

March 25, 1969

V. MANSFIELD

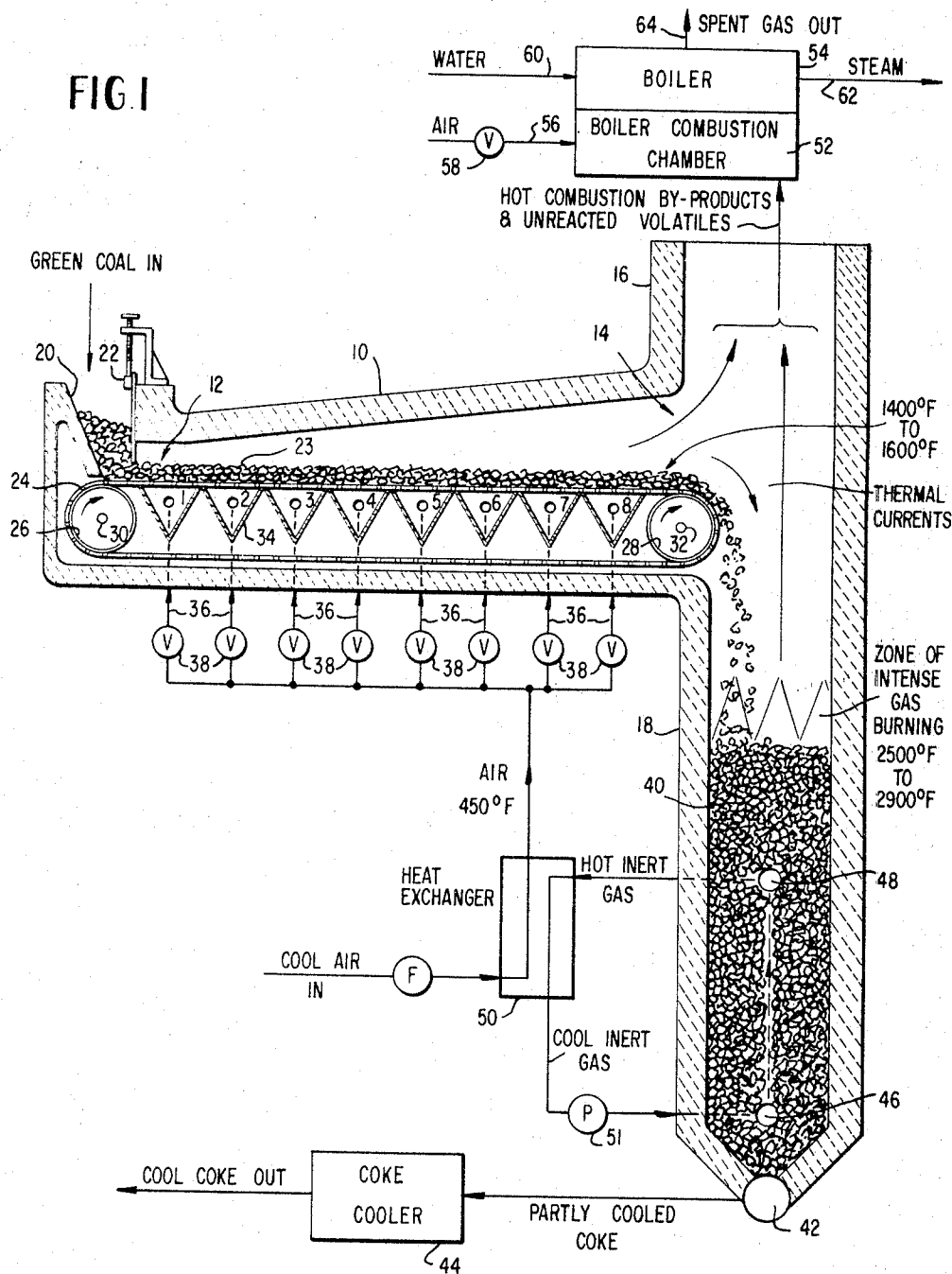
3,434,932

COKE AND HEAT PRODUCING METHOD

Filed March 30, 1967

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FIG. 1



INVENTOR

