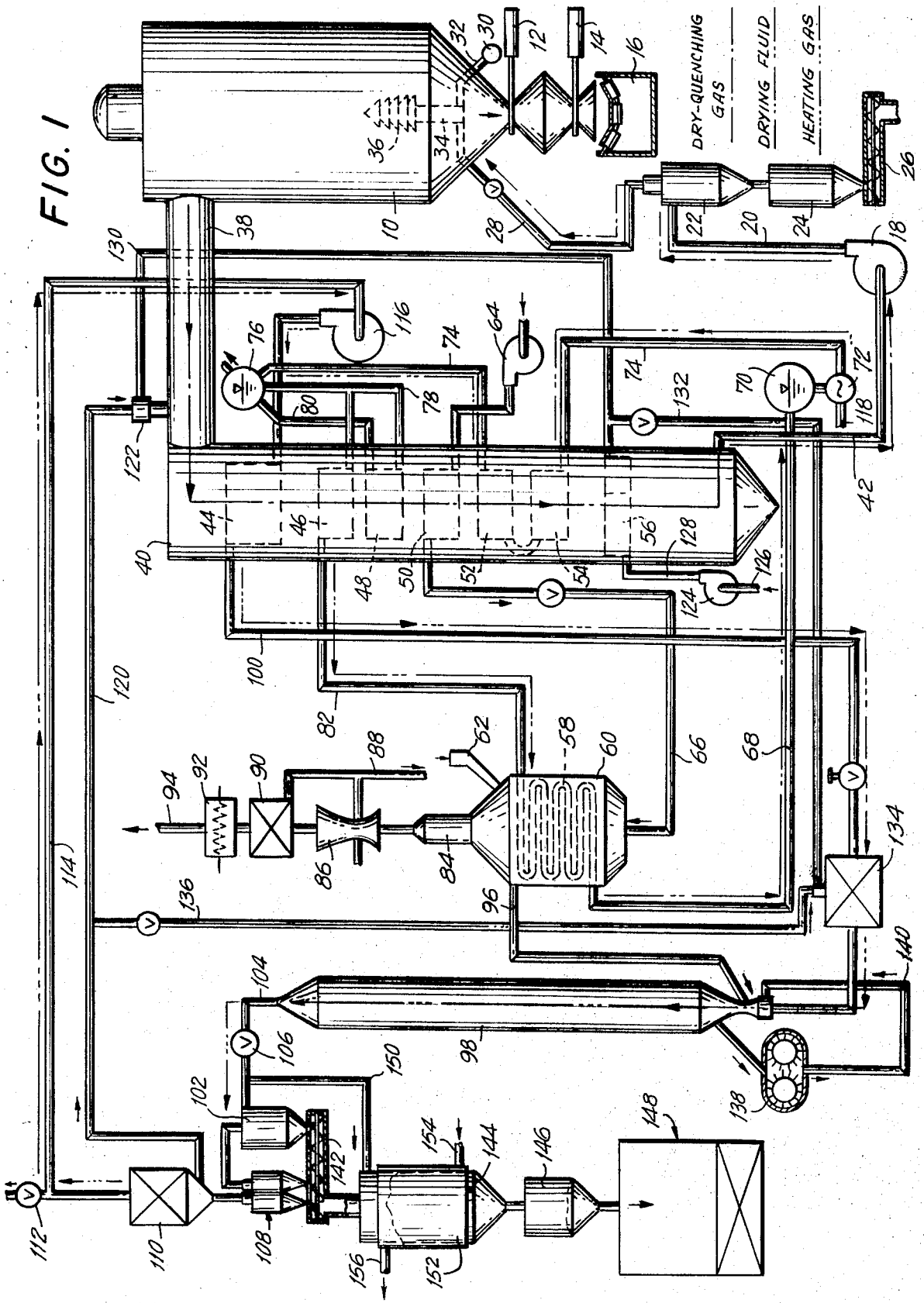
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COAL TREATING METHOD AND APPARATUS FOR COKE PLANTS

