

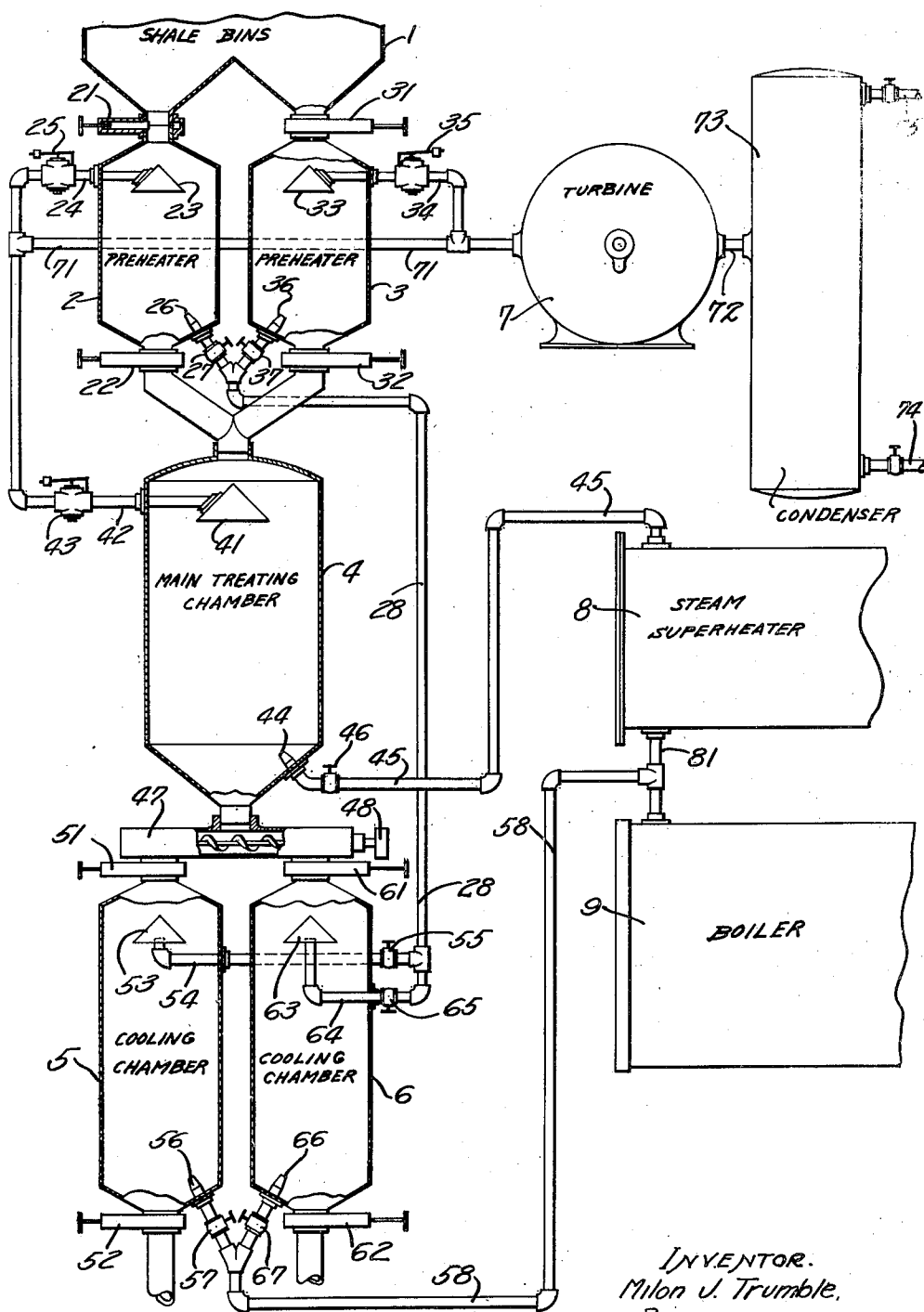
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M. J. TRUMBLE

PROCESS FOR DISTILLING SOLID CARBONACEOUS MATERIAL

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INVENTOR.
Milton J. Trumble,
By
Graham + Kain
ATTORNEYS.