VAUGHN MANSFIELD

BY

James H. Littlepage
ATTORNEY

March 25, 1969

V. MANSFIELD

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FIG. 2

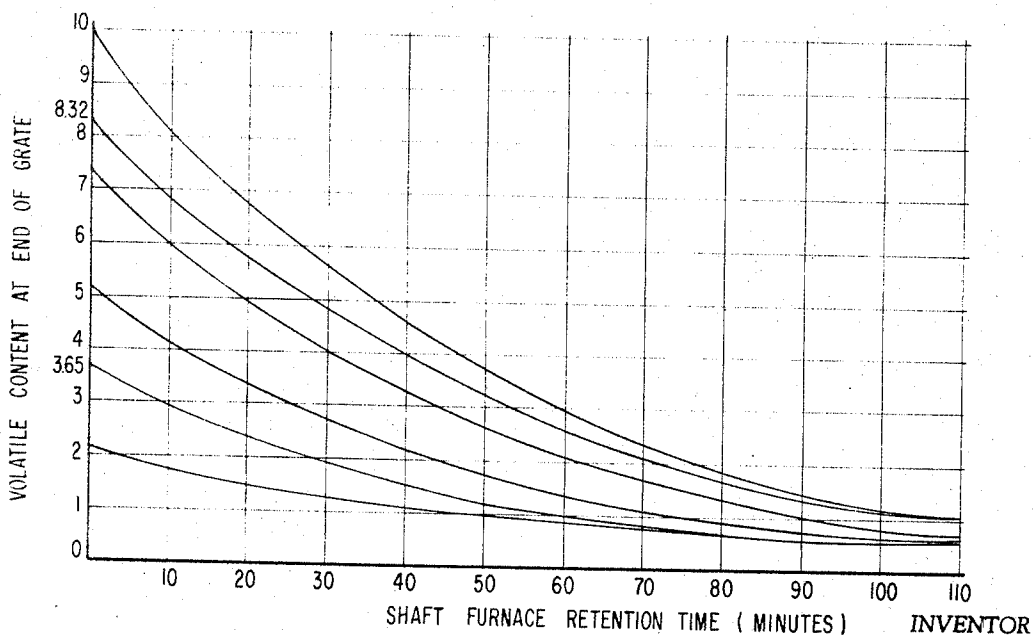
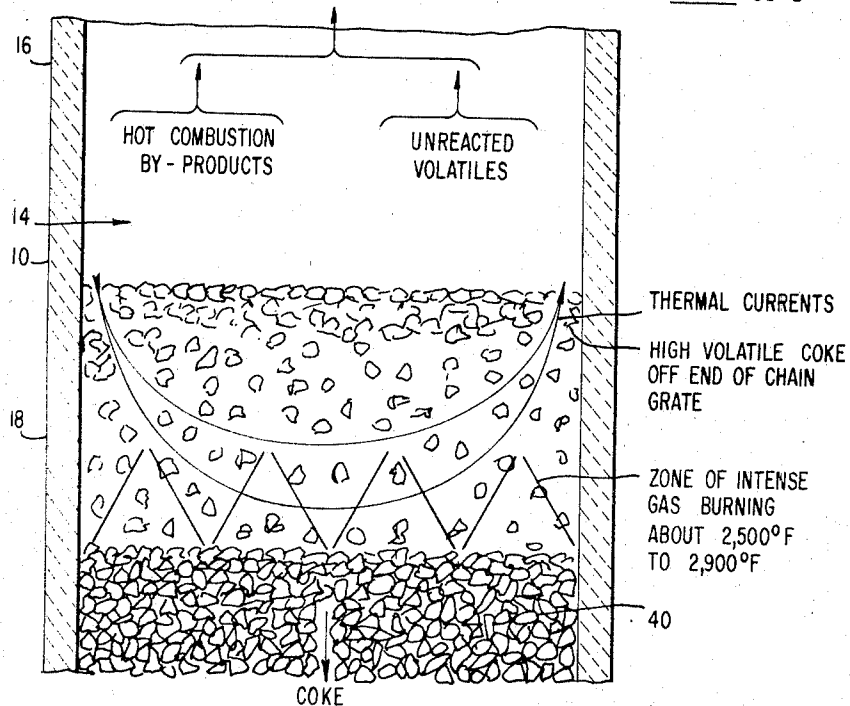


