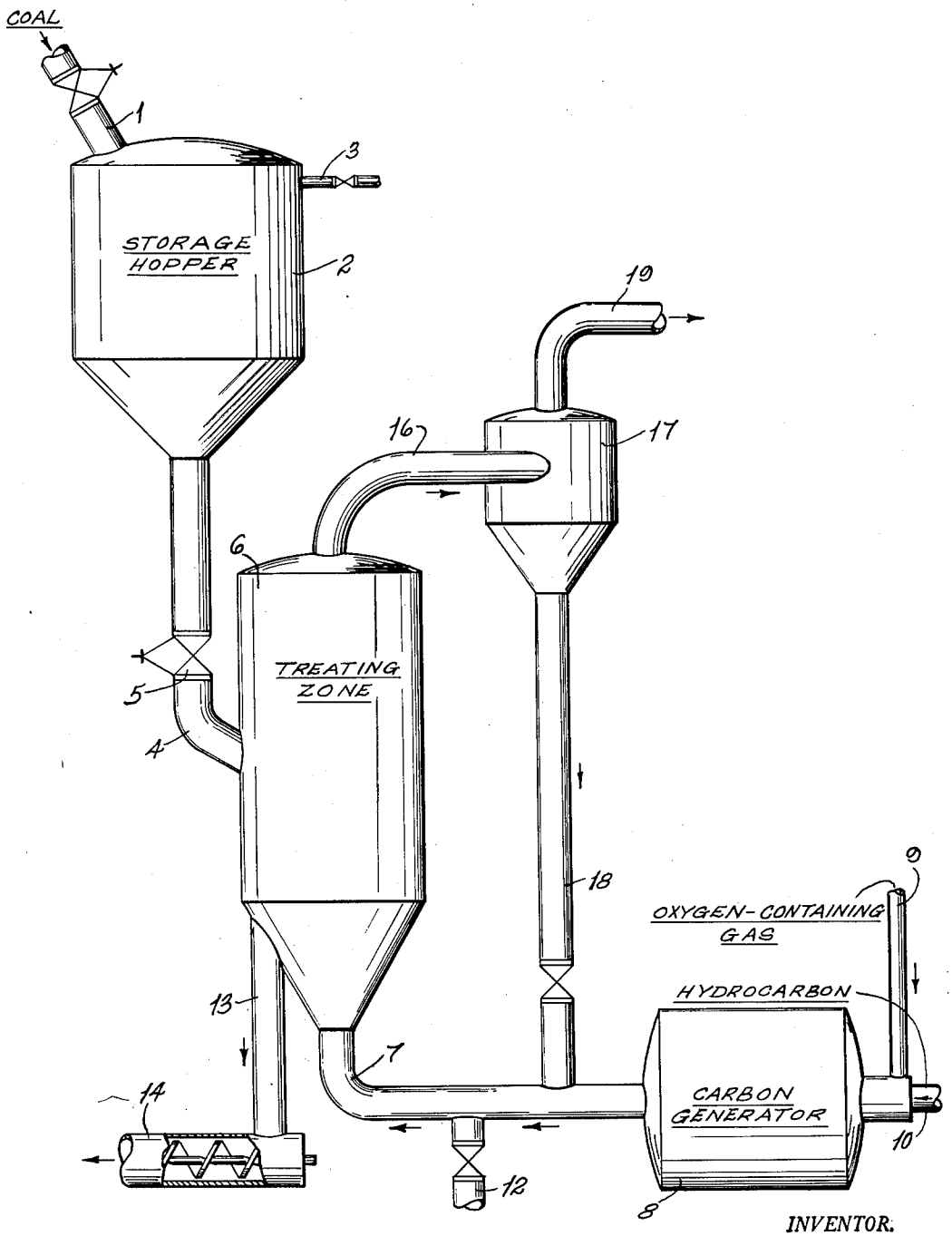
Jan. 3, 1956 P. W. GARBO 2,729,597

PROCESS FOR RENDERING SOLID CARBONACEOUS MATERIALS NON-AGGLOMERATIVE

Filed April 30, 1949



INVENTOR.
PAUL W. GARBO
BY Daniel Stryker
J. H. Grahame
ATTORNEYS

United States Patent Office 2,729,597
Patented Jan. 3, 1956

2,729,597

PROCESS FOR RENDERING SOLID CARBONACEOUS MATERIALS NON-AGGLOMERATIVE

Paul W. Garbo, Freeport, N. Y., assignor to Hydrocarbon Research, Inc., New York, N. Y., a corporation of New Jersey

