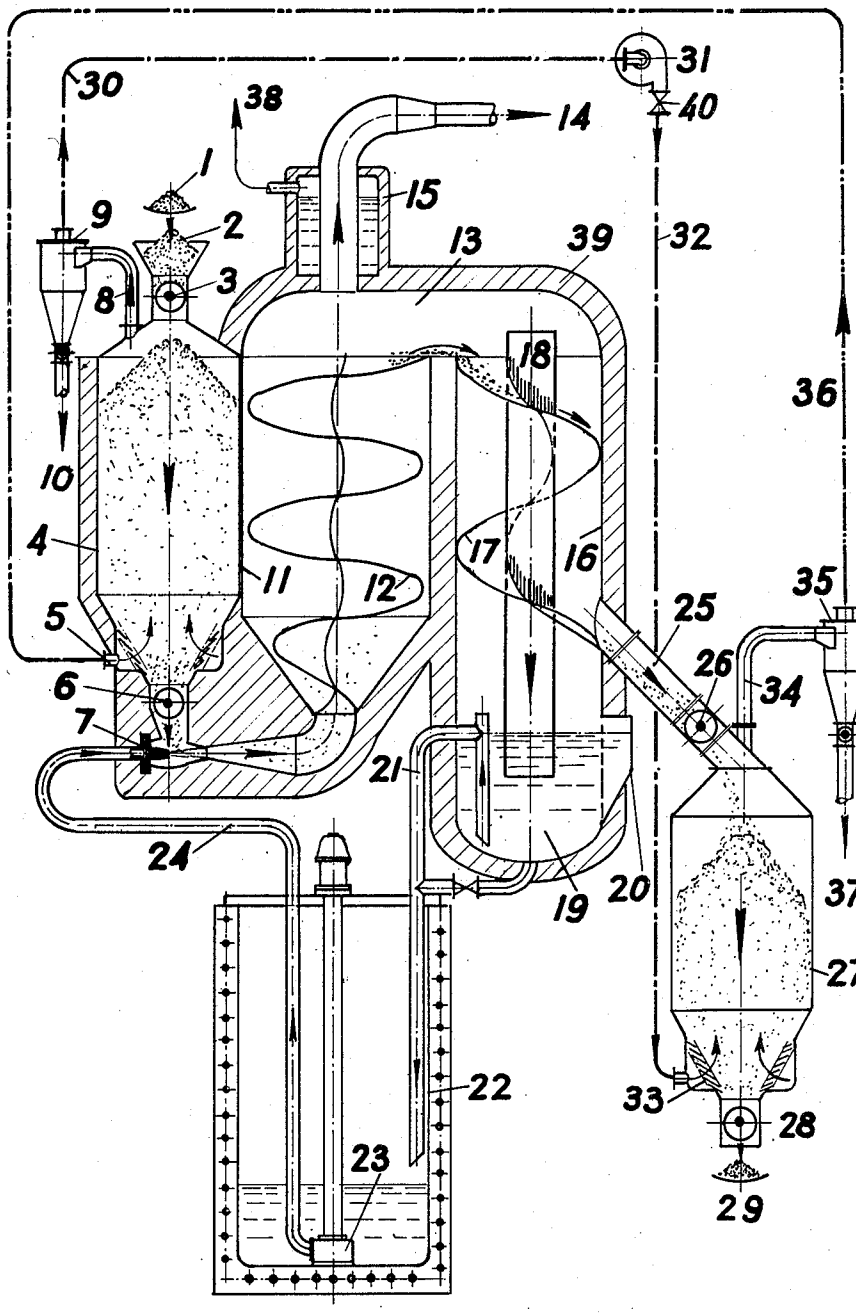
April 2, 1957 W. M. FARAFONOW 2,787,584

CONTINUOUS CARBONIZATION PROCESS AND APPARATUS FOR SOLID CARBONACEOUS MATERIALS

Filed Feb. 4, 1954



W. M. Farafonow - INVENTOR

United States Patent Office

2,787,584

Patented Apr. 2, 1957

2,787,584

CONTINUOUS CARBONIZATION PROCESS AND APPARATUS FOR SOLID CARBONACEOUS MATERIALS

Wladimir Michael Farafonow, San Francisco, Calif.

Application February 4, 1954, Serial No. 408,167

5 Claims. (Cl. 202—16)

Introduction.—In the field of heat-treatment processes for upgrading solid carbonaceous fuels (viz.: various kinds of coal, lignite, etc.) the high-temperature carbonization process, i. e. the coal coking process is the most important one because it is used for the manufacture of hard coke which is the main raw material supplying the metallurgical plants, foundries and the several branches of chemical industries. As an example in 1950 the world coking industry produced about 178 million tons of coke according to the U. S. Bureau of Mines data.

