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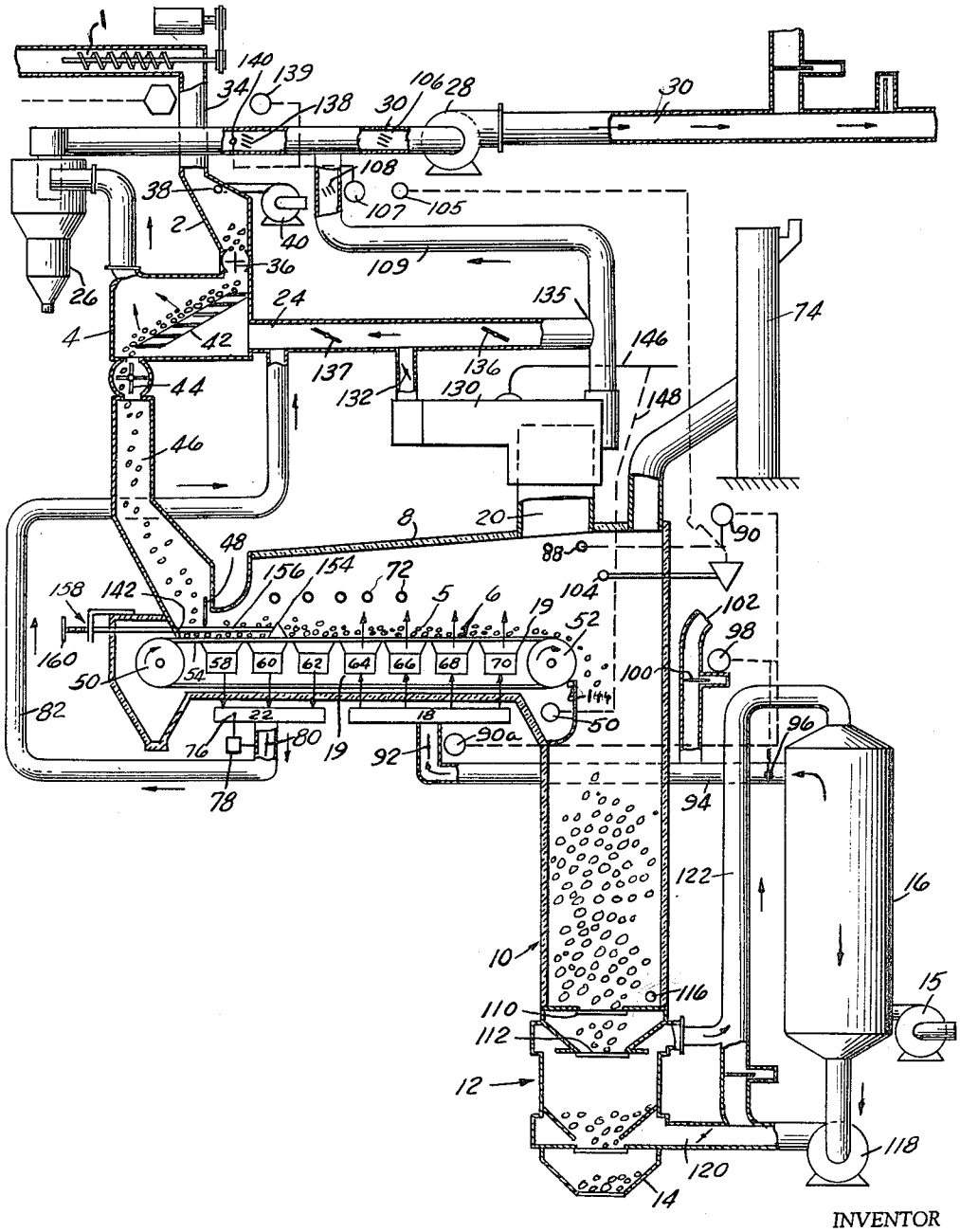

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METHOD FOR PRODUCING COKE AND GAS FROM CARBONIZABLE MATERIAL

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This invention relates to a method for producing coke and gas from carbonizable material, such as coal.

