Sept. 8, 1959 F. E. POINDEXTER ET AL 2,903,400

APPARATUS FOR LOW TEMPERATURE DISTILLATION OF CARBONACEOUS MATERIALS

Filed Dec. 12, 1955 5 Sheets-Sheet 1

FIG. 1.

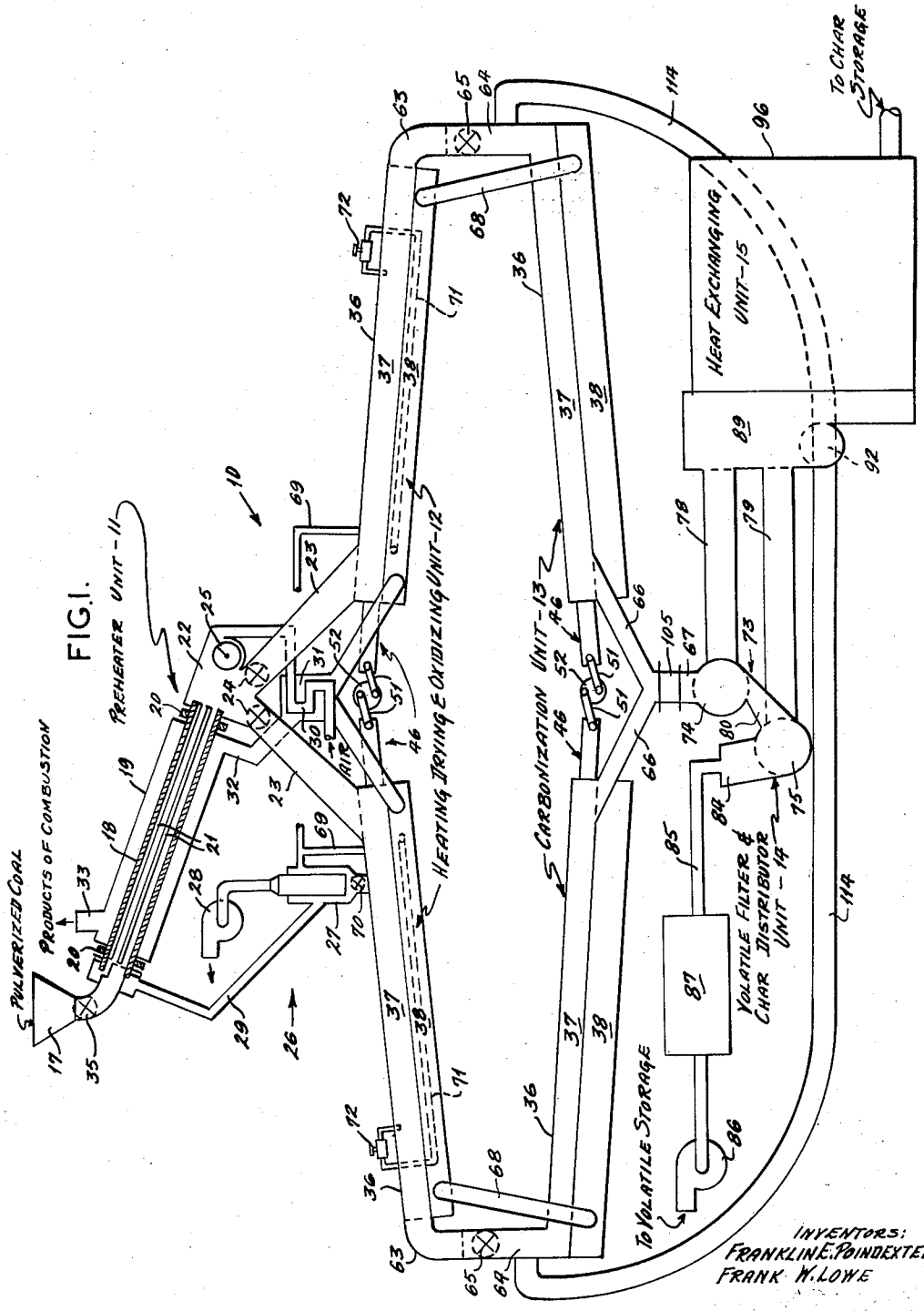

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FIG. 3.

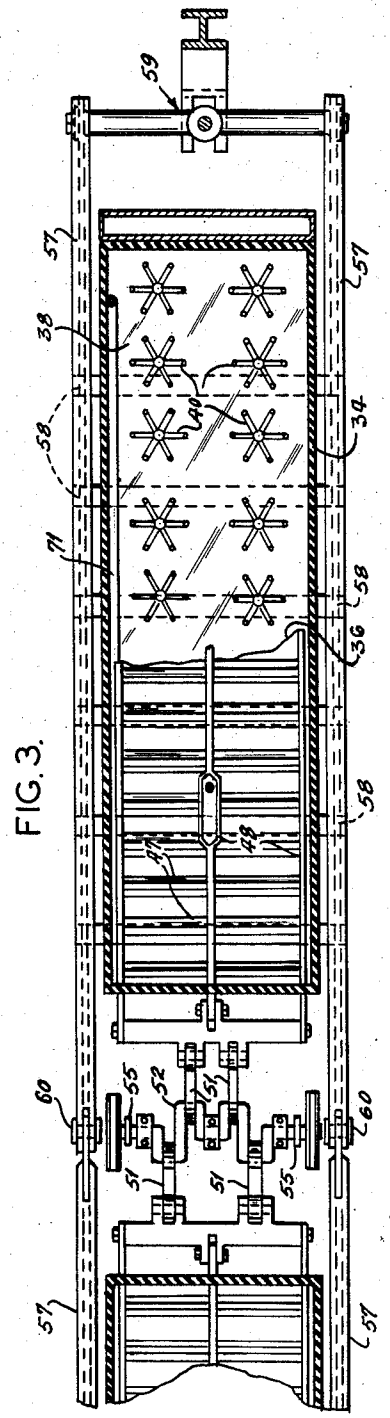

FIG. 2.

