

Dec. 29, 1931.

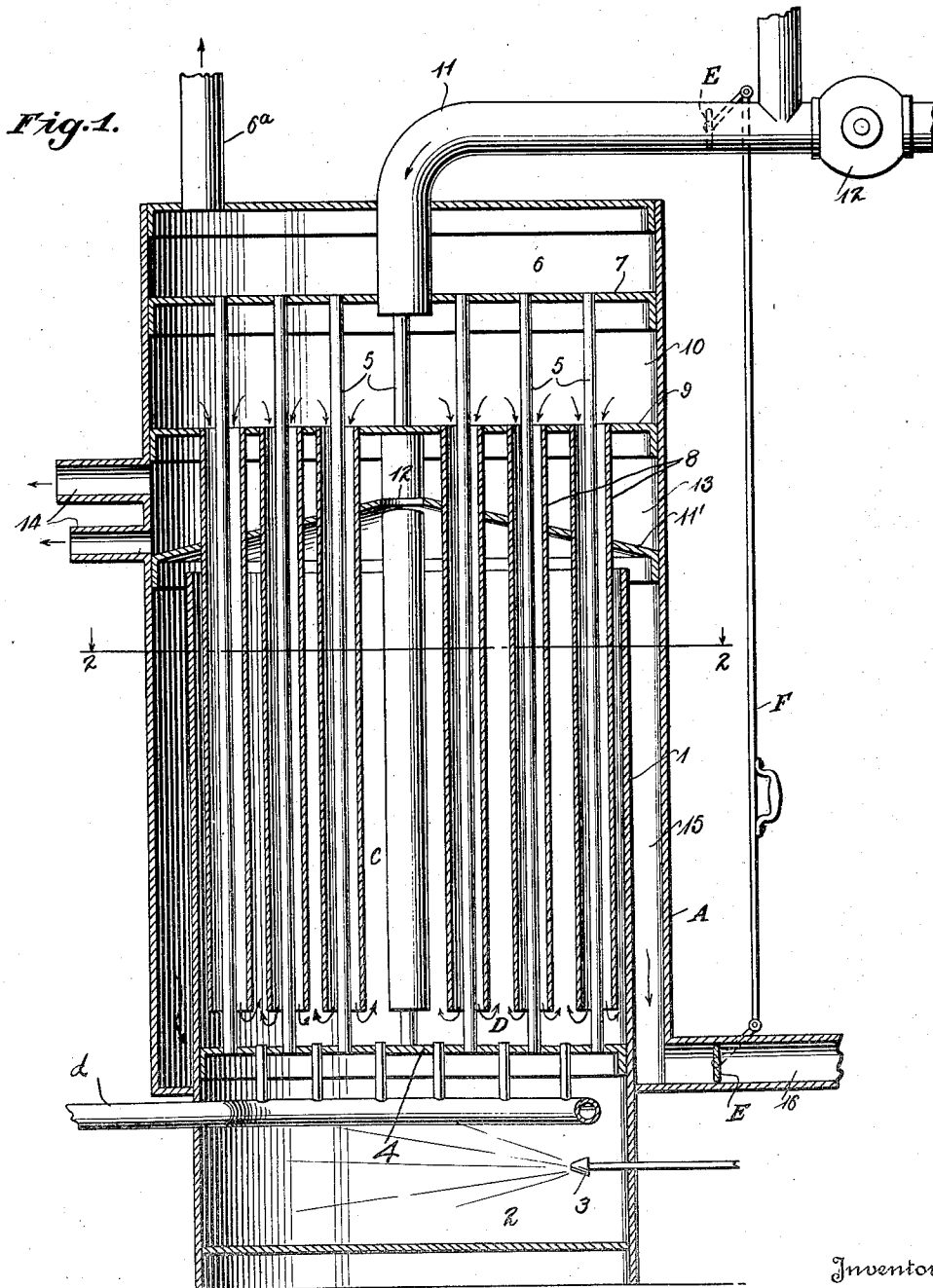
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1,838,883

PROCESS FOR PRODUCING CARBONIZED PARTICLES FROM FINELY PULVERIZED COAL

Filed Sept. 14, 1926

3 Sheets-Sheet 1



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Fig. 2.

