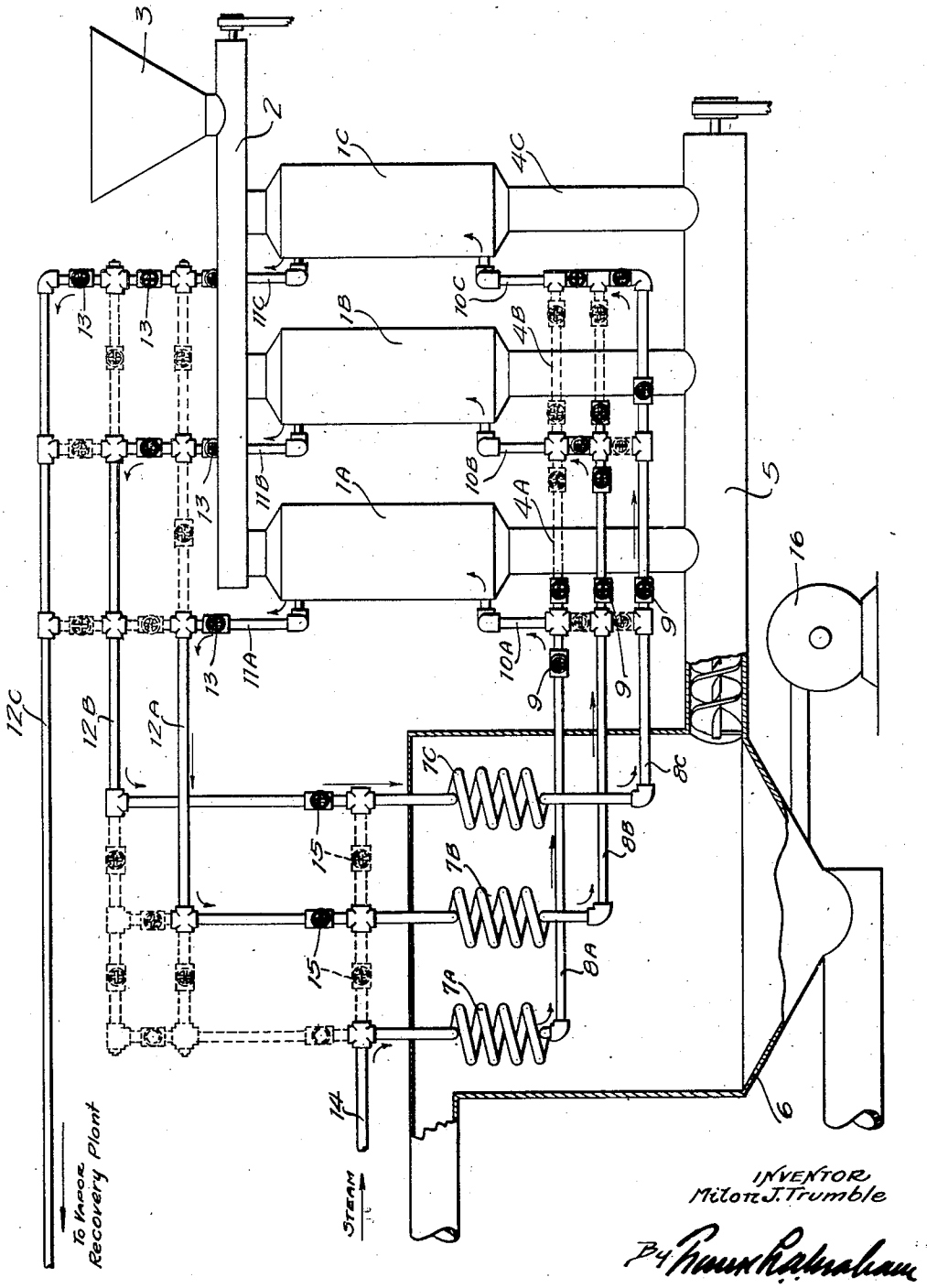
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SHALE DISTILLATION

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SHALE DISTILLATION

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This invention relates to a process for the recovery of volatile hydrocarbon materials from solid bituminous substances, such as coal, oil shale or the like, hereinafter referred to as solid carbonizable material and a preferred form of apparatus for effecting this process. It is the primary object of this invention to produce a process of this character in which a super-heated vapor, preferably steam, is employed as the distilling medium.

It is well known to the art, that from the standpoint of chemical efficiency, in the extraction of volatile carbon materials from solid bituminous substances, that steam has particular value as a distilling medium and numerous processes have been devised for the purpose of utilizing this particular property of steam in the distillation of coal, etc. From the standpoint of thermal efficiency however, steam as commonly used in very costly due to the fact that the majority of the heat content of the steam is in the form of latent heat of vaporization which is lost immediately upon the condensation of the steam. For this reason the use of steam in the distillation of bituminous materials has not been considered as economically sound and has therefore not come into the general practice.