One main object of the invention is to provide a system for producing gas which may be utilized either as fuel or for its chemical constituents. It is intended particularly that the gas output of the system be hot, thereby conserving some of the heat required for its production for utilization in a chemical processing plant, but not so hot that it cannot be propelled by fans. This means that the upper temperature limit of the gas, as it leaves the apparatus in which it is produced for delivery through a conduit to the utilization plant, is approximately 650° F. When gas is produced from coal in a carbonizer furnace, as is intended here, the volatile matter driven off the coal includes tars which condense when the temperature of the gas drops as low as 320° F. Some of these tars are not desired for use in certain chemical processes for which the gaseous output of the subject system is intended. Of perhaps more concern are the problems resulting from condensation if tars are present in the gas as it flows through the delivery line, fan and associated equipment. It would be possible, of course, to cool the gas to below 650° before it is delivered and condense out the tars, but this entails extra equipment and handling, heat loss, and results in tar by-products in which certain constituents are potentially more valuable.

The subject apparatus includes a coal pre-heater, a carbonizer furnace, and a cooker through which coke from the furnace passes for final devolitilization. Excessively hot gases emerging from the cooker and furnace, the latter particularly containing tar-forming constituents, would, but for this invention, be unsuitable for transmission, and undesirable because of tar content. According to one object, a large percentage of the emerging hot gases is passed through incoming coal in the preheater with the following results: heat is transferred from the hot gas to the coal, thereby drying the coal and raising its temperature while lowering the temperature of the gas. Second, the coal in the pre-heater serves as a filter for cleaning the out-flowing gas of flying solid particles. Third, the coal in the preheater provides cool surfaces on which the tar-forming constituents of the through-flowing gas condense and deposit, thereby eliminating these constituents from the gas while simultaneously starting them on re-cycle through the carbonizer furnace. As the tars are re-cycled, time and time again, through the carbonizer furnace, the cracking phenomona take place. Certain of the fractions resulting from cracking are of more value, and are more usable as coke and in chemical processes for which the gas is produced than they were as tar constituents. The system thus becomes a simple and highly economical device not only for ridding the gas of most of the tars, but also for utilizing and converting low-temperature molecules into molecules which will not condense at transmission temperatures and are thus available for their more valuable purposes.

The carbonizer furnace utilized in this invention has a long front arch which overlies the entire coal bed moving through the furnace. Instead of updraftng air through the bed from all the air-box zones, only those near the rear end of the furnace are used for this purpose. Part of the oxygen-free gases, at about 1800° F., emerging upwardly from the bed near the rear end of the furnace are pulled towards the front end and downdrafted through the bed, thereby raising the bed temperature while driving and sweeping off low-temperature volatiles, i.e., those which come off at temperatures between 300° F. and about 950° F. Thus the rear portion of the furnace, in which limited combustion takes place, is utilized for providing the hot oxygen-free gases for the front portion which functions as a black furnace.

The gaseous outtake from the rear portion of the furnace, i.e., those gases from the rear portion of the furnace which have not been downdrafted, and those coming off the coke cooker, are combined, partially cooled by passing them through a boiler, then combined with the gas outtake from the front of the furnace, and then piped to a chemical plant or other utilization device.

Another object of the invention is to provide a method and apparatus in which coal of extremely small size, as well as sized particles, or mixtures of both, may be used. Heretofore in chain grate carbonizers, it has appeared necessary to use coal of substantial and uniform size. If the coal was too fine, a layer of hardpan would form in the bed, thereby blocking the flow of sufficient air to finish off carbonization of the remaining thickness of the bed. While various devices have been tried for skimming off layers or raking off the top of the bed and breaking up hardpan, there are certain metallurgical problems with equipment of that sort because of the heat to which they are subjected. Also, great care should be exercised to avoid channelizing of air through the bed, lest hot spots be created. While the full explanation of what happens within a bed consisting of various-size particles is not known, it is now believed that the fine particles go into plastic state and carbonize sooner than the large, with a resultant agglomeration of individual particles, rather than simultaneous agglomeration of large masses of adjacent particles. Premature plasticization of the small particles also apparently prevents free flow of hot gases to and around the large particles so that their plasticization, agglomeration and carbonization are delayed. An optional feature, intended to prevent premature agglomeration of small particles by prolonging the time in which they remain in plastic state while simultaneously preventing the formation of a hardpan layer and preventing also the formation of localized channels or hot spots through the bed, is the provision of a hurdle-like plow bar adjustably affixed across the furnace, immediately over the upper surface of the grate run so that the coal bed moving along the grate run is lifted as it passes over the plow bar. By locating the plow bar at the point, along the length of the grate run, at which the small particles start to plasticize, the bed is churned up, so to speak, sufficiently so that the small particles are prevented from agglomerizing, and free flow of hot gases around the large particles is provided so that the plasticization is accelerated. By this means, it is believed that all the particles, small and large, can be maintained in plastic state at the same time, and large hunks of strong coke will set as the particles all agglomerate at about the same time.

