July 4, 1933. J. N. VANDEGRIFT ET AL 1,916,900

METHOD OF LOW TEMPERATURE DISTILLATION

Filed Aug. 16, 1928 2 Sheets-Sheet 1

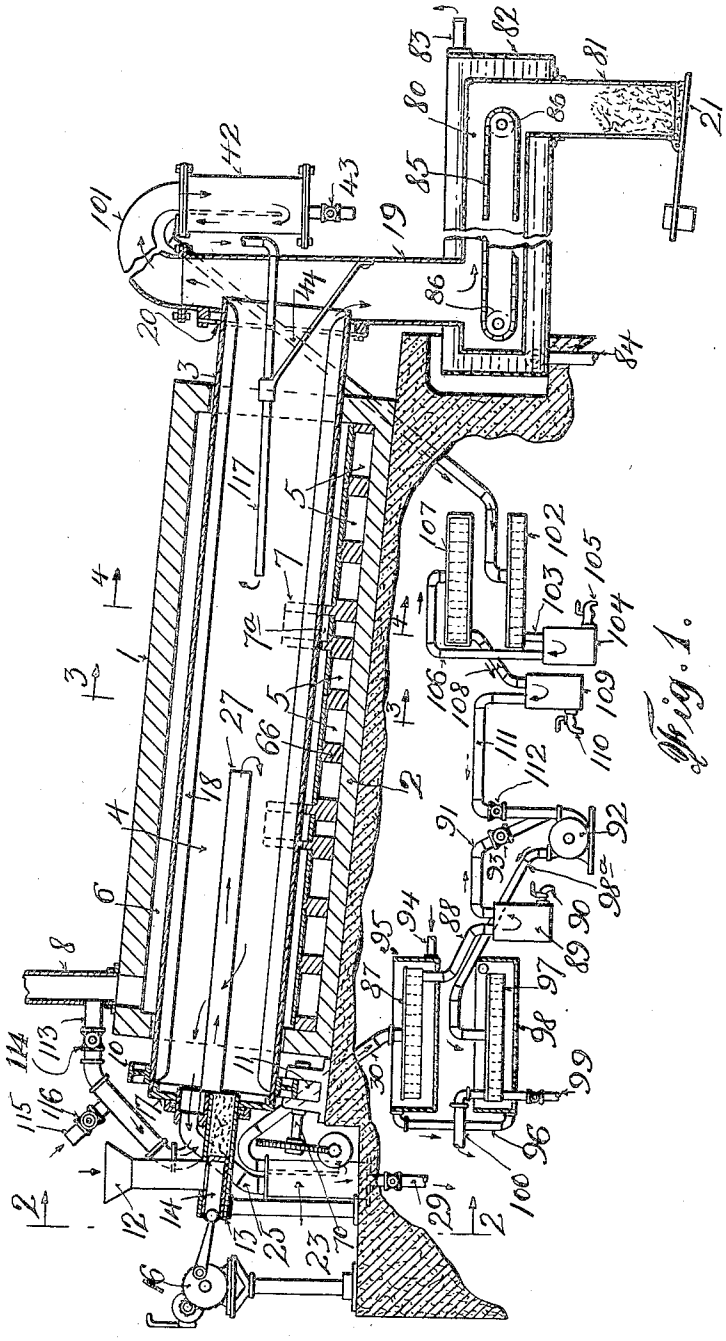


Fig. 1.

Inventors
James N. Vandegrift and
Carl Bostel
By their Attorney
Charles G. Hensley