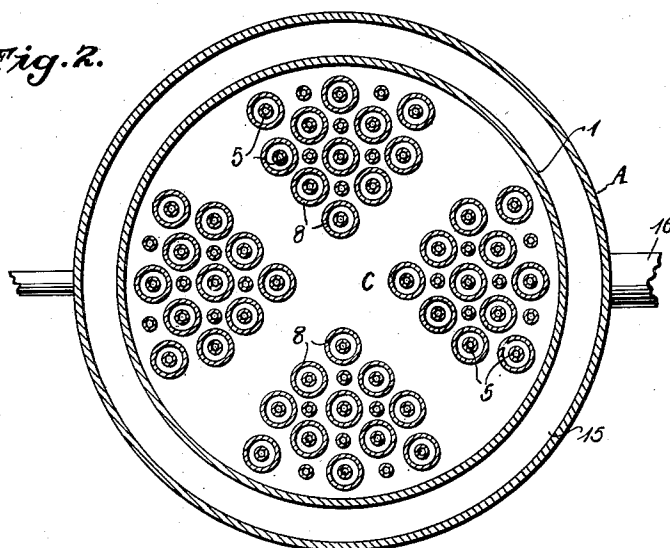
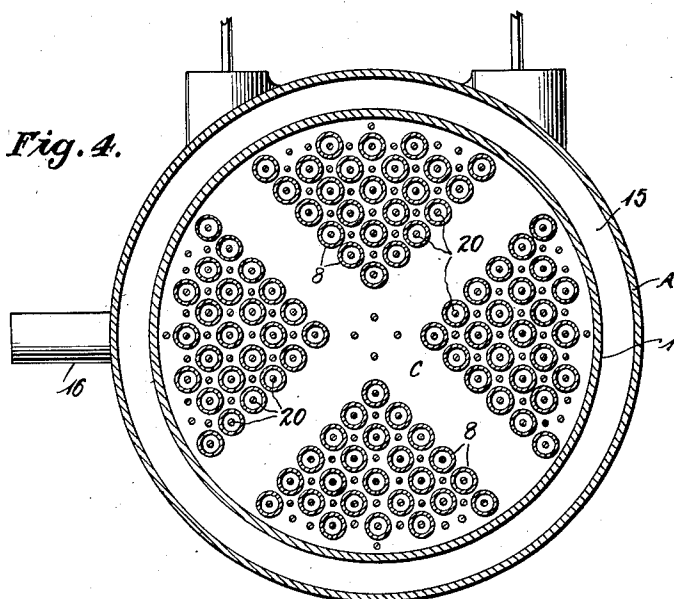


Fig. 4.



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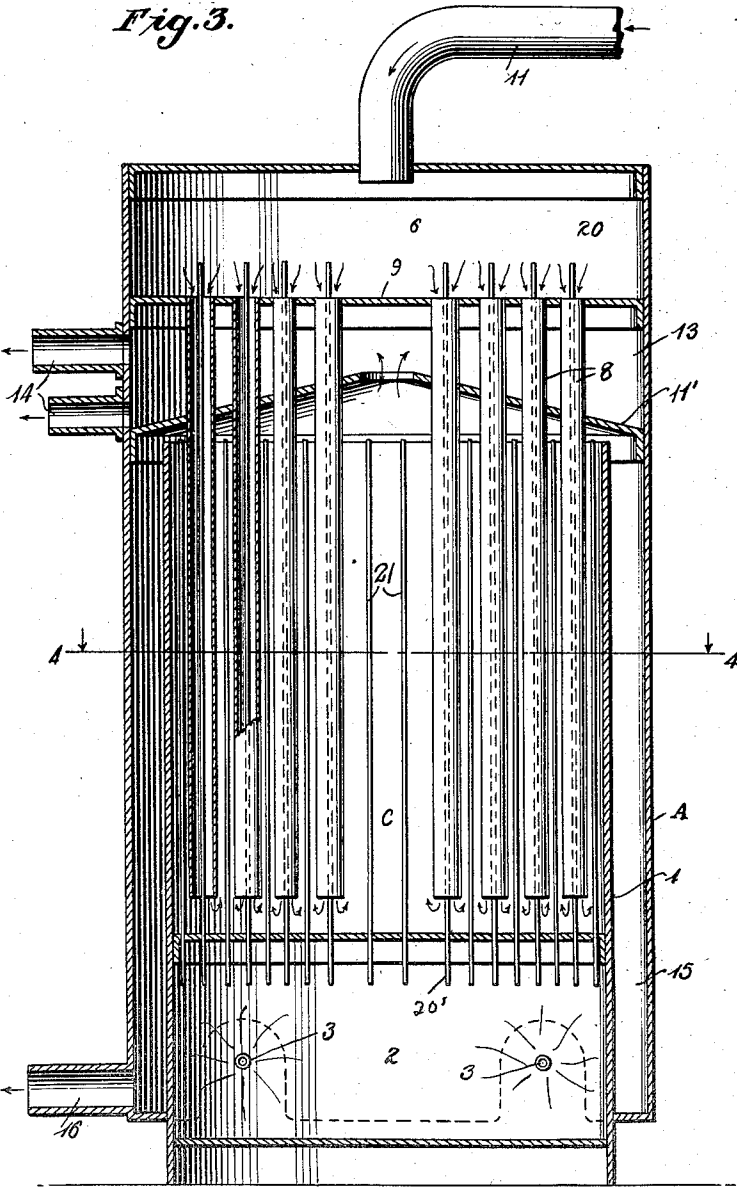
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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

