

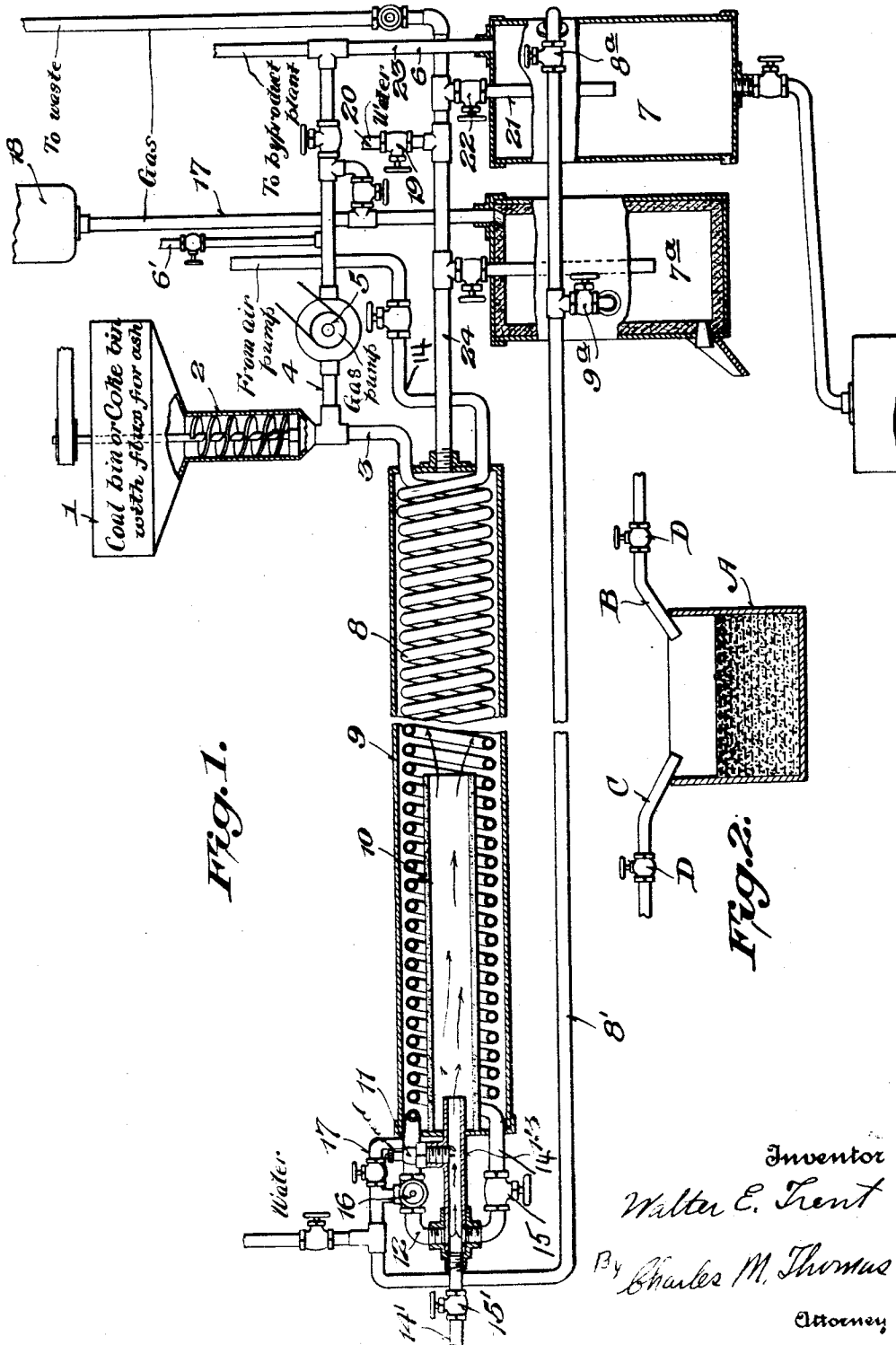
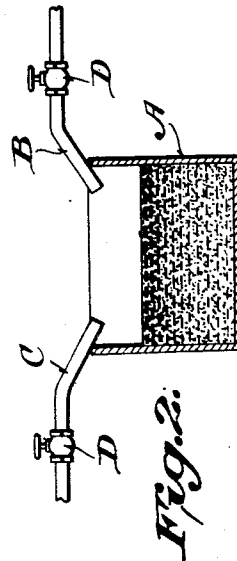
Jan. 19 , 1926.