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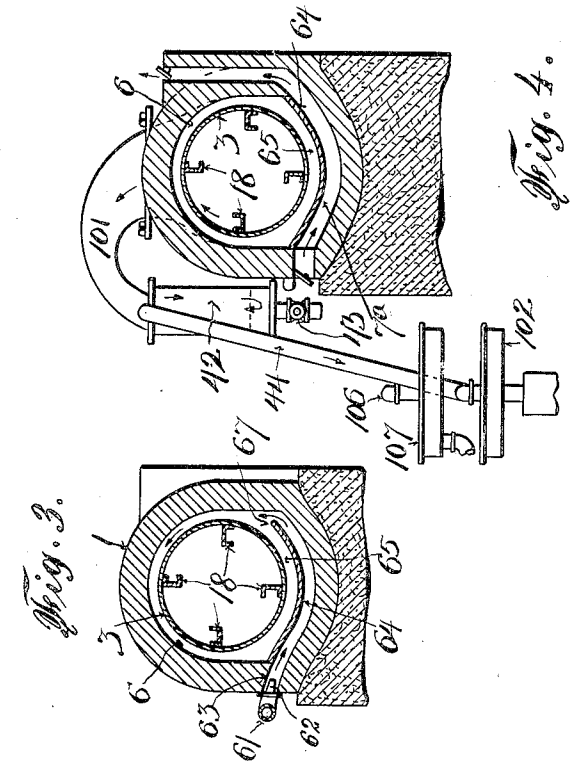


Fig. 4.

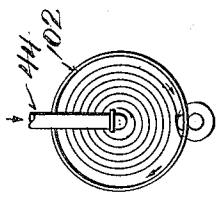


Fig. 5.

Fig. 3.

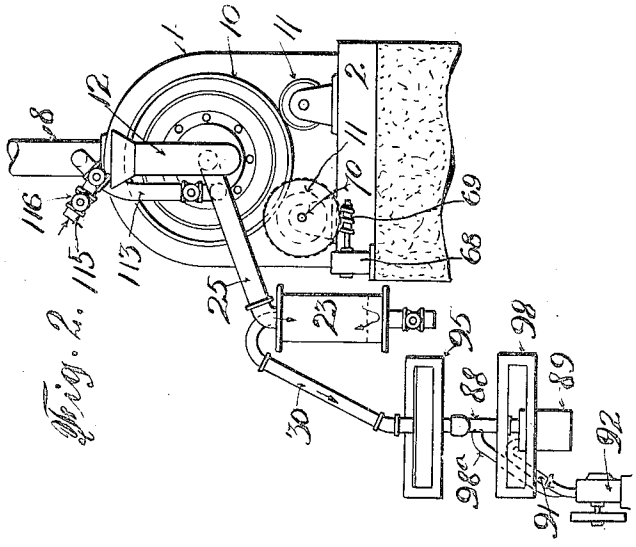


Fig. 2.

INVENTORS
James N. Vandegrift
Earl Postal
BY
Charles G. Hensley
ATTORNEY

Patented July 4, 1933

1,916,900

UNITED STATES PATENT OFFICE

JAMES N. VANDEGRIFT AND CARL POSTEL, OF NEW YORK, N. Y., ASSIGNORS TO INTERNATIONAL BITUMENOIL CORPORATION, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE

METHOD OF LOW TEMPERATURE DISTILLATION

Application filed August 16, 1928. Serial No. 299,928.

The object of our invention is to provide a method for the low temperature distillation of bituminous coals, lignites, oil shales, tar sands, wood waste and other materials from which volatiles may be recovered in the form of gas, oil tars, pyroligneous acids and coked residues, including smokeless fuel in domestic sizes or pulverized, either for briquetting or for use in powder fuel burners.

Our process embodies variations in heat control and in the zoning of the heat in the retort in combination with a novel method of removing the vapors simultaneously by suction from both ends of a single retort chamber, and in some cases introducing at the same time air or inert gas or a mixture of air and inert gas within the low temperature end of the retort, and at the same time withdrawing the air or air and inert gas, as well as moist vapor and light volatiles, from that end of the retort into which the air or air and inert gas is supplied. The higher boiling point vapors and gases are removed by suction from the carbonizing, high temperature zone at the opposite end of the retort. This double take off action makes it possible to treat a coking coal completely in a single operation in one retort chamber, instead of having to perform separate operations in separate retort tubes or chambers, as has heretofore been done.

Heretofore it has been customary to preheat or dehydrate the raw material to prepare it for the second operation and then, afterwards, in a second step or stage, treat the material at high temperatures; and it was difficult in this latter stage or step to handle the material because of the tendency of the material to become sticky or to coke. One advantage of the present method is that there is a saving of nearly one half in the cost of the plant equipment for the complete operation, as well as greater economy in operating expense, cost of fuel and maintenance.