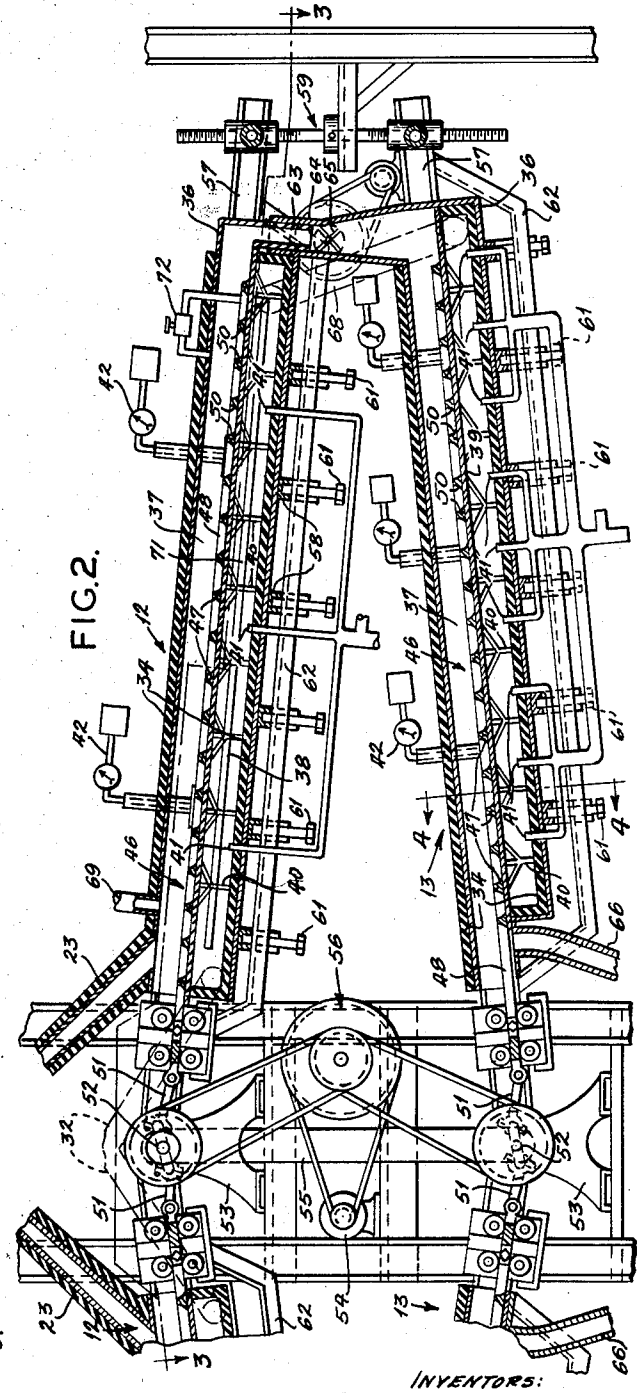

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FIG.4.

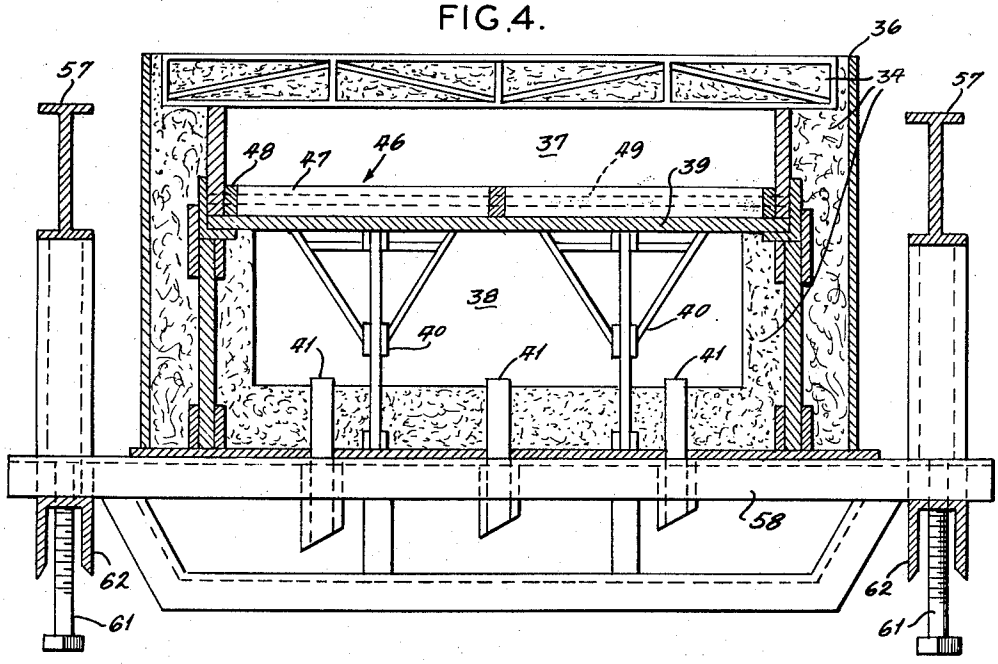

FIG.5.

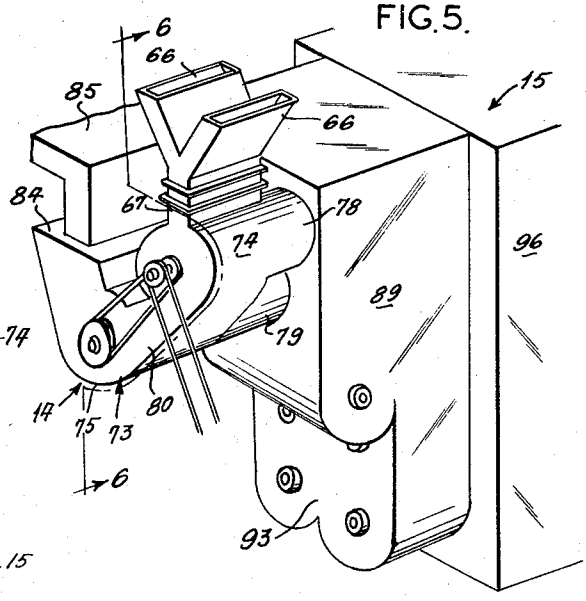

FIG.6.