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MILON J. TRUMBLE, OF LOS ANGELES, CALIFORNIA.

PROCESS FOR DISTILLING SOLID CARBONACEOUS MATERIAL.

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My invention relates to the art of treating material containing hydrocarbons and is particularly applicable to the recovery of oils from oil shales.

It is a well known fact that the oil shales do not commonly contain free oil but that if the shale is subjected to proper conditions of heat and pressure oil is produced therefrom. It is supposed that the oil is present in the shale in a form sometimes referred to as kerogen, which is not volatile nor solvent in other hydrocarbons. Whenever sufficient temperature and pressure are applied to the shale, the kerogen is changed into a hydrocarbon oil which may be readily distilled therefrom. It is an object of my invention to provide a process and apparatus by which shale may be so treated as to produce valuable shale oils therefrom. It is a further object of my invention to provide a process which may be operated continuously, the shale being passed through the apparatus continuously, and the shale oil being taken off continuously.

Owing to the fact that high temperatures and pressures must be employed in any oil shale distilling apparatus, it is extremely difficult to make an efficient apparatus due to the large heat losses therefrom. It is a further object of my invention to provide an apparatus in which the heat losses are maintained at a low value, thus producing a very efficient process.

The distillation of shale and other materials containing hydrocarbon by previously devised processes is usually uneconomical due to the fact that the material contains considerable moisture which must be evaporated therefrom before the actual treating of the material can be commenced. The evaporation of this moisture requires considerable quantities of heat which are ordinarily lost, and it is a further object of my invention to provide a process by which the energy used in this preliminary drying step, as well as a considerable portion of the energy applied to the actual distillation or conversion of the shale, may be recovered as mechanical power.

In the operation of various types of distillation processes, it is extremely common to produce large volumes of high temperature vapors which must be cooled in suitable condensers before these vapors can be reduced to a low temperature liquid suitable for transportation and use. The initial cost

and expense of maintenance of large banks of condensers are considerable, and it is a further object of my invention to provide mechanical means for reducing the temperature and pressure of the vapors mechanically which can be conveniently accomplished by passing them through a steam turbine and causing them to do useful work therein.

Various types of processes have been developed in which the shale is placed in retorts and subjected to heat and pressure, after which the retort is opened and the residuum from the treatment is removed. These processes are objectionable as they involve the opening and cooling of the retort at periodical intervals, thus entailing considerable heat losses in the retorts. It is a further object of my invention to provide a continuous process in which the raw material is preferably fed by gravity through a series of treating chambers, which are maintained at substantially uniform temperatures over long periods.

Further objects and advantages will be made evident hereinafter.

The drawing is a diagrammatic elevation of a form of apparatus adapted to carry on my invention.

In the form of the invention illustrated in the drawings I utilize a raw material bin 1, preheating chambers 2 and 3, a main treating chamber 4, of the retort type, cooling chambers 5 and 6, a turbine 7, a superheater 8, and a boiler 9.

The preheating chambers 2 and 3 are provided with upper valves 21 and 31 adapted to close passages leading from the raw material bin into the preheating chambers. They are also provided with valves 22 and 32 adapted to close passages leading from the preheating chambers 2 and 3 into the main treating chamber 4. The preheating chambers 2 and 3 are provided with vapor take-off hoods 23 and 33 which connect to pipes 24 and 34 leading to regulating valves 25 and 35. These regulating valves are so formed that they will open at a predetermined pressure and allow fluid to pass from the pipes 24 and 34 into a turbine feed pipe 71. Steam may be injected into the charge in the preheating chambers 2 and 3 through steam injection pipes 26 and 36, which are provided with valves 27 and 37 and which are connected into a steam pressure pipe 28, this pipe extending downwardly and connecting with certain pipes in the cooling

chambers 5 and 6, as will hereinafter be explained.