Application April 30, 1949, Serial No. 90,636

2 Claims. (Cl. 202—16)

This invention relates to a process for treatment of a solid carbonaceous material. The process is particularly applicable to the treatment of those carbonaceous materials which tend to agglomerate on heating, e. g., caking coals. In one of its most specific aspects the present invention relates to a process for coating the surface of a caking coal with powdered carbon to render the coal substantially non-caking in character.

The fluidized solids technique has been applied to processes for the distillation and gasification of various solid carbonaceous materials. It is known, for example, that coal in finely divided form may be treated in a fluidized bed with hot gases to effect removal of volatilizable constituents therefrom by distillation. A number of solid carbonaceous materials have been reacted with gaseous reactants in a fluidized bed of particles of said material. Partial or complete gasification of carbonaceous materials may be accomplished by this means. Oxygen, hydrogen, carbon dioxide, and steam are useful gaseous reactants for the conversion of solid carbonaceous materials to valuable gases. Fluid bed gasification is particularly adapted to the treatment of coke or hard coal, such as anthracite, which does not tend to agglomerate on heating. Gasification of coal in moving beds, in processes such as the Lurgi process, is generally dependent for success upon a non-caking fuel. Frequently, however, those coals which are most readily available and most economical for gasification are bituminous coals of the caking type.

The present invention provides an improved process by which caking coals may be pretreated to eliminate their caking tendency and eliminate difficulties due to caking in subsequent carbonization and/or gasification reactions.

Coal may be treated to prevent agglomeration by subjecting the coal to distillation to drive off at least a portion of the volatilizable constituents or by partial preoxidation of the coal with an oxygen-containing gas. An expedient which has been proposed to prevent agglomeration of caking coals involves admixing the raw coal with clay, ash, sand, or other inert material. A disadvantage of this procedure is the necessity of using relatively large proportions of the inert material, which is circulated through the gasification equipment with the coal. Such inert materials reduce the capacity of the apparatus to a considerable extent because of the volume of inert material required for effective results. From about 3 to about 10 parts of inert material must be used per part of fresh coal, depending upon the character of the raw coal, to prevent agglomeration. A further disadvantage is found with some coals in that the ash thereof tends to combine with the inert material to yield a composite substance of lower softening point than that of the ash, with a result that agglomeration is aggravated.

The process of the present invention avoids the difficulties attendant upon these various methods of handling coal and provides a method whereby the coal may be effectively pretreated to avoid agglomeration and the resulting pretreated material charged directly to a subsequent processing zone like a carbonization and/or gasification apparatus. The process of this invention may be carried out simultaneously with the carbonization of coal by distillation to eliminate its caking tendencies and permit carbonization in a fluidized or moving bed without resorting to the use of an added solid diluent. The carbon content of the resulting treated product is substantially as high as that of the original coal when the process is conducted under conditions which avoid the simultaneous carbonization or distillation of the solid fuel undergoing pretreatment.

In accordance with this invention, particles of a solid carbonaceous material which has the property of caking or agglomerating when exposed to an elevated temperature are contacted at such an elevated temperature with a gaseous stream substantially non-oxidizing in character and carrying in suspension finely divided carbon, such as soot, lamp-black or carbon black, to effect the coating of the solid particles with the finely divided carbon. The contacting of the particles of solid carbonaceous material with the gaseous stream containing suspended carbon may be achieved by any of several conventional procedures. For instance, the solid particles may be passed through a rotary kiln while flowing a hot gaseous stream containing suspended carbon countercurrently through the kiln. Alternatively, the solid particles may be dropped through a tower against an ascending gaseous stream carrying finely divided carbon.

