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Kemmetmueller

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[54] POLLUTION-FREE COAL-PREHEATING WITH WASTE HEAT FROM DRY COKE-QUENCHING

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[51] Int. Cl. C10b 39/02

[58] Field of Search 202/227, 228, 150; 201/39, 201/43, 44

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[57] ABSTRACT

In order to provide a source of dry preheated coal to be supplied to a coke oven, an inert completely dry gas is directed through a body of hot coke which has just been discharged from a coke oven in order to cool the hot coke, which is thus dry-quenched, while the inert gas becomes heated. The hot inert gas is then placed directly in contact with the wet coal so that the wet coal is in this way dried and preheated with heat extracted from the coke by the inert gas. After the coal is thus dried and preheated, the inert gas is cleaned, dried and then returned to flow again through a body of hot coke, so that in this way the inert gas is continuously circulated along a closed path extracting heat from hot coke and delivering the heat to wet coal.

21 Claims, 2 Drawing Figures

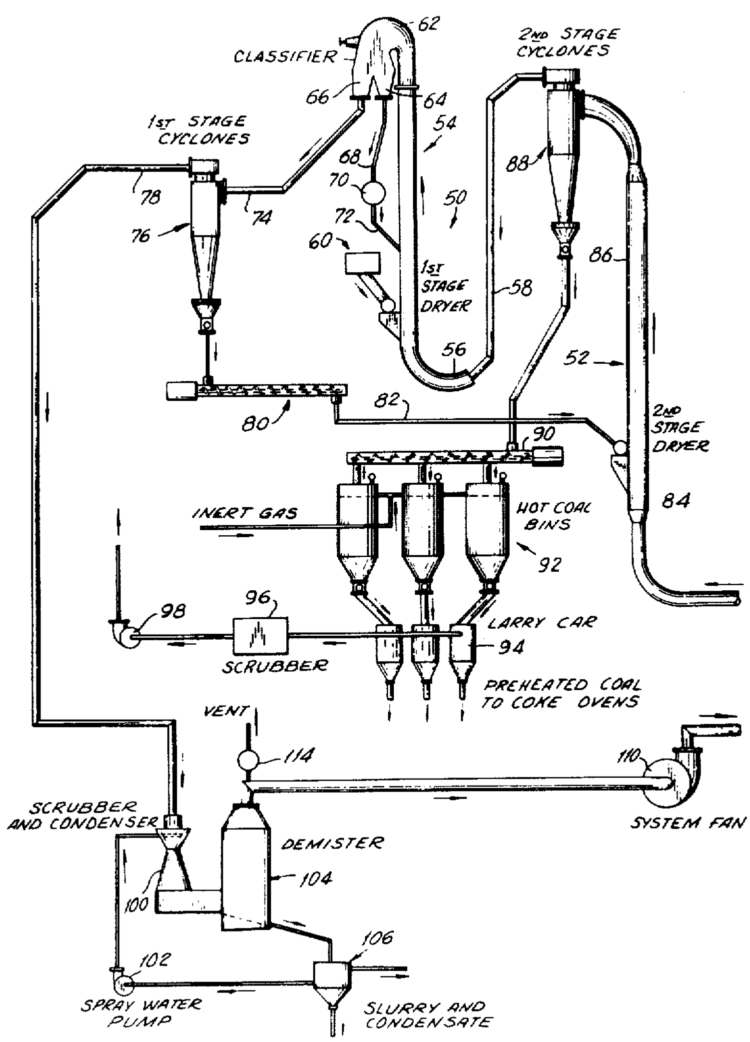


FIG. 1A

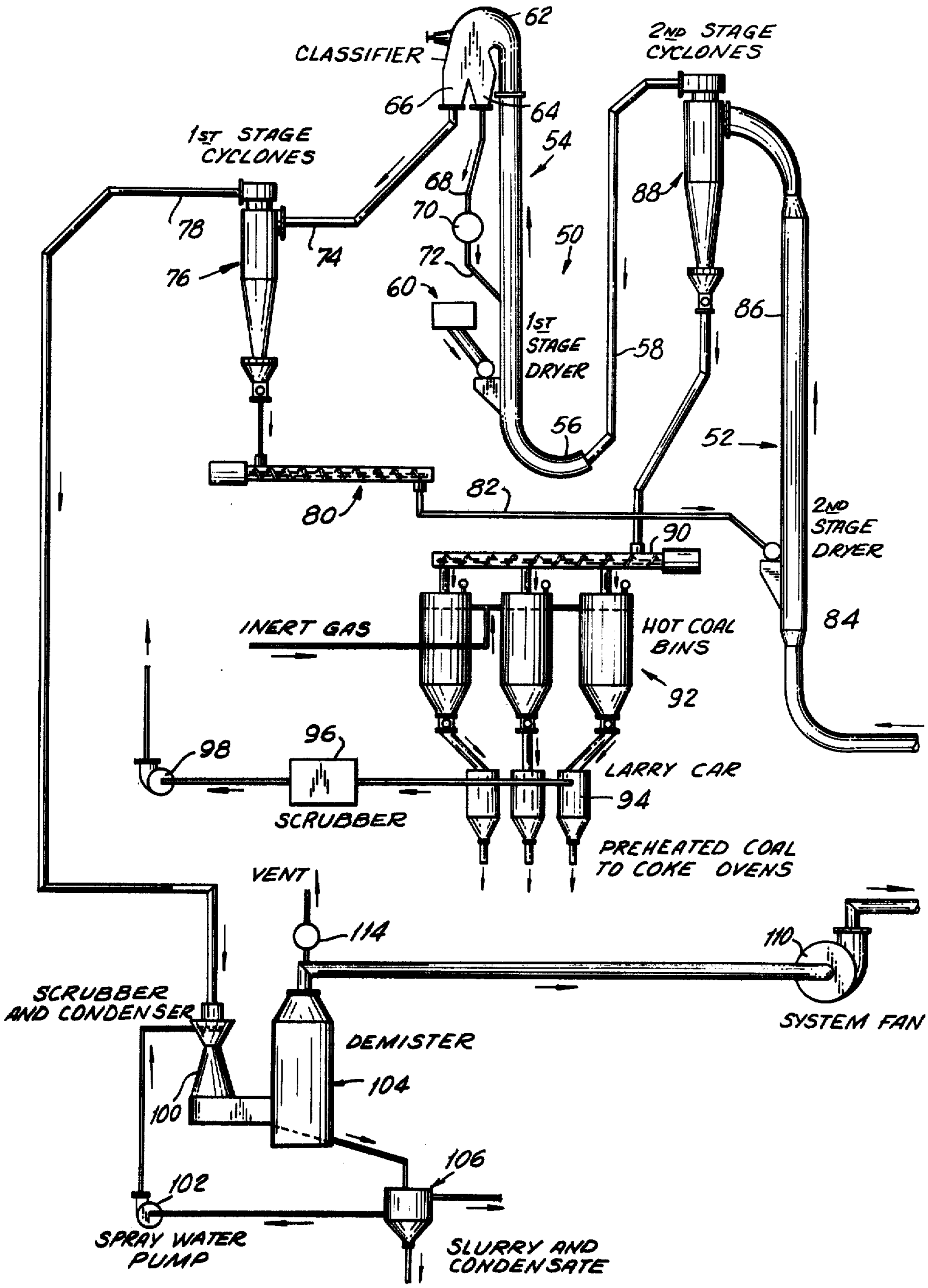
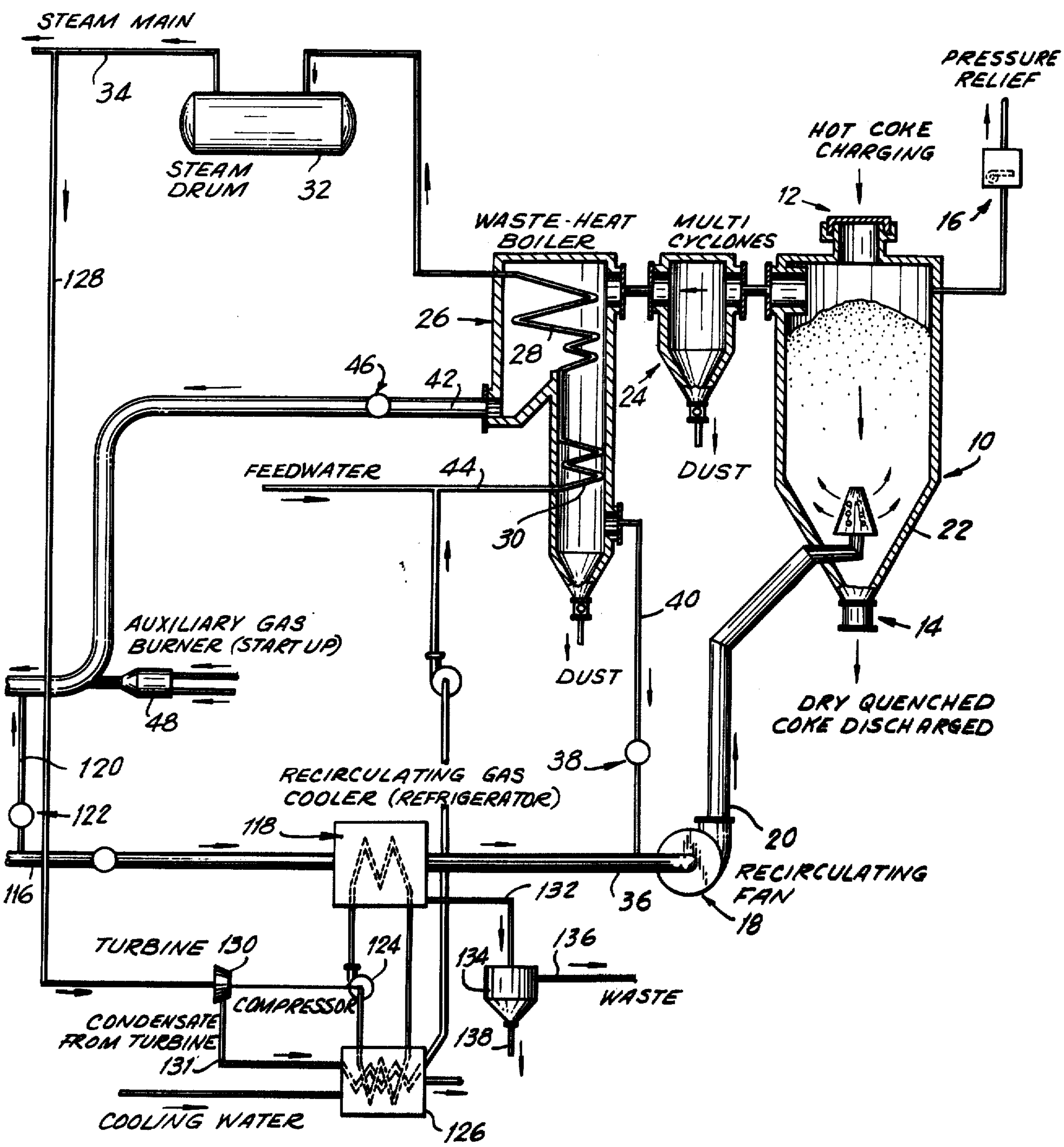