1,570,103

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METHOD OF TREATING COAL PRODUCTS

Original Filed Sept. 23. 1919



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UNITED STATES PATENT OFFICE.

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METHOD OF TREATING COAL PRODUCTS.

Application filed September 23, 1919, Serial No. 325,632. Renewed July 18, 1925.

To all whom it may concern:

Be it known that WALTER E. TRENT, a citizen of the United States, residing at New York city, in the county of New York and State of New York, has invented certain new and useful Improvements in the Method of Treating Coal Products, of which the following is a specification.

The invention relates to a process of distilling the volatile content from carbonaceous and other materials. The invention more particularly aims to provide a process for distilling the volatile substances from carbonaceous materials, such as oils, oil shales, coal and the like.

Many carbonaceous materials such as coal, besides containing a carbon content, also possess valuable by-products, such as hydrocarbon gases, benzol, tar and the like, which have a material value. When the coal is burned with these products, a great waste is involved, and at the present time less than ten percent of the coal used in this country is treated for the recovery of its by-products, and that which is treated is for primarily obtaining metallurgical coke which must be a hard, firm and lumpy product for the production of which very few coals are suitable. Coals which will not yield coke of the above described nature are not treated for either the by-products or coke, and this class of coal exceeds in amount many times that which is commonly known as coking coal.

Practically unlimited fields of use have been found for carbon particles in a finely divided or impalpable state, and the present invention comprises a process of treating coal to yield carbon particles in this finely divided or impalpable condition, and at the same time to recover the valuable by-products for use. The present method enables all classes of coals to be economically treated to yield all of their products.

It is a further object of the invention to provide a method wherein the entire carbonaceous content of the coal may be gasified when gases are required rather than the carbon particles, and to likewise recover such by-products as benzol, tar, ammonia, and the like.

A still further object of the invention is

to provide a method of liquefying the fixed carbon content of the coal with the contained oils of the coal.

Another object of the present method is to produce carbon products of coal free from deleterious ash-forming material.

In carrying out the invention, the coal is introduced in a very fine state of division to a travelling liquid or gas and is entrained and carried in suspension in the gas while subjected to a heat treatment to substantially instantaneously distill the volatile products of the coal and retain the carbon content in its fine state of division. The entire carbonaceous content of the coal may be gasified, if such is desirable, which gases and other by-products are recovered after treatment for use. It will be understood that by introducing the coal in its impalpable powdered form to the travelling current while subjected to a heat treatment, the carbon particles produced are in a finely divided state.

When the coal contains ash-forming substances, in following this method the finely divided coal particles are thoroughly intermixed with a fluxing agent and when subjected to heat, the fluxing agent will associate with the ash-forming materials producing a slag product of a much greater specific gravity than the fine particles of carbon which latter enables a quick and satisfactory separation of the two. The predominating and most deleterious ash-forming materials of coal consists of iron sulphides, which have a basic reaction, and silica and silicates which have an acid reaction. When subjected to a heat treatment, the iron sulphides undergo a change of state to metallics or oxides and become a natural flux for the silica and silicates. The iron sulphides have a tendency to float when agitated in the presence of oil, but when changed to oxides they do not retain this characteristic, which makes possible the recovery of the carbon particles later made by flotation with the oils. The nature and amount of flux needed in treating the coal depends upon the relative quantities of iron sulphides and silicates.

In a more specific aspect, the invention

comprehends a method of treating coal products which consists in introducing to a travelling fluid or gas current finely pulverized coal that is carried through a zone of heat in a direction opposite to the flame travel whereby the volatile substances of the coal are distilled therefrom, after which they may receive any well known treatments to permit them to be independently used.