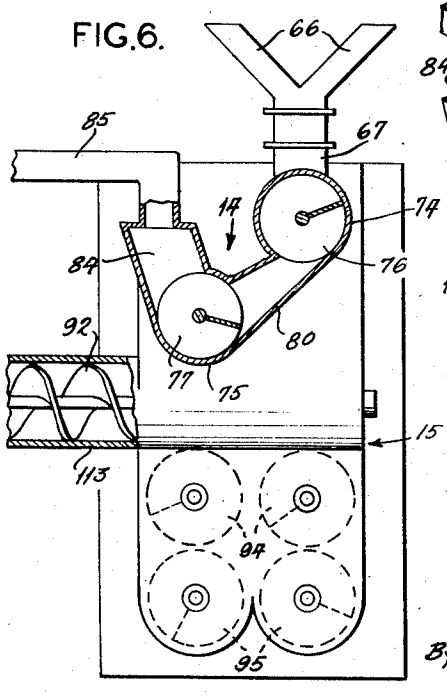

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FIG. 7.

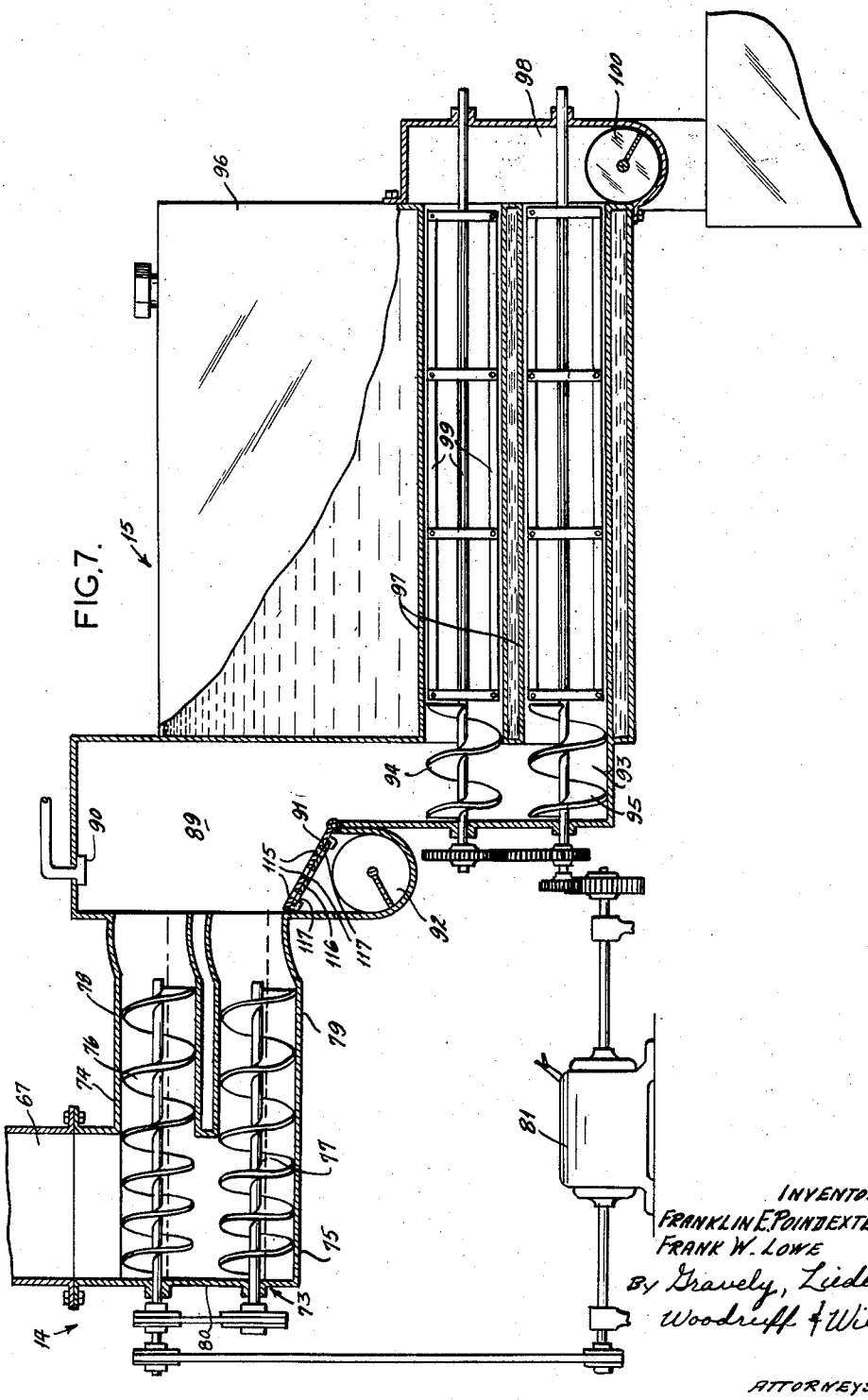

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FIG. 8.

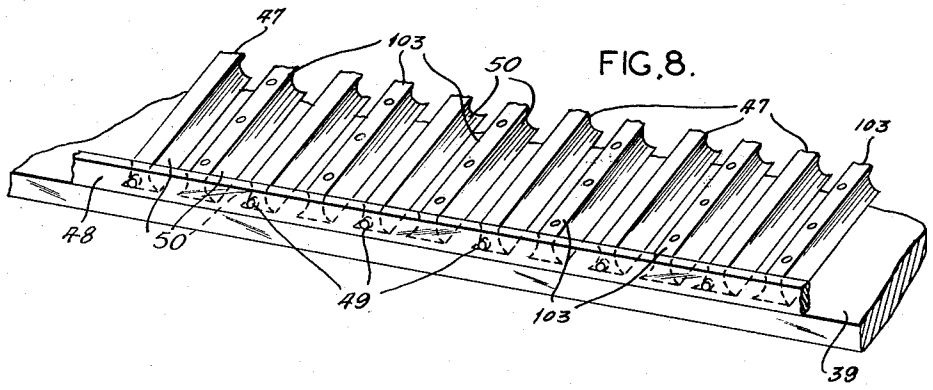
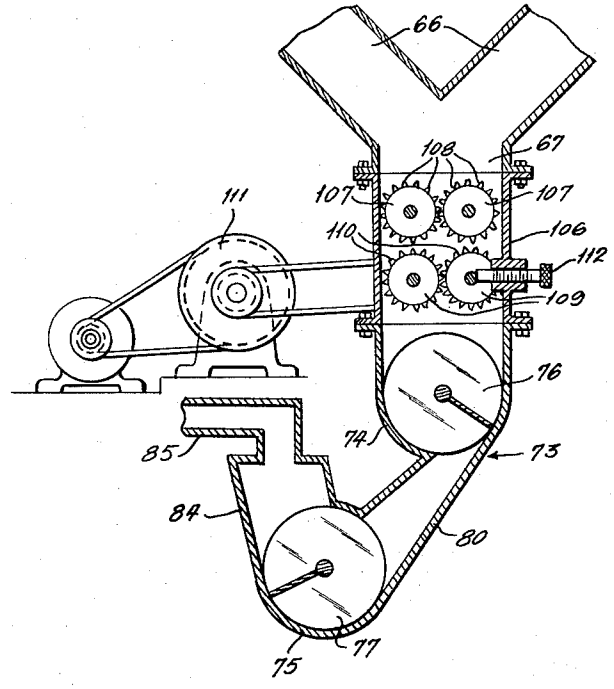


FIG. 9.