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FIG. 1

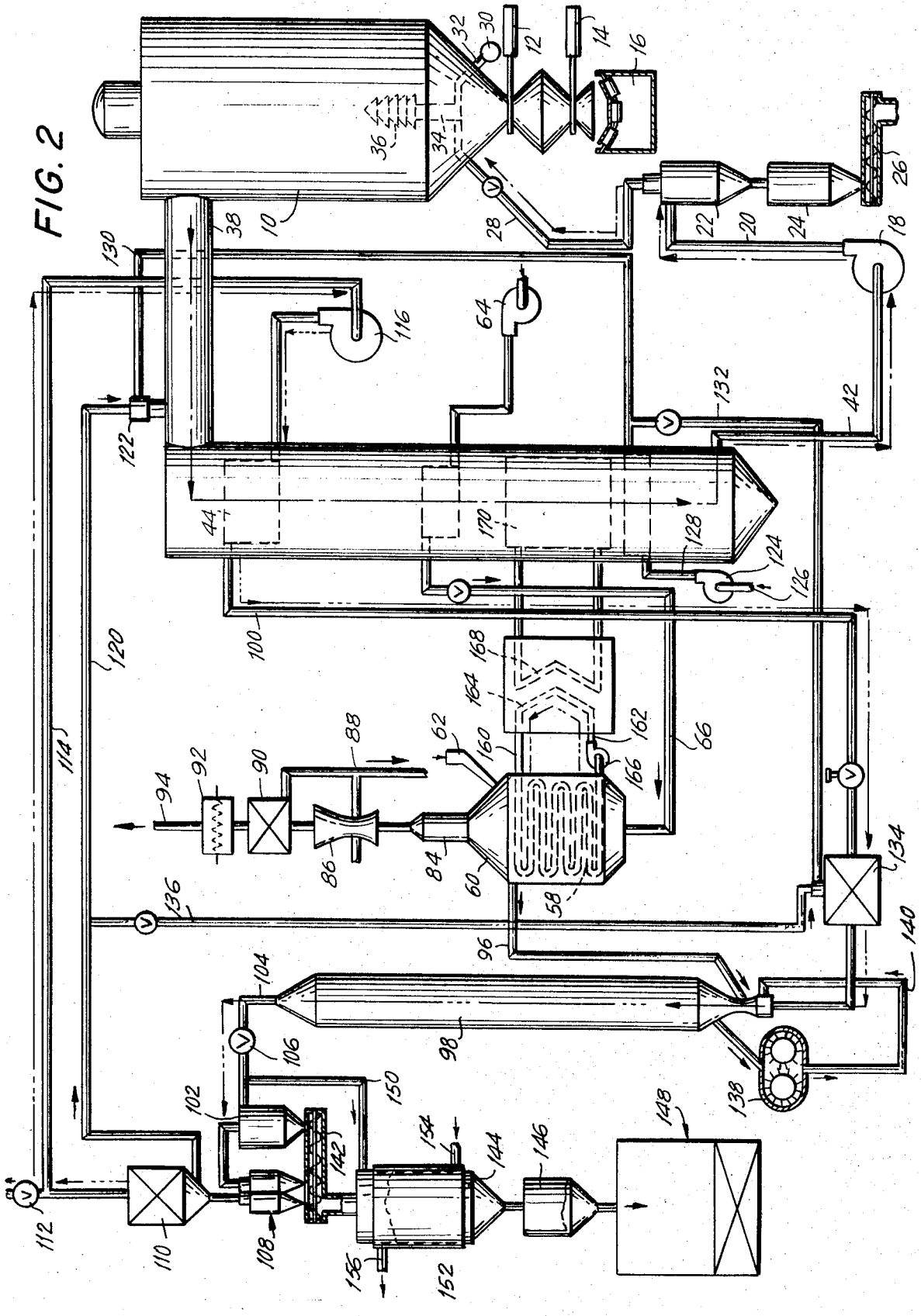


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COAL TREATING METHOD AND APPARATUS FOR COKE PLANTS

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FIG. 2



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COAL TREATING METHOD AND APPARATUS FOR COKE PLANTS

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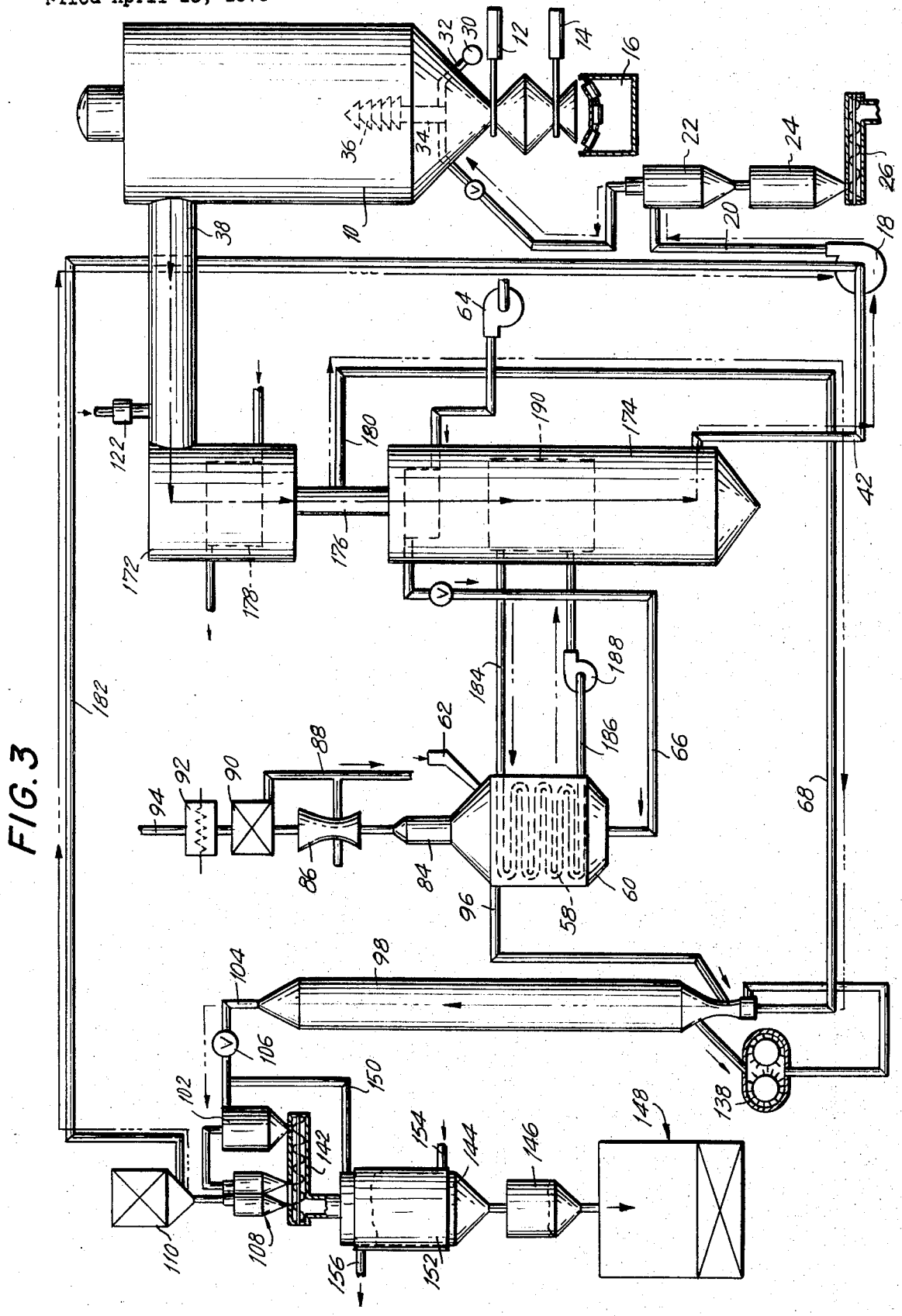


FIG. 3

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3,843,458

COAL TREATING METHOD AND APPARATUS FOR COKE PLANTS

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Continuation-in-part of application Ser. No. 224,154, Feb. 7, 1972, now Patent No. 3,728,230. This application Apr. 13, 1973, Ser. No. 350,961
Int. Cl. C10b 39/02
U.S. Cl. 201—39 20 Claims

ABSTRACT OF THE DISCLOSURE

A coal treating method and apparatus for coke plants, according to which coal is delivered to coke ovens in a dry, preheated condition. Pulverized coal is fed to a coal dryer in which the coal is suspended in a fluidized bed of heated gaseous material while in the coal dryer the coal is free to move into contact with coils through which a drying fluid is circulated. A dry-quenching gas is circulated through a body of hot coke shortly after pushing of the latter from a coke oven, so that the dry-quenching gas extracts heat from the hot coke, and it is this heat which is used to heat the drying fluid. From the coal dryer, the coal in a fully dry condition is delivered to a heater which also receives its heat from the heat energy extracted from the body of hot coke by the dry-quenching gas, and in this heater the temperature of the dry coal is raised, so that coal in a dry heated condition issues from the heater. From the latter the coal is transported to the coke ovens so that in this way the coke ovens are charged with dry, preheated coal, with the energy which is used for this purpose being taken from the hot coke which is discharged from the coke ovens.