The flexibility of the present method of treating various materials will be apparent from the detailed description hereinafter, and this flexibility results, to a large degree, from the fact that suction is effected at opposite ends of the retort to maintain a neutral point at approximately atmospheric pressure within the retort between the low temperature preheating zone, at the end where the material is introduced, and the higher temperature carbonizing zone near the discharge end of the retort, the suction action serving to conduct the vapors through the separate vapor lines and condensers leading from the opposite ends of the retort to a single vacuum pump or blower from which they may be delivered into additional condensers and gas scrubbers. With the present method a very wide range of treatments may be effected with a minimum ef equipment, and at a minimum cost.

It may be pointed out that continuous low temperature distillation of coking coal may be effected without the material clogging in the retort, the moisture content of the raw material being removed near the feed end of the retort, together with some of the gases and air, if the latter has been introduced for the purpose of hardening the surfaces of the small pieces of coal while in a semi-plastic state, and while at a temperature below the combustion point of the solid material, and of the gases evolved in the low temperature zone. The oil vapors and combustible gases released in the higher temperature zone, from which air is excluded, are removed from the lower end of the inclined retort which is the end where the carbonized or solid material is discharged. The lumps or particles of solid material are discharged after treatment without having been subjected to combustion nor are the vapors, gases or coke material subjected to combustion, notwithstanding the fact that air may have been introduced at the low temperature end of the retort chamber. Actual tests have proven that double suction take off from opposite ends of the retort may be effected, so that a neutral point may be maintained between the air swept or preheating zone, which zones may be heated to a temperature of about 550° F. and a higher temperature carbonizing zone which may be maintained, say at a temperature between 900° F. and 1100° F. The volatiles withdrawn from these two

zones are as separate and distinct as if the raw material were subjected to separate treatments in separate retorts.

In the treatment of lignites or other coals having high moisture content, the steam evolved from the product, if allowed to pass through the high temperature carbonizing zone, would necessitate the consumption of from two to two and a half times as much fuel for the operation as is required under the present process. Lignite, being a non-coking fuel, no air treatment is required under the present process, but a large volume of steam is removed at the feed end of the retort, which steam is condensed into water before it reaches the vacuum pump. This pump also connects with the discharge end of the retort from which the oil vapors and fixed gases are withdrawn, through a vapor line which is separate from the vapor line from which the vapors are withdrawn from the feed end of the retort.

In the treatment of shales and some non-coking coals of low moisture content, the vapor line may be closed at the low temperature or feed end of the retort and vapors and fixed gases may be taken off only at the lower or discharge end of the retort.

To insure maximum recovery of saturated hydrocarbon oils from dry shales, it is advantageous to introduce steam or moisture in the carbonizing or high temperature zone of the retort to prevent decomposition into fixed gases of the oil vapors released in this high temperature zone. This is also desirable in treating some low moisture coking coals in which case there are removed from the feed end of the retort all of the moisture and such air as may be introduced to oxidize the plastic globules of coal to prevent clogging or sticking of the same in the preheating zone, and thereafter moisture or steam is introduced into the carbonizing zone near the discharge end of the retort to prevent cracking the oil vapors into fixed gases.

In a continuous process, therefore, the coal is dehydrated for one purpose at the feed end and the vapors are hydrated for another purpose at the opposite end of the retort.

By combining successfully these several operations in a single retort for the treatment of coking coals, and also non-coking coals, lignites, semi-bituminous and cannel-coals, peat, oil shale and other materials, there is provided a process which makes it possible to convert various classes of carbonaceous materials into smokeless fuels adapted for domestic as well as industrial uses. By the use of the present method it is possible to convert lumps of semi-bituminous and cannel-coals and some bituminous coals into lumps of anthracite which are firm in structure, without having to be briquetted. The carbonized lumps have the same low volatile smokeless fuel characteristics and heat value as anthracite although produced from bituminous or semi-bituminous raw material.