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Patented Sept. 8, 1959

2,903,400

APPARATUS FOR LOW TEMPERATURE DISTILLATION OF CARBONACEOUS MATERIALS

Franklin E. Poindexter, Richmond Heights, and Frank W. Lowe, Clayton, Mo.

Application December 12, 1955, Serial No. 552,424

5 Claims. (Cl. 202—109)

This invention relates generally to the distillation of carbonaceous materials and more particularly to an apparatus and method for rapidly and efficiently carbonizing such materials at low temperatures.

It has recently been discovered that when carbonaceous materials such as coal, peat, wood, lignite, and oil shale are maintained at low carbonizing temperatures, the volatiles in the materials will be distilled therefrom without cracking or fractionating into less desirable products. However, the properties of these carbonaceous materials present problems which, heretofore, have made low temperature carbonization impractical. For instance, coal has an extremely low thermal conductivity which creates the problem of how to heat coal rapidly enough at low carbonizing temperatures to reduce the time and expense normally required for carbonization. However, an apparatus for overcoming the low heat conduction properties of carbonaceous material is broadly disclosed in the Poindexter Patent No. 2,615,834, issued October 28, 1952, and entitled Horizontal Retort With Reciprocating Agitator, and this apparatus together with the physical law applied therein is utilized in the present invention.

Still other problems to be obviated include the heating, drying and oxidizing of the material previous to distillation, the effective filtration of the distilled volatiles to eliminate solids (dust) and vapor or gaseous impurities, the improvement in heating efficiency, and the extraction and utilization of the heat in the carbonized material—which in its final condition is called "char." Another serious problem is caused by the tendency of carbonaceous material to melt and agglomerate at low carbonizing temperatures whereby the even distillation of volatiles is prevented and the propagation and distribution of heat through the material is reduced by the heat insulating effect of the agglomerate.

The present apparatus also constitutes an advance over the apparatus disclosed in prior Poindexter United States Patent No. 2,697,068, dated December 14, 1954.

A principal object of the present invention is to provide improved apparatus for carbonizing a variety of materials economically and rapidly at low temperatures, whereby the material is heated and dried previous to distillation, distillation is rapidly and efficiently carried out, heat losses are maintained at a minimum, agglomeration of the material is prevented, effective filtration of the distilled volatiles is provided, and the char heat is recovered and utilized.

Another object of the invention is to provide apparatus which is arranged to process carbonaceous materials where the heat input to the material is utilized in several stages.

Still another object is to provide a method for distilling carbonaceous materials at low temperatures whereby purer products are obtained without an appreciable amount of waste resulting therefrom.

A further object of the present invention is to provide a sturdy apparatus and effective method for distilling carbonaceous materials at low temperatures whereby the

problems and disadvantages of prior art devices and methods therefor are obviated.

These and other objects and advantages will become apparent hereinafter.

Briefly, the present invention comprises an apparatus for and method of low temperature carbonization including means for preheating carbonaceous material, heating and drying means for preparing the carbonaceous material for distillation, means associated with the preheating and heating means for carrying off moisture and gases of oxidation and for returning dust to the heating means, distillation means for removing volatiles from the carbonaceous material, filter means for purifying the volatiles, and heat exchanger means for utilizing the heat in the charred carbonaceous material. The invention also consists in an arrangement of preheating and carbonizing units for improving the application of heat and heat utilization to the material, and in the arrangement of means for actuating and driving the material moving and agitating means for efficient operation of the entire apparatus.

This invention also consists in the parts and in the combinations and arrangements of parts hereinafter described and claimed, and in the process performed thereby.

In the accompanying drawings which form a part of this specification and wherein like numerals refer to like parts wherever they occur:

Fig. 1 is a diagrammatic view of a low temperature carbonization apparatus constructed in accordance with the teachings of the present invention,

Fig. 2 is a fragmentary longitudinal sectional view of Fig. 1, showing the details of typical heater and carbonizer units for the apparatus,

Fig. 3 is a sectional plan view taken substantially along line 3—3 of Fig. 2 and showing the heater unit and the agitator actuator therefor,

Fig. 4 is a transverse sectional view of the carbonizer unit taken substantially along line 4—4 of Fig. 2,

Fig. 5 is a fragmentary perspective view of the apparatus of Fig. 1 showing a filter unit and a heat exchanger unit for the appratus,

Fig. 6 is a transverse sectional view of the filter unit taken substantially along line 6—6 of Fig. 5,

Fig. 7 is a longitudinal sectional view of the filter and heat exchanger units shown in Fig. 5,

Fig. 8 is a fragmentary perspective view of an agitator for the carbonizer unit, and

Fig. 9 is a sectional end view of a char crusher.

In accord with the objects and purposes of the present invention, an apparatus **10** for the low temperature distillation of coal, peat, wood, lignite, oil shale or like carbonaceous materials comprises a preheating unit **11**; heating, drying and oxidizing units **12**, hereinafter referred to as heater units; carbonization units **13**, hereinafter referred to as carbonizer units; a volatile filter and char distributor unit **14**, hereinafter referred to as the filter unit; and a heat exchanging unit **15**; as shown in Fig. 1.