A basic object is to provide for close control and limitation of air flowing through the bed. By preheating the air before it enters the bed, and limiting the amount of hot air to the minimum necessary to carbonize the coal, the amount of nitrogen in the volatile matter driven off the bed is correspondingly restricted so that a relatively undiluted gas, capable for use as fuel gas and for chemical processes is derived. By preheating the air, up to approximately 720° F., before it is introduced into the furnace, not only is there provided a very quick heat transfer, but also the capability of the air for even distribution through the bed is enhanced. The high-temperature air takes up more space per unit volume of oxygen, whereas if the air were cool, the volume of air per unit volume of oxygen would be so small that even distribution across the full width of the stoker would be difficult.

Another feature in the close control and distribution of air is to ensure that air passes through only that portion of the bed which overlies the airbox zones towards the rear of the furnace. The oxygen content of the air is consumed as the air passes through the bed, and the hot gases emerging upwardly from the bed are thus substantially oxygen free. By applying relative negative pressure to the airbox zones towards the front of the furnace, the hot oxygen-free gases which ascend from the rear end of the furnace are downdrafted through that portion of the bed which is passing through the front portion of the furnace. Much of the volatile matter is pulled off the coal in an oxygen-free atmosphere, and optimum agglomeration is achieved. If oxygen is present at the time the particles plasticize, apparently some of the bonding constituents in the coal are oxidized before they can function to agglomerize or set the coke. An object of this invention is to maintain the integrity of bonding constituents in the coal by causing them to function so as to agglomerate the partly carbonized coal in a non-oxidizing atmosphere.

Another object, in connection with air control, is to prevent the admission of air into the lower portion of the furnace, i.e., beneath the upper run of the chain grate, and particularly in the spaces surrounding the airbox zones. Air leaking into this region of the furnace might be drawn into downdrafted mixture and thus create a mixture which could be explosive. To this end, it is intended to introduce steam at above atmospheric pressure from the boiler which forms a part of the system, thereby to block the ingress of air. A further object in the introduction of steam here is to provide a cooling medium and thus prevent heat build-up beyond tolerable limits in the grate clips and associated support mechanisms.

These and other objects, including the provisions of inter-related control mechanisms, and various by-pass and short-circuiting conduits and dampers for accomplishing the main purposes will be apparent from the following specification and drawings, in which the sole figure is a diagrammatic showing of the carbonizer furnace and associated system.

Referring now to the drawings, in which like reference numerals denote similar elements, the major components and flow of coal, air and gas through the system will first be outlined.

Green coal, such as West Kentucky No. 11 seam, at room temperature, sized from fines up to ¾ x 28 mesh, is introduced through infeed worm 1 and hopper 2 to a preheater-dryer 4, in which moisture is removed and the coal temperature raised to about 300° F., and then spread to form a bed 5 on a chain grate 6 running through a carbonizer furnace 8. After passing through furnace 8, the nearly completely devolatized coal, or coke, then at about 1,800° F. drops into a cooker 10 through which it slowly descends while almost all the remaining volatiles come off, and thence through cooler locks 12 to an outfeed 14 from which it descends at about 450° F.