There is illustrated herein an apparatus adapted to be employed in carrying out the method and in the drawings forming part of this application,

Figure 1 is a longitudinal, sectional view through a retort embodying the present invention,

Figure 2 is a sectional view taken on the line 2—2 of Figure 1,

Figure 3 is a sectional view taken on the line 3—3 of Figure 1,

Figure 4 is a sectional view taken on the line 4—4 of Figure 1, and

Figure 5 is a plan view of one of the condenser units with the cover removed.

One apparatus for carrying out our method is illustrated herein but it may be pointed out that the apparatus shown in our copending case, Serial No. 253,479 filed February 10, 1928 may likewise be used with the present method.

There is shown herein an enclosure for the revolving retort cylinder, which is preferably made of fire brick or other refractory material and it consists of a top wall 1 which surrounds the greater portion of the retort cylinder and it also includes a bottom wall 2 lying below the cylinder. At 3 there is shown the revolving retort cylinder and it may consist of a long tube of metal forming a chamber 4 of considerable length through which the carbonaceous material to be treated travels by gravity, the cylinder 3 being disposed in an inclined position for this purpose. The cylinder 3 is shown disposed concentrically with relation to the enclosure walls to provide a fuel space 5 below the cylinder, and a heating space 6 above it, the space being divided in the direction of the length of the device by annularly shaped walls 7 which extend partially around the cylinder 3. The space above these walls is, therefore, continuous, for the length of the retort to allow the products of combustion from all of the combustion chambers to pass in a common stream to the outlet flue or chimney 8 which latter is preferably disposed adjacent the inlet or feed end of the retort. Along the side of the outer enclosure there is provided a fuel supply pipe 61 from which extend laterally the nozzles 62 which project into openings 63 in the side walls of the outer structure. These burners are for the purpose of applying heat to the rotating cylinder and the product contained therein.

The number or capacity of these burners will be so proportioned that greater temperature will be maintained adjacent the right hand end of the retort cylinder in Figure 1 and progressively lower temperatures will be maintained at different zones along the

cylinder toward the feed end at the left in Figure 1.

There are provided a number of stationary plates 64 which are made of a refractory material, such as carborundum, and these plates are arranged around the bottom wall 2 and preferably they are of curved shape so that an annular space 65 is formed between these plates and the bottom of the cylinder 3. These plates are mounted on supports 66 resting on the bottom wall 2 to form a continuous wall lengthwise of the apparatus and the spaces 5 below these plates and between the supports 66 form transverse combustion chambers into which the flames from the burners 62 are projected. The space between the plates 64 and the bottom of the retort cylinder is divided off in the direction of the length of the apparatus by the walls 7, as previously indicated, so that the heat from the burners in the different compartments may be so applied to the retort cylinter as to maintain different heat zones lengthwise thereof. The plates are shown as in contact with the side wall of the enclosure adjacent the burners 62 but with a space 67 adjacent the opposite side which permits the products of combustion to pass from the combustion chambers 5 into the space 65 surrounding the cylinder 3.

The cylinder 3 is revolvably mounted, preferably as follows:

At each end of the cylinder there are attached annular members 10 of I cross section and these rest upon and revolve in relation to the revolvably supporting trunnions 11 disposed under the members 10 at opposite sides of the vertical center line of the cylinder. The motor 68 operates through a worm and worm gear 69 to revolve the shaft 70 which carries one of the trunnions 11 and this motion is imparted to one of the members 10 resting on the trunnions so that the cylinder is gradually revolved to bring various portions into close relation with the burners 62 and to agitate the carbonaceous material within the cylinder and to cause the same to progress lengthwise thereof. Suitable lifters 18 are attached to the interior of the cylinder to serve to lift the carbonaceous material and drop it in order to agitate it.