CLASSIFIER
62
2ND STAGE CYCLONES
66
64
1ST STAGE CYCLONES
54
68
88
70
78
74
50
76
72
60
86
1ST STAGE DRYER
58
56
52
80
82
90
2ND STAGE DRYER
INERT GAS
HOT COAL BINS
84
92
98
96
LARRY CAR
94
SCRUBBER
PREHEATED COAL TO COKE OVENS
VENT
114
110
SCRUBBER AND CONDENSER
SYSTEM FAN
DEMISTER
104
100
106
102
SPRAY WATER PUMP
SLURRY AND CONDENSATE

FIG. 1B


STEAM MAIN
34
STEAM DRUM
32
PRESSURE RELIEF
HOT COKE CHARGING
12
16
WASTE-HEAT BOILER
MULTI CYCLONES
-128
26
28
46
42
24
DUST
10
FEEDWATER
44
30
22
40
AUXILIARY GAS BURNER (START UP)
14
DUST
48
DRY QUENCHED COKE DISCHARGED
120
38
RECIRCULATING GAS COOLER (REFRIGERATOR)
122
118
20
116
132
36
RECIRCULATING FAN
18
TURBINE 130
124
134
136
COMPRESSOR
WASTE
CONDENSATE FROM TURBINE
138
131
COOLING WATER
126

POLLUTION-FREE COAL-PREHEATING WITH WASTE HEAT FROM DRY COKE-QUENCHING

BACKGROUND OF THE INVENTION

The present invention relates to coke plants as well as to methods of operating coke plants.

As is already well known, it is highly desirable to make use of heat in coke discharged from a coke oven, so that the energy of this heat which otherwise is wasted can be used to advantage. For this purpose the coke which is discharged from the coke oven is placed in contact with a gas so as to carry out dry-quenching of the coke, and the gas which extracts heat from the coke in this way is then directed through a heat exchanger so that in the heat exchanger heat is taken from the dry-quenching gas which may then be returned to the coke from the coke oven in order to further dry quench coke and extract additional heat therefrom. A second gas which is heated by the heat exchanger may be used for purposes such as drying and preheating coal.

However, arrangements of this type are extremely expensive in that the heat exchanger used to take heat from the dry-quenching gas and deliver the heat to the coal-drying and preheating gas is an extremely expensive unit. In addition such a heat exchanger is complex in its construction, requires a relatively large amount of space, and creates problems with respect to installation and maintenance.

Proposals have already been made for preheating coal, prior to delivery thereof to a coke oven, by placing the coal directly in contact with a dry-quenching gas, but up to the present time the gas as it issues from a dry-quenching bunker has never been used both for drying wet coal and for preheating the coal. In known installations where preheating of coal takes place by directing a dry-quenching gas through a body of coal, there is an unavoidable generation of undesirable water gas. The gas after preheating the coal is circulated back to the coke to carry out dry-quenching, but the gas is not in a dry condition so that considerable disadvantages result from placing such a moisture-laden gas in contact with the hot coke.

SUMMARY OF THE INVENTION

It is accordingly a primary object of the present invention to provide a coke plant and coke plant operating method according to which heat exchangers of the above type are not required.

Thus, it is an object of the present invention to provide a coke plant and coke plant operating method according to which an inert gas used for dry-quenching is also used directly for drying and preheating coal prior to delivery of the coal in the dry preheated condition to a coke oven.

Furthermore, it is an object of the present invention to provide a method and apparatus of the above type according to which the gas is returned after drying and preheating the coal to a dry-quenching bunker with the gas being in a perfectly dry as well as clean condition before being returned to the coke.

In addition it is an object of the present invention to carry out the above operations with an inert gas which will maintain the coal out of contact with oxygen during the drying and preheating of the coal.

Furthermore it is an object of the present invention to provide a method and apparatus of the above type according to which the coal is necessarily maintained below a given size prior to delivery to the coke oven.