Air forced in through fan 15 passes through a heat exchanger 16 in which heat from hot coke in cooler locks 12 is transferred to raise the air temperature to about 720° F., and thence fed through certain zones of an airbox 19 near the rear end of the furnace. Limited oxidation occurs in the bed, and part of the hot oxidation by-products, devoid of oxygen, plus high-temperature volatile matter are taken off through hot gas flue 20, through which gases ascending from cooker 10 also pass. Part of the hot gas, at about 1,800° F. flowing upwardly from the portion of the bed near the rear of the furnace is pulled towards the front of the furnace and downdrafted through the bed into the first few zones of airbox 19. The hot oxygen-free gas passing through the portion of bed 5 towards the front of the furnace, raises the bed temperature to about 950° F., thereby driving off most of the low-temperature volatiles (i.e., those which are liberated as the coal approaches and reaches plasticity) and causing the coal particles to plasticize and start to agglomerate. Having imparted heat to the coal, the downdraft gas, then enriched by the low-temperature volatile matter driven off the coal, enters outtake manifold 22 at about 950° F., from which it is pulled and mixed with the hot gas from the flue 20 in a blending conduit 24. After cooling, the blend gas, at from 900° F. to 950° F. is drawn through the dryer 4 in which it gives up heat to the green coal therein and, at the same time, low temperature tars in gaseous stated in the blend condense on the cool surface of the coal. The low temperature tars are re-cycled through the furnace. The blend gas, then at about 650° F. is drawn through a dust collector 26 and thence combined with gases from the boiler and propelled by fan 28 through a delivery line 30 to the consumer.

Considering the system in more detail, the green coal is fed by a screw 1 to a chute 34 for infeed hopper 2 from which it is fed by star feeder 36. In order to prevent entrance of air into the system through the coal infeed mechanism, sufficient suction may be applied through a port 28 in infeed hopper 2 by exhaust fan 40 to create a slight updraft through star feeder 36.

Dryer 4 has a degressing series of step-like louvres 42 down which the coal slides towards a star feeder 42 in the top of furnace hopper 46. Hot gas, as previously outlined, at 900° F. to 950° F. flows through louvres 42 and through the coal thereon. The cool coal functions as a condensing medium, and filters out low temperature condensible tars in the through-flowing gas. The condensible constituents in the gas, mainly tars, deposit on the relatively cool surfaces of the coal in dryer 4. When the coal reaches star feeder 44, all water moisture has been driven off, and the coal, plus the condensed tars, at approximately 300° F., flows through carbonizer hopper 46 from which it is spread by a conventional vertically adjustable spreader gate 48 to form a bed 5 on a conventional chain grate 6, which runs over sprockets 50, 52 driven by conventional mechanism so that its upper run 54 moves from front to rear through furnace 8.

The coal spread on the chain grate, then being completely devoid of moisture, is constituted substantially as follows:

	Percent
Ash	6.00
Volatile	42.85
Fixed carbon	51.15

Between upper and lower runs 54, 56 of the chain grate are a series of zones 58–70 into which airbox 19 is divided. The characteristics of zoned airboxes are well known in the art, it being sufficient now to note that zones 58, 60 and 62, which lie towards the front end of the furnace, are connected by conduits to a suction manifold 22, and zones 64, 66, 68 and 70 which lie towards the rear of the furnace are connected by conduits to a hot air infeed manifold 18. The conduits which connect the airbox zones to their respective manifolds are throttled by conventional dampers so that the suction applied to the front zones or pressure applied to the rear zones may be individually controlled.

In starting up, a fire is built in the carbonizer furnace on the coal bed and over-fire air is temporarily admitted through ports 72 in order to bring the furnace up to operating temperature, any smoke created during the start-up being exhausted via stack 74. Thereafter, the stack and over-fire air ports are closed, and throughout the normal operation of the system and the front portion of furnace 8 functions as a black furnace, in that no burning takes place, and the coal passing over airbox zones 58, 59 and 60 is treated with hot oxygen-free gas produced in the rear portion. The temperature of the coal spread on grate 6 at 300° F., is raised by the 1,800° F. gas downdrafted through the bed into airbox zones 58, 59 and 60 to between 900° F. and 1,000° F., preferably 950° F. by the time the bed passes beyond zone 62, and

the low temperature volatiles are liberated and swept off with the downdrafted gas. The 1,800° F. gas passing over the condensed tars on the incoming coal cracks the tars into the following components:

	Percent
(*a*) Carbon (coke)	22
(*b*) Tar	45
(*c*) Gas (1000 B.t.u. content)	33

The 45% tar is then recycled again until 100% cracking is accomplished. The gas produced from the cracked tar runs 1000 B.t.u. per s.c.f., thus improving the product gas from the process. Some of the low temperature tars and gases start coming off as bed temperature rises above 320° F., and they all start coming off as the coal temperatures rises above 900° F. The temperature of the enriched gases drawn into manifold **22** is sensed by a thermocouple **76** which, through a mechanism **78**, controls a damper **80**. If the temperature sensed by thermocouple **76** drops below 950° F., damper **80** opens sufficiently to draw more hot gas down through the bed, and if the sensed temperature starts to rise above 950° F., the damper closes accordingly. The enriched gas is taken from manifold **22** through a line **82**.