CROSS REFERENCE TO RELATED APPLICATION

This application is a continuation-in-part of copending application Ser. No. 224,154, filed Feb. 7, 1972 and entitled Coke Plant and Method for Operating Same.

BACKGROUND OF THE INVENTION

The present invention relates to coke plants.

In particular, the present invention relates to the treatment of coal which is to be converted into coke in the coke plant.

As is well known, the treatment of the coal in preparation for converting the latter into coke is an extremely important phase of the operation of a coke plant. The output of any given coke plant will of course be determined by the operating cycles at the coke batteries. The shorter the time required for converting the coal into coke at the coke ovens, the greater the output. Moreover, it is known that a higher quality coke can be achieved from coal which is in a given condition prior to distillation in the coke ovens.

A further factor which is of great importance is the necessity of reducing pollution of the surrounding atmosphere to the greatest possible extent. One of the greatest sources of pollution at the present time in the operation of coke plants is the result of the handling of the coke as it is discharged from the coke ovens and the handling of the coal during transportation and treatment thereof in preparation for charging the coke ovens.

While it is possible to improve the above factors, at the present time the available expedients for this purpose involve considerable costs so that if steps are taken to reduce pollution and to treat the coal so as to achieve coke of superior quality with a high output, the result is an undesirably high operating cost.

It is accordingly a primary object of the present invention to provide a method and apparatus which will avoid the above drawbacks.

In particular, it is an object of the present invention to provide a method and apparatus which make it possible to achieve coke of high quality at relatively low cost.