FIG. 3

VAUGHN MANSFIELD

BY

James H. Lippert

ATTORNEY

March 25, 1969

V. MANSFIELD

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CONVENTIONAL										IMPROVED							
PROXIMATE ANALYSIS , DRY																	
BASIS OF COKE , IN %		F.C.		VOL.		ASH		F.C.		VOL.		ASH					
LEAVING CHAIN GRATE		82.15		3.65		14.20		80.50		8.32		11.18					
LEAVING SHAFT FURNACE		84.47		0.90		15.01		86.14		1.90		11.96					
% YIELD OF FIXED CARBON IN																	
COKE TO FIXED CARBON IN COAL										42.78							
49.30																	
BTU'S PER HOUR INPUT TO																	
BOILER COMBUSTION CHAMBER										150,920,000							
130,510,000																	
OVER-ALL THERMAL																	
EFFICIENCY OF PLANT										82.3							
86.5																	
AIR FEED TO																	
AIR BOX ZONES		1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
INCHES OF H ₂ O		0	1.6	1.6	1.	.2	0	0	0	0	.2	.1	.1	.1	0	0	0
SIZE CONSIST OF COKE LEAVING SHAFT FURNACE , IN PERCENTAGES																	
+ 1 INCHES		1.6								3.9							
+ 5/8 INCHES		5.6								11.7							
+ 1/2 INCHES		7.6								23.5							
+ 4 MESH		58.6								53.2							
+ 6 MESH		5.8								1.5							
+ 8 MESH		3.3								0.8							
+ 16 MESH		2.6								0.9							
+ 30 MESH		1.9								0.8							
- 30 MESH		12.9								3.7							
SULPHUR CONTENT LEAVING																	
SHAFT FURNACE										2.60 %							
2.60 %																	

INVENTOR

VAUGHN MANSFIELD

FIG. 4

BY

James H. L. L. L.

ATTORNEY

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3,434,932

COKE AND HEAT PRODUCING METHOD

Vaughn Mansfield, Gallatin, Tenn., assignor, by mesne assignments, to Peabody Coal Company, St. Louis, Mo., a corporation of Delaware
Continuation-in-part of application Ser. No. 408,833, Nov. 4, 1964. This application Mar. 30, 1967, Ser. No. 627,009

Int. Cl. C10b 47/20

U.S. Cl. 201—27

3 Claims

ABSTRACT OF THE DISCLOSURE

Coal is fed onto a chain grate moving horizontally through a hot carbonizing furnace, and limited quantities of air are fed upwardly through the coal on the grate as to combust with only part of the volatiles, leaving a comparatively large amount of volatiles in the partly carbonized coal. The partly carbonized coal, i.e., high-volatile coke, drops off the end of the grate into a vertical shaft furnace, which extends downwardly from the rear of the carbonizing furnace, to form a column which progresses downwardly and is finally discharged from the bottom of the shaft furnace into a cooler. Thermal currents develop at the rear of the carbonizing furnace so that unreacted oxygen from the carbonizing furnace, plus unreacted oxygen entrained in the coke, burn violently with the volatiles in the coke as the latter drops onto the top of the column in the shaft furnace, creating a layer of intense burning over the top of the stack in the shaft furnace, thereby driving off and consuming most of the volatiles remaining in the coke.

RELATED APPLICATIONS

This is a continuation-in-part of Ser. No. 408,833, entitled Coke Producing Method, filed Nov. 4, 1964, now abandoned. A related application is Ser. No. 286,334, filed June 7, 1963, now U.S. Patent No. 3,331,754, entitled Coke Quenching System.

BACKGROUND OF INVENTION

Field of invention

The invention falls within the class of distillation methods.

Description of prior art

In a prior commercial installation utilizing apparatus consisting of a horizontal chain grate carbonizing furnace, a vertical shaft furnace at the rear end thereof and a boiler having a combustion chamber fed with unburned volatiles and hot combustion byproducts from both the carbonizing and shaft furnaces, the practice was to remove as much volatile matter as was feasible from the coal as it passed through the carbonizing furnace on the chain grate. This resulted in overheating of the chain grate and excess burning of the fixed carbon in the coal, and reduction in percentages of yield of fixed carbon in the coke and overall plant efficiency.