Briefly, the process for distilling carbonaceous material so that volatiles and char are derived therefrom includes feeding the material in pulverized form through a hopper **17** into the preheater unit **11** where the material is warmed and some moisture is removed therefrom. The warmed material is then distributed to the heater units **12** in which the temperature of the material is raised to a point just below the temperature range at which distillation of the volatiles from the material begins to occur. The distillation step is carried out in the carbonizer units **13**, the volatiles and char resulting therefrom passing to the filter unit **14**. In the filter unit **14**, the volatiles are filtered through the char and taken off to condensers and storage, the char being taken off

through the heat exchanger unit 15 to storage. This process will be more fully set out hereinafter in conjunction with the details and functions of the different units of the apparatus 10.

As shown in Fig. 1, the preheater unit 11 includes a tilted feed tube 18 having its upper end in communication with the hopper 17. The feed tube 18 is encased by an insulated jacket 19 through which hot gaseous products of combustion from the heater units 12 pass for warming the carbonaceous material fed into the tube 18 by the hopper 17. The feed tube 18 is journaled in bearings 20 and rotated relative to the jacket 19 by suitable drive means (not shown), the inner periphery of the tube 18 being provided with spaced radially extending vanes 21 so that the material is thoroughly stirred and warmed as it passes through the feed tube 18. The lower end of the feed tube 18 opens into a chamber 22 in which the warmed material is deposited, distributor ducts 23 being provided to carry the material to the heater units 12. Each of the distributor ducts 23 is provided with a feeder 24 in the form of a rotatable gate for simultaneously regulating the flow of material to the heater units 12 and sealing the chamber 22 from the ducts 23, it being apparent that the material above the feeder 24 will effectively prevent the passage of gases or dust therethrough. The chamber 22 also houses an overflow feed screw 25, which is rotatably positioned adjacent to the feeders 24 for carrying off material in excess of the amount that can be handled by the feeders 24 and thereby preventing clogging in the chamber 22.

As will become apparent hereinafter, the warming and drying of the material in the preheater unit requires an outlet for moisture laden air, which is also filled with carbonaceous dust particles because of the stirring of the material in the feed tube 18. The dust amounts to a large percentage of the carbonaceous material and a dust collection system 26 is provided for trapping the dust and returning it to the heater units 12. The dust collection system 26 of the preheater unit 11 includes a centrifugal type dustcatcher 27 in which a vacuum is created by a pump or blower 28 so that the dust and moisture laden air is drawn from the feed tube 18 and chamber 22 through a conduit 29 into the dustcatcher 27. The conduit 29 is in communication with the feed tube 18 at the hopper inlet, which may also be provided with a gate feeder 35 so that the dust is drawn out of the feed tube 18 into the conduit 29. Inasmuch as the feeders 24 effectively seal the heater units 12 from the chamber 22, the chamber is provided with an air inlet passage so that a vacuum will not be created in the chamber 22. This inlet passage 30 extends circuitously through an enclosure 31 which is connected in a conduit 32 between the heater units 12 and the jacket 19 so that the hot products of combustion from the heater units 12 will heat the air passing into the chamber 22, the products of combustion then passing upwardly through the jacket 19 to a discharge opening or flue 33. It is now apparent that the heated air is drawn through the chamber 22 and feed tube 18 counterflow to the material to effectively remove moisture and dust therefrom, the dust and moisture laden air being drawn into the dustcatcher 27 through conduit 29. Furthermore, the material is warmed directly by the heated air and indirectly by the transfer of heat from the products of combustion to the tube 18 as they pass through the jacket 19. Although not shown in all figures of the drawings, the various units are provided with insulation material 34 wherever feasible so that heat losses are maintained at a minimum.

For the purposes of disclosure, the apparatus 10 is provided with similar and opposed pairs of heater and carbonizer units 12 and 13, these individual units being somewhat similar in construction to the apparatus disclosed in Poindexter Patent No. 2,615,834 for Horizontal Retort With Reciprocating Agitator, but constituting an assembly which improves upon that prior patent. Referring to Fig. 2, the heater and carbonizer units 12 and 13 are housed in longitudinal retorts 36 having an upper chamber 37 in which the material is received for heating or distillation and a lower chamber 38 in which heat is applied. The chambers 37 and 38 in each retort 36 are divided and sealed from each other by a plate 39 having relatively good heat conduction properties. This plate 39 is maintained substantially planar by suitable supports 40 secured in the bottom wall of the lower chamber 38. The plate 39 is heated by a plurality of gas burners 41 or the like in the lower or heat chamber 38, which burners 41 are connected to and controlled by thermostatic couples 42 attached to the plate 39 so that predetermined temperatures may be obtained thereon. It is apparent from the drawings that the upper and lower chambers 37 and 38 are enclosed, pilot lights (not shown) being provided for igniting the burners 41 in the heat chamber 38. As pointed out hereinbefore, insulating material 34 is provided throughout the apparatus 10 to prevent heat losses.

An agitator or shaker 46 is reciprocably positioned on the plate 39 in the upper chamber 37 of each of the retorts 36, the agitator 46 comprising a plurality of scraper blades 47 secured in spaced transverse relation to longitudinal frame members 48 by centrally located bars 49. Each of the scraper blades 47 is provided with concave forward and rearward faces 50, the longitudinal reciprocation of which is adapted to contact and lift material from the surface of the plate 39 and mix it with other material. The scraper blades 47 are preferably constructed from material having good heat conduction properties so that they are heated to the plate temperatures. The agitator 46 is reciprocated at a rapid rate so that the material is continuously stirred up and heated to the plate temperatures by conduction and convection.

Referring to Figs. 2 and 3, the agitators 46 for the opposed pairs of heater and carbonizer units 12 and 13 are connected by links 51 to crankshafts 52, which are supported on suitable frame work 53. The crankshafts 52 are rotated by a suitable variable speed motor 54, horizontal vibration being maintained at a minimum in each crankshaft 52 by the counterpoise relationship of the agitators 46 connected thereto. Vertical vibration of the crankshafs 52 is substantially eliminated by vertical connecting bars 55 in which the ends of the crankshafts 52 are journaled. Necessary speed reduction between the motor 54 and the respective crankshafts 52 may be obtained through the belt and pulley means 56. It is apparent that the counterpoise relationship of the opposed heater and carbonizer units 12 and 13 provides a vast improvement in carbonizing apparatus inasmuch as operating conditions in the opposed units are always substantially the same.

