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CONTINUOUS CARBONIZATION OF COAL AND OIL MIXTURES

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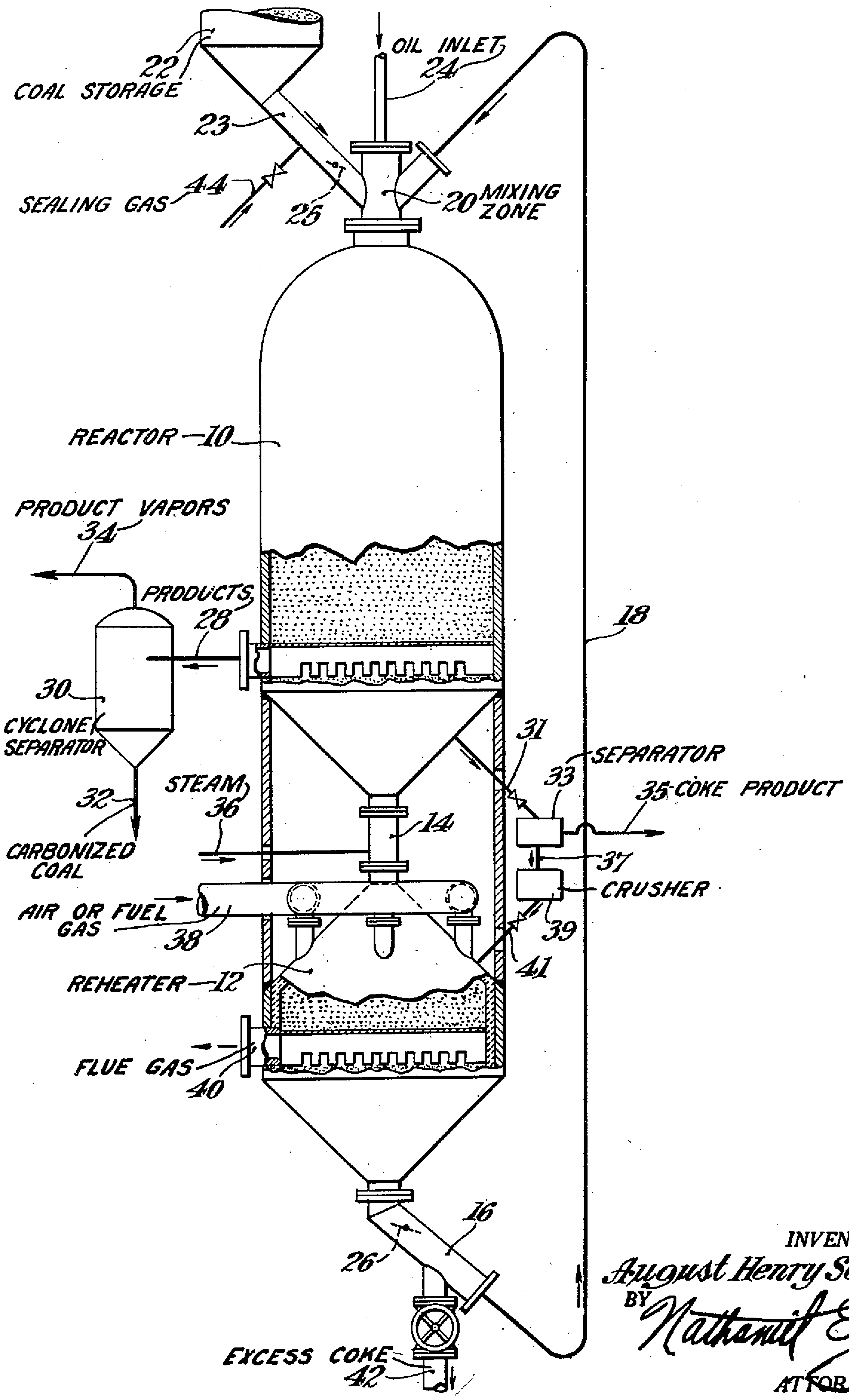

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CONTINUOUS CARBONIZATION OF COAL AND OIL MIXTURES

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1 Claim. (Cl. 202—9)

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This invention relates to an improved method and apparatus for the carbonization of coal in the presence of a continuously moving column of heat-carrying coke.

