

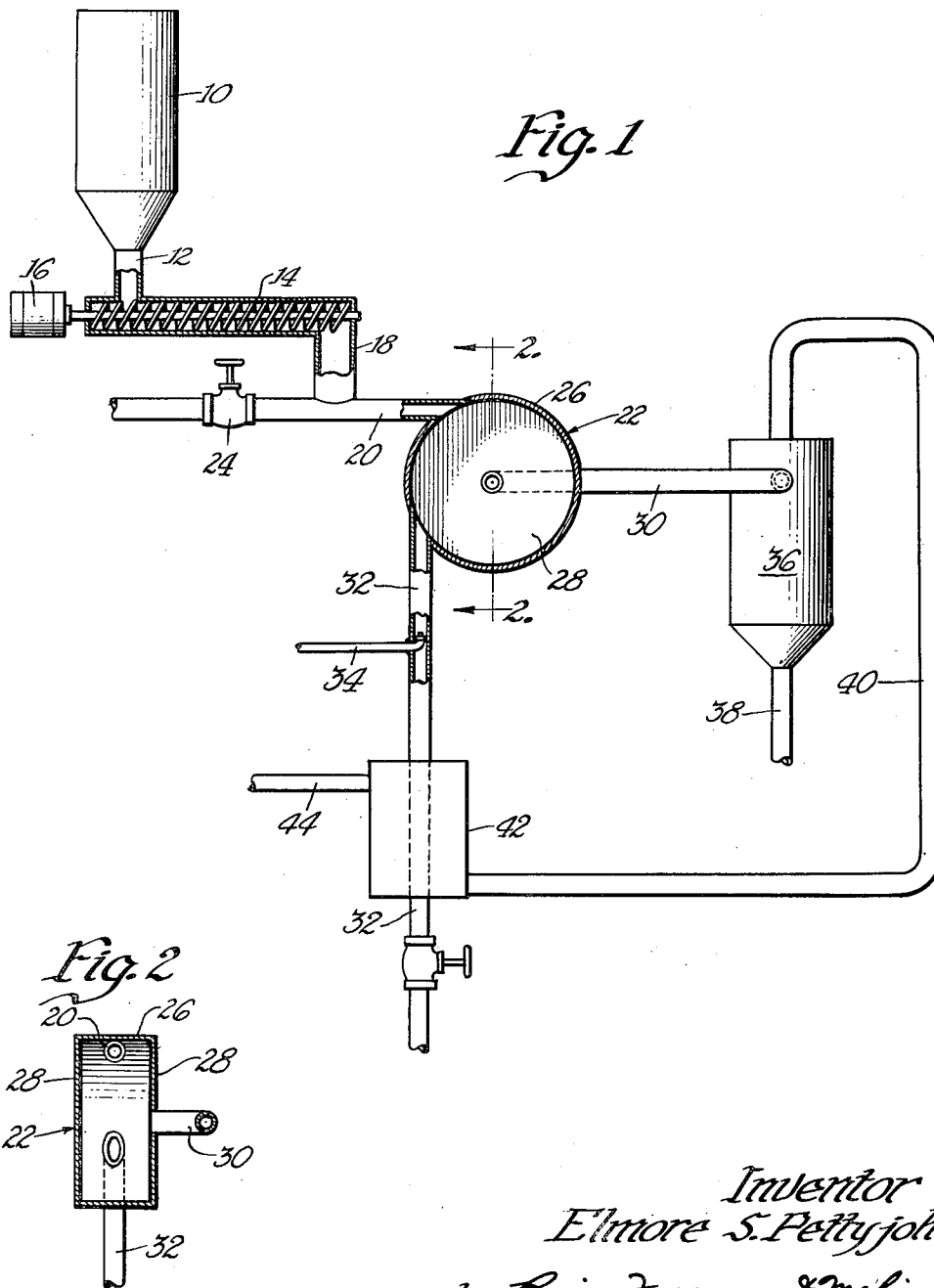
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METHOD OF DEVOLATIZING COAL FUEL

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METHOD OF DEVOLATIZING COAL FUEL

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1 Claim. (Cl. 202—26)

This invention relates to methods of preparing smokeless fuels from coal containing from about 25 per cent up to 36 to 38 per cent volatile matter which, when burned, yields an excess of objectional smoke.

More specifically, the invention relates to a method for devolatilizing and simultaneously comminuting such coal by a method involving a combustion step and yielding a finely divided partly devolatilized hot coal which can be burned immediately or, if desired, briquetted while still hot.

It is an important object of the present invention to provide methods for converting coal of medium or high volatile content into smokeless fuels by the use of simple apparatus of high capacity so that such conversion of coal can be carried out on a large scale with a minimum plant investment.