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PROCESS FOR PRODUCING CARBONIZED PARTICLES FROM FINELY PULVERIZED COAL

Application filed September 14, 1926. Serial No. 135,471.

The invention relates to a process for carbonizing finely pulverized coal particles to remove a maximum quantity of the contained volatiles therefrom, and to provide a carbonized residue consisting substantially of finely carbonized particles which have not appreciably agglomerated or fused.

My invention is based on the discovery that when extremely fine coal is heated at a slow rate and the gases evolved are caused to travel in contact with the heated or partially carbonized coal, that if the coal is thoroughly devolatilized so far as possible at a temperature slightly below its normal coking temperature, then after such substantial initial maximum devolatilization the temperature of the carbonized product may be raised beyond its normal coking temperature without resulting in an agglomeration or a fusing of the carbonized particles. In other words, I have discovered that if the time and temperature of the heat treatment of the coal are coordinated, I may manufacture carbonized particles from coal particles made from coking coals even though I attain temperatures beyond the normal coking temperature of such particles. As far as I am aware, this discovery is a new one. Workers in the art have discovered that slowly heating and agitating coking coal particles in open vessels or in the presence of air will destroy the coking properties, but no one has hitherto discovered, so far as I know, that the same result can be accomplished without the presence of air or without agitation, if substantially all the volatile matter is driven out that is susceptible to distillation at temperatures just below the normal fusing point of the coals. It is neither helpful nor necessary to heat the coal slowly while bringing it up to the critical temperature, namely that just below the normal fusing point. It can be brought up to the critical temperature with great rapidity if after this temperature is attained it is held there until the volatile matter removable at the temperature is substantially all expelled, after which the temperature can be raised to and beyond the fusion point without causing the particles to fuse or agglomerate.

This operation can be done without air or agitation, but it requires a close heat control and a time period of considerable length.

It is not the object merely to distill products up to the normal fusing point; it is to be able to carry distillation to the high temperatures for the products that result therefrom, and also to cause partial or complete gasification of the carbon residue. In order to get such results by my preferred process, the coal particles must not be permitted to fuse because the operation is based upon having the solid fuel flow as a moving solid stream from one end of the process to the other. One of the great advantages of keeping the coal in a flowing condition is the ease with which the sensible heat of the finished powder can be transmitted to heat the incoming coal and the further use of the finished product to jacket the retort to prevent heat radiation.

One of the most important features of this invention is that of the complete gasification either by complete or incomplete combustion at temperatures far below any point heretofore possible by any other method. It is a fact that by keeping the particles in a powder condition, by compelling the gases to travel with and around the particles to retard undue rise of temperatures, by admitting air or oxygen at a retarded rate and by compelling the operation to be an exceedingly slow one, the coal can be completely gasified at about 500° C. Gas made under these conditions is rich and carries out all of the primary condensible products. It is especially valuable to gasify coals at temperatures below the slagging or clinkering temperatures of the ash.