SUMMARY

By air-starving the coal as it moves through the hot carbonizer furnace on the horizontal chain grate, a volatile content of about 7% to 10% is retained in the coke dropping off the end of the grate onto the top of the downwardly moving stack of coke in the vertical shaft furnace, as contrasted with the conventional operation wherein a volatile content of about 3.65% which is retained in the coke dropping off the end of the grate when the carbonizer furnace was operated by feeding more air through the bed on the grate, so as to remove the optimum amount of volatiles, i.e., about 3.65% or less. The

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increased quantity of volatiles left in the coke according to the improved method creates a zone of intense gas burning over the coke at the top of the stack in the shaft furnace, whereas under conventional practices the lesser volatile content of the coke resulted in no significant gas burning over the coke stack in the shaft furnace. The intense gas burning over the coke stack in the shaft furnace drives off most of the remaining volatiles without appreciable burning of the fixed carbon in the coke; the maintenance of the lower temperatures in the coal or coke passing through the carbonizer furnace reduces erosion of the grate; and increased overall plant efficiency is attained.

DESCRIPTION OF PREFERRED EMBODIMENT

FIG. 1 is a diagrammatic longitudinal cross section taken vertically along the center through the carbonizer furnace and vertical shaft furnace, showing the boiler combustion chamber and boiler heat exchanger and coke cooler in block diagram;

FIG. 2 is a fragmentary diagrammatic transverse cross section taken vertically through the rear end of the carbonizer furnace and the upper end of the shaft furnace showing the paths of the thermal currents and the zone of intense burning of volatiles over the top of the stack of coke in the shaft furnace;

FIG. 3 is a graph showing the percentages of volatile matter in the coke plotted against residence time in the vertical shaft furnace; and,

FIG. 4 is a chart comparing the vital statistics of conventional operation against improved operation.

Referring now to the drawings, in which like reference numerals denote similar elements, FIG. 1 diagrammatically shows a carbonizing furnace 10 having a front end 12, and a rear end 14 from which a stack 16 extends upwardly and a vertical shaft furnace 18 extends downwardly. Green coal input to the front end 12 of the carbonizing furnace 10 through a hopper 20 is spread by a spreader gate 22 so as to form a bed 23 of about four inches thickness on the upper run of a horizontally moving chain grate 24 which runs over sprockets 26, 28, at least one of the shafts 30 or 32 of which is driven by a suitable source of power, not shown, so that the coal bed 23 progresses through the carbonizer furnace from the input end 12 to the output end 14. In the present example chain grate 24 is 19' wide, 23' long, and shaft furnace 18 is 19' wide, 5' deep and 17' high. As the coal progresses through carbonizer furnace 10 it passes over eight separate zones 1-8 of an airbox 34, which zones are fed by separate air inlet conduits 36 individually controlled by valves 38. The air, which in the examples hereof is at about 450° F., is derived from a heat exchanger 50, supplied by an F.D. fan.

As the coal progresses along chain grate 29, it is coked, and the incandescent chunks of coke drop off the end of the chain grate to form a downwardly moving column 40 in vertical shaft furnace 18. The coke product is discharged into a coke cooler 44 and thence out through a suitable conveyor, not shown. Near the bottom of vertical shaft furnace 18 are inert gas inlets, one of which inlets 46 is shown. Cool inert gas works its way up the coke column 40 and is withdrawn through outlets part way up the height of the shaft furnace, one outlet 48 being shown. The inert gas absorbs heat from the coke in the lower part of column 40, the heat being given off in a heat exchanger 50 to preheat the air fed by fan F to airbox 34, and the cooled gas is forced back by a pump 51 into the bottom of the coke column through inlet 46. The coke cooler 44 and inert gas system, including a gas makeup feature, are detailed in my copending application

Ser. No. 286,334, filed June 7, 1963, entitled Coke Quenching System.

Stack 16 leads to the combustion chamber 52 of a boiler 54. Air for combustion is supplied through a line 56 controlled by a valve 58. Boiler water is supplied by a line 60, steam is output through a line 62, and spent gas is exhausted through a suitable outlet 64. All the apparatus thus far described is old or shown in copending application Ser. No. 286,334 (supra) and forms no part of the invention.

In describing the novel process which constitutes the invention reference will be made to "conventional operation" and "improved operation" in order to point out the invention. In both the conventional and the improved operations it will be assumed that in both operations the starting material is West Kentucky coal No. 11 crushed to 1½" x 0 having a makeup (dry basis) as follows:

	Percent
Fixed carbon -----	51.43
Ash -----	7.00
Volatiles -----	41.57
Water -----	10.02
Sulphur -----	13.02

¹ In fixed carbon, ash and volatiles.