To facilitate the separations of the ash-forming materials from the coal, if any such materials exist, the entire mass of coal is previously mixed with a fluxing agent prior to the passing of the mass through the heating zone. The application of heat to the mass causes the fluxing material to agglomerate with the ash-forming substances, building up slag particles of an appreciable size and of a higher specific gravity so that when the entire coal mass has been treated for the recovery of its volatile products, the carbon, and ash-forming materials which later have become associated with the flux, are collected and may then be separated in any approved manner because of the material difference in specific gravities. The fluxing materials thoroughly intermixed with the impalpable mass of the coal may be of different characters inasmuch as different impurities of the coal more readily associate with one fluxing agent than with another. For instance, calcium and iron oxides are preferably used to combine with the silica and silicates of the coal forming fusible and insoluble slags, while another flux, such as soda carbonates, may be used to form with the silica and silicates fusible and soluble slags. In any event, the slags being of a greater specific gravity than the coked carbon particles may be removed therefrom by any well known process. By the term "insoluble slags" it is meant that the slag is insoluble in water, while the term "soluble" manifestly means that the slag is soluble in water. Iron and lime slags are insoluble, but soda silicate slags are readily soluble and therefore can be readily removed from the carbon particles by dissolving in a body of water. However, in order to form soluble slags, it would be necessary to first remove the iron content of the coal by either of the processes disclosed in my co-pending applications, Serial Numbers 309,642 and 324,071, and then introduce the soda carbonates to the products produced in those processes.

It will be understood that the finely reduced coal may be treated by a separation process to remove the ash-forming materials before it is introduced to the combustion chamber for a volatilizing treatment, and in this event, the use of a fluxing agent will become unnecessary.

A highly important feature of the method resides in the treatment of the finely pulverized coal while in suspension in the gas

and free of oxygen so as to prevent combustion, permitting the carbon particles to be subjected to a heat treatment and to be collected after their treatment in a very finely divided state inasmuch as these particles when treated in suspension do not have a tendency to agglomerate. In treating the coal products, the same may be subjected to the presence of heat by the radiation of the heat through conducting walls, or the materials may be directly introduced to the treating flame after passing through the heating coil. When the materials are introduced to the treating flame, sufficient air is conveyed to the combustion chamber to cause combustion to take place therein, but this air is so regulated that there will be practically no carbon dioxide gases formed, but only carbon monoxide gases. Then again, the quantity of air may be so regulated that only the distilled gaseous product of the coal will be burned and the fixed carbon will not undergo a change of state. In many cases, the method aims to convert all of the carbons into gases, which may be carbon monoxide or a mixture of carbon monoxide and water gas, in any event, it being manifest that by accurately controlling the air supply, the resultant products may be of the character desired.

The temperature of the treating flame is sufficiently high to distill the volatile matter from the coal products and to cause the desired reaction of the ash-forming materials and the fluxes when necessary. After treating the coal particles to drive off the volatile material and to bring about the reaction of the flux and ash-forming materials water may be introduced to collect the carbon particles in their finely divided state, the slags, and the condensable volatilized substances, all in the form of an emulsion, the fixed gases being allowed to escape to a receiver for a proper treatment. The entire mass, after treatment, may also be collected by introducing the same to a hot collecting chamber in which the ash-forming materials are fluxed and the divided carbon particles, if they have not been gasified, collect, while the volatilized substances are conveyed to a plant for the recovery of the different by-products. The entire carbonaceous content of the coal may be gasified by raising the temperature in the combustion chamber to the proper degree and admitting sufficient oxygen, and the gases and oils of the coal are then collected and treated in any approved manner.