The amount and temperature of the air fed upwardly through the bed as it progresses over airbox zones **64–70** determines not only the quality of the coke end product, but also the characteristics of the gas end product. Air is fed in amounts insufficient to support a flame, but sufficient to make the bed glow. It is anticipated that, by preheating the air to 720° F., the ratio of air passed through the bed to coal passing into the furnace, pound for pound, need be no more than 0.7 pound per pound coal. In operating the system, damper **92** which controls the hot air infeed to manifold **18** should always be regulated so that, taking into account the temperature of the air, the temperature of the coal as it starts over airbox zone **64**, the rate at which the coal passes over zones **64–70**, and the amount of air required to raise the bed temperature to about 1,800° F., the ratio of air to coal is kept as low as possible. If, for example, this ratio can be reduced to ½:1, the hot gas ascending from the bed should be little more than 40% nitrogen and, when mixed in conduit **24** with the enriched gas downdrafted from the bed via line **82**, the nitrogen content of the blend should be no more than 29% nitrogen by volume, capable of conversion by shift reactors for economical production of ammonia. The temperature of part of the gas ascending from the bed towards the rear of the furnace, and also the gas arising from cooker **10** is sensed by a thermocouple **88** in flue **20** which, through mechanism **90**, **90***a* controls damper **92** in the hot air line branch **94** leading to manifold **18**. Another thermocouple **96** is provided in hot air infeed pipe **84**. The signal from thermocouple **96** controls motor **98** for a damper **100** which discharges excess air to maintain the desired temperature to the oxidizing section of the stoker. There is thus maintained a predetermined ratio between the input air temperature and gas temperature in flue **20**. If, however, the temperature sensed by thermocouple **88** rises above 1,800° F., motor **90***a* closes damper **92** and reduces input air sufficiently to drop the temperature so that safe operating temperature of the grate will not be exceeded. Also near the bottom of flue **20** is a draft senser **104** controlling a motor **105** for damper **106** in a gas delivery line **30**. Over-riding manual controls and fail-safe mechanisms (not shown) are also provided for the system. The delivery and hence the suction produced by outtake fan **28**, which is driven by a constant speed motor, is the primary draft controlling factor in the system, and the temperature sensed by thermocouple **88** becomes the master factor by which the operator of the system sets all other controls. If, for example, the gas temperature in flue **20** rises above 1,800° F. and if, after dampers **92** and **108** are shut, the temperature sensed by thermocouple **88** continues to rise, the operator knows that there is an air leak, and the system is immediately shut down and all combustion is extinguished.

In passing over airbox zones **64–70**, the hot coal, having previously been stripped of most of its low-temperature volatiles, and having already started to carbonize, is brought to about 1,800° F. by the hot air from manifold **18**. During the temperature rise from between 900° and 1,000° to 1,800° F., most of the high temperature volatiles are driven off; the coke firmly sets so that, as the now glowing chunks drop into cooker **10**, only a small percentage of residual volatile matter remains. Locks **110**, **112** at the cooker bottom are controlled by a conventional level sensing device so that approximately one hour is required for the coke to move downwardly through the cooker. A small amount of air may be added through an inlet port **116** leading into the cooker, sufficient to maintain the temperature of the cooking coke at 1,700° F. so as to drive off all but from 1% to 2½% of the residual volatiles. From lock **112**, the coke drops into a cooler **12**, and then through a lock out-feed **14**. Cool inert gas is forced by a fan **118** through duct **120** through the coke in cooler **12**. Heat is imparted to the gas, which, at about 1,200° F., is fed through a duct **122** and thence through the flues of heat exchanger **16**, wherein it gives up heat to the air supplied by input fan **15**, the cooled inert gas, then at about 400° F., being returned to fan **118**. A suitable conventional level senser and associated controls are provided for the out-feed locks, and conventional damper, bypass, and temperature sensing devices in the inert gas circuit maintain the desired heat transfer from the hot coke through the heat exchange to the incoming cool air. The blend of hot gases arising from cooker **10** and the rear portion of furnace **8** through flue **20** and boiler **130** with the cooler enriched gas drawn from manifold **22** is regulated by dampers **132**, **136** and **137**.