Also it is an object of the present invention to provide a method and apparatus capable of achieving a high output of coke, also at relatively low cost.

Furthermore, it is an object of the present invention to provide a method and apparatus which will protect the atmosphere against pollution without involving any extremely high cost.

In particular, it is an object of the present invention to take advantage of energy which is present in the form of heat in coke which is discharged from the coke ovens, and making use of this energy for the purpose of achieving the above objects at a relatively low cost.

According to the present invention pulverized coal is fed to a coal dryer in which the pulverized coal is suspended in an upwardly directed hot drying gas so as to form a fluidized bed. A drying fluid is circulated through coils in the fluidized bed in order to further dry the coal by contact with these coils. The drying fluid which is circulated through the coils is heated at least indirectly with heat which is extracted from hot coke shortly after the latter is discharged from a coke oven. The dry coal is transported from the coal dryer to a heater where the dry coal is exposed to a heating gas which has been preliminarily heated with heat from the hot coke, so that in this way a dry, preheated coal is achieved to be delivered in this dry, preheated condition to the coke battery.

The coke plant of the invention includes a coal-drying means for drying pulverized coal. A heating means communicates with the coal-drying means for receiving the dry coal therefrom and for heating the dry coal. A bunker is provided to receive hot coke from a coke oven. A heat-transfer means communicates with this bunker, with the coal-drying means, and with the heating means for extracting heat from the coke in the bunker and for delivering the extracted heat in part to the coal drying-means and in part to the heating means for drying the coal at least in part with heat extracted from the hot coke in the bunker and for heating the coal at the heating means with heat extracted from the coke in the bunker. A transporting means communicates with the heating means to transport the coal in hot, dry condition from the heating means to a coke battery, so that the coal is received at the coke battery in dry, preheated condition.

BRIEF DESCRIPTION OF DRAWINGS

The invention is illustrated by way of example in the accompanying drawings which form part of this application and in which:

FIG. 1 is a schematic illustration of one possible method and apparatus according to the present invention;

FIG. 2 is a schematic illustration of a variation of the method and apparatus illustrated in FIG. 1; and

FIG. 3 is a schematic illustration of a third embodiment of a method and apparatus according to the present invention.

DESCRIPTION OF PREFERRED EMBODIMENTS

Referring first to FIG. 1, there is schematically illustrated therein, at the upper right part of FIG. 1, a bunker **10** which receives in a known way hot coke immediately subsequent to pushing of the coke from a coke oven. The hot coke in the bunker **10** is cooled therein prior to being discharged in a known way by way of the valves **12** and **14** so that the relatively cool coke will be received on a

conveyer means **16** to be conveyed to suitable bins where the coke is maintained in readiness to be used for such purposes as blast furnace operations, for example.

The hot coke which is received in the bunker **10** contains a tremendous amount of energy. In many conventional coke plants this energy is wasted, particularly in the case where the coke is cooled by wet-quenching procedures. Thus, it is known to cool the hot coke immediately subsequent to discharge thereof from a coke oven with liquid which creates great clouds of steam, creating undesirable pollution of the surrounding atmosphere and wasting the energy which is contained in the heat of the hot coke.

Therefore, dry-quenching of the hot coke is far more preferable, and in the method and apparatus shown in FIG. 1 dry-quenching is provided with a dry-quenching gas. The dry-quenching gas, which may if desired be a suitable inert gas, is directed along a closed circuit indicated by the dot-dash line in FIG. 1, as explained by the code at the lower right portion of FIG. 1. The dry-quenching gas is circulated through the closed path by a suitable blower **18** or the like. This lower **18** delivers the dry-quenching gas through a conduit **20** to a cyclone **22** in which any particles of coke entrained in the gas are separated, these particles of coke being delivered to a collecting bin **24** from which they are transported by a suitable screw conveyer **26** or the like to any desired location where the fine particles of coke will be used.

From the cyclone **22** the dry-quenching gas continues to travel through a pipe **28** to a supply header **30** in the form of a ring having suitable valves and communicating through pipes **32** with an inlet **34** in the interior of the bunker **10**. The inlet **34** in a known way has the baffles **36** between which the dry-quenching gas escapes with these baffles preventing the travel of the dry-quenching gas into the body of coke from being obstructed.

The dry-quenching gas enters the bunker **10** at a temperature of approximately 150° C., as indicated in FIG. 1, and after travelling upwardly through the hot coke, the dry-quenching gas discharges from the bunker **10** into the discharge pipe **38** at a temperature of approximately 800° C., for example. At this latter temperature the dry-quenching gas will reach the top of an elongated vertical housing **40** down which the dry-quenching gas flows to discharge out of the housing **40** into an inlet pipe **42** which returns the dry-quenching gas to the blower **18**. Thus, the dry-quenching gas has been cooled from 800° C. to a temperature of 150° C. in the illustrated example before being returned to the bunker **10**. As the dry-quenching gas travels down the housing **40**, it gives up its heat to various heat exchangers, economizers, and the like, which are distributed along the interior of the housing **40** in a manner described in greater detail below.