The higher or left hand end of the cylinder 3 in Figure 1 is the inlet end where the material to be treated is first introduced. There is a hopper 12 into which the carbonaceous material is introduced and the material falls from this hopper into an inclined tubular portion 13 which extends through the front head 17 of the inclined retort cylinder and discharges the material within the cylinder. There is a piston 14 which reciprocates in the tubular member 13 past the bottom end of the hopper 12 and it is operated by a motor 16 through a crank motion so that as the piston moves back and forth across the bottom of the hopper it forces the material through the tube 13 into the cylinder 3. There will always be sufficient material lying in the tubular member 13 to prevent the escape of vapors or intake of air through this tube as the piston stroke of the plunger stops a considerable distance from the discharge end of the tubular member 13.

The material fed to the interior of the revolving cylinder is carried up by the lifters 18 and dropped in order to advance it by gravity lengthwise of the cylinder. As the material progresses through the cylinder, it is heated in the several heat zones by the action of the various burners in the compartments 5 so that while it is traveling from the inlet end of the cylinder to the point of the first dividing wall 7 it is gradually raised in temperature to a point where substantially all of the aqueous vapor is evolved. In passing from the line represented by the first dividing wall 7 to the line represented by the second dividing wall 7 which is the second heat zone of the retort cylinder, the carbonaceous material is raised to a higher temperature, so that other volatiles may be liberated. After passing the line of the second dividing wall 7 the temperature of the material is further increased to a point where all of the remaining volatiles are liberated from it. It will be obvious that the number of heat zones may be lesser or greater than the number shown herein. The carbonaceous material passes out of the lower or right hand end of the cylinder 3 and drops into a discharge tube 19 which is stationarily arranged adjacent the discharge end of the cylinder. This tubular member 19 surrounds the discharge end of the cylinder and is provided with a packing 20 resting against the surface of the cylinder to prevent the escape of the volatiles. At the bottom end of the tube 19 there is a horizontally extending chamber 80 into which the tube 19 opens and at the opposite end of the member 80 there is a downwardly extending discharge tube 81 which has a weighted valve 21 for closing the lower end until the accumulation of the coke at the lower end overbalances the valve and discharges the accumulated material.

The member 80 is arranged within a liquid containing tank 82 which surrounds it and which is supplied with a cooling liquid, such as water, fed to it by a pipe 84 and the overflow discharges through a pipe 83 so that the member 80 is continually cooled to reduce the temperature of the material while still sealed from air before being discharged from the pipe 81 at the valve 21. This avoids the danger of combustion taking place as the discharged material is too cool to ignite when finally exposed to the oxygen of the

air. Within the member 80 there is an endless conveyor 85 for conveying the coke from the tube 19 to the discharge tube 81 this conveyor traveling over rollers 86 arranged at opposite ends and driven by suitable means (not shown) applied to the shaft of one of these rollers.

The following description relates to the means for causing the volatiles to be conducted away by suction in separate streams or currents from opposite ends of the revolving retort cylinder. There is shown the chamber 23 disposed near the receiving end of the cylinder and the pipe 25 which is connected with the stationary head 17 at the inlet end of the cylinder, communicates with the space 4 within the cylinder and it is connected at its opposite end with the chamber 23. The volatiles from the inlet end of the cylinder are adapted to be drawn through the pipe 25 into the chamber 23 and some of these vapors will precipitate as liquids in this chamber and may be drawn off from time to time through the discharge pipe 29. There is an outlet pipe 30 extending from the top of the chamber 23 to a condenser 87, preferably of the construction shown in U. S. Patent No. 1,833,664.

In Figure 1 there is shown one condenser unit 87 corresponding with the type of condenser shown in said patent and the pipe 30 is connected to feed volatiles into this condenser unit. The pipe 88 connected with the outlet end of this condenser is connected with the upper portion of a collecting chamber 89 where the liquid may fall to the bottom and the volatiles may accumulate above the liquid. The liquid, mostly water condensed from the vaporized moisture content of the material, may be withdrawn from this receiving tank from time to time through the valve 90. There is a pipe 91 connected with the upper or vapor portion of the receiving tank 89 and this pipe connects with one inlet of the pump 92, the pipe 91 being provided with a valve 93 to control the suction exerted by this pump upon the vapors in the feed end of the retort cylinder. The condenser unit 87 is shown as water-cooled and for this purpose water may be introduced by the pipe 94 into the shell 95 surrounding and immersing the condenser, and this water, after circulating around this unit, flows off through the pipe 96 and is delivered to a similar tank in which a similar condenser unit is contained. The water, after circulating around this condenser unit, is discharged through a pipe 97. The unit 98 through the pipe 98*a* is connected with the discharge outlet of the pump 92 which delivers any uncondensed vapors in the fixed gases drawn to the pump from both ends of the retort to the inlet portion of the condenser unit 98 which contains means for scrubbing the gases, corresponding with the scrubber unit of said patent.