In the coke industry of today the main processing equipment consists of the slot-type coke ovens with horizontal coking chambers charged by coal blends and externally heated by combustion of a fuel gas. The fixed coal charge heated up to 1000° C. eliminates volatile matters and it is converted into coke. The charging capacity of such coke ovens is between 12 to 20 tons of coal; coking time is from 14 to 24 hours and depending upon the width of the coking chamber (16"–20") as well as the temperature maintained in the heating flues (1200°–1500° C.). The above mentioned method of coke making has certain disadvantages, for example: (1) The process is intermittent, i. e. coal is charged into the coking chamber and after certain period of time when the coking process is completed, the coke cake should be pushed from the chamber into the quenching car. This requires frequent cleaning periods which result in "time- and heat-losses" in the process. (2) The coal heating is an indirect process, it means that when the fuel gas burns in the heating flues the heat transfer takes place through refractory wall and a half the coal charge (8"–10" thick); the above facts give the higher thermal resistance and, therefore, the process requires a long coking period.

The ideal form in the majority of technological processes is the continuous production which promises many advantages from technical as well as economical viewpoints, and the same may be applied to the continuous carbonization process and apparatus.

Brief summary of the invention.—The present invention relates to the continuous carbonizing or coking process for carbonaceous solid materials such as all types of coal, lignites, etc. to produce hard coke and valuable coal chemicals. More particularly, the invention is concerned with a new method and apparatus for the continuous carbonization of said materials prepared in the form of blended spherical briquettes or, in certain cases, screened lumps of about 2"–2½" in size, passing through a heat-treating system comprising preheater, reactor, separator and cooling chamber, and operating with circulating heating medium which is a molten metal at temperature higher than 800° C. selected from the group consisting of aluminum and magnesium and having the specific gravity between 1.5 and 2.5, which should be higher than the specific gravity of material treated. This molten metal, being heated by an electrical or combustion method in a special heater, circulates through said reactor and separator and supplies the heat required for preheating of starting material to the proper carbonizing temperature as well as for supporting the endothermic carbonizing reaction if any.

In this new process, the direct heat transfer from the circulating molten metal to the carbonaceous material carried therein is made very efficient and uniform, thus resulting in short carbonizing time and better quality of coke produced. This process involves also one more feature, which has tendency to increase the coke strength due to the fact that the processed material is subject to the pressure of the molten metal during the carbonization period. The operation of this new process applying a flowing heating medium carrying the process material can be made completely continuous and simultaneously involves considerable heat economy in the use of the sensible heat of the following products: (1) from volatile matters in steam generating by means of a special device installed around outlet pipe; (2) from the produced coke (which is continuously removed) whose heat to be used in preheating the starting process material which, in turn, is continuously fed into carbonizing process; this heat exchange is provided by means of circulation of inert gases.

Description according to the enclosed drawing.—Having set forth the general nature and objects, the present invention will be best understood from the more detailed description hereinafter in which reference will be made to the accompanying drawing which is an illustration of a system suitable for carrying out a preferred embodiment of the invention.

The starting carbonaceous material in the form of spherical briquettes or, in some cases, screened lumps is supplied by conveyer 1 through a hopper 2 and feeder 3 to the preheater 4 wherein the material is preheated by means of circulating inert (smoke) gases entering the preheater through the louver 5 from line 36. The preheated material feed is discharged by extractor 6 to the eductor 7 from which said material is transported by molten metal to the bottom of the cylindrical reactor 11 in which a perforated helicoid 12 is mounted coaxially therewith. The material, being upwardly carried along the helicoidal surface by molten metal, is intensively and uniformly heated by direct contact with the latter one up to a proper temperature and subjected to a carbonization process. Volatile products formed during coking process pass through the perforated holes of said helicoid 12 and enter the top chamber 13 from which they are evacuated through the jacketed pipe 14 to the condensation and chemicals-recovery plants. A part of the heat of the volatile products is used for steam generation in the jacket-boiler 15 supplying the steam produced through pipe 38 to a consumer. From the top of said reactor, molten metal carrying coke formed during the coking process flows over to the separator 16 consisting of the cylindrical shell, helicoid 17 surrounding the central standpipe 18 with drain slots. The molten metal is separated from coke by drainage through slots in the standpipe 18 and flows down to the bottom part of the separator 16 wherein said molten metal is cleaned by separation from coke breeze which, being of a lower density than molten metal, comes to the upper surface of the latter one and can be removed through the pocket 20. The clean molten metal flows over through the pipe 21 to the combined accumulating tank-heater 22 which is used for three purposes: (*a*) preheating of the circulating molten metal to the proper temperatures, (*b*) initial melting of the solid metal, and (*c*) storage of molten metal during the emergency emptying of circulating system. From the heater 22 the molten metal is delivered by a special pump 23 through pipe 24 back to the eductor 7 wherein the circu-