As the hot dry-quenching gas flows downwardly along the interior of the tubular housing **40**, it first flows across a heat exchanger **44**, then across additional heat exchangers or economizers **46** and **48**, and so on across additional heat exchangers or economizers **50**, **52**, and **54**. Before discharging out of the housing **40** into the pipe **42** in order to be returned back to the blower **18**, the dry-quenching gas flows also across an additional heat exchanger **56**. All of the above heat-exchanger units in the housing **40** successively cool the dry-quenching gas so that it is returned to the bunker **10** at a temperature of approximately 150° C. while issuing from the bunker **10** at a temperature of approximately 800° C., in the illustrated example, as pointed out above. Through this series of heat exchangers energy is extracted from the dry-quenching gas, and thus through the latter from the hot coke in the bunker **10**, so that further use may be made of this energy.

After flowing downwardly past the first heat exchanger **44**, the temperature of the dry-quenching gas is reduced in the above example to approximately 250°. The heat exchanger **46** forms part of a closed path for a drying fluid which in the illustrated example is steam, this drying fluid flowing through coils **58** situated in a coal dryer **60**. The coal dryer **60** is in the form of a suitable container to which pulverized coal is fed by way of a feeding means **62** part of which is illustrated schematically in FIG. 1. Thus, coal in pulverized condition is conveyed in any suitable way to the inlet **62** from which the pulverized coal drops down into the interior of the closed vessel **60**. The coils **58** are distributed through the container **60** so that the particles of pulverized coal will engage the coils **58**. The bottom of the container **60** communicates with a pipe **62** by which a hot drying gas is directed upwardly through the interior of the container **60**. This hot drying gas is taken from any suitable source such as a source of waste gas, this gas arriving at a temperature of approximately 150° C., for example, to a blower **64** which delivers the drying gas to the heat exchanger **50** so that in the latter the temperature of the gas will be elevated to a range of 250–450° C., in the illustrated example, before reaching the container **60**. The blower **64** assures that the gas has a sufficient pressure to be able to suspend the pulverized coal particles to form a fluidized bed therefrom. As is well known the gas may be delivered to a lower plenum defined at its upper end by a perforated plate through which streams of drying gas issue upwardly to form the fluidized bed in a well known manner. The particles of coal move about in the fluidized bed so as to contact the coils **58** a number of times, and in this way the coal is dried not only by the drying gas which forms the fluidized bed but also by contact with the coils **58**.

The fluid in the coils **58** also flows in accordance with the invention along a closed path, this path being designated by the dash-dot-dot line, as is apparent from the code at the lower right of FIG. 1. Thus upon discharging from the coal dryer **60** the drying fluid will flow along a pipe **68** to a condensate tank **70** from where the condensed liquid flows to a pump **72** in order to be pumped thereby along the pipe **74** into the heat exchanger **54** from which the pumped fluid flows to a second heat exchanger **52** and then along a pipe **74** to the steam drum **76**. From the steam drum **76**, from which steam may be taken for other purposes also, the fluid circulates through the heat exchanger **48** by way of a pair of pipes **78** and **80**. A branch from the pipe **78** directs some of this fluid through the heat exchanger **46** from which the heated fluid at a temperature of 250°, for example, flows along the pipe **82** to the coils **58** to progress along these coils to the pipe **68**, in this way completing the closed path for the drying fluid.

The drying gas from the fluidized bed flows out through an outlet **84** at approximately a temperature of 100° C. This gas then flows through a Venturi scrubber **86** from which moisture with particles of coal is discharged by a pipe **88**, and a desmister **90** condenses further liquid out of the discharging gas to flow also along the pipe **88** to any suitable receptacle. A heater **92** is provided to raise the temperature of the gas before it is vented at **94** to the outer atmosphere. In this way this gas has been cleaned before being released to the outer atmosphere.

From the coal-dryer **60**, the pulverized coal in dry condition flows through a supply conduit **96** at a temperature of approximately 100° C. to the inlet of an elongated heating means **98** which may be a flash heater, for example. The pipe **96** is in the form of a pneumatic conveyor for the pulverized dry coal particles. Thus, the coal is completely dry by the time it reaches the heating means **98**. This heating means **98** is in the form of an elongated hollow container having the inlet end to which the dry coal is delivered by the conveyer **96**.

The heating gas which flows along the interior of the heating means **98** is preferably an inert gas such as nitrogen or a mixture of nitrogen and carbon dioxide. This heating gas reaches the inlet of the heating means **98** at a temperature of approximately 650° C., in the illustrated

example. The heating gas is heated by the first heat exchanger **44** to an extremely high temperature on the order of 650° in the illustrated example. Thus, from the heat exchanger **44** the heating gas flows through the pipe **100** to the inlet of the heating means **98**. This gas flows through the heating means **98** at a speed of approximately 60 meters per second, so that the pulverized coal is conveyed along the interior of the heating means **98** to issue at the outlet thereof into a cyclone **102**. The pipe **104** connects the discharge end of the heating means **98** with the cyclone **102**, and at this pipe **104**, which may be provided with a suitable valve **106**, the coal has a temperature of approximately 250° C.