The oils and the like that are removed from the coal by the treatment are extremely valuable and may be used independently for different uses, but I have found that if these substances are mixed with carbon particles that have been coked, a fuel consisting of the coked carbon particles liquefied with the oils recovered from the coal is a

highly efficient fuel, capable of very broad use and applications owing to the removal of the ash-forming substances. Experiments have demonstrated that by first removing the oil products from the coal and in then thoroughly intermixing the recovered oils with the carbonaceous content of the coal a highly desirable liquefied fuel is produced. The introduction of the removed oils will also result in a separation of the carbon particles from the ash forming substances liberated from the carbonaceous material by a heat treatment in a manner as disclosed in my application Serial No. 324071.

In the accompanying drawings I have shown an apparatus which is capable of supporting the present method, but manifestly many other forms of apparatus may be used in following the method.

In the drawings, Figure 1 represents a view of the apparatus disclosed for carrying out the invention with parts in section. Fig. 2 is a detail.

Referring now more particularly to the drawings wherein like reference characters indicate corresponding parts, the numeral 1 designates a bin or any like receiver that is adapted to contain the finely pulverized coal which may or may not be intermixed with a fluxing agent such as calcium or iron oxides, soda carbonates or the like. The coal, prior to being introduced to the bin, is reduced to an impalpable form of such a degree of fineness as to physically detach the ash-forming substances from the carbonaceous content of the coal. From the bin the mass is conveyed by means of the screw conveyor 2 into a feed pipe 3 which is in communication with a gas or liquid conveying pipe 4 having a gas pump 5 disposed within its line, and in communication with a source of gas or oil supply. The coal or other particles may be placed in the bin 1 in the form of an amalgam of oil and solid material, or in the nature of a free flowing liquid consisting of oil having suspended therein particles of carbonaceous material that may or may not have been treated for the separation of ash. Gas or a liquid oil may be introduced to the pipe 4 through the gas conducting pipe 6, or oil conducting pipe 6', although manifestly the supply of these substances may come from any suitable source. The finely divided coal fed by the conveyor 2 is carried in suspension in the rapidly moving gas or fluid current together with any flux that may have been introduced to the bin with the combustion chamber 9 for a substantially instantaneous treatment of the coal to remove its volatile products and to cause a union between the fluxing agent and the ash-forming substances.

The combustion chamber 9 has disposed therein a tubular refractory element 10 extending through a portion of its length so

as to prevent the intense heat of the products of combustion at the time of their generation from destroying the coils 8. It will also be noted that the combustion takes place at the left end of the chamber, while the coal products and flux are introduced to the combustion chamber at the opposite end so that the products travel in a directly opposite direction to the travel of the treating flame. This permits the finely divided coal products to absorb the heat of the gases of combustion to the greatest possible economic degree, thus preventing excessive loss of heat in the gases of combustion. The present invention has in mind the recovery of the volatile products from the coal while the carbonaceous content is being coked, or the gasifying of the entire carbonaceous content by the necessary regulation of the oxygen introduced. The entire carbonaceous content is gasified when gases are more desirable than finely divided carbon particles and it will be understood that when an operation of this character is being carried out, the oils removed from the coal may be separated and recovered from the gases.

After the products have travelled through the combustion chamber 9, they pass out through the conducting pipe 11, and for the purpose of supplying fuel to the chamber to create the necessary heat, some of the gases that have been removed from the coal product are introduced by the pipe 12 into the feeding pipe 13 which receives a source of heated air introduced through the pipe 14 passing through the combustion chamber and wound with the coil 8 controlled by the valve 15. The air is fed to the chamber from any source preferably a pump and absorbs some of the heat of combustion while passing through the chamber prior to its discharge. When a portion of the gases are permitted to enter the combustion chamber in this manner, the valve 16 in the pipe 12 is slightly opened and the entrance of these gases into the feeder pipe 13 brings about an intimate association of the same with the incoming air producing a combustible mixture that burns immediately. Any other fuel can be used, such as oil, gasoline, or the like from an outside supply through the pipe 14' controlled by the valve 15', if it is not desired to utilize some of the distilled gases of the coal for this purpose. The coal products that do not enter the combustion chamber pass on through the valve controlled pipes 17 and 18 and either into the wet collecting tank 7 or the dry collecting tank 7^a. The collecting tank 7 is termed a "wet collecting" receptacle inasmuch as water is introduced thereto through the water feed pipe 20 controlled by a suitable globe valve to collect the slag and carbon particles and the oils in the form of an emulsion.