The process which forms the subject matter of this application, is designed to use steam under superatmospheric pressure in a manner such that the latent heat content of the steam may be considered as being used repeatedly for the treatment of a plurality of bodies of material being treated. This is accomplished by treating the material in a series of separate retorts passing the same vapor from one retort to another throughout the series and providing individual superheaters between the individual retorts for the purpose of raising the temperature of the vapor above the condensation point corresponding to the pressure conditions in the system so that at no time is the latent heat of vaporization given up due to the condensation of the water vapor present.

It is a noteworthy feature of this process that the mixture of water vapor and hydrocarbon vapor which are present after the steam has passed through the first retort, has a chemical efficiency toward the extraction of volatiles of the solid bituminous material which is even greater than that of pure superheated steam. This is a feature both of novelty and utility, which is stressed at this point to emphasize the value of this process.

As was mentioned above, this invention also embraces a preferred form of apparatus for carrying out the above mentioned process and it is a noteworthy feature of this apparatus that it is adapted to increase the thermal efficiency of the process by taking advantage of the carbon content in the spent shale to provide the heat for super-heating the steam and mixture of steam and volatile hydrocarbons. This feature is accomplished by conducting the so-called spent shale from the retorts into a suitable furnace which contains the mentioned superheaters and in which the carbon contained in the spent shale is burned by injecting a blast of air through the shale.

The process forming the subject matter of this application and the details in the preferred form of apparatus by means of which this process may be carried out, will be better understood from the following description of the accompanying drawing in which the figure is a diagrammatic illustration showing a unit designed for the distillation of coal or shale in accordance with my process.

More particularly describing the invention as herein illustrated, reference numerals 1A, 1B and 1C indicate retorts which are adapted to receive solid bituminous material, from a conveyor indicated by reference numeral 2.

A hopper indicated by reference numeral 3 is adapted to deliver the material in the conveyor.

It will be understood of course, that the series of retorts may be carried to any desired extent and that the conveyor organization is preferably arranged so that shale may be delivered into any one of the retorts of the series during the operation of the system, and that the retorts are so arranged and connected that any one of the retorts may be recharged during the operation of the remainder of the series.

The bottom of the retorts are preferably provided with shale outlet means indicated by reference numerals 4A, 4B and 4C which are connected with a spent shale conveyor 5 adapted to deliver the spent shale containing a certain amount of fixed carbon resulting from the treatment, into a suitable furnace indicated by reference numeral 6.

A plurality of super-heaters corresponding substantially in number with the number of retorts used in the process, are positioned within the furnace 6, such superheaters being indicated by reference numerals 7A, 7B and 7C.

The super-heaters 7A, 7B and 7C are connected with super-heater inlet headers 8A, 8B and 8C, each of which is provided with suitable valves generally indicated by reference numeral 9, through the adjustment of which super-heated steam may be delivered from any one of the super-heaters into any one of the retorts through inlet pipes generally indicated by reference numeral 10A, 10B and 10C.

Each of the retorts 1A, 1B and 1C is provided with a vapor outlet pipe such pipes being indicated by reference numerals 11A, 11B and 11C respectively. These pipes are in turn connected with vapor outlet headers 12A, 12B and 12C, respectively, such headers being provided with valves generally indicated by reference numeral 13, by means of which the vapors coming from the retorts may be directed to an intermediate superheater through the header 12A or 12B or to a vapor recovery plant not shown through the header indicated by reference numeral 12C.

Steam is introduced into the system through a suitable header indicated by reference numeral 14 which is provided with valves 15 by means of which the steam may be directed into any one of the super-heaters 7A, 7B or 7C.

In order that the spent shale delivered to the furnace 6 may be burned therein, it is preferable to provide a furnace with a suitable blower indicated by reference numeral 16, by means of which air is blown through the hot spent shale in the furnace, such air effecting the combustion of the fixed carbon in the shale.

For the purpose of more clearly understanding the operation of this process, the inlet and outlet headers of the retorts are shown in full and dot and dash lines, the full lines being used to indicate the course of vapors through the system. The dotted lines indicate that portion of the headers which are closed from the system by means of valves, and which provide alternative means for directing the steam and mixture of steam and vapors through the system.

In the operation of the process, all of the retorts of the system may be filled with solid bituminous material such as coal, oil shale or the like and steam is introduced into the system through the header 14. For the purpose of description, this steam will be considered as passing through the super-heater 7A into the header 8A, from which it is introduced into retort 1A.

The super-heated steam permeates upwardly through the retort in direct contact with the shale, distilling the solid hydrocarbons therefrom and with such hydrocarbons admixed with the steam, it is introduced into the header 12A which carries it to the super-heater 7C in which the temperature of the mixture is raised substantially above the condensation temperature of the steam under the pressure conditions of the system and from the retort 7B the super-heated mixture of steam and hydrocarbon vapors is introduced into the retort 1B in which the super-heated mixture permeates upwardly through the shale in the retort removing the solid hydrocarbons therefrom.

It has been previously mentioned and it is again emphasized, that this mixture of solid hydrocarbons and super-heated steam has a highly efficient solvent action upon the hydrocarbon materials contained in the shale, this efficiency exceeding that of super-heated steam alone.