The heating gas is also directed along a completely closed path designated by the dash-dot-dot-dot line, as shown by the code at the lower right of FIG. 1. From the cyclone **102** the heating gas flows with any additional smaller coal particles to an additional cyclone assembly **108**, and from the latter the heating gas flows into the lower end of a bag filter assembly **110** or the like where cleaning of the gas takes place. A part of the gas may be vented to the atmosphere through a vent **112**. However, the greatest part of the gas flows from the filter **110** along a pipe **114** back to a blower **116** from which the gas is delivered to the heat exchanger **44** in order to again be raised to the elevated temperature on the order of 650° C. in the illustrated example before again reaching the heating means **98**. In this way the heating gas is also directed along a closed path.

The above method and apparatus of the invention are completed by a number of added features. Thus, make-up water is added to the pump **73** through an inlet **118**.

Also, part of the inert gas with fine coal dust suspended therein is delivered by a pipe **120** from the filter **110** to an auxiliary burner **122** which may be operated to regulate the temperature of the dry-quenching gas before it reaches the heat exchanger **40**. For example, toward the end of a cooling cycle it may happen that the temperature of the dry-quenching gas falls below a desired value. At this time the auxiliary burner **122** may be used to increase the temperature of the gas so that the heat exchanger **44** will receive a sufficient amount of heat to provide the desired temperature in the heating gas.

Of course, the coal dust is suspended in the pipe **120** in an inert atmosphere. Combustion air for the burner **122** is derived by way of a blower **124** which conveys air from an inlet **126** through a pipe **128** into the heat exchanger **56** in which the air is preheated before flowing along a pipe **130** to the burner **122** in order to provide at the burner **122** combustion air to regulate the temperature of the dry-quenching gas.

Also, part of this preheated combustion air may be branched through a pipe **132** to an additional burner **134** which also receives coal dust suspended in the inert gas by way of a conduit **136**, and thus by way of the auxiliary burner **134** it is also possible to regulate the temperature of the heating gas before it reaches the heating means **98**.

In addition, those fairly large coal particles which are too heavy to be carried along with the heating gas flow automatically to a crusher **138** which further pulverizes these particles and directs them back through a recirculating pipe **140** to the inlet of the heating means **98**.

The dry, preheated coal is delivered from the cyclones **102**, **108** to a conveyer **142**, such as a suitable screw conveyer, which delivers the coal to a bin **144** in which the coal is temporarily stored for a relatively short time before being delivered by the larry car units **146** to an oven of the coke battery **148**.

According to a further feature of the invention part of the inert gas discharging from the heating means **98** is diverted by a branch pipe **150** to the bin **144** so that this inert gas which is at a temperature approximately 250° C. in the illustrated example serves on the one hand to contribute toward maintaining the coal at its eleveated temperature and on the other hand to prevention of any explosions. For the purpose of maintaining the coal at the bin **144** at the desired temperature, the bin **144** may be surrounded by a jacket **152** to which steam is supplied through an inlet **154**, from any suitable source, this steam discharging through the outlet **156** and being again heated in any way before returning to the inlet **154**. Thus maintenance of the dry coal at the elevated temperature is assured with the method and apparatus of the invention so that perfectly dry pulverized coal at an elevated temperature on the order of 250° C. reaches each coke oven of the coke battery.

It has been found from experience that with the above method and apparatus of the invention fully 50% of the heat energy available in the hot coke in the bunker **10** is utilized for the various drying and heating operations referred to above. Furthermore, it has been found that the operating time required at each of the coke ovens can be reduced by 40% because of the treatment of the coal according to the method and apparatus of the present invention, so that in this way the output of a given coke battery will be greatly increased with the present invention. Furthermore it will be noted that no where is there any escape of pollutants to the outer atmosphere, so that the method and apparatus of the invention have the additional advantage of enhancing the quality of the atmosphere.

Of course, it is possible to achieve still additional use from the available energy as by utilizing steam issuing from the steam drum **76** for other purposes, as pointed out above.