Other and further objects and features of this invention will become apparent from the following description and appended claim as illustrated by the accompanying drawings showing, diagrammatically and by way of example, apparatus for carrying out the method of this invention. More particularly:

Figure 1 is a diagrammatical representation (with parts shown in elevation and other parts shown in vertical cross section) for carrying out the method of this invention; and

Figure 2 is a fragmentary cross sectional view taken along the line 2—2 of Figure 1.

The starting material for the method of this invention is medium or high volatile coal having a volatile content ranging from about 25% up to 36 to 38%. This coal is initially comminuted to a size not exceeding about minus 6 to 8 mesh by any suitable conventional method, for instance, hammer milling.

Referring now to the drawing, the coarsely granular coal may be contained in a hopper 10. From the latter, the coal moves under the influence of gravity through a conduit 12 into a generally horizontal tubularly enclosed screw conveyor 14 driven by motor 16. The conveyor 14 feeds the coal, at any desired predetermined rate, into a vertical conduit 18 discharging into a generally horizontally extending conduit 20 between the ends of the latter. Air is caused to flow through the conduit 20 from the left to the right. This air need not be under more than 2 or 3 lbs. per square inch pressure in excess of the pressure prevailing in a short tubular vortex chamber generally indicated at 22 into which the conduit 20 discharges in a generally tangential direction. The amount of air admitted into the conduit 20 is controlled by adjusting a valve 24. The air in question is maintained at a temperature below the softening point of the coal being treated but is suitably held at a temperature 100° F. within said softening point. A temperature of around 400° F. has been found to give good results. The rate of air flow through the conduit 20 is sufficiently high to suspend or entrain the coal particles and thus to carry the coal particles into the vortex chamber 22. In general, the air flows at least at a velocity of about 5 to 10 ft. per second, and the ratio (by weight) of coal to air should not exceed 10 to 1.

The vortex chamber 22 is made up of a tubular wall 26 and disc-shaped end walls 28. One of the end walls 28 is centrally apertured to permit discharge into an axial outlet conduit 30. A second valved air conduit 32 discharges generally tangentially into the vortex chamber 22. A burner 34 may be provided in the conduit 32 for heating the air discharged through the conduit 32 into

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the vortex chamber 22, or other suitable means may be arranged for otherwise raising the temperature of this air to the level indicated hereinbelow.

The conduit 30 may discharge into a cyclone separator 36 or other means for separating gases from finely divided solids. The separated solids are discharged through a conduit 38, while the separated hot gases may pass into a conduit 40 leading to a heat exchanger 42 for preheating the air passing through the conduit 32 ahead of the burner 34. The gases may be vented from the heat exchanger 42 through a conduit 44.

The air entering the vortex chamber 22 is heated to a temperature ranging from about 800° to 1500° F. The temperature in the vortex chamber 22 is maintained at from 1200° and preferably from 1400° up to 1800° to 1900° F. At this temperature level, the coal particles are partly devolatilized, and the resulting vapors burn in the presence of the air, thus maintaining the vortex chamber at the indicated temperature level.

The rate of flow of air into the vortex chamber 22 through the conduit 32 is adjusted to keep the coal particles in the vortex chamber suspended and in rapid vortical movement. The air should have a velocity of at least 5 to 10 ft. per second.

In the vortex chamber 22, a ratio of coal to air ranging from 1:1 to 1:4 is maintained by adjusting the flow of air into the vortex chamber through the conduits 20 and 32 and by adjusting the rate of feed of the screw conveyor 14. As between the conduits 20 and 32, the ratio of air flow is regulated so as to maintain the above indicated temperature level in the vortex chamber. As disclosed hereinabove, the air flowing through the conduit 20 is maintained below the softening point of the coal and ordinarily at about 400° F., so that this air by itself, cannot always serve to maintain the above indicated temperature level. Hence sufficient air at from 800° to 1200° F. must be added through the conduit 32. Further, the total amount of air added must be sufficient to support the combustion in the vortex chamber 22.

In the vortex chamber 22, the coal particles are comminuted, due to the simultaneous effects of several agencies. Thus, comminution is effected by impact and by attrition as between the coal particles and as between the coal particles and the walls of the vortex chamber, under the influence of the centrifugal force generated by the vortically flowing gas. The relatively finely comminuted coal particles are carried out in suspension by the gas through the central axial discharge conduit 30. The relatively coarse coal particles, on the other hand, are held by centrifugal force in the radially outermost portion of the vortex chamber until comminuted finely enough to be carried away by the suspending gas through the central axial discharge conduit.

At the elevated temperature prevailing in the vortex chamber 22, comminution of the coal is facilitated and carried to a greater extent as compared to normal temperatures due to the greater softness of the coal at elevated temperatures (above 700° to 900° F.).