In a preferred embodiment of this invention, a bed of particles of solid carbonaceous material is maintained in a fluidized state in a treating zone by the action of a stream of gas passing upwardly therethrough. Particles of fresh coal may be fed intermittently or continuously into the fluidized bed and admixed with particles undergoing treatment. Finely divided carbon, for example, carbon black, lampblack, or soot, is supplied to the treating zone with the gas stream. Heat is supplied to the treating zone sufficient to make the surface of the coal particles tacky and, if desired, to volatilize at least a portion of the volatilizable constituents therefrom. The particles of carbon black coat the surface of the coal particles and aid in eliminating the caking tendency of the particles. At the same time more or less of the volatilizable constituents, particularly undesirable moisture in the coal, are distilled from the coal. Treated particles of coal are intermittently or continuously withdrawn from the treating zone as a non-caking product. Entrained particles of powdered carbon may be separated from the effluent gas from the treating zone and recycled to the fluidized bed.

The powdered carbon may be supplied from any suitable source, for example, commercial carbon black or lamp-black may be admixed with the stream of treating gas. Generally it is preferable to generate the powdered carbon by partial combustion of a hydrocarbon gas or oil and to pass the resulting hot gaseous products of combustion and entrained powdered carbon into the treating zone. A number of processes for the production of carbon are known in the art. Volatilizable constituents distilled from the coal may be used as a source of the powdered carbon, for example, the hydrocarbon gases or oils may be recovered and utilized for the production of powdered carbon.

Suitable non-oxidizing gases include hydrogen, carbon monoxide, steam, carbon dioxide, flue gas, natural gas, and the like. Gases produced along with carbon black by partial combustion of a hydrocarbon are generally suitable as a treating gas stream. These gases may serve to supply heat to the treating zone for the softening or tackifying of the coal and any accompanying distillation of volatilizable constituents. The effluent gas discharged from the treating zone contains any volatilized constitu-

ents from the coal and these may be recovered from the gaseous effluent as hydrocarbon gases and oils.

An object of this invention is to provide an improved process for the treatment of solid carbonaceous material.

Another object is to provide a process for the treatment of caking coals and like solid fuels to render them substantially non-caking in character.

Still another object is to provide an improved process for the distillation of volatilizable constituents from solid carbonaceous materials, such as coals and oil shale.

The drawing is a diagrammatic elevational view illustrating one embodiment of the process of the present invention.

With reference to the drawing, coal is fed through line **1** into a feed hopper **2**. An inert gas may be supplied through line **3** to build up pressure in the hopper. The gas also forms an inert blanket in the feed hopper, avoiding explosion hazards. The particles of coal from the feed hopper are fed through line **4** at a rate controlled by valve **5** into a treating zone **6**. A fluidized bed of particles of coal undergoing treatment is maintained within the treating zone.

The particles of coal undergoing treatment within the treating zone are fluidized by a gas passing upwardly therethrough. The fluidizing gas, containing powdered carbon in suspension, is admitted to the lower portion of the treating zone through line **7**. Powdered carbon is produced by partial combustion of a hydrocarbon oil or gas in a carbon generator **8**. The hydrocarbon is supplied to the generator through line **10** while an oxygen-containing gas is supplied through line **9**. Air or oxygen may be supplied to the generator as the oxygen-containing gas. The gaseous products of combustion from the generator, containing powdered carbon in suspension, are ideally suited as the gas for fluidization of the coal in the treating zone. The fluidizing gas stream from the generator may be supplemented by additional gas from any suitable source admitted to line **7** through line **12**.

Heat may be supplied to the treating zone by any conventional means; preferably it is supplied by the gas stream entering through line **7**. Alternatively, the heat may be supplied by indirect heat transfer through the walls of the treating zone or by heating elements or coils disposed in the fluidized bed.