The embodiment of the method and apparatus which is illustrated in FIG. 2 of the drawings is identical with that of FIG. 1 except for the drying fluid which is circulated through the coils **58** in the coal dryer **60** and the manner in which this drying fluid is heated. In the embodiment of FIG. 2, the drying fluid is in the form of a suitable liquid such as oil or glycerine. The coils **58** communicate with a pair of pipes **160** and **162** which in turn communicate with a suitable heat exchanging coil **164**. A pump **166** is connected for example to the pipe **162** for continuously circulating the drying liquid through the coils **58** and through the heat exchanging coil **164** which is schematically represented in FIG. 2. The heat exchanging coil **164** is in heat exchanging relationship with a vessel **168** in which circulates another heat-exchanging fluid such as a suitable liquid, steam, or the like, this latter fluid being heated by way of a heat exchanger **170** in the housing **40**. Thus, this heat exchanger **170** may be in the form of a simple set of coils across which the dry-quenching gas flows to heat the fluid in these coils, this fluid being, for example, water which is converted into steam and then condenses before flowing back to the lower end of the coils **170**, so that in this way there is a natural circulation of the heating fluid in vessel **168** which transfers its heat to the liquid in the coil **164** which is continuously pumped through the coils **58**. Of course, with the embodiment of FIG. 2 the drying fluid circuit does not require the series of economizers or heat exchangers **46**, **48**, **52**, **54**, or the condensate tank **70** and the pump **72**. Thus, a simpler arrangement is provided for heating a drying liquid which continuously circulates through the coils **58**, but in this case also it is to be noted that the heat is derived, although indirectly, from the dry-quenching gas which extracts the heat from the hot coke in the bunker **10**.

Except for these differences the embodiment of FIG. 2 is the same as that of FIG. 1.

As was indicated above in connection with FIG. 1, the dry-quenching gas is preferably an inert gas, such as carbon dioxide or a mixture of the latter with nitrogen, and according to the embodiment of FIG. 3 the dry-quenching gas itself serves as the heating gas for heating the pulverized dry coal in the heating means **98**. Thus, referring to FIG. 3 it will be seen that the housing **40** is replaced by an upper housing section **172** communicating with a lower housing section **174** by way of a connecting pipe **176**

through which the dry-quenching gas flows downwardly after giving up some heat to a heat exchanger **178** which may be used as a source of steam for any desired purpose with this embodiment. From the pipe **176** some of the dry-quenching gas is branched along a pipe **180** to flow therethrough into the heating means **98** where the gas also enters at a temperature of approximately 650° C. in the illustrated example, and from the heating means **98** the heating gas in this embodiment also conveys the heated dry coal to the cyclones **102** and **108** from which the coal is delivered to the bin **144** in the same way as described above. Part of the heating gas is also diverted to the bin **144** for the purposes referred to above, and of course the bin **144** may also be further heated by way of a steam jacket **152** as described above. While part of the gas may be cleaned at the filter **110** and vented to the outer atmosphere, most of the heating gas flows from the filter **110** through the pipe **182** back to the blower **18** with this part of the dry-quenching gas also reaching the blower **18** at a temperature of approximately 150° C. as is the case with the dry-quenching gas returned through the pipe **42** in the manner described above. Thus the heating gas is recirculated together with the remainder of the dry-quenching gas through the bunker **10** in the embodiment of FIG. 3. In this way it becomes unnecessary to provide an additional heating gas which is separate from the dry-quenching gas.

Also, with the embodiment of FIG. 3, the drying fluid which circulates through the coils **58** in the dryer **60** is delivered to the coils **58** through a supply conduit **184** while flowing out of the coils **58** through a discharge conduit **186** which delivers the drying fluid to a circulating pump **188**. Through this circulating pump the drying fluid is circulated through a heat exchanger **190** to return in heated condition to the supply pipe **184**. In this case the drying fluid may also be steam which is heated at the heat exchanger **190** with heat taken from the dry-quenching fluid which flows through the lower housing portion **174** in the example of FIG. 3. In this case also the steam which flows through the coils **58** can be delivered to the latter at a temperature on the order of 250° C.

With the embodiments of FIGS. 2 and 3 it is also possible to achieve the advantages set forth above in connection with FIG. 1, with respect to the economy of the operation, utilizing approximately 50% of the available heat in the hot coke and reducing the operating time at the coke ovens by approximately 40%. Also with the embodiments of FIGS. 2 and 3 there is no discharge of pollutants to the outer atmosphere.

Thus, with all of the embodiments of the invention the heat energy available from the hot coke is used to a very large degree, so that waste of this valuable source of energy is reduced to a great extent. In addition, experience has shown that perfectly dry pulverized coal at the above temperature on the order of 250° C. is capable of producing the highest quality coke, enhancing operations such as those which are encountered in a blast furnace, so that a very superior quality of coke is achieved with the method and apparatus of the invention.

What is claimed is:

1. In a method of operating a coke plant, feeding pulverized coal into a coal dryer, directing a hot drying gas at a first given temperature upwardly through the coal dryer and suspending the pulverized coal in the upwardly flowing drying gas to form a fluidized bed, circulating a drying fluid through coils in the fluidized bed for further drying the coal by contact with the coils, heating the drying fluid circulated through the coils at least indirectly with heat extracted from hot coke shortly after the coke is discharged from a coke oven, transporting dry coal at a second given temperature from the coal dryer into a heater, exposing the dry coal in the heater to a heating gas at a temperature substantially higher than said first and second given temperatures after preliminarily heating the latter gas with heat extracted from the hot coke, and delivering the dry, heated coal to a coke oven so that the coal is received at the oven in a dry, preheated condition.