The retorts 36 also include longitudinal and transverse supporting frame members 57 and 58 so that a sturdy apparatus for handling the carbonaceous material is provided. As shown in Figs. 2, 3 and 4, each pair of the heater and carbonizer units 12 and 13 are adjustable positioned at equal angles of inclination from a horizontal plane, adjustability being provided by a turn-buckle type screw jack 59. The screw jack 59 is threadedly connected to one end of the longitudinal members 57 for the retorts 36 in the pair of units 12 and 13 and the other end of the longitudinal members 57 is pivotally mounted as at 60 so that rotation of the screw jack 59 causes reverse vertical movement of the units 12 and 13 to adjust their angle of inclination relative to horizontal. The angle of inclination at which the units are set is determined by the time required for the heating and distillation of the particular material being processed, inasmuch as the angle or tilt of the plates 39 in the retorts 36 and the rate of reciprocation of the agitators 46 determines the rate of movement of the material through the retorts 36. The transverse frame members 58 are provided with screws 61 at each of their ends, the screws 61 being threadedly engaged in longitudinal supports 62 carried

by the longitudinal frame members 57 (Figs. 2 and 4). Therefore, the plate 39 in any of the retorts 36 is prevented from warping due to the heat or for other reasons. The bottom of the retort 36 may be vertically adjusted in both a transverse and a longitudinal direction to adjust and maintain the plate 39 planar so that the agitator 46 will slide smoothly thereon.

Referring to Figs. 1 and 2, it will be seen that the distributor ducts 23 from the chamber 22 are connected to the upper ends of the heater units 12 in position to deposit the warmed material from the preheater 11 on the agitator 46 in each of the heater retorts 36. The lower end of the heater units 12 are provided with outlet ducts 63, which are telescopically arranged with inlet ducts 64 to the upper ends of the carbonizer units 13 to permit the relative vertical adjustment between the heater and carbonizer units 12 and 13 as just described. Each of the inlet ducts 64 is provided with a rotatable gate feeder 65 (similar to the feeders 24 in the distributor ducts 23) for regulating the flow of material to the carbonizer units 13 and for sealing the ducts 64 to prevent passage of volatiles or the like to the heater units 12. The lower ends of the carbonizer units 13 are provided with outlet ducts 66, which are connected to a vertical duct 67 to the filter unit 14 (Fig. 5) as will become apparent hereinafter.

Referring specifically to Fig. 2, the heat chamber 38 of each of the carbonizer units 13 is provided with a relatively large number of the burners 41 in order to produce controlled temperatures on the carbonizer plate 39 for distilling the carbonaceous material to produce volatiles and char, the temperatures being within the lower portion of the range of distillation temperatures of the material being distilled. The upper end of the carbonizer heat chambers 38 are connected to the lower end of the heat chambers 38 of the heater units 12 by conduits 68 through which the hot products of combustion from the carbonizer burners 41 are carried into the heater heat chambers 38. The heat from these products of combustion is supplemented by heat from the relatively small number of burners 41 in the heater retorts 36 so that controlled temperatures up to the degree required for carbonizing are produced on the heater plates 39. The hot products of combustion in the heat chamber 38 of the heater units 12 are then carried through the conduits 12 to the enclosure 31 for heating air for directly heating and drying the material in the preheater unit 11 and collecting some of the dust therefrom, then from the enclosure 31 to the jacket 19 in which the material is indirectly preheated as previously described.

The warmed pulverized material from the preheater 11 is fed into the heater units 12 through the distributor ducts 23. In the heater units 12 the warmed material is rapidly heated to temperatures just below the range of distillation temperatures of the material so that moisture and the like is evaporated from the material before it is fed into the carbonizer units 13. This moisture is drawn off to the dustcatcher 27 by the blower 28 through conduits 69 connected between the dustcatcher 27 and the upper chamber of each of the heater units 12. Although some of the dust has previously been removed, additional dust will be stirred up in the heater units 12. As will presently be described in detail, the heater units 12 are provided with an inlet means in the upper chambers 37 so that oxidation of the material, as well as heating and drying, as desired may occur in the heater retorts 36. Therefore, the blower 28 draws the dust and moisture laden gases of oxidation out of the heater units 12 and into the dustcatcher 27 in which the dust is trapped and settled with the dust from the preheater unit 11. The dustcatcher is provided with a feeder controlled duct 70 for returning the settled dust to one of the heater units 12 where it is processed with the pulverized carbonaceous material.

It is known that some carbonaceous materials have a tendency to agglomerate or fuse and become lumpy when subjected to carbonizing temperatures, whereby the agitation and distribution of heat by convection is prevented and distillation of volatiles is substantially stopped. This tendency varies greatly with different materials due, in part, to the low oxygen content in some of them. Accordingly, each of the heater units 12 is provided with an air tube 71 having a valve 72 so that the upper chambers 37 of the heater units 12 may be opened to atmosphere. The tubes 71 are longitudinally positioned in the heat chambers 38 so that the air entering the upper chambers 37 is heated. Thus, the material in the heater units 12 may be oxidized to reduce or prevent agglomeration of the material during distillation in the carbonizer units 13.

The heated, dried and oxidized material is carried from the heater units 12 through ducts 63 and 64 to the feeders 65, which regulates the flow of material into the carbonizer units 13 and seals the ducts 64 against the passage of volatiles to the heater units 12. In the carbonizer units 13, the desired distillation temperatures are obtained in the material so that the volatiles (oils and gases) and char are separated. These products of distillation then pass through the outlet ducts 66 and vertical ducts 67 to the filter unit 14, which will now be described in detail.

Referring to Figs. 1, 5, 6 and 7, it will be seen that the lower end of the vertical duct 67 is connected to a casing 73 having upper and lower tubular portions 74 and 75 in which upper and lower char take-off screws 76 and 77 are rotatably mounted. The screws 76 and 77 extend horizontally from one end of the casing 73 into tubular ducts 78 and 79, which are integrally connected to the tubular portions 74 and 75 of the casing 73 and serve to carry the char from the filter unit 14 to the heat exchanger unit 15. The tubular portions 74 and 75 of the casing 73 are connected by a downwardly enlarging tapered duct portion 80 so that the distillation products will freely pass diagonally downwardly from the upper screw 76 to the lower screw 77 by gravity feed. Accordingly, as the char is discharged from the carbonizer retorts 36 through ducts 66 and 67, it will pass into the filter casing 73 and fill up the lower tubular portion 75 and the duct portion 80. The char take-off screws are driven by a suitable variable speed motor 81, the lower screw 77 being rotated at a slow rate of speed so that it is filled with char at all times. The upper screw 76 is rotated at a relatively fast rate of speed and, under normal carbonizing conditions, it is approximately one-third full. Accordingly, the upper screw 76 is adapted to handle increases in the output of char from the carbonizer units 12. It should be noted that the spacing of the turns (the pitch) of the screws 76 and 77 increases toward the tubular ducts 78 and 79 so that the char will be carried evenly from the casing 73.