The main treating chamber 4 is provided with a vapor takeoff hood 41 which connects to a pipe 42, having a pressure regulating valve 43 therein. The pressure regulating valve 43 is similar in construction to the valves 25 and 35, being set to open and allow steam or gas to pass from the pipe 42 into the pipe 71. In operation the valve 43 is set to open at a somewhat higher pressure than the valves 25 and 35. The main treating chamber 4 is also provided with a superheated steam injection nozzle 44 which connects to a pipe 45 provided with a regulating valve 46, the pipe 45 leading back to the top of the superheater 8, by means of which it is supplied with high temperature steam under pressures considerably in excess of atmospheric. In practice I have used steam at temperatures as high as 1800 degrees Fahrenheit and at pressures of 250 pounds per square inch. The process operates well at temperatures considerably lower than this but for high economy both the temperature and pressure of the superheater should be kept high.

The main treating chamber discharges into a conveyor 47, driven by any suitable source of power by means of a pulley 48. This conveyor is of the standard helicoidal form and the driving mechanism is made reversible so that this conveyor can be driven in either direction to deliver material into the top of either the cooling chamber 5 or the cooling chamber 6. The cooling chambers 5 and 6 are provided with valves 51 and 61, through which material is delivered into the cooling chamber, and with valves 52 and 62, through which the material may be withdrawn. Vapor takeoff hoods 53 and 63 are provided which are in open communication with pipes 54 and 64, these pipes being provided with valves 55 and 65 and connecting with the pipe 28. The cooling chambers 5 and 6 are also provided with steam injection nozzles 56 and 66 which are provided with valves 57 and 67, these nozzles connecting into a pipe 58 which leads back and connects into a pipe 81 connecting the superheater 8 with the boiler 9. Saturated steam is delivered from the boiler 9 through the pipe 81 into the superheater 8, a portion of this saturated steam being taken off through the pipe 58 for use in the cooling chambers 5 and 6.

The turbine 7 may be of any desired form and in some cases a reciprocating type of prime mover may be conveniently substituted therefor. It is preferably connected to an electric generator, not shown, the power therefrom forming a valuable product obtained by my process.

The exhaust vapors from the turbine 7 are passed through a pipe 72 into a cooling

tower or condenser 73 in which the oil and steam are condensed, being withdrawn from a pipe 74, the uncondensable gases being delivered through a pipe 75.

The method of operation of my invention is as follows:

The apparatus is started by charging one of the preheating chambers, for example the preheating chamber 2 and the main treating chamber 4, with raw material such as shale, this material passing downwardly through the valves 21 and 22 and filling the chambers 2 and 4. The valve 21 is then closed and high temperature steam is admitted to the main treating chamber 4 through the nozzle 44 from the pipe 45 by a suitable manipulation of the valve 46. The high temperature steam passing into the chambers 2 and 4 raises them to substantially the same temperature and pressure as the steam from the superheater 8. This pressure is sufficient to open the valve 25 and allow the steam to flow into the pipe 71 and to the turbine 7. The temperature and pressure, acting upon the shale, convert the kerogen therein into an oil vapor which passes through the turbine 7, causing the turbine to deliver mechanical power. In passing through the turbine the temperature and pressure of the steam and vapor are reduced to such a point that the oil and water are readily condensed out in the condenser 73, the oil and water being delivered through the pipe 74 and the gas being delivered through the pipe 75. In some cases the gas 75 may be used to fire the boiler 9.

As soon as the charge in the main treating chamber 4 is thoroughly treated, the conveyor 48 may be started and the valve 51 may be opened, the valve 52 being closed. A portion of the charge in the main treating chamber is then fed into the cooling chamber 5, the material in the preheating chamber 2 being in turn discharged into the main treating chamber. The valves 51 may then be closed. The treating chamber 2 being free from material, the valve 22 is closed and the valve 21 is opened and the chamber 2 is filled with fresh raw material from the bin 1. The valve 21 may then be closed. At this stage of the process the preheating chamber 2 is filled with untreated raw material, the main treating chamber 4 is filled with partially treated material, and the cooling chamber 5 is filled with spent shale. The spent shale in the cooling chamber 5 may, however, be at a very high temperature, say for example 1500 degrees Fahrenheit. The valve 57 is then opened, allowing saturated steam from the boiler 9 to blow into the cooling chamber and into the hot shale therein. The valve 55 being opened, the saturated steam passing through the material in the cooling chamber 5 is raised in temperature and passes upwardly through