A boiler **130** utlizes much of the heat in the gases arising through flue **20** and, in passing through the boiler, the gases are cooled. Conventional water and steam pipes (not shown) lead to and from the boiler. Nearly half of the gases, after heating the boiler, are taken off via bypass line **109** and led directly into delivery line **30** on the low-pressure side **28**. This bypass gas should be at about 650° F. Other gas, from which not so much heat is extracted by boiler **130**, is led off at about 950° F. via a line **132** into blending conduit **24**. A connection **135** from duct **109** to conduit **24** controlled by a damper **136** permits controlled amounts of 650° F. gas to be let into the hotter stream from line **132** so that the resultant temperature of the stream entering blending conduit **24** from boiler **130** is 950° F. A damper **137** controls the total amount of gas from the boiler let into blending conduit **24**. A damper **138** is operated by a motor **139** responsive to a thermocouple **140** subjected to the heat of the gases flowing into delivery line **30** from dust collector **26**. Thus, the amount and temperature of the gas flowing through dryer **4** can be closely controlled, and the temperature of the gases entering delivery line **30** can also be held to no more than 650° F. by the various damper, blending and bypass mechanisms. The velocity of the gas passing through the dryer is limited so that the large coal particles will not be lifted from the green coal and also to prevent over-preheating of the coal in the dryer.

Furnace **8** and cooker **10** are constructed of conventional refractory materials and metal capable of withstanding heat. A lower furnace enclosure is provided by front and rear seals **142**, **144** which seal against the chain grate and the lower interior of the furnace is as airtight as possible. Steam from the steam output line **146** of boiler **130** is led via a branch conduit **148**, having conventional pressure and quantity controls (not shown) to an inlet port **150** in the lower portion of the furnace. If necessary, the steam introduced through port **150** may be bled off, at suitable locations beneath the upper grate run, so as to

insure the free circulation of steam through the space between the upper and lower grate runs. It is anticipated that the steam will absorb heat from the metal from which the grate is formed and be superheated thereby, perhaps up to 1,000° F., thus preventing heat build-up in the metal as the latter passes around and around. The steam, being above atmospheric pressure, prevents any air, other than that introduced through airbox zones 64–70, from entering the furnace.

An optional feature is a plow bar 154 extending across the furnace so that the upper surface of the grate run 54 scrapes beneath it. Bar 154 is supported by rods 156 at its ends, and the rods are adjustable lengthwise of the furnace by suitable mechanical means 158 whose details are not important to this invention, it being understood that when hand wheels 160 at each side of the furnace are turned, bar 154 is moved lengthwise of the furnace so that it can be located precisely at the point where the smallest particles start to plasticise. The coal bed on the grate, riding up and over the plow bar, will be agitated sufficiently to prevent the smaller plastic particles from sealing around the larger ones and to permit flow of the down-drafted hot gases around the larger particles.

In a typical example, it will be assumed that the grate run is approximately 20 feet long and 15 feet wide; and that 10.125 tons of West Kentucky No. 11 coal per hour are fed through the furnace; and 0.7 lb. of air per pound of coal are fed to the coal via manifold 18. It is further assumed that about 100% of the oxygen in the air reacts with the coal in the bed; about 50% of the heat liberated in the bed as it passes through the oxidizing section is available to heat the coal in the bed; and approximately 5,890,000 B.t.u./hour are transferred to the boiler. Operating under these conditions, it is anticipated that the coke output will be about 10,763 lbs. per hour, consisting of less than 2% volatile matter, the original ash content, and substantially all of the original fixed carbon in the coal.

The gas output for the system is estimated at 12.42 s.c.f. per pound coal at 650° F., consisting (dry basis by volume) of the following:

N_2	54.8
CO	2.5
CO_2	12.5
H_2	12.9
CH_4	9.8
C_2H_6	2.2
C_3H_8	.7
C_4H_{10}	.3
C_5H_{12}	.1
C_6H_{14}	.1
C_2H_4	1.4
C_3H_6	.8
C_4H_8	.1
C_5H_{10}	.2
C_6H_{12}	.1
C_7H_{14}	.1
H_2S	.7
A	.7
	100.0

H.F.=282.5 B.t.u./s.c.f.