An upwardly-extending chamber 84 is connected to the lower tubular portion 75 of the casing 73 through which the volatiles are drawn into a conduit 85 by a fan 86. The volatiles are delivered through suitable condensers 87 to a storage chamber (not shown), the condensers 87 being preferably constructed in accordance with the teachings of Poindexter Patent No. 2,697,068 for Rotatable Carbonizing Machine. The fan 86 creates a vacuum through the filter unit 14 and in the carbonizer units 13 so that the volatiles are drawn down with the char and not permitted to accumulate on the sides and top of the upper chambers 37 in the carbonizer units 13. The volatiles are drawn through the continually changing layer of char in the filter unit 14 by the fan 86 so that dust and other matter is trapped in the char and the volatiles are in substantially pure form.

Referring particularly to Fig. 7, the char is carried by the screws 76 and 77 from the casing 73 into the tubular ducts 78 and 79 and pushed into a vertical steam chamber 89 below a water spray 90 therein. The steam generated by the contact of water from the spray 90 on the

hot char purges the char of any remaining or adsorbed volatiles, which are drawn back through the filter unit **14** to volatile storage by the fan **86**. The lower portion of the steam chamber **89** is divided by a swingable baffle wall **91** for directing the hot char to the heat exchanger unit **15** and to a transverse char screw **92** to be discussed hereinafter. As shown in Fig. **7**, when the baffle wall **91** is in heat exchanger feed position, the char is directed to a take-off chamber **93** in which upper and lower screws **94** and **95** are rotatably positioned for pushing the hot char through the heat exchanger unit **15**.

The heat exchanger unit **15** includes a boiler tank **96** in which spaced upper and lower tubular char ducts **97** are positioned, each of the ducts **97** being in communication with the take-off chamber **93** and extending through the tank **96** to a char storage inlet chamber **98**. The shafts of the screws **94** and **95** extend through the char ducts **97** and have longitudinal paddle members **99** mounted thereon in scraping contact with the walls of the ducts **97**. These paddle members **99** may have a slight helix twist so that the char carried into the ducts **97** from the the take-off chamber **93** by the screws **94** and **95** will be agitated or stirred and moved freely along in the ducts **97**. If desired the ducts **97** may be positioned at a downwardly inclined angle to horizontal to assist the screws and paddle members in moving the char through the heat exchanger unit **15**.

The paddles **99** and the screws **94** and **95** are driven by the variable speed motor **81** in a similar manner as the screws **76** and **77** in the filter unit **14** so that the lower screws **95** turn more slowly than the upper screws **94**. Furthermore, the lower screws **95** will be filled with char whereas the upper screws **94** will only be approximately one-third full so that variations in the carbonization output of char will be accommodated. The boiler tank **96** is also provided with conventional water and steam pipe connections and valves (not shown) and water circulating means may be provided. It is now apparent that the water in the boiler tank **96** is in contact with the char ducts **97** so that steam is generated as the char is cooled to storage temperatures, the steam being utilized for power purposes or the like. It is also apparent that the heat in the char could be utilized for heating air for oxidation of the material preparatory to distillation or for preheating raw material. The cooled char is deposited in the inlet chamber **98** by the paddle members **99**, the char being carried to storage containers (not shown) by suitable screw means **100** or the like.

As previously described, carbonaceous materials have a tendency to agglomerate at distillation temperatures. Of course, some materials do not agglomerate and become lumpy, the char resulting from the distillation of these materials being light and friable. Char having these characteristics is easily handled and forms the most perfect filter for volatiles. However, some materials tend to agglomerate even though oxidized in the heater units **12**, as described hereinbefore. When material agglomerates in the carbonizer units **13**, it may form large lumps or even a solid sheet of fused material which cannot be discharged into the outlet ducts **66**. Accordingly, alternate scraper blades **47** of the agitators **46** for the carbonizer units **13** may be disconnected from the longitudinal frame members **48** and secured to the plates **39**, as at **103** in Fig. 8. The scraper blades **47** of the agitators **46** are then reciprocated during carbonization in the usual manner, the relative movement between these fixed and movable blades **103** and **47** exerting compressive forces on the material therebetween whereby the material is broken into smaller lumps or prevented from agglomerating. Therefore, the char, though lumpy, will be discharged into the vertical duct **67** to the filter unit **14**.

As shown in Figs. 1 and 9, the vertical duct **67** may be provided with a removable section **105**, which may be replaced by a char crusher section **106** including rough upper crushing rolls **107** with large teeth **108** and fine lower crushing rolls **109** with relatively small teeth **110**. The rolls **107** and **109** are journaled in the walls of the crusher section **106** and rotated by a variable speed motor **111** through suitable gearing (not shown) so that the lumpy char discharged from the carbonizer units **13** will be pulverized therebetween. Roll adjusting means **112** may also be provided for moving one of the lower rolls **109** toward and away from the other one whereby the coarseness of the char passing to the filter unit **14** may be regulated. The upper rolls **107** may also be provided with similar adjusting means, although none is shown.

It is now apparent that, even though the carbonaceous material has a tendency to agglomerate, distillation of the material is facilitated by the action of the fixed and movable blades **103** and **47** of the agitator **46**, the small lumps of char discharged from the carbonizer units **13** being pulverized by the char crusher **106** so that the char is light and in condition for the effective filtration of the volatiles therethrough.