lating cycle starts again. The coke separated from molten metal and downwardly moved along the helicoid **17**, is discharged from the separator **16** and chute **25** by the extractor **26** to the cooling chamber **27** wherein said coke is cooled by said inert (smoke) gases entering from pipe **32** through louvers **33** and counterflowing through coke bulk. The cooled coke is discharged from said cooling chamber **27** by the continuous extractor **28** to the conveyer **29** and becomes the main product manufactured. The inert gases circulated by means of the fan **31** through the preheater **4** and the cooling chamber **27** are used for heat recuperation from coke produced to the starting material, while the rate of these gases is controlled by valve **40**. In the preheater **4** the starting material may be preheated to a temperature of about 250–300° C. at which no appreciable carbonization takes place, and this preheating requires only a part of the sensible heat supplied by coke entering said cooling chamber, therefore the surplus heat of the coke can be used in a boiler for steam generation (not shown) which may be connected to line **36**. The cleaning of circulating gases is carried out in the cyclons **9** and **35** to which said gases enter through the pipes correspondingly **8** and **34**. Separated coal and coke fines may be withdrawn from said cyclons through pipes **10** and **37** and returned to the process as a blending component, while said gases substantially free of solids are withdrawn through pipes **30** and **36** to further circulation. The apparatus and piping are insulated by thermo-insulation **39** which includes, when necessary, the electro-heating equipment.

The present inventor claims:

1. The continuous process of producing hard coke as well as coal chemicals from carbonaceous materials prepared in the form of screened lumps as well as spherical briquettes carbonized at temperatures over 800° C., which comprises passing carbonizable material through an elongated spiral zone in direct contact with molten metal heating medium selected individually or in combination from the metal group consisting of aluminum and magnesium to provide a higher density than variable density of material treated, upwardly flowed and which was previously heated independently of said carbonaceous material at least to said carbonizing temperature, withdrawing the volatile products into an exhausting zone, overflowing the suspension of coke produced in the molten metal into separating zone from which said coke is discharged through a cooling zone as a final product while said molten metal, after its separation from coke breeze, is overflowed into a heating zone for reheating to said process temperature and further returned to the recirculating process.

2. The process of claim 1 wherein the surplus heat of both the volatile products exhausted and coke produced is subject to utilization in preheating of said starting carbonaceous material to reduce heat consumption in the process by heat convection from said hot products to the starting material by means of recirculating heat-carrying gases and steam produced application.

3. The process of claim 1 wherein said starting material is introduced into main heating zone from below and, being lighter than said molten metal, flows upwardly

simultaneously while subjected to both direct heating and pressing from said molten metal thus causing favourable carbonizing conditions for the manufacture of high grade hard coke.

4. The process of claim 1 wherein said starting material is subjected to the heat treatment at temperatures between 600°–800° C. which may involve the medium-temperature processes yielding a low-volatile coke suitable for use as a domestic and industrial smokeless fuel.

5. The apparatus for the continuous carbonization process described in claim 1, comprising a cylindrical preheater with feeder and extractor for said carbonaceous material and with inlet and outlet for circulating heating gases, an eductor intended to convey raw material from said preheater into a reactor by stream of said molten metal, said cylindrical reactor with a perforated helicoid mounted coaxially therewith intended for extending period of contact between the carbonaceous material processed and heating molten metal as well as its improving by a cross flow to secure the complete carbonization but to enable for the volatiles produced to pass the shortest way to a top chamber, said top chamber joining said reactor with a separator and having open outlet for said volatiles moved to a heat-exchange boiler and then to a chemical recovery plant, said cylindrical separator having in its upper section a coaxially placed drain pipe with slots for molten metal surrounded by a helicoid whose cross section is inclined in the direction of said drain pipe and whose lower end is joined to a chute for coke to be discharged into a cooling chamber, and a lower section for separation of said molten metal overflowing into a heater from coke breeze which is removed through a sealed pocket at the shell of said separator while an overflow pipe with a normally closed emergency drain branch controls a proper fixed lever of said molten metal in said separator allowing the excess of the clean molten metal to overflow from the lower part of separating zone into a heater but preventing said coke breeze from entering it, said heater furnished with special pump for delivery of molten metal to said eductor and with heating system which may be either of electrical or combustion nature, said cylindrical cooling chamber vertically installed and furnished with both feeder and extractor for coke produced and also with louvre inlet and outlet for circulating gases, a heat utilization system acting by means of circulating inert gases to transfer surplus heat from coke produced to starting carbonaceous material and which involves said preheater, said cooling chamber, a circulating fan, two conventional cyclons for solid fines separation, and necessary piping.

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