It is a further object of my invention to provide an improved process for producing carbonized particles from coking coals in which the coal is ground to an ultra degree of fineness and in fact so fine that it will flow in a solid stream (not in suspension) downwardly through a heating zone by gravity to undergo a carbonization treatment and will then flow upwardly during and after the last stages of carbonization for the purpose of transferring the sensible or contained heat in the upwardly moving carbonized material to

the downwardly flowing streams undergoing treatment.

It is a further object of the invention to provide a process in which the gases and vapors are compelled to travel in the same direction as the stream of coal undergoing carbonization, and which gases and vapors develop a faster rate of travel as the coal increases in temperature so that they pass around the particles undergoing carbonization, wipe the surfaces thereof, slightly agitate these particles, and then impede and prevent an excessive rise in temperature due to exothermic reactions or other reasons.

It is a further object to utilize part of the sensible heat of the vapors and gases to raise the temperature of the incoming coal. This is done by surrounding the incoming coal pipes with the hot gases.

The invention further comprises an improved form of apparatus for carbonizing coals consisting of a retort having a series of vertical columns through which the relatively thin streams of coal slowly descend, these columns being heated during such travel, while the lower ends of the columns lead into an open space in which the coal streams gradually ascend undergoing carbonization during this travel while the gases likewise are compelled to travel in the direction of the material being treated and finally discharge from the upper end of the retort. In this invention in order to conserve the heat of the carbonized particles, as they leave the retort, they enter a circular space or passageway constituting an insulating wall for the retort to prevent the escape of excess heat and to impart their heat to the material in the retort being treated. I provide means to control the rate of flow of the aforesaid solid streams to accomplish the results portrayed above.

Other advantages of the process and apparatus will be apparent from the accompanying description.

In the drawings Figure 1 represents a sectional view through a retort;

Figure 2 is a section on line 2—2 of Figure 1;

Figure 3 is a modified form of the invention; and,

Figure 4 is a section on line 4—4 of Figure 3.

Referring now more particularly to the drawings wherein like reference characters indicate corresponding parts, the letter A designates a retort or carbonizing oven. The bottom of this retort is provided with a fire box 2 having a burner 3 mounted therein. The retort has a lower wall 4. Extending from this wall are a series of heat conducting tubes 5. These tubes lead to the upper chamber 6 of the retort and at their upper ends are supported by the circular wall or

plate 7. The chamber 6 is provided with an outlet 6^a.

Intermediate the walls or plates 4 and 7 I provide a series of circular tubes 8, one tube spanning each vertical heating pipe or flue 5. These tubes at their upper ends are supported by a partition 9, the tubes being open ended with the upper end communicating with the coal feed reservoir 10 to which material is fed through a line 11 by a centrifugal pump 12 or otherwise. The lower end of each tube opens into a distilling zone C which is that zone or chamber between the elements or partitions 4 and 9 of the apparatus. The upper end of the distilling zone C receives a deflecting plate 11' of a substantially conical shape, this plate at its apex having a vapor orifice or outlet 12 leading to the vapor receiving and discharge compartment 13.

From the compartment 13 vapors, gases and oils are discharged through the lines 14. An annular carbonized carbon particle chamber 15 is provided around the retort between the outer wall of the oven A and an inner concentrically-arranged wall 1 terminating short of the deflecting plate 11'. This annular chamber receives carbonized material from the retort through the annular passage defined between the upper edge of the wall 1 and the deflecting plate 11'. This hot material acts as an insulator for the apparatus, while some of the sensible heat of the coke is also imparted to the material in the apparatus undergoing treatment. A discharge line 16 leads from this annular chamber. In carrying out my process I employ coal in a very fine state of subdivision. It must be so fine as to flow when carried to the desired temperature. This usually requires a fineness such that about 50% will pass through 300 mesh, but if the coals have been previously dried to remove water it is not necessary to have more than 25% pass through 300 mesh. The coal may be fed to the system under a pump pressure or otherwise. Preferably a pump is used as indicated by the character 12. On entering the coal feed compartment 10 this very fine coal passes into the vertical tubes 8. Here it very slowly descends through these tubes where it is gradually heated by the heat transmitted through the walls of the heating flues 5, which heat treatment occurs in the presence of entrained air that is naturally contained in the voids between the coal particles. The streams of coal gradually descend at a slow rate through the tubes 8.