In the foregoing specification and ensuing claims, the temperature at which most of the low temperature volatiles have been driven off is stated as between 900° F. and 1,000° F., preferably 950° F. The range is stated thusly because of variations in particle size of the coal and the feed rate. From the standpoint of protecting the associated equipment from heat, the lower end of this range is preferred. However, in order to remove the desired percentage of volatile matter from the coal, it is contemplated that the higher end of the range might be necessary.

Insofar as concern the relative amounts of gaseous by-products of the oxidation zone (i.e., the portion of the bed towards the rear of the furnace) which are downdrafted through the carbonization zone (i.e., the portion of the bed towards the front of the furnace), on the one hand, and the remainder of said by-products which are fed through the boiler, the following observation is applicable: From the standpoint of economics, the greater percentage of said by-products which can be downdrafted through the carbonization zone, the better. The main object in feeding the remainder through the boiler, or heat exchanger, is to maintain a proper heat balance in the system by preventing temperature rise in the carbonization zone substantially above 950° F.

It should be understood that those skilled in the art may make various adjustments in accordance with variables such as the size, feed rate and heat transfer characteristics of the particular apparatus with which the invention is utilized, the characteristics of the coal fed into the system, the amount of heat to be extracted in the boiler, and the desired or permissible characteristics of the gas and coke end products, and that the estmates set forth herein are subject to change in accordance with the variables. The invention encompasses all substitutions, modifications and equivalents within the scope of the following claims.

I claim:

1. In a method for producing coke and gas from coal which contains low temperature volatiles capable of being liberated at temperatures ranging from about 300° F. to about 950° F. and high temperature volatiles capable of being liberated at temperatures ranging from between about 950° F. to about 1,800° F., at least some of said volatiles being tars which condense at temperatures at about 320° F. and below 320° F. the steps which comprise: passing initially cool coal of the order of 90° F. and below through a preheater-dryer; forming a bed of the dry preheated coal and horizontally passing the bed through a hot carbonizer furnace from an input end to an output end thereof so as to form a first bed portion contiguous to the input end of the furnace and an adjacent second bed portion which lies contiguous to the output end of the furnace; feeding air upwardly through the second bed portion in limited quantities sufficient only to oxidize part of the volatiles in the coal and raise the second bed portion temperature toe about 1,800° F. so as to create a mixture of hot substantially oxygen-free by-products of oxidation and unburned high-temperature volatiles at about 1,800° F. above the bed, downdrafting at least part of said mixture through the first bed portion in sufficient quantities to raise the first bed portion temperature to about 950° F. while liberating and sweeping off at least most of the low-temperature volatiles and partially cooling said part of the mixture to about 950° F.; sweeping the downdrafted part of the mixture and low temperature volatiles through the coal passing through the dryer, and condensing said tars on the coal in the dryer, the air fed upwardly through the second bed portion being substantially the only air fed through the coal while the latter passes through the furnace.

2. In a method for producing coke and gas from coal which contains low temperature volatiles capable of being liberated at temperatures ranging from about 300° F. to between 900° F. and 1,000° F. and high temperature volatiles capable of being liberated at temperatures ranging from between 900° and 1,000° F. to about 1,800° F., at least some of said volatiles being tars which condense at about 320° F. and below, the steps which comprise: passing initially cool coal through a preheater-dryer; forming a bed of the dry preheated coal and horizontally passing the bed through a hot carbonizer furnace from an input end to an output end thereof so as to form a first bed portion contiguous to the input end of the furnace and an adjacent second bed portion which lies contiguous to the output end of the furnace; feeding air upwardly through the second bed portion in limited quantities sufficiently only to burn with part of the volatiles in the

coal and raise the first bed portion temperature to about 1,800° F. so as to create a mixture of hot, substantially oxygen-free by-products of oxidation and unburned high-temperature volatiles at about 1,800° F. above the bed; downdrafting at least part of said mixture through the first bed portion in sufficient quantities to raise the first bed portion temperature to between 900° to 1,000° F. while liberating and sweeping off at least most of the low-temperature volatiles and partially cooling said part of the mixture; sweeping the downdrafted part of the mixture and low temperature volatiles through the coal passing through the dryer, and condensing said tars on the coal in the dryer so that said tars are recycled through the furnace.