As has been pointed out, the finely divided particles of coal thoroughly intermixed with the fluxing material are carried in suspension in the gas or fluid through the pipes 3 and 8 while being subjected to the heat of the products of combustion. The temperature of this heat is variable so as to either gasify the entire carbonaceous content of the coal or to distill the volatile substances from the coal products and at the same time bring about a chemical union of the fluxing agent with the ash-forming substances. When the material has been subjected to its heat treatment by passing through the combustion chamber, the carbonaceous content has been thoroughly coked, but is in its same fine state of division as it was when introduced to the action of the heat, the volatile substances having been removed therefrom. If the material is to be conveyed to the dry collecting receptacle 7^a, this is accomplished by closing the valve 8^a and opening the valve 9^a having a communication with the pipe 8, causing the entire mass to enter the hot receptacle 7^a in which the slags, consisting of the ash-forming substances that have become associated with the fluxing agent and the finely divided particles of carbon are collected, the distilled gases and volatilized substances of the coal rising in the tank and passing out through the conducting pipe 17 to a receptacle 10 where they may undergo treatment in any well known manner to place them in condition for use, either with the carbon particles to form a liquid fuel, or independently for such uses as may be desired.

In many cases it will be desirable to collect the treated mass in the receptacle 7, and should this be preferable, the valve 9^a is closed and the valve 8^a opened, permitting the treated products and gases to enter the receptacle 7. At the same time the valve 19 in the water feed pipe 20 is likewise opened permitting water to flow through the pipe 20 and pipe 21 controlled by the valve 22 directly to the tank 7. The treated mass upon entering this tank comes in contact with the inflowing water which condenses the volatilized oils of the coal and collects the solid particles of carbon and slags in the form of an emulsion in the bottom of the receptacle, the gases distilled from the coal passing out through the discharge pipe 23 to a point for treatment or use. The sludge or emulsion accumulating in the tank resulting from the introduction of the water thereto can be conveyed to any well known apparatus for the separation of the carbon particles and oils from the slags, I having disclosed in my copending application, Serial No. 309642, a convenient flotation apparatus for separating this slag from the treated carbon granules.

Should it be desirable to introduce the

entire mass of pulverized coal and the flux after its passage through the pipes 3 and 8 directly into the flame, it is only necessary to close the valve 17 and open the valve 16, this permitting the gases to carry the coal products through the pipe 12 and feeder pipe 13 to the interior of the combustion chamber.

Sufficient air is, of course, introduced through the pipe 14 to associate with the material carried in the gases to promote combustion within the combustion chamber, the distilled gases from the coal furnishing the required fuel. The amount of air introduced depends upon the results desired to be accomplished, that is, the condition of the carbon after its treatment and the nature of the recovered gases. The air can be regulated so that there will be such a quantity introduced to the chamber as to prevent the formation of carbon dioxide gases, but on the other hand produce carbon monoxide gases which have a decidedly high heat value when further combined with oxygen. The air can also be so regulated that only the distilled gaseous products of the coal will be burned and the fixed carbon will be left in its fixed state. In any event, after the treatment, the resultant gases, slag and finely divided particles of carbon pass out through the discharge pipe 24 and are collected in either the receptacle 7, or 7^a, this depending upon whether or not the treated materials are to be discharged into the dry receptacle 7^a or to be given a wet treatment in the receptacle.