In copending application Serial No. 3,747 (now Patent No. 2,561,334), patented July 24, 1951 of which I am a co-inventor, there is disclosed a unique method and apparatus for reducing heavy oil, tars, and other residuum by the use of a continuous gravity packed, gravity moving column of granular coke. The coke may be heated to any desirable reaction temperature without damage and due to its hardness, it withstands attrition very well. Furthermore, due to the large particle size, which may run from $\frac{1}{16}$ inch to $\frac{3}{4}$ inch, the resultant forces in the column tends to prevent any adherence between particles at the time the oil passes through the sticky stage just before dry coke is formed. No rabbling, agitation, or mechanical force is necessary to maintain the desired continuous flow.

In the present invention, some of the features of the earlier invention are taken advantage of. The coke heat-carrying material becomes an ideal circulating medium in which to conduct coal carbonization, for the petroleum coke has a high density, is substantially non-porous, can be repeatedly recycled with low production of fines, and can be reheated without spalling or other damage. Furthermore, it can be reproduced simultaneously in the system by the mere addition of some residual oil.

My invention materially differs from prior attempts to coke coal either by low temperature or by high temperature operations. It it well known that coal when heated passes through a swelling period which has caused objectionable agglomeration and has required tapered vessels, large rams or other extractors, or mechanical agitators for suitable operation. The use of supplementary materials has also been suggested but low temperature coal coke, or char and most forms of petroleum coke are too frangible for effective use.

My invention on the other hand is based not only on the use of supplementary coke, but on the use of our previously described dense or equilibrium coke, and in such preponderance that the reaction zone temperatures may be kept closely within the desired limits to avoid cracking of the vapors. My invention also contemplates ready control of conditions for the optimum yield of valuable products, and the absence of complicated mechanical apparatus heretofore thought necessary to aid the movement of the materials through the reaction zone.

In the attached drawing, illustrative of a preferred embodiment of my invention, such drawing being a schematic elevation of the reactor, reheater, and attached equipment, the reactor is

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indicated at 10. It is an elevated closed vessel which may be structurally mounted on the reheater, a separate sealed vessel indicated at 12. They are connected by transfer line 14 through which the materials flow by gravity.

At the lower end of reheater 12 is a line 16 leading to an elevating mechanism 18 which carries material to inlet chamber 20. Line 42 is provided for drawing off material from line 16. The elevated material is passed to inlet chamber 20 which is supplied with an oil inlet line 24 and a coal storage hopper 22. A sealing gas inlet 44 is provided for passing gas to line 23 and valve 25 controls the flow of coal in line 23.

In the lower part of reactor 10 there is supplied a product outlet line 28 leading to a cyclone 30. The product is withdrawn at 32 while vapors are removed at 34. A gas sealing line 36 is provided for transfer line 14. Reheater 12 has an upper air or flue gas inlet line 38 and a lower flue gas outlet at 40.

The unit is also provided with coke drawoff line 31 leading to separator 33. Product materials from certain operations may be drawn off at 35 while recycled material is passed through line 37, crusher 39 and line 41. Suitable valves may be provided in these lines.

In operation the unit contains a heat-carrying material, as described in Bowles and Schutte copending application Serial No. 46,168 filed August 25, 1948 which is a rounded, dense, homogeneous petroleum coke produced by the repeated circulation of coke particles through a reaction chamber similar to that hereinbefore described and to which heavy petroleum residues are applied in liquid form and coked. The coke layers in such case were of the order of 0.001 inch, the density was in excess of 50 lbs. per cu. ft., the crushing strength was approximately 300 lbs. for a $\frac{1}{2}$ inch particle, and the particle size range, I find for most effective operation, is from $\frac{1}{16}$ inch major dimension to not above $\frac{3}{4}$ inch major dimension.

In an operating cycle, hot regenerated heat carrying material such as petroleum coke is passed from the reheating zone by elevating mechanism 18 to inlet chamber 20. Simultaneously crushed or ground coal, preferably of a size smaller than the average size of the petroleum coke, is passed from hopper 22 through line 23 under the control of valve 25 into inlet chamber 20. Inert sealing gas is passed from line 44 to line 23.

The mixing of the coal with preheated circulating coke is done in the free-falling mixing zone 20. The coal is rapidly heated to and passed through its plastic state in this zone of maximum flow turbulence and maximum velocity of motion, thus preventing the formation of harmful agglomerates.

Coking of coal as hereinbefore described produces a charred, powdery product. This is separated in cyclone 30 and is withdrawn through line 32. Vapors are taken off through line 34.