As the coal is heated water vapor, CO₂ gas and other products are distilled. These products, together with the entrained air, pass along in the direction of the travel of the coal thoroughly commingled with same but traveling at a faster rate due to their increasing volume. It is, of course, appre-

ciated that as the temperature of the coal streams rise gases and vapors continue to be generated from the coal. The coal continues to descend through the vertical tubes and is discharged at the lower ends of the tubes as indicated by the arrows D into the open interior C or chamber of the retort. The coal then travels vertically upwardly through this chamber C, the gases and heated air being compelled to also travel in this direction in order to reach the vapor and gas outlet 12 in the conical deflector 11' from whence they escape from the apparatus through the lines 14.

The carbonized particles discharge into the annular chamber 15 and pass out through the outlet 16 of this chamber to a suitable point of collection. As the coal passes downwardly through the tubes 8 it is progressively raised in temperature. It reaches its maximum temperature approximately at the time it discharges from the lower ends of these tubes, although the temperature may slightly rise during a portion of the upward travel of the coal particles through the chamber C in which the tubes are located. The application of the heat, however, and the travel of the coal through the tubes 8 is so controlled that the material is very slowly heated, particularly just before the normal fusing point of the coal is reached. I have found that the coal can be rapidly heated to a point just below the fusing point of the coal, but from this time until the normal fusing point of the coal is reached the heat must be very slowly applied to the coal. This is for the reason that it permits a very complete removal of the volatiles from the coal, which volatiles when removed will permit the carbonized particles to be heated above their normal fusing temperature without causing an agglomeration or fusing thereof.

A rapid rise in temperature is checked particularly when the coal is nearing its fusion temperature so as to prevent fusion, by having the gases removed from the coal particles as well as any water vapors that may be generated travel in the same course as but more rapidly than the coal throughout its treatment and at all times in intimate contact with the carbonizing particles. To effect this, it is always preferable to have the coal both descend and ascend in a vertical path. While rising through the upper portion of the chamber C the carbonized material transfers its sensible heat to the descending charges passing through the tubes 8. This insures a very efficient transfer of heat and permits the process to be carried on with a minimum amount of fuel. The water vapors removed, of course, contact with the very hot carbonaceous particles which are sufficiently hot to cause the water gas reaction $\text{H}_2\text{O plus C}=\text{CO plus H}_2$. It will be appreci-

ated that when a temperature is reached somewhat higher than the temperature necessary to form water vapors that CO_2 gas starts to issue from the particles, travels in the same course as the water vapors and acts in the same manner to prevent an excessively rapid rise in temperature, and that when the CO_2 gas reaches and comes in contact with the particles of carbon in the hottest zone it reacts with the carbon according to the reaction $\text{CO}_2 \text{ plus C} = 2\text{CO}$.

In operating the process I have found that the period of time necessary for the streams of coal to flow through the apparatus should be not less than five hours to obtain the most efficient results. I have furthermore found that this coal can be heated to any temperature without causing a substantial agglomeration or coking of the particles provided the heat is imparted to the coal very slowly prior to the attaining of the normal fusing temperature of the coal. Due to the fine condition of the material and the fact that it may be fed into the system under any pressure the coal not only flows downwardly, but will ascend at a uniform and gradual rate. The coal in the vertical tubes also exerts a static head on the ascending body, which, together with the pressure, and the influence of the rising or ascending vapors serves to constantly and uniformly elevate this body. It will also be appreciated that no air need be supplied to the distilling retort other than the air that is entrained or carried with the coal, and that notwithstanding the absence of substantial quantities of air and even though the coal is heated far beyond its normal fusing temperature no substantial agglomeration of the particles occurs.

The process is also operated continuously, and if an apparatus capable of treating 5 tons per hour is employed, this apparatus should have a capacity of at least 25 tons, be approximately 8 feet in diameter, and have a treating chamber of 40 feet depth.