In all examples the coal handling was as follows:

Grate speed—75 feet per hour.

Coal input per hour—10.9 tons.

Retention time on grate—18.5 minutes.

Bed thickness—4 inches.

Retention time in shaft furnace—1 hour, 20 minutes.

"Conventional operation" as used herein means operation of the disclosed system according to former practices, wherein as much volatile matter as practicable was removed from the coal in carbonizing furnace 10 as was feasible while retaining acceptable percentage of fixed carbon in the coke leaving shaft furnace 18. This was accomplished by control of valves 38 so that the under-fire air passing upwardly from airbox zones 1-8 reacted with the volatiles in the coal, and to some extent with the fixed carbon in the coal, until the average temperature of the coke dropping off the end of the chain grate was between about 1850° F. and 2000° F., and the volatile content ranged from about 3.65% to about 2.15%. It was the residual heat in the coke in the column 40 in shaft furnace 18 which drove off most of the residual volatiles until the coke leaving the bottom of the shaft furnace had a volatile content of from about 2.15% to about 1.65%, which was within acceptable limits. However, as will be seen from the tables of FIG. 4, this resulted in loss of fixed carbon, size consist which left something to be desired, and decrease in overall plant efficiency, taking into account steam production, plus fixed carbon content of the coke.

According to this invention, the air issuing upwardly from the airbox zones 1-8 is so reduced that the average bed temperature, as averaged from top to bottom, at the end of the grate run is between 1,400° F. and 1,600° F., optimum about 1,500° F. Since burning works its way downwardly through the bed, starting adjacent the input end 12 of the carbonizing furnace and being deepest at the output end 14, this means that the temperature of the coke adjacent the bottom of the bed is considerably less than the average, and the grate is comparatively cool. The volatile content of the coke dropping off the end of the grate run is from about 7.18% to 10%. When this high volatile coke drops onto the top of the coke column 40 in shaft furnace 18, it is physically agitated by the impact. A zone of intense almost explosive gas burning occurs over the top of the coke column, and the downcoming coke must pass through the gas burning zone, thereby causing further release of the volatiles from the coke.

It is believed that the oxygen for reaction with the

gas above the top of column 40 comes from several sources, namely from about bed 23, this having passed through the coke in bed 23 and having not completely reacted with the volatiles in the coal in the bed; and possibly from leaks in the system as, for example, beneath spreader gate 22. Whatever be the sources, there is enough oxygen to react with the volatiles in the coke and create the zone of violent burning over column 40, this being judged to be from about 2000° F. to about 2500° F. It has been observed that thermal currents prevail in the upper portion of shaft furnace 18, these being illustrated diagrammatically in FIG. 2 by the curved arrow lines. Apparently there are downsweeping drafts, in one direction or the other, which establish themselves to supply oxygen for reaction with the volatiles in the coke. The net result is that instead of being subjected to only about 1,850° to 2,000° heat as is conventional practice, the coke at the top of column 40 is subjected for a short while to heat of about 2,000° F. to 2,500° F., and the volatiles therein are driven off and burned without appreciable loss of fixed carbon; and below the top of column 40 there is no appreciable oxygen to react with the fixed carbon so that insignificant loss of fixed carbon as the coke in the column moves downwardly through vertical shaft furnace 18.

Meanwhile, hot combustion byproducts and a rich mixture of volatiles from the coal in bed 23 move upward through stack 16 so as to supply heat and fuel to boiler combustion chamber 52. As will be apparent from FIG. 4, the B.t.u.'s available for boiler combustion chamber 52 are greater under conventional operation than with the improved, but the overall plant efficiency is greatly less, due to the lower percentage yield of fixed carbon in the coke.

The computation of fixed carbon, volatiles and ash in FIG. 4 and in the limitations set forth in the claims are based upon West Kentucky coal No. 11 with the makeup set forth hereinbefore as the starting material, it being understood that the percentages of these constituents in the coke at the end of the chain grate and at the output of the vertical shaft furnace will vary in accordance with variations in percentages of these constituents in the coal. Also, the stack to the boiler combustion chamber may lead upwardly from the front part of the carbonizer, instead of from the rear as shown.