In practicing the invention powdered coal is used, which is preferably finely ground and of a size sufficient to pass through a screen of say 200 meshes per linear inch. This coal is mixed with oil, and the proportions may be, for instance, one-third oil and two-thirds coal by weight depending upon what consistency the amalgamated masses are to be in. Obviously, a lower percentage of oil can be used in accordance with this invention. The material travels in an air current, and this current is so controlled that the material is caused to remain therein until it receives the desired heat treatment. The velocity of the air current will, of course, vary, depending upon the character of coal being treated, the length of the chamber to which the heat is applied and the degree of coking or carbonization that it is desirable to subject the coal particles to. The temperature to which these particles are subjected likewise varies, but a coking temperature of say 450° C. may be maintained in the treatment chamber during the passage of the coal particles and oil therethrough and the time of treatment is always governed so that the volatiles are removed and the fine particles reduced to an entirely carbonized state,

The fluxing agent is furthermore mixed with the coal for the purpose of fluxing the ash content contained in the coal particles, and this fluxing agent may, as before stated, consist of calcium or iron oxides or soda carbonates or the like. The quantity of the agent used will, of course, largely depend upon the character of the coal and the amount of ash that this coal contains. If the coal contains say 15% ash by weight, then I preferably add the fluxing agent in the proportion of about two pounds of this agent to fifty pounds of the coal. This is merely an example, however, and this operation is one that is peculiarly within the control of the operator, as he can definitely ascertain when using the process with little practice if sufficient fluxing material is being employed for the purposes desired. When the treated materials are collected in the dry collecting receptacle 7^a, it will be observed that the oils and gases removed from the coal are conveyed to the tank 18 for a future treatment to be placed in condition for use, while if the treated material is injected into the wet collecting tank 7, the removed oils of the coal are condensed and form a part of the emulsion consisting of the water, oils, slag and carbon particles, the distilled gases having been permitted to escape as has been heretofore described.

The oils, tar, or the like removed from the coal after undergoing the necessary treatment may be introduced to the receptacle A through the feed pipe B, while the finely divided particles of carbon are introduced thereto through the feed pipe C, both pipes being controlled by the valves D. It will therefore be seen that the carbon particles after their separation from the ash forming substances of the coal are again liquefied with their own ingredients so as to form a liquid fuel consisting of finely divided particles of carbon and the original oil of the coal. The carbon particles, however, may be used in a dry state or pressed into briquette form in which event the tar product of the coal may be used as a binder. It is, of course, understood that coals do not contain oil in sufficient quantities to liquefy the entire carbon content, but either water or oil from another source can be added to complete the liquifying, or part of the carbon content can be used dry, or formed into briquettes.

Having thus described the invention, what I claim is:

1. The method of treating coal which consists in introducing the coal in a finely divided state with a fluxing agent to a moving fluid current, in conveying the coal and fluxing agent through a heat zone to remove the volatile by-products of the coal from the carbonaceous content and to cause a union of the ash-forming substances and the flux-

ing agent, and in then collecting the carbon content of the coal free of its volatile by-products.

2. A method of treating coal which consists in introducing coal mixed with a fluxing agent and in a finely divided state to a travelling fluid current to be suspended therein and subjected to a heat treatment to remove the volatile by-products from the carbonaceous content of the coal and to cause a union of the flux and ash-forming substances, and in then separately collecting the treated carbon particles, detached ash-forming impurities and the removed volatile by-products.

3. A method of treating coal to permit a separation of the ash-forming content from the carbonaceous matter, which consists in introducing to a finely divided mass of coal a fluxing agent, in subjecting the mixture to a heat to liberate ash forming substances from the carbonaceous matter and to cause a union of the ash-forming substances and the fluxing agent forming slags detached from the carbon, and in then separating the two products.

4. A method of treating coal to permit a separation of the ash-forming content from the carbonaceous matter, which consists in introducing to a finely divided mass of coal a fluxing agent, in subjecting the mixture to a heat treatment to liberate ash forming impurities from the carbonaceous matter and to cause a union of the ash-forming substances and the fluxing agent forming slags detached from the carbon, of a greater specific gravity than the carbonaceous content, whereby the two products may be readily separated.

5. The process of treating mineral containing a volatile content, which consists in introducing to a fluid current the material in a comminuted state, in subjecting the material while entrained in the current to the presence of heat to distill the volatile constituents therefrom, and condensing the distilled substances, by injecting to the distilled gases a condensing medium, and in collecting the medium and condensed distilled constituents with the unvolatilized residue.

