traps 10, whence it passes through the pressure regulating valve 11 and pressure release valve 12 into the pipe line 13.

Heat is supplied to the oil in the heater 7 by steam from the steam boiler 81. The steam is led from the boiler by the steam line 81^a into the top of the heater 7 whence it passes downwardly in contact with the heating pipes 5^a. It will be noticed that the oil is heated indirectly by the steam while in the pipes 5^a and by direct contact with the steam when in the pan 8. While imparting its heat to the oil in the heater 7, the steam condenses, and the water of condensation is conducted back to the steam boiler 81 by the pipe 81^b. Further heating is obtained by circulation of hot water from the boiler through the pipe 81^c into the heater 7 and back to the boiler through pipe 81^b.

The crude oil in the heater 7 has been maintained under pressure and therefore vaporization has been suppressed. However, after the release of the pressure by the valve 12 it is conducted by the pipe 13 into the expansion chamber 14, where, because of the release of pressure, the more volatile products assume the form of vapors which are conducted away by the pipe 15 through the trap 16 and pipes 17 and 17^a where they join the vapors from the evaporator 37, to the condenser 18. Any liquids caught in the trap 16 are returned to the chamber 14 by the pipe 16^a. The vapors are partially condensed in the surface condenser 18, and the condensate and uncondensed vapors are passed by pipe 19 to the separator 20. The liquid condensate is conducted from the

separator 20 to the reheater 21, which is heated by exhaust steam introduced by the pipe 21ª and discharged by pipe 22ᵇ. The heated condensate is passed from the reheater 21 by the pipe 22 into the evaporator 23. The unvaporized distillate is withdrawn by pipe 23ª to a storage tank. This distillate is kerosene.

The uncondensed vapors from the separator 20 are conducted by the pipe 20ª to the vapor line 24 where they join the vapors from the evaporator 23. The line 24 conducts the combined vapors to the surface condenser 25 (see Fig. 8) where most of the vapors are condensed. From the condenser 25 the condensate and vapors are conducted to the separator 26 where the liquid condensate (which is gasoline) is separated and drawn off by pump 27 to the storage tank 28. The uncondensed vapor is drawn off from the separator 26 by the pipe 26ª to the condenser 29 from which any condensate that separates is drawn off by pipe 29ª to the pump 27. The uncondensed vapors and gas are drawn off by the pump 30 through the pipe 29ᵇ and injected below the surface of water in the tank 31.

Referring to Figure 7, the cooling water for the condensers is supplied by the pump 32 to the condenser 25, which is the coolest, and then flows into the next warmer condenser 18 by the pipe controlled by the valve 33. The pipe 34 acts as a stand pipe to regulate the flow of water to the condenser 18 and also as a means for discharging the water directly to the water tank 35. The water from condenser 18 flows to the tank 35. The valves 36 (Fig. 2) are back pressure valves which reduce the pressure of the exhaust steam before passing into the reheater 21.

The unvaporized residuum in the expansion chamber 14 (Fig. 2) is conducted by the pipe 14ª to the evaporator 37 whence any vapor that is separated passes by line 37ª to the vapor line 17ª.

The residuum from the exaporator 37 passes by the pipe 37ª to the pipe 38 (Fig. 1) which forces the oil through the heater 39. From the heater 39 the oil is conducted to the steam injector 40 (Fig. 6) which discharges into the heating coil 40ª placed in the waste heat flue 40ᵇ of the steam boiler furnace.

From the heating coil 40ª the heated oil is discharged into the expansion tank 41 (Fig. 3). The vapors separated in the tank 41 are drawn off by pipe 42 to the jet condenser 43 where they are condensed. By the action of this jet condenser, the pressure in the expansion tank 41 is kept below atmosphere. The unvaporized oil is conducted from the tank 41 by pipe 41ª to the evaporator 59, which is also under reduced pressure, the vapors being drawn off by the pipe 44 to the jet condenser 45 where they are condensed, which causes the reduced pressure in the evaporator 59. The liquids from the condenser 45 are conducted by the pipe 45ª directly to the jet condenser 43 where they act as the jetting fluid. The water for the condenser 45 is supplied by the pipe 58 from the hot water tank 35 (Fig. 7). The condensate and water are pumped from the condenser 43 through the line 46 to the separating tank 47 from which the oil is drawn off by the pipe 48 into the settling tank 49. From the tank 49 the oil is drawn through the float controlled valve 50 and the pipe 51 into the condensate reheater 52, thence by the pipe 53 to the expansion tank 54. The unvolatilized oil is drawn from the tank 54 by the pump 55 to a storage reservoir where it is stored as fuel oil. The vapors are drawn off by the pipe 56 to the coil 57 (Fig. 7) in the water tank 35 where a condensate is formed and conducted to the separator 20 (Fig. 2) and treated together with the condensate from the first distillation step.