In addition it is an object of the above invention to provide a method and apparatus of the above type according to which the gas is returned to the dry-quenching bunker in a cool condition, with cooling of the gas being brought about also by way of energy derived from the heat extracted from the hot coke.

In addition it is an object of the present invention to provide a method and apparatus according to which the dry and preheated coal may be reliably stored with complete safety in bins prior to delivery to a coke oven in such a way that an inert gas which forms a cushion over dry and preheated coal in bins is also used to make up any losses in the inert gas which circulates along a closed path during the dry-quenching and coal drying and preheating operations.

According to the method of the invention an inert gas is circulated along a closed path while being directed in a perfectly dry state through a body of hot coke shortly after discharge of the latter from a coke oven so that the inert gas will cool the hot coke while extracting heat therefrom, thus raising the temperature of the inert gas. Wet coal is fed to a part of the path to which the thus-heated inert gas travels after passing through the body of hot coke so that the wet coal is dried by direct contact with the heated inert gas. In this way the inert gas is cooled while drying the coal with the heat extracted from the hot coke as a result of the direct contact between the wet coal and the heated inert gas. The coal which is dried in this way is delivered to a coke oven while the inert gas is cleaned, dried, and then returned along the closed path of flow thereof to a body of hot coke to again be heated by the latter before again returning to the location where the wet coal is situated in order to be dried by the heated inert gas. Preferably the temperature of the inert gas which contacts the wet coal is sufficiently high to bring about not only drying of the coal but also preheating thereof, so that in this way a dry preheated coal is available for supply to the coke oven.

With the apparatus of the invention a dry-quenching bunker means is provided to contain a body of hot coke received from a coke oven, and a coal-drying means is provided for drying coal prior to delivery of the coal to a coke oven. A conduit means has one portion extending from the bunker means to the coal drying means and another portion extending from the coal-drying means to the bunker means, so that the conduit means defines with the bunker means and the coal-drying means a closed path along which an inert gas may be circulated for extracting heat from the hot coke in the bunker means during dry quenching of the hot coke and for then drying the coal with heat extracted from the hot coke during direct contact between the coal and the inert gas prior to return of the inert gas to the bunker means. A means is provided at the portion of the conduit means carrying gas from the coal-drying means to the bunker means for cleaning and drying the gas, so that the inert gas is completely free of moisture when reaching the hot coke.

BRIEF DESCRIPTION OF DRAWINGS

The invention is illustrated by way of example in the accompanying drawings which form part of the application and in which FIGS. 1A and 1B, which are a continuation of each other, illustrate schematically one possible method and apparatus according to the present invention.

DESCRIPTION OF PREFERRED EMBODIMENTS

Referring first to FIG. 1B, there is schematically illustrated at the right thereof a dry-quenching bunker **10** which is charged with hot coke pushed out of a coke oven. For this purpose the hot coke is charged into the bunker **10** through the top end thereof which in a known way is provided with a closure assembly **12**. Thus, this assembly **12** closes off the interior of the bunker **10** from the outer atmosphere, and the closure assembly **12** is capable of being opened in a known way to receive a charge of hot coke directly from a coke oven, these operations preferably being carried out in such a way that there is no escape of pollutants to the outer atmosphere. After the coke is cooled in the dry-quenching bunker **10** it is discharged out of the lower discharge end **14** thereof also in a known way. At the lower end **14** the bunker **10** is provided with suitable gates which are known and which control the discharge of the cooled coke from the coke oven, this coke being screened and delivered to suitable bins where it is available for use in blast furnaces, for example. When the coke is discharged from the dry-quenching bunker **10** it has a temperature on the order of 50°-70° C, since at this temperature the coke has been cooled sufficiently so that it will not burn belt conveyers.

The interior of the dry-quenching bunker **10** communicates with a pressure release valve **16** for safety purposes.

According to a particular feature of the invention it will be apparent from the description which follows that during the dry-quenching there is no generation of water gas in the dry-quenching bunker. This is one of the important advantages achieved with the method and apparatus of the invention.

The inert gas which flows upwardly through the hot coke in order to cool that latter while extracting heat therefrom is preferably nitrogen or a mixture of nitrogen and carbon dioxide. This inert gas is fed in a perfectly dry condition to the lower end region of the bunker **10** by way of a recirculating fan **18** which drives the inert gas through a conduit **20** into the interior of the bunker **10**. As is well known at the interior of the bunker **10** the latter carries a discharge head **22** in the form of a hollow component of substantially conical configuration into the interior of which the inert gas is delivered with this distributor head being formed with openings through which the inert gas escapes to flow up through the body of hot coke in the bunker **10**.

The inert gas flows out of the bunker **10** at a temperature on the order of 800°-850° C, and immediately after discharging from the upper region of the bunker **10** the inert gas is directed through the multicyclone unit **24** where dust is removed from the inert gas. This dust is a valuable combustible product and may be used at any desired location.