2. In a method as recited in claim **1**, circulating a dry-quenching gas along a closed path through the hot coke, and utilizing heat in the dry-quenching gas as a source of heat for the drying fluid which is circulated through the coils in the coal dryer and for the heating gas to which the dry coal is exposed in the heater.

3. In a method as recited in claim **2**, circulating the heating gas along a closed path which intersects the closed path along which the dry-quenching gas is circulated while placing the gases in heat-exchanging relation at the place where said paths intersect.

4. In a method as recited in claim **3** and wherein the heating gas is an inert gas.

5. In a method as recited in claim **4** and wherein the heating gas is selected from the group consisting of nitrogen and mixtures of nitrogen and carbon dioxide.

6. In a method as recited in claim **2**, branching part of the dry-quenching gas from said closed path and utilizing the branched dry-quenching gas as the heating gas.

7. In a method as recited in claim **6**, returning the branched dry-quenching gas after exposing the dry coal thereto at the heater back to the closed path for recirculation with the remainder of the dry-quenching gas through the hot coke.

8. In a method as recited in claim **2**, circulating the drying fluid along a closed path and heating the drying fluid at the latter closed path with heat extracted from the dry-quenching gas.

9. In a method as recited in claim **8**, wherein the drying fluid is steam and is circulated along a closed path which intersects the closed path along which the dry-quenching gas is circulated and which is in heat-exchanging relation with the dry-quenching gas at the location where said paths intersect.

10. In a method as recited in claim **8** and wherein the drying fluid is a liquid.

11. In a method as recited in claim **10** and wherein said liquid is placed in heat-exchanging relation with a further fluid which is heated directly by the dry-quenching gas.

12. In a coke plant, coal-drying means for drying pulverized coal while raising the temperature thereof to a given value, heating means communicating with said coal-drying means for receiving dry coal therefrom and for heating the dry coal to a temperature substantially higher than said given value, a bunker for receiving hot coke from a coke oven, heat-transfer means communicating with said bunker, with said coal-drying means, and with said heating means for extracting heat from coke in the bunker and for delivering the extracted heat in part to said coal-drying means and in part to said heating means for drying the coal at least in part with heat extracted from the hot coke in the bunker and for heating the coal at said heating means with heat extracted from the coke in the bunker, and transporting means communicating with said heating means for transporting coal in hot, dry condition from said heating means to a coke oven battery, so that the coal is received at the coke oven battery in dry, preheated condition.

13. The combination of claim **12** and wherein said heat-transfer means includes a quenching gas circulating means for circulating a dry-quenching gas along a closed path through said bunker to extract heat from hot coke therein, a drying fluid circulating means including coils situated in said coal-drying means for at least partly drying coal by contact between the latter and said coils, said drying fluid circulating means providing a closed path for a coal-drying fluid, and heating-gas circulating means for circulating a heating gas through said heating means to heat coal therein, said heat-transfer means further including a pair of heat exchanger means one of which provides transfer of heat from said quenching gas circulating means to said drying fluid circulating means and the other of

which provides transfer of heat from said quenching gas circulating means to said heating gas circulating means.

14. The combination of claim **13** and wherein said one heat exchanger means is situated subsequent to said other heat exchanger means in the path of flow of the dry-quenching gas from said bunker out of the latter and back to said bunker so that said other heat exchanging means cools the dry-quenching gas before said one-heat exchanging means extracts heat therefrom.

15. The combination of claim **14** and wherein said coal-drying means includes a container and means for directing upwardly through the latter a hot gas which will maintain pulverized coal suspended therein to form a fluidized bed in which the coal particles will be dried not only by the fluidizing gas but also by contact with said coils.

16. The combination of claim **15** and wherein said means for directing the hot fluidizing gas upwardly into said coal-drying means includes an additional heat exchanger situated along the closed path of the dry-quenching gas for extracting further heat from the latter to be used to achieve drying from the fluidizing gas.

17. The combination of claim **16** and wherein said additional heat exchanger is situated in the path of flow of the quenching gas out of the bunker and back to the latter subsequent to the other heat exchangers for extracting heat from the quenching gas only after heat has been extracted therefrom for the heating gas and drying fluid.

18. The combination of claim **13** and wherein said transporting means includes a bin in which the dry, preheated coke is temporarily stored for a relatively short time just prior to being charged into the coke ovens of a coke battery, and a branch conduit communicating with said bin and said heating-gas circulating means for directing a part of the latter gas to said bin.

19. The combination of claim **18** and wherein the heating gas is an inert gas such as nitrogen, to prevent explosions at said bin and to reduce the rate of cooling of coal in said bin.

20. In a method as recited in claim **4** and wherein just prior to delivery of the dry, heated coal to a coke oven, the latter coal is temporarily stored for a short time in a bin, and delivering part of the inert heating gas to the latter bin for preventing explosions at the bin and for maintaining the coal at the bin at an elevated temperature.

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