Liquid is withdrawn from this condenser unit through the pipe 99 and any volatiles in this unit will be drawn off through the pipe 100 and these will, usually, consist of the fixed or non-condensible gases. Heat may be applied from time to time to this unit to vaporize the light volatiles scrubbed therein from the non-condensible gases, the light volatiles, such as gasoline or naphtha being condensed by apparatus not shown.

The volatiles freed from the carbonaceous material in the right hand or carbonizing zone of the retort cylinder in Figure 1 are withdrawn by suction created by the pump 92, through the vapor outlet 101 which is provided with an elbow and descent into the collecting chamber 42 where the heaviest high boiling point fractions, such as tar or paraffin may condense and may be drawn off through the valve 43. There is a baffle plate extending down into the tank 42 but terminating above the liquid level therein and the uncondensed vapors pass under this baffle to the outlet pipe 44 which is connected to deliver volatiles to the receiving connection of the condenser unit 102 which latter may be an air-cooled unit, corresponding with some of the units shown in said patent. The pipe 103 connected with the outlet of the condenser 102 connects with a receiving tank 104 where liquid condensates may be drawn off from time to time by the valve 105. The uncondensed volatiles received in the tank 104 are drawn off from the upper portion by the pipe 106 and the latter delivers these volatiles into the receiving part of another condenser 107. The pipe 108 connects with the discharge outlet of the latter condenser and delivers volatiles and any liquid to the receiving tank 109.

Liquids collected in this latter tank may be drawn off through the valve 110. Any uncondensed volatiles passing into the receiving tank 109 will be drawn off through the pipe 111 which connects with a second inlet of the pump 92, the valve 112 being arranged in this pipe to control the suction exerted in the right hand or maximum heat zone and spent material discharge end of the retort cylinder. The volatiles drawn into the receiving connections of the pump 92 through the pipes 91, and 111, are discharged in a common stream through the single outlet pipe 98*a* into the scrubbing unit 98. These volatiles will be composed principally of any aqueous vapor not condensed in the unit 87 and fixed gases, because the condensible fractions will have been removed in the various stages before the residue vapors reach the pump.

In some cases it is desirable to introduce air or inert gas, or both, into the inlet end of the retort cylinder. I have shown a pipe 113 connected with the stack 8 whereby some of

the inert gas discharging from the flue space 6 may be drawn into this pipe, the flow being regulated by the valve 114. This pipe 113 is connected with the stationary head 17 of the retort and is, therefore, in communication with the interior of the retort cylinder. Preferably, this pipe extends some distance through the stationary head, as shown at 27, so that the inert gas is delivered into the retort cylinder some distance to the right of the left hand end of this cylinder in Figure 1, in order that the inert gas introduced by this pipe will come into contact for some distance with the carbonaceous material before it is drawn off through the pipe 25. There is a connection 115 on the pipe 113, also provided with a valve 116 which connection permits air to be drawn into the pipe 113 to be discharged from the open inner end 27.

By operating the valve 114 or the valve 116, or both of them, either inert gas or air, or a mixture of both may be fed into the retort cylinder by the pipe 27 according to the nature of the material under treatment to prevent, as in a coking coal, the particles from either agglomerating or adhering to the walls of the retort.