6. A process of treating finely pulverized coal, consisting in introducing the fine coal to a moving fluid current, and in subjecting said coal while travelling through a confined passage in said current to a temperature sufficient to distill the volatile products from the coal, in discharging the volatiles removed, and in collecting the residue as carbonized particles in substantially their original state of subdivision.

7. The method of treating coal to remove volatiles therefrom, consisting in introducing the finely pulverized coal to a moving vehicle where said particles are maintained

in a separated condition while travelling through a closed path and subjected to the presence of heated vaporized volatile constituents contained in said particles, in collecting the vapors thus removed and in collecting the carbonaceous residue as carbonized particles.

8. A process of treating coal to remove volatiles therefrom, which consists in introducing the coal in a fine state of division to a moving fluid current, in carrying the coal in suspension in said current through a closed path, in subjecting the moving coal particles while thus confined to a heat treatment to vaporize volatiles from said coal particles, in collecting the carbonized particles beyond the heating zone in substantially their original state of sub-division, and in also collecting the gases and vapors removed from said coal.

9. A distillation process consisting in subjecting finely pulverized coal to a heat treatment to vaporize the volatiles from said coal, in maintaining the coal particles in a substantially separated condition during their heat treatment to assist in preventing fusing of said particles, and in finally collecting said treated coal in the form of finely divided carbonized particles.

10. The process of gasifying carbonaceous mixtures which comprises intermixing finely pulverized coal with a hydrocarbon oil, in subjecting the mixed materials to an indirect heat treatment sufficient to distill the volatiles from the coal and vaporize the oil without fusing the carbon particles, in collecting the vapors so produced, and in recovering the residue consisting of finely pulverized carbonized particles.

11. A distillation process, comprising thoroughly intermixing a comminuted carbonaceous mineral with a hydrocarbon oil, in forcing the mixture through a heating zone to be subjected to an indirect heat treatment at a temperature sufficient to vaporize volatile constituents of the intermixed materials without fusing the carbon particles, in discharging the vapors for condensation and collection and in recovering the carbonaceous residue.

12. A process of purifying coal, comprising subjecting finely pulverized coal to a heat treatment sufficient to vaporize volatiles contained therein, and in continuing said treatment to cause inherent impurities

to be liberated from the coal particles by explosive force exerted within said particles, and in collecting the carbonized residue and the vaporized products.

13. The process of treating coal, comprising subjecting finely divided coal to an indirect heat treatment while in motion to vaporize volatiles from said coal and to liberate inherent non-carbonaceous impurities by explosive force exerted within said carbonaceous particles, and in collecting the vaporized products and the residue.

14. A process for removing the volatiles from coal, consisting in continuously feeding pulverized coal in oil suspension under pressure through a closed heating zone, in applying heat to said material indirectly while passing through the heating zone to vaporize volatiles contained in the oil and coal, in collecting the carbonized residue after such treatment, in removing generated vapors and in condensing and collecting the same.

15. A process for removing volatiles from coal, consisting in continuously forcing under pressure reduced coal through a conduit disposed within a heating zone, in applying heat to the walls of said conduit to heat said moving coal particles indirectly to a temperature to remove volatiles therefrom, in discharging the volatiles removed from said coal, and in collecting the carbonized residue.

16. A process for treating finely pulverized coal, consisting in continuously advancing the finely pulverized coal while in fluid suspension through a heating zone, in heating the moving coal particles passing through said zone in said fluid suspension to a temperature sufficient to vaporize volatiles contained therein, in removing the vaporized fractions from the heating zone, and in collecting the carbonized residue.

17. A process for removing volatiles from coal, consisting in continuously introducing pulverized coal to a closed conduit to pass therethrough, in applying heat to the walls of said conduit to heat the advancing particles of coal indirectly to a temperature sufficient to remove volatiles therefrom, in collecting the removed volatiles and in recovering the carbonized residue.

In testimony whereof he affixes his signature.

WALTER E. TRENT.