the pipe 28, around the chamber 4, and into the preheating chamber 2, the valve 27 being opened for this purpose. The pressure of the heated steam is slightly above that required to open the valve 25 and the steam therefore passes through the pipe 24 into the pipe 71, being fed into the turbine. In its passage through the cooling chamber 5 the saturated steam is heated and raised in temperature and in its passage through the preheating chamber 2 the steam is again lowered in temperature, at the same time preheating the material therein. If this material contains moisture, this moisture is turned into steam by the steam blowing therethrough, and the material in the chamber 2 is reduced to a dried condition, at the same time being raised in temperature. As the material in the chamber 5 cools, the temperature of the steam passing upwardly through the pipe 28 falls and a condition of heat balance is approached in which the material in the cooling chamber 5 and the material in the preheating chamber 2 would be at about the same temperature as the saturated steam delivered through the pipe 58. Before this condition is reached it is convenient to close the valves 57 and 55 and dump the cooling chamber 5 through the valve 52.

The valve 27 may then be closed and the preheated and dried material in the chamber 2 may be delivered through the valve 22 into the main treating chamber 4, this being accomplished by reversing the direction of the conveyor 47 and delivering material from the main treating chamber into the cooling chamber 6. During the time that the material in the preheating chamber 2 is being given its preliminary heating, the preheating chamber 3 is filling, the chambers 2 and 3 being operated alternately to prevent any interruption of the process in the same manner that chambers 5 and 6 are operated alternately. After the process is thoroughly in operation a continuous pressure is maintained on the pipe 71 and the material flows through the chambers 2, 3, 4, 5 and 6 in a more or less continuous stream. Usually the chamber 4 is in open communication with one of the chambers 2 or 3. In the event that it is shut off from communication with both of these chambers, the pressure in the chamber 4 will rise slightly and the valve 43 will open, allowing steam to flow directly from the chamber 4 into the pipe 71. In the practical operation of the device, one turbine may be supplied with superheated steam and vapor from a plurality of chambers such as those shown.

While I have described my apparatus as applied to the treatment of shale, it is obvious that it may be applied to the treatment of any material containing hydrocarbons. It may, for example, be applied to the treatment of garbage which is dried in the pre-

heating chambers 2 and 3, subjected to a distillation in the main treating chamber 4, and discharged through the cooling chambers 5 and 6 in the form of a coke, all of the volatile products appearing in the pipes 74 and 75 in the form of liquid or gas. By applying superheated steam to the material, all of the water therein is converted into steam, the energy so applied being recovered from the turbine 7 in the form of electrical or mechanical power. The process may also be applied to the treatment of coals or lignites, in which case a coke is delivered through the valves 52 and 62.

I claim as my invention:

1. A process of destructive distillation of solid carbonaceous materials which consists in: first, subjecting the material to the action of steam at a preheating temperature by percolating the steam through said material to cause a distillation therefrom; second, subjecting the residuum from said distillation to the action of superheated steam under pressures above atmospheric by percolating the steam therethrough at a destructive distillation temperature; and, third, passing saturated steam through the residuum of the second step, this steam being raised in temperature and then used to carry on the first step.

2. An apparatus for treating solid material containing hydrocarbons which comprises: walls forming a preheating chamber; walls forming a main treating chamber of retort type, connected with an outlet therefrom; means for subjecting material in one of said chambers to the action of a hot gas under pressures above atmospheric pressure; walls forming a cooling chamber; means for controllably admitting material from said main treating chamber to said cooling chamber; means for passing steam through the material in said cooling chamber; means for delivering said steam, after it has passed through said cooling chamber, around said treating chamber and into said preheating chamber; and means for controllably admitting material into said treating chamber without completely releasing the pressure on said chamber.

3. In the destructive distillation of carbonaceous solids: first, preheating the raw material; second, decomposing said preheated material by percolating therethrough highly superheated steam; third, passing initially substantially saturated steam through the hot residue from the second step, whereby the heat content of said saturated steam is increased as the residue is cooled; and thereafter passing said steam through additional raw material to perform such preheating.

In testimony whereof, I have hereunto set my hand at Los Angeles, California, this 5th day of September, 1923.

MILON J. TRUMBLE.