In some cases it may be desirable to supply a small percentage of moisture to the product in the hottest zone of the retort cylinder because the moisture has previously been removed from the material near the opposite end of the retort in giving the material non-caking qualities. For this purpose we have shown a steam pipe 117 extending through a wall of the member 19 and having its open end terminating within the retort cylinder some distance from the right hand end in the zone which is effected by the suction action which is removing the volatiles through the outlet 101. By introducing steam through this pipe into the presence of the carbonaceous material in the maximum heat zone of the retort, sufficient moisture may be added, where required to increase the liberation of the volatiles and prevent their cracking or secondary decomposition. This will not be necessary with materials having a large moisture content, in which case the vacuum at either end of the retort will be adjusted so that a portion of the moisture vapors will be taken off through the maximum heat zone making the introduction of steam through the pipe 117 unnecessary. Where such moisture is not required or desirable the steam pipe 117 will simply be closed by a suitable valve.

When the apparatus is in operation the cylinder 3 will be continually revolved and the carbonaceous material fed into the hopper 12 will be pushed by the plunger 14 through the tubular member 13 and through the stationary head 17 to the interior of the cylinder.

This material will be lifted up continually by the lifters 18 as the cylinder revolves, so that it will be broken up and all portions will be subjected to uniform treatment. The material will progress by gravity through the revolving cylinder and the remaining solids will discharge into the member 19 onto the conveyor 85 and while traveling on the latter will be subjected to the cooling action of the water in the member 82 and will be finally discharged through the member 81.

The revolving cylinder is heated by the several burners 62 (it being understood that there are a number of these burners arranged in the several fire chambers 5) which act directly upon the fire plates 64 (which are arranged at the top of each fire chamber 5) and by reason of the dividing walls 7 and the intervening air spaces 7*a* different heat zones will be created and different sections of the revolving cylinder will be heated to different temperatures so that as the carbonaceous material progresses through the cylinder it will be increased in temperature in different stages. Conduction of heat along the retort tube from a higher to lower heat zone may be prevented by automatically opening the dampers (Fig. 4) under theremostatic control (not shown) thus inducing a current of air through the duct 7*a* leaving the flue through the open damper at the top. The air while passing through the duct cools the metal plates over the duct immediately under the revolving retort cylinder, thus checking heat conduction along the cylinder at this point and confining the higher heat zone within the limits desired. The pump 92 creating suction in the pipe 91 will create a suction at the mouth of the discharge tube 25 to withdraw the vapors from the in-feed end of the cylinder 3 from a section extending slightly beyond the end of the inert gas or air pipe 27.

The pump will operate to create suction in the pipe 111 and this will create a suction or partial vacuum in the vapor outlet 101 through the pipe 44 and the various condensing devices interposed betwen it and the pipe 111 and this will cause vapors which are evolved at the right hand or maximum temperature zone of the retort cylinder in Figure 1 to be drawn off through the pipe 44. The vapors withdrawn in the two separate streams will be separately treated and fractionated and only the remaining vapors will pass through the pump and be delivered from the pipe 98*a* into the scrubber 98. The tube 25 being arranged near the feed in end of the retort cylinder will act directly on the vapors initially evolved from the carbonaceous material while in the initial or low temperature zone and these are generally water vapors and carbon oxides. They are removed before the oil and other vapors begin to evolve from the solid material and are removed from the presence of the latter as soon as they begin to evolve, so that the wa-

ter vapors do not have to pass over the whole body of material under treatment. The result is that while the carbonaceous material is passing through the first heat zone of the cylinder substantially all of the aqueous vapors and oxide gases are evolved and this is equal to or superior to the first step or separate retort treatment in previous methods of handling carbonaceous material. By the time the carbonaceous material reaches the second heat zone all or nearly all of the aqueous vapor will have been evolved and will have been withdrawn through the tube 25. At the same time that the above action is taking place the volatile liberated from the carbonaceous material which has reached the maximum heat zone at the right will be withdrawn through the outlet 101 and pipe 44 and will be fractionated downwardly by condensation in the manner hereinabove described.

By manipulating the two valves 93 and 112 the suction action at opposite ends of the cylinder may be modified to suit conditions required by different products under treatment.