I claim:

1. The method of producing coke from coal having a dry basis content, for example, of:

	Percent
Fixed carbon -----	51.43
Ash -----	7.00
Volatile matter -----	41.57

which comprises: continuously depositing said coal onto a horizontal grate run in a hot coking furnace so as to form a bed of substantially uniform thickness; igniting said coal upon entry thereof into said furnace; feeding the ignited coal on the grate run horizontally through the furnace and zone feeding hot air at about 450° F. upwardly through the coal in the bed in controlled amounts until average bed temperatures at the end of the grate run is from about 1400° F. and 1600° F. and the coal has set into partly carbonized chunks of coke having a volatile content of from about 7.18% to 10%, fixed carbon content from about 79% to 81% and ash content from about 11.00% to 11.85% dropping the partly carbonized chunks of coke off the end of the grate run onto the top of a downwardly moving column thereof in a vertical shaft furnace; burning over the top of the column volatile matter released from said chunks dropping onto the top of the column so as to create over the top of the column a temperature zone of from about 2000° F. to 2500° F.; and maintaining said chunks in said downwardly moving column until the residual heat in said chunks drives off volatile matter remaining therein until said chunks contain from about 0.50% to 2.00% volatile matter and with

fixed carbon content of from about 85.50% to 87.50% and ash content of from about 12.00% to 12.50%.

2. The method of producing coke and heat from coal having a dry basis content, for example, of:

	Percent
Fixed carbon -----	51.43
Ash -----	7.00
Volatile matter -----	41.57

which comprises: continuously depositing said coal onto a horizontal grate run in a hot coking furnace so as to form a bed of substantially uniform thickness; igniting said coal upon entry thereof into said furnace; feeding the ignited coal on the grate run horizontally through the furnace and zone feeding hot air at about 450° F. upwardly through the coal in the bed in controlled amounts sufficient to react with part of the volatile matter and fixed carbon in the coal until average bed temperatures at the end of the grate run is from about 1400° F. and 1600° F. so as to drive off volatiles from the coal and set the same into partly carbonized chunks of coke having a volatile content of from about 7.18% to 10% while producing above the bed hot gaseous byproducts of reaction of the air with volatile matter and fixed carbon in the coal and a substantial amount of unreacted volatiles; dropping the partly carbonized chunks of coke off the end of the grate run onto the top of a downwardly moving column thereof in a vertical shaft furnace; reacting over the top of the column volatile matter released from said chunks dropping onto the top of the column so as to create over the top of the column a temperature zone of from about 2000° F. to 2500° F.; feeding the hot gaseous byproducts and unreacted matter from above the bed, plus hot reaction byproducts from over the column to the combustion chamber of a boiler and feeding air to the boiler combustion chamber in sufficient quantities to react with substantially all of the previously unreacted volatiles from the coal in the bed while maintaining said chunks in said downwardly moving column until the residual heat in said chunks drives off volatile matter remaining therein until said chunks contain from about 0.50% to 2.00% volatile matter.

3. The method of producing coke from coal having a dry basis content, for example, of:

	Percent
Fixed carbon -----	51.43
Ash -----	7.00
Volatile matter -----	41.57

5 which comprises: continuously depositing said coal onto a horizontal grate run in a hot coking furnace so as to form a bed of substantially uniform thickness; igniting said coal upon entry thereof into said furnace; feeding the ignited coal on the grate run horizontally through the furnace and zone feeding hot air at about 450° F. upwardly through the coal in the bed in controlled amounts until average bed temperatures at the end of the grate run is from about 1400° F. and 1600° F. and the coal has set into partly carbonized chunks of coke having a volatile content of about 8.32%, fixed carbon content of about 80.50% and ash content of about 11.18%; dropping the partly carbonized chunks of coke off the end of the grate run onto the top of a downwardly moving column thereof in a vertical shaft furnace; reacting over the top of the column volatile matter released from said chunks dropping onto the top of the column so as to create over the top of the column a temperature zone of from about 2000° F. to 2500° F.; and maintaining said chunks in said downwardly moving column until the residual heat in said chunks drives off volatile matter remaining therein until said chunks contain from about 0.50% to 2.00% volatile matter, fixed carbon content of from about 85.50% to 87.50%, and ash content of from about 12% to 12.50%.

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NORMAN YUDKOFF, *Primary Examiner.*

DAVID EDWARDS, *Assistant Examiner.*

U.S. Cl. X.R.

201—32, 34, 36, 44