It has also been discovered that another means of preventing agglomeration of the material during carbonization is to recycle a small percentage of the hot light char through the carbonizer units **12**. Referring again to Figs. 1, 6 and 7, it will be seen that the transverse char screw **92** extends from the steam chamber **89** into a duct **113**, which is in communication with recycle char ducts **114** connected to the inlet ducts **64** of each of the carbonizer units **13**. Therefore, hot char may be carried from the steam chamber **89** to the recycle ducts **114** through which the char may be conducted by forced air or the like back to the carbonizer units **13**. Of course, only a percentage of the char needs to be recycled, and the baffle wall **91** may be provided with suitable openings **115** for permitting a portion of the hot char to pass to the char screw **92** when the baffle wall **91** is in heat exchanger feed position. The openings **115** may be controlled by a plate **116** having openings **117** adapted to register with the openings **115**, the plate **116** being slidable to move the openings **117** out of communication with the openings **115** when no char recycle is desired.

If desired the char screw **92** may also be utilized as a conveyor means for carrying all of the hot char to other means for heat transfer or to a high temperature carbonization apparatus to produce coke. This is accomplished by pivoting the baffle wall **91** to close off communication with the heat exchanger take-off chamber **93** whereby the baffle wall **91** directs all of the hot char to the screw **92**.

It is now apparent that an improved apparatus and method for low temperature distillation of carbonaceous materials has been provided whereby heating and drying of the material is effected previous to distillation, distillation is rapidly and efficiently carried out, heat losses are maintained at a minimum, agglomeration of the material is prevented, effective filtration of distilled volatiles is provided and heat from both the products of combustion and the char is recovered and utilized.

It is to be understood that the foregoing description and the accompanying drawings have been given only by way of illustration and example, and that changes and modifications in the present disclosure, which will be readily apparent to all skilled in the art, are contemplated as within the scope of the present invention, which is limited only by the claims which follow:

We claim:

1. In an apparatus including a carbonizer unit for distilling carbonaceous material to produce char and volatiles; the improvement which comprises a filter unit including a casing having spaced apart upper and lower portions interconnected by a duct portion, said upper portion having an inlet adapted to receive char from the carbonizer unit and through which char passes into said duct and lower portions to provide a body of char therein,

conveying means positioned in said lower portion for removing char therefrom at a predetermined rate to maintain the body of char in said duct and lower portions, second conveying means in said upper portion adapted to prevent fluctuations in char output of the carbonizer from filling said upper portion with char, and means connected to said lower portion for drawing the volatiles through the body of char to filter foreign particles from the volatiles.

2. In an apparatus including a carbonizer unit for distilling carbonaceous material to produce char and volatiles; the improvement which comprises a filter unit including a casing having upper and lower portions, said upper portion having an inlet adapted to receive char from the carbonizer unit and through which char passes into said lower portion by gravity feed to provide a relatively deep body of char therein, conveying means in said lower portion for removing char therefrom at a predetermined rate so that a continually changing body of char is maintained in said lower portion, other conveying means positioned in said upper portion for removing char therefrom so that fluctuations in char output from the carbonizer unit will be accommodated, said lower portion conveying means removing char from said casing at a relatively slow rate of speed compared with said upper portion conveying means, and means connected to said lower portion for drawing volatiles from the carbonizer unit through the changing body of char in said lower portion to purify the volatiles by removing foreign particles therefrom.

3. An apparatus for low temperature distillation of carbonaceous materials; said apparatus comprising preheater means for warming, drying and oxidizing the material; heater conveyor means for heating the material to a temperature below the distillation temperature range of the material, said heater conveyor means being adapted to provide an oxidizing atmosphere for the material; a first feeder between said preheater means and said heater conveyor means for discharging the warmed material from the former to the latter and sealing the former from the latter against the passage of gaseous matter therebetween; carbonizer conveyor means for distilling the material to produce volatiles and char; a second feeder between said heater conveying means and said carbonized conveying means for discharging the heated material from the former to the latter and preventing the passage of volatiles from the latter to the former; filter means adapted to receive char from said carbonizer conveyor means, said filter means including a casing having a conveyor in the bottom thereof for carrying off char at a predetermined rate to provide a changing relatively deep layer of char in said filter casing, and a second conveyor in said casing above the level of the first mentioned conveyor for carrying off char in excess of the relatively deep layer of char at a predetermined rapid rate; and means in communication with said filter casing adjacent to said conveyor and below the layer of char for developing a negative pressure in said carbonizer conveyor means for drawing volatiles through the layer of char in said filter casing whereby the volatiles are cleaned.

4. An apparatus for low temperature distillation of carbonaceous material comprising a tilted rotary cylinder having an external heat chamber and through which pulverized carbonaceous material is tumbled; a heated air inlet in communication with the discharge end of said cylinder; means for drawing heated air through said cylinder counterflow to the movement of carbonaceous material therethrough whereby the material is oxidized and moisture is removed therefrom; a first titlted longitudinal retort having a material agitator and a controlled external heat source maintaining the first retort at temperatures below the range of distillation temperatures of the material; heated air inlet means to said first retort through which heated air is adapted to be drawn for further drying and oxidizing the material; a first material feeder adapted to discharge warmed material from the cylinder to said first retort and to seal against the passage of gases between said cylinder and first retort; a second tilted longitudinal retort having a material agitator and a controlled external heat source maintaining the second retort at temperatures within the distillation temperature range of the material, the material being distilled in said second retort to produce char and volatiles; a second feeder adapted to discharge dried and oxidized material from the first retort to said second retort and to seal against the passage of gases and volatiles between said retorts; a filter casing receiving char from said second retort including a duct having spaced apart upper and lower char conveyors therefrom, said lower conveyor being positioned at the bottom of said duct and removing char from said casing at a predetermined rate to maintain a body of char between said upper and lower conveyors, said upper conveyor being adapted to remove char from said casing at a relatively rapid rate of speed compared with said lower conveyor; pressure means connected to said casing to draw volatiles from said second retort through the body of char in said casing whereby solid particles are filtered from the volatiles; and a steam chamber to which said upper and lower conveyors deliver the char from said casing.

5. In an apparatus for low temperature distillation of carbonaceous material including heating means for drying and oxidizing raw pulverized material and heating it to a temperature below the distillation temperature range theerof, carbonizing means for heating the material to a temperature with the distillation temperature range to produce volatiles and char, and filter means for receiving both char and volatiles from the carbonizing means and filtering the latter through the former; the improvement which comprises feeder and sealing means between the heating and carbonizing means to discharge material from the former to the latter and to seal against the passage of volatiles counterflow to the material whereby the removal of substantially all volatiles in undiluted form to the filter means is assured.

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