For instance, if it is found that other than aqueous vapors and gases are being withdrawn through the pipe 25 the suction action at the right hand end of the cylinder may be increased by manipulating the valve 112 and vice versa, if some of the aqueous vapors, not needed, are passing to the right and into the pipe 44 the suction action at the feed end of the retort cylinder may be increased to shift the neutral point within the cylinder.

In cases where it is desirable or necessary, air may be admitted by opening the valve 116 and this air will be drawn by suction action through the tube 27 into the retort cylinder at a point away from the left hand or feed end thereof which air will come into contact with the carbonaceous material and will be drawn off by the suction action through the tube 25. Where inert gas is desirable, the valve 114 may be opened and the air valve 116 closed and some of the inert furnace gas from the flue 8 will be drawn through the pipe 113 and delivered into the left hand or upper portion of the retort cylinder. In some cases both inert gas and air may be drawn in through the pipe 27. In some cases it is desirable to supply air alone in the manner described but in treating many grades of coking coals we have found inert gas preferably in combination with our method of heat zoning of the retort, in preventing agglomeration and sticking of the material in the retort.

It is the purpose of the device to remove all or nearly all of the aqueous vapors and gases released in the left hand or low temperature zone of the retort cylinder and in some cases it may be desirable to add a small percentage of moisture or steam to the material when it reaches the higher heat zone for the purpose above described, and this may be done by admitting water or steam through the pipe 117. The steam thus admitted will not ordinarily be sufficient to add a material water content to the condensates drawn off through the pipe 44 from the outlet 101.

Having described our invention, what we claim is:

1. A continuous process of distillation of solid carbonaceous materials in an inclined retort which comprises heating the material in a relatively low temperature zone adjacent the feed end of the retort, thereby removing the moisture content therefrom, introducing into said zone a current of air into contact with the material passing therethrough before the material passes to the higher temperature carbonizing zone adjacent the discharge end of the same retort, simultaneously withdrawing adjacent the feed end of the retort by suction the moisture vapors and the air introduced into the feed end of the retort chamber, and separately removing adjacent the discharge end of the retort by suction the higher boiling point volatiles and fixed gases from a higher heat zone of the same retort chamber.

2. A continuous process of distillation of solid carbonaceous materials in an inclined retort which comprises heating the material in a relatively low temperature zone adjacent the feed end of the retort, thereby removing the moisture content therefrom, introducing into said zone a current of air into contact with the material passing therethrough before the material passes to the higher temperature carbonizing zone adjacent the discharge end of the same retort, simultaneously withdrawing, by suction, adjacent the feed end, the moisture vapors and the air introduced into the feed end of the retort chamber and separately removing, by suction adjacent the discharge end of the retort, the higher boiling point volatiles and fixed gases from a higher heat zone of the same retort chamber, the vapors withdrawn from opposite ends of the retort being removed through separate vapor lines and condensers.

3. The method of distilling solid carbonaceous material in an inclined, revolvable retort cylinder which comprises heating different portions of the same cylinder progressively to different degrees, introducing solid carbonaceous material of such character as to require air to decrease its agglomerating properties in the relatively low temperature end of the cylinder and withdrawing it from the high temperature end of the cylinder, introducing air into the relatively low temperature end of the cylinder and withdrawing the air, together with any moisture vapors evolved, by suction from said relatively low temperature end of the cylinder in such

manner as to prevent the air from reaching the relatively high temperature portion of said cylinder.

4. The method of distilling solid carbonaceous material in an inclined, revolvable retort cylinder which comprises heating different portions of the same cylinder progressively to different degrees, introducing solid carbonaceous material of such character as to require air to decrease its agglomerating properties in the relatively low temperature end of the cylinder and withdrawing it from the high temperature end thereof, introducing air into the relatively low temperature end of the cylinder, withdrawing the air together with any moisture vapors evolved, by suction from said relatively low temperature end of the cylinder in such manner as to prevent the air from reaching the relatively high temperature portion of the cylinder, and separately withdrawing, by suction, the hydrocarbon vapors and fixed gases from the relatively high temperature portion of said cylinder.

Signed at the city, county and State of New York, this first day of August, 1928.

JAMES N. VANDEGRIFT.
CARL POSTEL.