The inert gas which is in this way cleaned by the multicyclone unit **24** and which has the above temperature on the order of 800°-850° C then is received by a steam generator means **26** in the form of a waste-heat boiler having upper coils **28** and lower coils **30** as illustrated. The lower coils **30** communicate with the upper coils **28** and receive feed water from any suitable supply as schematically illustrated in FIG. 1B. This water is converted to steam which is received in a steam drum **32** from which the steam is delivered through suitable steam main **34** to any desired location where use will be made of the steam which is generated in this way.

Part of the inert gas, which is still in a perfectly dry condition, is returned from the steam generating means **26** to a conduit **36** which communiates with the suction end of the recirculating fan **18**, and through the conduit **36** the perfectly dry inert gas is returned to the fan **18** to be delivered thereby to the bunker **10** as described above. The proportion of inert gas from the steam generating means **26** which is mixed with the inert gas flowing along the conduit **36** can be controlled by a valve **38** in the conduit **40** which communicates with the conduit **36** and with the lower end region of the steam generator **26**. It will be noted that additional dust is delivered out of the steam generator **26**. This dust also is combustible and forms a valuable product. Generally the inert gas flowing along the conduit **40** to the conduit **36** will have a temperature on the order of 200°-250° C and approximately 30 percent of the gas delivered by the fan **18** to the bunker **10** will be derived from the conduit **40**, the remaining 70 percent being derived through the conduit **36** which in a manner described below delivers a cool dry inert gas to the fan **18**, this latter gas which flows along the conduit **36** to join with the gas from the conduit **40** having a temperature on the order of 0°-10° C. In this way the temperature of the gas flowing into the bunker **10** can be controlled. In other words by operating the damper or valve **38** it is possible to control the proportions of the inert gas derived from the conduits **36** and **40** so as to regulate the temperature of the inert gas which is delivered to the bunker **10**. At the same time it is possible to control the temperature of the inert gas discharging out of the steam generator means **26** through the conduit **42** by controlling the flow of cool boiler feed water into the steam generator **26** through the supply conduit **44**. In this way it is possible to maintain a relatively constant predetermined temperature for the dry inert gas which is used for drying and preheating coal as described below. The flow of the inert gas from the the steam generator means **26** along the conduit **42** is controlled by a valve or damper **46**, and the arrangement is such that a completely dry gas having a temperature on the order of 600°-650° C flows out of the steam generator means **26** along the conduit **42**. Of the inert gas which flows to the waste-heat boiler **26** from the bunker **10**, approximately two thirds of the gas will flow out of the boiler **26** along the conduit **42** while the remaining inert gas will flow along the conduit **40** to be recirculated back to the bunker by way of the fan **18** together with the remaining cool inert gas derived from the conduit **36** upstream of its connection with the conduit **40**.

The conduit **42** may be provided with an auxiliary gas burner **48** for starting purposes, this unit being used only at the beginning of an operating cycle, and the initial heating provided by way of the unit **48** will serve to generate a certain amount of inert gas. Part of the dust discharged out of the units **24** and **26** may be used in the auxiliary gas burner **48**.

Referring now to FIG. 1A, it will be seen that the perfectly dry inert gas which in the above example is at a temperature on the order of 600°-650° C reaches a coal-drying means **50**. In the illustrated example the coal-drying means **50** is a two-stage dryer, and the hot, dry inert gas first flows through the second stage **52** of the coal-drying means **50** before reaching the first stage

54 thereof. With the illustrated coal-drying means **50**, the coal is dried in a countercurrent manner with respect to the flow of inert gas in the sense that the second stage **52** is situated upstream of first stage, but in each stage the coal flows concurrently with the gas so that concurrent drying takes place in each stage of the coal-drying means while the stages thereof are arranged in a countercurrent manner with respect to the flow of inert gas.

It is to be understood that although a two-stage dryer is illustrated in FIG. **1A** and described in detail below, the invention can equally well be used with a single stage dryer or with a fluidized bed type of coal dryer installation.

The first stage dryer unit **54** is in the form of an elongated tubular structure which has an upstream end region **56** communicating with a conduit **58** through which the heated inert gas flows into the tubular structure of the first stage unit **54** in order to dry coal therein. The wet coal is fed in a crushed particulate form, after passing through suitable crushing mills as is well known, into the tubular structure of the dryer unit **54** at the region of the upstream end **56** thereof. Thus FIG. **1A** shows schematically a wet coal feed means **60** which serves to feed the wet coal in particulate form into the tubular structure of the first stage unit **54**. The particles of wet coal become suspended in the flowing stream of inert gas to be be carried along with the gas, while being dried thereby, toward the downstream end region **62** of the unit **54**. This end region **62** is provided with a pair of classifier units **64** and **66**. Thus, as the particles of coal suspended in the inert gas flow with the latter toward and through the curved end region **62** of the unit **54**, the larger and therefore heavier coal particles will discharge out of the classifier outlet **64** while the smaller and lighter coal particles will discharge out of the subsequent classifier outlet **66**. In this way a classification is carried out to separate particles which are larger than a given size from coal particles which are smaller than a given size.