I have shown in Figures 1 and 2 a means for introducing steam to the carbonized material. This steam enters the retort through the steam line *d* having a series of jets extending through the bottom thereof.

In Figures 3 and 4 I have shown a slightly modified form of apparatus for carrying out this process. The operation of this apparatus is the same as the operation of the apparatus just described. The only difference in the two forms of apparatus is that in the construction shown in Figure 3, heat conducting tubes or rods 20 extend vertically through the coal receiving tubes 8 to impart heat to the charges of coal. Furthermore to facilitate the heating of the coal, additional heat conducting rods 21 may be located at various points in the chamber C of the apparatus.

To employ my method for complete gasification, air or oxygen is admitted with the coal to cause the incomplete combustion of the carbon. When the reaction starts the fire is discontinued in the fire box. It is preferable to use coals of a high content of water when making gas, otherwise steam may be admitted at the bottom of the coal tubes. When complete gasification takes place the ash is released as a powder and discharged in the same way as the carbonized particles when they are being made.

The method can be operated under pressure when it is desirable to distill coal under pressure to get products resulting from pressure distillation, the pressure being maintained by controlling the discharge of the material from the apparatus.

As shown in Figure 1 valves E are provided in the inlet line to the retort and the outlet line for the carbonized material. These valves are connected by a link F so that they operate in unison, whereby the outlet is equal to the inlet.

It is apparent that the vapors and volatiles removed from the coal are not extracted therefrom so rapidly as to carry the fine particles away in suspension. The slow removal is due to the fact that the coal is not rapidly heated.

While I have described the invention as being used for the treatment of coals of a coking nature, it is to be understood that any coal can be treated by this process and that furthermore the process is susceptible of use in the ore treating art where it is desirable to heat finely pulverized ores without causing a fusion thereof. The ores may be heated alone or when mixed with coal. Furthermore if a coal is being treated it may be mixed with any hydrocarbon oil if such a treatment is found desirable.

Having thus described my invention, what I claim is:

1. A process for producing carbonized fuel particles from finely pulverized coal, comprising advancing a stream of finely pulverized coal through a zone of heat controlling the rate of travel of the advancing stream of coal, and the application of heat thereto to allow time for substantially all constituents thereof that are volatilizable below the normal fusion temperature of the coal to be removed before it reaches its normal fusion temperature, thereafter raising the temperature of the residual particles above the normal fusion temperature of the coal to complete devolatilization and carbonization without substantially coking the same by slowly increasing the temperature of the coal, regulating the heat imparted thereto, and in continuously discharging such carbonized particles from the retort at a rate substantially equal to the rate of feed to the retort.

2. A process for producing carbonized par-

ticles from finely pulverized coal comprising passing a body of the finely pulverized coal through a zone of heat to effect substantial carbonization, thereafter passing the carbonized material in heat transferring relation with finely pulverized coal being led to said zone to transfer heat thereto, causing the evolved gases to travel in the direction of travel of the coal undergoing carbonization and the carbonized particles produced therein and in admixture therewith, and in discharging for collection the evolved vapors and gases and the carbonized residue.

3. A process for producing carbonized particles from finely pulverized coal comprising continuously passing a body of the finely pulverized coal through a zone of heat to effect substantial carbonization, the coal being led gradually from the coolest portion of said zone to the hottest portion, thereafter leading the carbonized material away from the hottest portion of said zone in heat transferring relation to the finely pulverized coal being led to said zone to transfer heat thereto, and discharging the carbonized particles for collection.

4. A process for treating coal comprising forcing coal, in a state of subdivision sufficiently fine to continuously flow under pressure substantially as a fluid in relatively fine substantially solid streams through a heating zone, applying heat to such streams at such a rate of temperature as will insure removal of substantially all of the constituents volatilizable below the fusion temperature of the coal before that temperature is reached, carrying the heating treatment to a point above the initial fusion temperature of the coal, the gases and vapors evolved during heating being passed in contact with the particles of the coal undergoing heat treatment in the direction of travel thereof from said heating zone, and collecting the residue in the form of finely-divided carbonized particles.

In testimony whereof I affix my signature.

WALTER EDWIN TRENT.