As the coal granules enter the vortex chamber 22, the temperature of the coal granules is rapidly raised to a level where the volatile matter therein is vaporized. As a result, the vapors generated within the coal granules contribute to the comminution by cracking the granules, transforming the granules into cellular or bubble form characterized by a thin fragile wall structure, and even by explosively disintegrating the granules. The devolatilization of the coal particles effected at the elevated temperature of the vortex chamber is uniform with respect to the individual coal particles as well as with respect to the whole amount of coal entering the vortex chamber because of the fine comminution effected in the vortex chamber. As a result of this rapid devolatilization of the coal particles, and because of the rapid admixture of previously devolatilized coal particles with those just introduced into the vortex chamber, the coal particles do not tend to agglomerate nor to adhere to the walls of the vortex chamber.

The residence time of the coal particles in the vortex chamber is adjusted to reduce the volatile content of the coal to from 6 to 30%. Ordinarily, this residence time may range from 1/4 to 20 seconds.

Under the conditions indicated, the coal is comminuted to a fineness such that 80% will pass an 80 mesh screen and 60% will pass a 325 mesh screen.

The product issuing through the discharge conduit 30 is a hot suspension of partly devolatilized coal in combustion gas and air. The combustion gas is derived principally from the combustion of vaporized volatile coal constituents, the coal particles themselves not being burned. If desired, this hot suspension can be burned immediately in a furnace for the purpose of generating heat. The suspension, being hot and carrying finely divided coal in suspension, can be burned rapidly and completely in a small space to generate intense heat, as much secondary air (if desired, in preheated form) being added to the suspension as may be required for complete combustion.

For making a smokeless domestic fuel, the coal suspension is passed through the cyclone 36 and the hot comminuted partially devolatilized coal recovered through the conduit 38. At its elevated temperature, the finely divided coal can be immediately pressed to form briquettes, without the use of any binder such as tar, although such binders can be used if desired. Due to its residual volatile content (which may be as low as 6%), the coal still possesses sufficient adhesive properties to form briquettes when subjected to a molding pressure before it has cooled down to more normal temperatures.

By way of an example, I have treated a smoky Illinois coal containing 35.5% volatile matter and passing a 6 mesh screen as follows. The coal was fed to the vortex chamber 22 at the rate of 150 lbs. per hour. Air at about 320° F. and a pressure of 6 lbs. per square inch was caused to flow through the conduit 20 at the rate of 166 lbs. per hour. Air at 1380° F. and a pressure of 6 lbs. per square inch was caused to flow through the conduit 32 at the rate of 340 lbs. per hour. The temperature at the center of the vortex chamber was 1700° F. The product coal contained 14.2 per cent volatile matter and 80 per cent thereof passed a 200 mesh screen while 60 per cent passed a 325 mesh screen. Part of this coal was immediately burned in suspension, without any formation of objectionable smoke. Another part was immediately pressed into briquettes, which were thereafter burned without formation of objectionable smoke.

In the preparation of smokeless fuel from coal containing 25% or more volatile matter, the extent of devolatilization required to eliminate smoke formation on burning varies with the original volatile content of the coal. In the case of coal containing 36 to 38% volatile matter (such as Illinois coal), devolatilization down to about 30 to 32% is sufficient. Coal containing 25 to 30% volatile matter should be treated to reduce the volatile content down to about 16 to 18%.

The method of this invention can also be used to prepare a semi-char for blending with raw coal and subsequent devolatilizing of the resulting blend to prepare

a metallurgical coke. For this purpose, the coal is devolatilized to an extent where about 16 to 23%, and preferably about 17 to 18% of the volatile matter is retained. In the blend, the semi-char should range from about 40 to 60%. This blend is subjected to a conventional high temperature carbonization yielding a high grade metallurgical coke.

Many details of procedure may be varied without departure from the principles of this invention and it is therefore not my purpose to limit the patent granted on this invention otherwise than necessitated by the scope of the appended claim.

I claim as my invention:

In a continuous process for preparing smokeless fuel in briquette form from a smoky coal containing 25 to 38 percent original volatile matter by simultaneously comminuting the coal and reducing the volatile matter to about 24 to 84 percent of the original volatile matter content, and forming the hot comminuted partially devolatilized coal into briquettes, the devolatilizing steps which comprise suspending the smoky coal in the form of about minus 6 mesh granules in a current of hot air at a temperature about 100° below the softening point of said coal, continuously forming the suspension into a vortex and incorporating additional air at at least 800° F. to increase the ratio of coal to air to a range of from 1:1 to 1:4, maintaining the temperature in said vortex at from 1200 to 1900° F. to drive off volatile matter and comminute the coal, the elevated temperature in said vortex being maintained solely by combustion of the driven-off volatile matter in the presence of said additional air without burning the coal, and continuously withdrawing finely-divided partially-devolatilized coal from the center of said vortex after a residence time of from 1/4 to 20 seconds.

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