In accordance with one of the features of the invention the particles larger than a given size which discharge out of the classifier outlet **64** are carried along with part of the inert gas through a conduit **68** to a hammer mill **70** which is situated outside the path of flow of the inert gas and the coal suspended therein, and in the hammer mill the size of the particles is further reduced after which the particles of reduced size are returned to the tubular structure of the first stage dryer unit **54** through a conduit **72**, as schematically represented in FIG. **1A**. Thus the invention provides outside of the path of flow of the inert gas and the coal suspended therein a means for reducing the size of coal particles which are greater than a given size, with the particles which have their size thus reduced being returned to the tubular structure of the coal dryer to again flow along with the inert gas toward the downstream end region **62** where the classifier means **64, 66** is situated. In this way the particles of coal which flow with the inert gas beyond the first stage of the dryer means **50** along the conduit **74** will necessarily be no larger than a given grain size. The inert gas with the coal particles suspended therein is received by a first stage cyclone means **76** wichh includes a number of cyclones in which the particles of coal dried at the first stage **54** are separated from the inert gas. The inert gas continues to flow beyond the cyclone separator means **76** along a conduit **78** where the inert gas has a temperature on the order of 110° C.

The particles of coal which are discharged from the cyclone means **76** are received by a conveyer means **80** such as a suitable screw conveyer, as schematically illustrated, and these particles of coal which are dried in the first stage unit **54** are delivered by the conveyer **80** through a conduit **82** into an upstream end region **84** of the tubular structure **86** which forms the second stage unit **52** of the coal-drying means **50**. Of course in this second stage unit **52** the temperature of the inert gas is higher than in the first stage unit **54**, the temperature of the gas at the second stage being on the order of 600° C, as pointed out above. In the second stage unit **52** the coal particles flow together with the inert gas toward the upstream end of the conduit **58** which interconnects the first and second stages, and in this second stage unit **52** the coal not only has been completely dried but is preheated to a temperature well above the ambient temperature so that coal in completely dry and preheated condition is discharged out of the second stage **52** of the coal-drying means **50**. The downstream end of the second stage unit **52** communicates also with a cyclone means **88** which include a plurality of second stage cyclones in which the inert gas is separated from the dry and preheated coal. This inert gas which is thus separated from the particles of coal at the second stage then flows through the conduit **58** to the first stage.

The dry and preheated coal is received from the second stage cyclone means **88** by a conveyer means **90** which may also take the form of a suitable screw conveyer. It is to be noted that during drying and preheating the coal has been maintained entirely out of contact with oxygen.

The conveyer means **90** delivers the dry preheated coal to a plurality of hot coal bins **92** which form a bin means in which the dry, preheated coal is temporarily stored prior to delivery to a larry car installation **94** which serves in a known way to deliver the dry, preheated coal to the coke ovens as schematically illustrated in FIG. **1A**. The gas which discharges from the larry car unit **94** is delivered to a scrubber means **96** where the gas is cleaned before being discharged to the outer atmosphere so that pollution is in this way avoided, a suitable blower **98**, or the like, being provided to draw the gases out of the larry car unit **94** and through the scrubber means **96** before discharging the clean gas to the outer atmosphere.

In the event that the system used for transfer of the hot coal from bin means **92** to the coke ovens is relatively tight with respect to the outer atmosphere, the gas discharged after the scrubber **96** by the fan **98** will still for the most part be in the form of an inert gas, and in this case the inert gas can be returned to any desired part of the closed path of flow along which the inert gas circulates in accordance with the invention, as will be apparent from the further description below.

In accordance with one of the futher features of the present invention, for safety purposes an inert gas derived from any suitable source such as a nitrogen tank or the like is delivered to the interior of the bins **92** into upper regions thereof to form an inert gas cushion over the dry preheated coal which is temporarily stored in these bins. In this way an extremely safe installation is provided free of any possibility of undesirable explosions. The inert gas which thus forms the gas cushions over the dry, preheated coal in the bins **92** is capable of escaping through the conveyer means **90** into the second stage cyclone means **88** to be combined with inert gas flowing through the second stage dryer unit, so that in this way the inert gas which forms the gas cushions above the preheated coal in the coal bins also serves to make up any losses in the continuously circulating inert gas which flows first through the bunker **10** and then through the coal-drying means **50.**

The inert gas which flows along the conduit **78** from the first stage cyclones **76** is delivered to a scrubber and condenser means **100.** The scrubber means **100** thus receives the cooled inert gas which has a temperature on the order of 100° C together with water vapor which has been removed from the coal during the drying thereof. In the scrubber and condenser means **100** the water is quenched out of the gas. The scrubber means **100** may be a single or two-stage scrubber and spray water is pumped into the scrubber means **100** by way of a suitable pump **102.** After traveling through the scrubber the gas flows through a demister unit **104** which serves further to remove any moisture from the gas, with the liquid which is removed being delivered to a clarifier means **106** which discharges the condensate and slurry. Make-up water if required is delivered to the clarifier **106** with this water being delivered to the spray water pump **102.** At the same time the gas which has been dried flows from the demister unit **104** along a conduit **108** to the inlet of the system fan **110** with part of the gas being discharged to the outer atmosphere through a suitable vent unit **112** controlled by a valve or damper **114,** so that in this way balanced operating conditions are maintained.