As before stated, the warm water from tank 35 (Fig. 7) is supplied to the condenser 45 by the pipe 58 (Fig. 3). The evaporator 59 is supplied with oil from the expansion tank 41, the unvaporized oil from the evaporator 59 being drawn off through pipe 59ª by the pump 60 to the heater 61 (Fig. 4) which is the first piece of apparatus of the third distilling stage.

Referring to Fig. 4, the heavy unvaporized oil from the first two distilling stages is supplied to the heater 61 by the pipe 61ª, where it is heated by direct contact with superheated steam applied by the pipe 82 from which it absorbs all of its superheat. A superatmospheric pressure is maintained in the heater 61 so that no vaporization of oil takes place therein, the steam, which leaves the oil as merely saturated steam, being drawn off through the trap 83 and used to operate the pumps.

The hot oil is drawn off from the bottom of the heater 61 through the float-controlled valve 62 and the pressure release valve 63 in the line 63ª to the feed distributor tank 64 in the expansion tank 65. The oil overflows the distributor tank 64 down along the chains 64ª suspended from the tank and thus presents a large surface for evaporation. The tank 65 is maintained under subatmospheric pressure by means later described, which further aids the evaporation due to the heat supplied in the heater 61. The unvaporized oil which is an asphalt, is drawn off from the bottom of the tank 65 to the storage tank 66.

The vapors from the expansion tank 65 pass by the pipe 67ª to the air-cooled condensers 67 where they are partly condensed. The condensate is drawn off by the pipe

67ª to the coil 68 in the cooling tank 69, from which it is pumped by the pump 70 to the separating tank 71. The heavy oily material is drawn off to the storage tank 72. The lighter oil is drawn off by the pipe 73 to the cylinder stock storage tank. The water is drawn off by the constant level overflow pipe 78.

The uncondensed vapors from the condenser 67 pass through the pipe 74 into the jet condenser 75 supplied by the pipe 79 with water from the tank 35 (Fig. 7) and are condensed. By the action of the jet condenser a sub-atmospheric pressure is maintained in the expansion chamber 65 through the pipe 74, condenser 67 and line 67ª. The condensate and water from the jet condenser 75 are pumped through the pipe 76ª to the separating tank 76 from which the oil is drawn through the pipe 77ª by the pump 77 to the paraffine wax distillate storage tank.

The saturated steam used in this process is supplied by the water tube boiler 81 (Fig. 1) as was described.

It will be noted that our process contemplates the complete distillation of crude petroleum by a continuous distillation in three steps or stages. The first distillation stage is carried out in the apparatus shown generally in Figs. 1 and 2, the second stage in the apparatus shown generally in Fig. 3 and the third stage of distillation in the apparatus shown in Fig. 4.

We claim:

1. The method of continuously distilling mineral oil which consists in heating the oil under pressure by means of steam, then releasing the pressure of the so-heated oil and passing the same into an expansion zone, where part of the oil vaporizes, conducting away the vapors so formed and fractionally condensing the same, withdrawing the unvaporized oil and further heating the same while not permitting vaporization of the oil, passing the said heated oil into an expansion zone maintained at a pressure below atmospheric and there permitting vaporization of the lighter products to take place, withdrawing and condensing the vapors so formed, withdrawing the unvaporized oil from said expansion zone and heating it by direct contact with superheated steam while maintaining the same under sufficient pressure to prevent vaporization of the oil, releasing the pressure of said oil and passing the heated oil into an expansion zone maintained at a pressure below atmospheric, thus permitting part of the oil to vaporize, withdrawing the vapors so formed and fractionally condensing the same, and withdrawing the unvaporized oil from said last named expansion zone.

2. The method of distilling crude petroleum oil which consists in heating and distilling said oil in a plurality of stages and in the last stage, heating the oil under pressure by injecting superheated steam in direct contact therewith, withdrawing the oil so heated and while in liquid state from the heating zone and releasing its pressure, introducing the oil into an expansion zone maintained at a pressure below atmospheric, passing the oil through said expansion zone in a plurality of finely divided continuous streams and thus exposing a large surface of said heated oil to the action of the reduced pressure in said expansion zone, withdrawing and fractionally condensing the vapors formed in said expansion zone, and withdrawing the unvaporized residuum from said expansion zone.

In testimony whereof, we have hereunto signed our names to this specification.

ALFRED R. EARL.
THOS. W. REEVES.