3. In a method for producing coke and gas from coal which contains low temperature volatiles capable of being liberated at temperatures ranging from about 300° F. to between 900° F. and 1,000° F. and high temperature volatiles capable of being liberated at temperatures ranging from between 900° F. and 1,000° F. to about 1,800° F., at least some of said volatiles being tars which condense at temperatures of about 320° and below, the steps which comprise: passing initially cool coal through a preheater-dryer; forming a bed of the dry preheated coal and horizontally passing the bed through a hot carbonizer furnace from an input end to an output end thereof so as to form a first bed portion contiguous to the input end of the furnace and an adjacent second bed portion which lies contiguous to the output end of the furnace; feeding air upwardly through the second bed portion in limited quantities sufficient only to burn with part of the volatiles in the coal and raise the first bed portion temperature to about 1,800° F. so as to create a mixture of hot substantially oxygen-free by-products of oxidation and unburned high-temperature volatiles at about 1,800° F. above the bed; downdrafting at least part of said mixture through the first bed portion in sufficient quantities to raise the first bed portion temperature to between 900° F. and 1,000° F. while liberating and sweeping off at least most of the low-temperature volatiles and partially cooling said part of the mixture; partially cooling the remainder of said mixture by passing the same through a boiler so as to transfer heat from said remainder to said boiler; sweeping the downdrafted part of the mixture and low temperature volatiles through the coal passing through the dryer, cooling the sweeping gases and condensing said tars on the coal in the dryer; and combining the gases swept through the dryer with at least part of said remainder after said remainder has passed through the boiler.

4. In a method for producing coke and gas from coal of relatively large and small particle size which contains low temperature volatiles capable of being liberated at temperatures ranging from about 300° F. to between 900° F. and 1,000° F. and high temperature volatiles capable of being liberated at temperatures ranging from between 900° F. and 1,000° F. to about 1,800° F., said coal becoming plastic in the temperature range at which the low temperature volatiles are liberated, the steps which comprise: forming a bed of the coal and horizontally passing the bed through a hot carbonizer furnace from an input end to an output end thereof so as to form a first bed portion contiguous to the input end of the furnace and an adjacent second bed portion which lies contiguous to the output end of the furnace; feeding air upwardly through the second bed portion in limited quantities sufficient only to burn with part of the volatiles in the coal and raise the first bed portion temperature to about 1,800° F. so as to create a gaseous mixture of hot substantially oxygen-free by-products of oxidation and unburned high-temperature volatiles at about 1,800° F. above the bed, downdrafting at least part of said mixture through the first bed portion in sufficient quantities to heat the first bed portion to temperature of the order of 900° F. to 1,000° F. while liberating and sweeping off at least most of the low temperature volatiles and partially cooling said part of the mixture; and agitating the coal which forms the first bed portion at the point where the relatively small particles start to plasticize.

5. In a method for producing coke and gas from coal which contains certain volatiles including tars capable of being liberated at temperatures at which the coal approaches and passes into a state of plasticity and certain other volatiles capable of being liberated at higher temperatures between that at which the coal becomes plastic and that at which the coal carbonizes, the steps which comprise: passing initially cool coal through a preheater-dryer; passing a bed of the dry preheated coal horizontally through a hot carbonizer furnace from an input end to an output end thereof in continuous stream in which there is a moving first bed portion contiguous to the input end of the furnace and a moving second bed portion which lies contiguous to the output end of the furnace; feeding hot air upwardly through the second bed portion in limited quantities sufficient only to oxidize part of the other volatiles in the coal and raise the temperature of the coal forming the second bed portion to carbonizing temperature while creating a mixture of hot substantially oxygen-free by-products of oxidation and unburned quantities of said other volatiles above the bed; downdrafting at least part of said mixture through the first bed portion in sufficient quantities to heat the coal forming the first bed portion to plasticizing temperature while liberating and sweeping off the first-named volatiles and partially cooling said part of the mixture; and sweeping the downdrafted part of the mixture and first-named volatiles through the coal passing through the preheater-dryer and cooling the sweeping gases and condensing said tars on the coal in the dryer so that said tars are re-cycled through the furnace, and cracking the re-cycled tars with the downdrafting mixture as said tars are re-cycled through the moving first bed portion.

6. In the method claimed in claim 5, the further steps comprising: passing the remainder of said mixture through a boiler so as to transfer heat therefrom to the boiler while partially cooling said remainder, and subsequently combining the partially cooled remainder of the mixture with the gases which have been swept through the coal in the preheater-dryer.

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