The gas in conduit **108** is a saturated gas at the dew point temperature of 30°–40° C. This gas has on the order of 0.02 grams of water in each cubic meter of gas.

The system fan **110** delivers the inert gas to a conduit **116** which serves to deliver the inert gas to a cooling means **118.** A conduit **120** may be provided if desired to interconnect the conduits **116** and **42.** This conduit **120** is optional. It may be used to deliver part of the inert gas directly from fan **110** to the conduit **42** in order to be combined with the hot inert gas from the steam generating means **26** before reaching the second stage dryer unit **52.** If the connecting conduit **120** is provided, it will be equipped with a valve or damper **122** enabling the proportion of gas which flows from the conduit **116** to the conduit **42** to be regulated.

As has been indicated above the inert gas may be a mixture of nitrogen and carbon dioxide and this inert gas flows from the demister unit **104** to the system fan **110** at a temperature on the order of 30°–40° C. In addition desulfurization, if necessary, is carried out at the demister unit **104.** In this way a relatively cool, relatively dry, clean gas is delivered to the recirculating gas cooler means **118.**

This cooling means **118** forms part of a refrigerating unit in which through suitable coils a refrigerant is circulated as by a compressor means **124,** suitable cooling water being directed through a section **126** of the cooling means as illustrated in FIG. **1B.** The cooling installation **118** will include suitable compressors **124** which must be driven, and for this purpose in accordance with a further feature of the invention steam is tapped from the main **34** and delivered by way of a conduit **128** to the steam turbine unit **130** of the cooling means **118** so as to drive the compressors **124** thereof. Condensate

from turbine **130** is delivered by conduit **131** to unit **126** together with the cooling water and is then fed by a pump and conduit to feedwater supply **44.**

As a result of the cooling action taking place at the cooling means **118,** the temperature of the gas is lowered to the order of 0.5° C, and all moisture in the gas is condensed out of the gas at the cooling means **118,** with the condensate being received by the conduit **132** which serves to deliver the condensate to the condensate treating unit **134** from which gas is discharged by the conduit **136** while the condensate is discharged by the outlet **138.**

In this way a perfectly dry, chilled inert gas is delivered along the conduit **36** to be combined with part of the gas flowing along the conduit **40** from the steam generating means **26,** as described above, enabling in this way the temperature of the dry inert gas which is delivered to the bunker **10** to be precisely regulated.

It is apparent, therefore, that with the method and apparatus of the invention a closed path of flow is provided for the inert gas, this closed path of flow having the body of hot coke through which the inert gas flows, at one part of the closed path, and a coal-drying means **50,** to which the wet coal is delivered, at another part of the closed path. It will be noted that an extremely efficient operation is achieved, making full use of the waste heat from the dry coke-quenching. Furthermore it will be noted that there is no generation of water gas as a result of the flow of the inert gas through the hot coke in the bin **10.** Full use is made of the energy of the waste heat from the dry coke-quenching by utilizing this heat not only for drying the wet coal initially but also for preheating the coal so that the coal is in a preheated as well as dry condition when delivered to the coke ovens. The situation of the hammer mill **70** at the exterior is also of advantage since in this way the hammer mill is not influenced by the heat and vapors in the dryer itself. Moreover it will be seen that throughout the entire system of the invention there is never a location where any gas with pollutants therein can escape to the outer atmosphere so that with the system of the invention there is no problem in connection with pollution of the atmosphere. Furthermore, the installation does not include any expensive heat exchanging units and is for the most part relatively inexpensive as well as highly efficient in its operation.

What is claimed is:

1. In a method for operating a coke plant, the steps of circulating an inert gas along a closed path, directing the inert gas as it circulates along said closed path through a body of hot coke shortly after discharge of the body of hot coke from a coke oven so that the inert gas cools the hot coke while extracting heat therefrom to raise the temperature of the inert gas, feeding wet coal to a part of the path to which the thus-heated inert gas travels after passing through the body of hot coke so that the wet coal is dried by direct contact with the heated inert gas, thus cooling the inert gas while drying the coal with heat extracted from the hot coke during direct contact between the wet coal and the heated inert gas, delivering the thus-dried coal to a coke oven, returning the inert gas along a return part of said closed path from the location where coal drying takes place back to a body of hot coke to again be heated by the latter before again returning to the location where the wet coal is situated to be dried by the heated inert gas, and completely drying the inert gas as it travels along the return part of the closed path to a body of hot coke so that the inert gas is in a moisture-free condition when reaching the body of hot coke.

2. In a method as recited in claim **1** and including the step of cleaning the gas before it returns to the hot coke.

3. In a method as recited in claim **1** and wherein the temperature of the inert gas when it contacts the wet coal is sufficiently high not only to dry the coal but also to elevate the temperature thereof to a temperture substantially above the ambient temperature, for preheating the coal, and delivering the coal in a dry preheated condition to the coke oven.

4. In a method as recited in claim **1** and wherein the dry coal is delivered to a bin before being delivered to the coke oven, and including the step of maintaining a cushion of the inert gas over the dry coal in said bin.