Particles of fresh coal admitted to the treating zone are admixed with particles of coal undergoing treatment therein. The fluidized bed comprises largely particles which have received sufficient treatment with hot gases containing powdered carbon to render them non-caking and free-flowing under the treating conditions. The fresh particles of feed are dispersed in the treated particles and subjected to heating to a temperature sufficient to soften or tackify the surfaces of the particles and permit coating them with powered carbon. The fluidized bed effects rapid mixing of the fresh coal and treated particles and rapid heating of the feed particles to the treating temperature. Dispersion of the feed particles in the treated particles prevents contact between the fresh particles until they have received sufficient treatment to render them non-agglomerating. Preferably the temperature of treatment is sufficient to volatilize at least a portion of the volatilizable constituents, especially moisture, from the coal.

The particles of treated coal are withdrawn from the treating zone through line **13**. The treated coal particles are discharged into a conveyer **14** through which they may be passed to storage or to subsequent operations.

The fluidizing gas after passing through the treating zone is discharged through line **16** into a separator **17** of the cyclone type for removal of entrained particles therefrom. Solid particles separated from the gas stream in the separator **17** are returned through line **18** to line **7** into admixture with the fluidizing gas and thence to the treating zone. The gas, substantially free from solid particles, is discharged through line **19**. This gas may be processed for the separation of condensable oils resulting from the distillation of the coal and may be recycled to the treating step, used in carbon generator **8** or utilized as a fuel gas or the like.

The temperature in the treating zone should be high enough for the particular solid fuel undergoing treatment to ensure that the soot or powdered carbon will stick to the surfaces of solid fuel particles. Generally, a satisfactory temperature will be at least about 600° F. and preferably at least about 750° F. With most solid fuels like coal, temperatures in excess of about 1000° F. will cause appreciable carbonization of the coal, i. e., an appreciable quantity of volatilizable constituents will be distilled from the coal. The pressure may vary from about atmospheric to about 500 pounds per square inch gauge and is determined largely by subsequent process requirements, the pressure having no appreciable effect upon the efficiency of the present process. Thus the pressure may be determined by the desired pressure at which the effluent gas or treated coal are supplied to associated processes. For example, in the gasification of coal it is often desirable to operate the gasification reactor at a pressure within the range of from about 50 to 500 pounds per square inch gauge. The treating step of the present invention may be operated at a comparable pressure so that the treated coal may be supplied directly to the gasification zone without any difficulties due to the pressure at which the gasification zone is operated.

It is well to observe that the pretreating process of this invention can serve the dual function of rendering caking solid fuels non-agglomerating and simultaneously preheating them prior to charging them into a gasification zone or other processing zone maintained at an elevated temperature.

Obviously many modifications and variations of the invention, as hereinbefore set forth, may be made without departing from the spirit and scope thereof and, therefore, only such limitations should be imposed as are indicated in the appended claims.

I claim:

1. The process of rendering fresh particles of caking coal non-caking without substantial carbonization, said particles being of a size adapted for gasification in a settled moving bed, which comprises introducing said fresh particles into a dense phase fluidized mass maintained at an elevated temperature of at least 600° F. adapted to cause tackiness of the surfaces of said fresh particles while passing a substantially non-oxidizing gas containing finely powdered soot suspended therein upwardly through said mass to effect the fluidization thereof and to coat the tacky surfaces of said fresh particles with said soot, said fluidized mass at all times consisting essentially of coal particles which have been thus rendered substantially non-caking, and withdrawing coal particles from said mass prior to substantial carbonization as substantially non-caking coal particles coated with soot.

2. The process of claim 1, wherein the non-oxidizing gas containing finely powdered soot suspended therein is generated by the partial combustion at elevated temperature of a fluid hydrocarbon.

References Cited in the file of this patent

UNITED STATES PATENTS

2,396,036	Blanding	Mar. 5, 1946
2,414,586	Egloff	Jan. 21, 1947
2,471,119	Peck et al.	May 24, 1949
2,512,076	Singh	June 20, 1950
2,534,728	Nelson et al.	Dec. 19, 1950

FOREIGN PATENTS

394,747	Great Britain	July 6, 1933
621,512	Great Britain	Apr. 11, 1949
104,346	Australia	June 22, 1938