Reheating of the coke of the column is accomplished in the reheater 12 after the coke column passes through transfer line 14 in which it can be purged of all vapors by the use of an inert material such as steam in line 36. Heating may be accomplished by auto-combustion of the coke in which case air or oxygen containing gas is introduced at 38 with the flue gas removed at 40. I prefer, however, to use a fuel gas at 38 and radiantly heat the column as it passes through, for usually fuel gas is a less expensive form of heat.

If it is desired to produce a more agglomerated product, a petroleum residue may be passed through line 24, into chamber 20 either simultaneously with the coal or separately. Thus larger coke particles may be produced, which may be used as the heat carrying material. In this manner, the bed may be built up to any desired size and a constant inventory may be maintained. If it is found that excessive coke is formed, the excess may be drawn off at 42.

Alternatively if large amounts of oil are admitted at 24 it is possible to control the agglomeration and to produce a larger product which may be removed through line 31 and passed to separator 33. Here the product may be taken off through line 35 and the remainder passed through line 31 to a crusher, if desired, to be recycled through line 41 to the reheater 12.

As the coke is hard and dry and of relatively large size, and the coal is in crushed or ground sizes, the gravity packed column will move solely by gravity through reactor 10, transfer line 14 and reheater 12 under control of valve 26 at the bottom.

The rate of movement will depend on the coal characteristics but with regulated gravity flow, reaction periods of from 30 minutes to several hours may be obtained without excessively high reaction chambers. Such relatively short coking periods may be obtained because the coal is uniformly heated without the necessity for transferring heat through deep layers of coal or coke, as is the case in conventional methods.

For low temperature carbonization, temperatures in the reactor 10 are in the order of 1000° F. to 1400° F. and I propose to feed from about 2 up to 6 parts of coke per part of coal feed. The coal may be introduced cold and an excess temperature of the coke will supply all the preheat as well as carbonization heat for the coal. The coal may also be preheated if desirable.

It is of course to be understood that high temperature carbonization can also be accomplished in the same apparatus as temperatures of the order of 1800° F. to 2100° F. can be readily obtained and without damage to the circulating coke.

An important feature of my invention is the absence of contaminating flue gas or air in the products of the coal carbonization. The vapors are readily removed from the lower part of reactor 10 through line 28 and passed to a separator such as the cyclone 30 from which char or coal coke is removed in line 32. The vapors leaving at 34 may be condensed in the well known manner to obtain the tars, vapors, etc. characteristic of the carbonization operation.

Generally the products of carbonization will correspond with well known practice and they depend on the types of coal treated. However, with more uniform and hence, lower reactor temperatures, there is less tendency for vapor cracking.

Under some conditions, it may be found possible to coke the tar yielded by the coal, particularly with the relatively low temperature operations. In such case the only other products will be the char removed at 32 and the volatile material removed at 34.

While I have shown and described a preferred form of embodiment of my invention, I am aware that modifications may be made thereto which come within the scope and spirit of the description herein and of the claim appended hereinafter.

I claim:

The method of low temperature carbonization of volatile coal in the presence of a particle form heated contact mass of granular coke, which comprises preheating the particles of said mass, independently and simultaneously introducing the coal as particles, said contact coke particles and a liquid oil into a common part of a free-falling zone with intermixing flow turbulence, during which intermixing the coal is rapidly heated to and passed through its plastic state, thereafter continuously moving the thus intermixed mass in its preheated condition downwardly through a reaction zone as an unagitated gravity packed column, mutually adjusting the inlet temperature of said contact particles to the reaction zone, and the rate of introduction of coal and liquid oil to maintain a reaction temperature of between about 1000° F. and about 1400° F. in said reaction zone below the free-falling zone of intermixing, retaining the coke contact particles with the admixed coal and oil in said column of said reaction zone and without other addition of heat for a time sufficient to complete conversion of the coal and oil to vapors and non-agglomerating particles of dry coke, withdrawing the coke contact particles from the reaction zone by a controlled gravity flow without agitation or application of mechanical force, removing the said vapors and dry coke particles from the lower part of said column prior to the withdrawal of the coke contact particles from the reaction zone, sealing the removal of the coke contact particles from the reaction zone against loss of vapors therefrom, passing said coke contact particles through a reheating zone, subjecting said coke contact particles to reheating in the presence of products of combustion, and reintroducing said reheated coke contact particles to the reaction zone, thereby maintaining a substantially uniform column level therein.

AUGUST H. SCHUTTE.

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