5. In a method as recited in claim **4** and wherein the inert gas cushion in said bin communicates with said closed path for making up any losses of inert gas from said closed path.

6. In a method as recited in claim **1** and including the step of partially cooling the inert gas after it flows through the body of hot coke but before it reaches the location to which the wet coal is fed so that the coal is dried with the inert gas at a temperature of the inert gas which is less than the temperature of the inert gas as it leaves the body of hot coke.

7. In a method as recited in claim **6** and wherein steam is generated with heat extracted from the inert gas during the partial cooling thereof.

8. In a method as recited in claim **7** and wherein the gas-drying step includes cooling the inert gas to condense moisture therefrom just before it returns to a body of hot coke, while utilizing at least as part of a source of energy for cooling the inert gas at least some of the steam generated with the inert gas during the partial cooling of the latter.

9. In a method as recited in claim **1** and wherein the gas-drying step includes cooling the inert gas to condense moisture therefrom just before it reaches a body of hot coke for extracting heat therefrom.

10. In a method as recited in claim **1** and including the steps of extracting from the location to which the wet coal is delivered to be dried by contact with the inert gas coal particles greater than a given size, reducing the size of the extracted coal particles at a location situated outside of the closed path and then returning the coal particles which thus have been reduced in size back to said closed path at the location to which the wet coal is delivered, so that the coal which is dried includes only particles which are smaller than a given size.

11. In a coke plant, dry-quenching bunker means for containing a body of hot coke received from a coke oven, coal-drying means for drying coal prior to delivery of the coal to a coke oven, conduit means having one portion extending from said bunker means to said coal-drying means and another portion extending from said coal-drying means to said bunker means, so that said conduit means defines with said bunker means and coal-drying means a closed path along which an inert gas may be circulated for extracting heat from hot coke in said bunker means during dry-quenching of the hot coke and for then drying coal with heat extracted from hot coke during direct contact between the coal and the inert gas prior to return of the inert gas to the bunker means, and gas-drying means operatively connected with that portion of the conduit means which delivers the inert gas to said bunker means for extracting all moisture from the inert gas, so that the inert gas is in a completely dry condition when reaching the bunker means.

12. The combination of claim **11** and wherein a steam-generating means is operatively connected with that portion of said conduit means which receives the heated inert gas from said bunker means for partially cooling the inert gas, while generating steam therefrom, prior to the drying of coal at said coal-drying means with the inert gas.

13. The combination of claim **11** and wherein a gas-cleaning means is operatively connected with said conduit means for cleaning the inert gas.

14. The combination of claim **11** and wherein said gas-drying means includes a gas-cooling means operatively connected with that portion of the conduit means which delivers the inert gas to said bunker means for condensing moisture out of the inert gas.

15. The combination of claim **14** and wherein a steam generating means is operatively connected with that portion of the conduit means which delivers the inert gas from the bunker means to the coal-drying means for partially cooling the inert gas while generating steam therefrom prior to drying of the coal with the inert gas, and means for directing part of the generated steam from said steam-generating means to said gas-cooling means for operating the latter at least partially with steam generated from the inert gas during the partial cooling thereof.

16. The combination of claim **11** and wherein a means is situated outside of said coal-drying means but communicates therewith for receiving particles of coal above a given size from said coal-drying means and for reducing the size of the coal particles before returning the latter to said coal-drying means.

17. The combination of claim **11** and wherein a conveyer means communicates with said coal-drying means for conveying dry coal away from the latter, bin means communicating with said conveyer means for receiving the dry coal therefrom and storing the dry coal prior to delivery thereof to a coke oven, and inert gas supply means communicating with said bin means for maintaining a cushion of inert gas over dry coal stored at said bin means.

18. The combination of claim **17** and wherein said bin means communicates through said conveyer means with said coal-drying means for utilizing part of the inert gas supplied to said bin means to form said cushion to make up losses of inert gas from the closed path of travel of the inert gas.

19. The combination of claim **11** and wherein a larry-car means communicates with said bin means for transferring coal therefrom to a coke oven and gas-cleaning means communicating with said larry-car means for cleaning the gas discharged therefrom.

20. The combination of claim **11** and wherein said coal-drying means includes an elongated tubular structure having an upstream end connected to said one portion of said conduit means which receives the inert gas from said bunker means and a downstream end portion from which the inert gas flows after drying coal in said elongated tubular structure, means for delivering wet coal to the region of the upstream end of said tubular structure, and cyclone means operatively connected with said conduit means downstream of the downstream end of said tubular structure for separating the dry coal from the gas prior to return of the latter to said bunker means.

21. The combination of claim **20** and wherein a second elongated tubular structure is connected with said conduit means upstream of the first-mentioned tubular structure and conveyer means for conveying the dry coal from said cyclone means to said second tubular structure so that the latter forms a second stage of said coal-drying means, an additional cyclone means being situated between said tubular structures for separating the gas from the coal dried in said second tubular structure, and conveyer means communicating with said additional cyclone means for conveying the dry coal away from the latter.

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