The vapor mixtures coming from the retort 1B is recycled through the super-heater 7C from which it is introduced into the retort 1C which may be considered as forming the last of the series of any preferred number of retorts, each of which is preceded by a super-heating unit.

The vapor mixtures accumulating from the retort 1C is introduced into a recovery line 12C which takes the mixed vapors to a dephlegmating and condensing plant (not shown).

It will be understood from the foregoing description that the invention comprises a process and an apparatus for effecting same in which the chemically efficient medium of super-heated steam is made practical from a thermal standpoint through the conservation of the latent heat in the steam, by providing super-heaters in the system at points between individual bodies of shale which are being treated, in a manner such that there is no loss of latent heat in the process through condensation of the steam. In the practical operation of this invention, using say 12 retorts, the cycle of operations is carried out substantially as described.

The vapor mixtures coming from the retort 1B is recycled through the super-heater 7C from which it is introduced into the retort 1C which may be considered as forming the last of the series of any preferred number of retorts, each of which is preceded by a super-heating unit.

The vapor mixtures accumulating from the

retort 1C is introduced into a recovery line 12C which takes the mixed vapors to a dephlegmating and condensing plant (not shown).

It will be understood from the foregoing description that the invention comprises a process and an apparatus for effecting same in which the chemically efficient medium of super-heated steam is made practical from the standpoint of thermal efficiency through the conservation of the latent heat in the steam by providing super-heaters in the system at points between individual bodies of shale which are being treated, in a manner such that there is no loss of latent heat in the process through condensation of the steam.

In the practical operation of this invention, using say 12 retorts, the cycle of operations is carried out substantially as described above. When the process is carried out in connection with coal, which carbonizes at substantially 1050° F., I employ steam under a pressure of 100 lbs. per square inch at a temperature of substantially 1100° F., and when the process is carried out in connection with shale, which carbonizes at a temperature of substantially 800° F., the steam temperature is substantially 850° F., it being preferable to maintain a steam temperature substantially 50° F. above the carbonization temperature of the material which is being treated.

It will be apparent to those familiar with the art, that the temperature employed is dependent upon the character of the material being treated and the quality desired in the products from the treatment. For an economically sound process it is preferable that the temperature be suitable for vapor phase cracking of the distillation vapors. This temperature is dependent upon the quality of the raw material, the quantity of steam employed and the pressure under which the process is carried out. As pointed out above by way of example, the temperature which I prefer to employ in treating coal is in the neighborhood of 1100° F., however, I do not limit myself to this temperature, since higher temperatures might be found necessary for vapor phase cracking of the hydrocarbon vapors coming from other materials or under other conditions.

It will be understood that while I have herein described and illustrated the process as being carried out in one preferred form of apparatus, that the same is not to be limited by the scope of the description above, but includes such changes as may fairly come within the spirit of the appended claims.

I claim as my invention:

1. A process for distilling solid carbonizable material for the recovery of volatiles therefrom, which comprises: charging a series of retorts with said shale; introducing superheated steam into direct contact with said shale in one retort of said series; withdrawing the mixture of steam and volatile products of distillation from said retort, superheating said mixture only to the temperature suitable for vapor phase cracking of hydrocarbon vapors and introducing said superheated mixture into direct contact with the shale in the next retort of said series.

2. A process for distilling solid carbonizable material for the recovery of volatile hydrocarbons therefrom which comprises: treating said material in separate bodies with a mixture of superheated steam and volatile hydrocarbons, said mixture being permeated successively through separate bodies of said material and superheated only to a temperature suitable for vapor phase cracking of hydrocarbon vapors before each permeation to prevent the condensation of the steam.

3. An organization for the utilization of solid carbonizable material embodying: a plurality of retorts adapted to receive charges of solid carbonizable material, said retorts being connected in series to form a substantially closed distillation system; inlet means for delivering a heated gaseous circulating fluid into direct contact with the solid carbonizable material in said retorts; outlet means for receiving volatile hydrocarbons in admixture with said circulating fluid from said retorts; and means for superheating said mixture of circulating fluid and volatile hydrocarbons after the mixture passes through each successive retort of the system, said superheating means comprising a furnace adapted to receive residual carbon from the solid carbonizable material in said retorts, and superheaters in said furnace connected individually in series between the respective retorts.

4. An organization for the utilization of solid carbonizable material embodying: a plurality of retorts adapted to receive charges of solid carbonizable material, said retorts being connected in series to form a substantially closed distillation system; inlet means for delivering a heated gaseous circulating fluid into direct contact with the solid carbonizable material in said retorts; outlet means for receiving volatile hydrocarbons in admixture with said circulating fluid from said retorts; means for superheating said mixture of circulating fluid and volatile hydrocarbons after the mixture passes through each successive retort of the system, said superheating means comprising a furnace adapted to receive residual carbon from the solid carbonizable material in said retorts and superheaters in said furnace; and means for delivering residual carbon from said retorts to said furnace.

In testimony whereof, I have hereunto set my hand at Los Angeles, California, this 18th day of November, 1924.

MILON J. TRUMBLE.