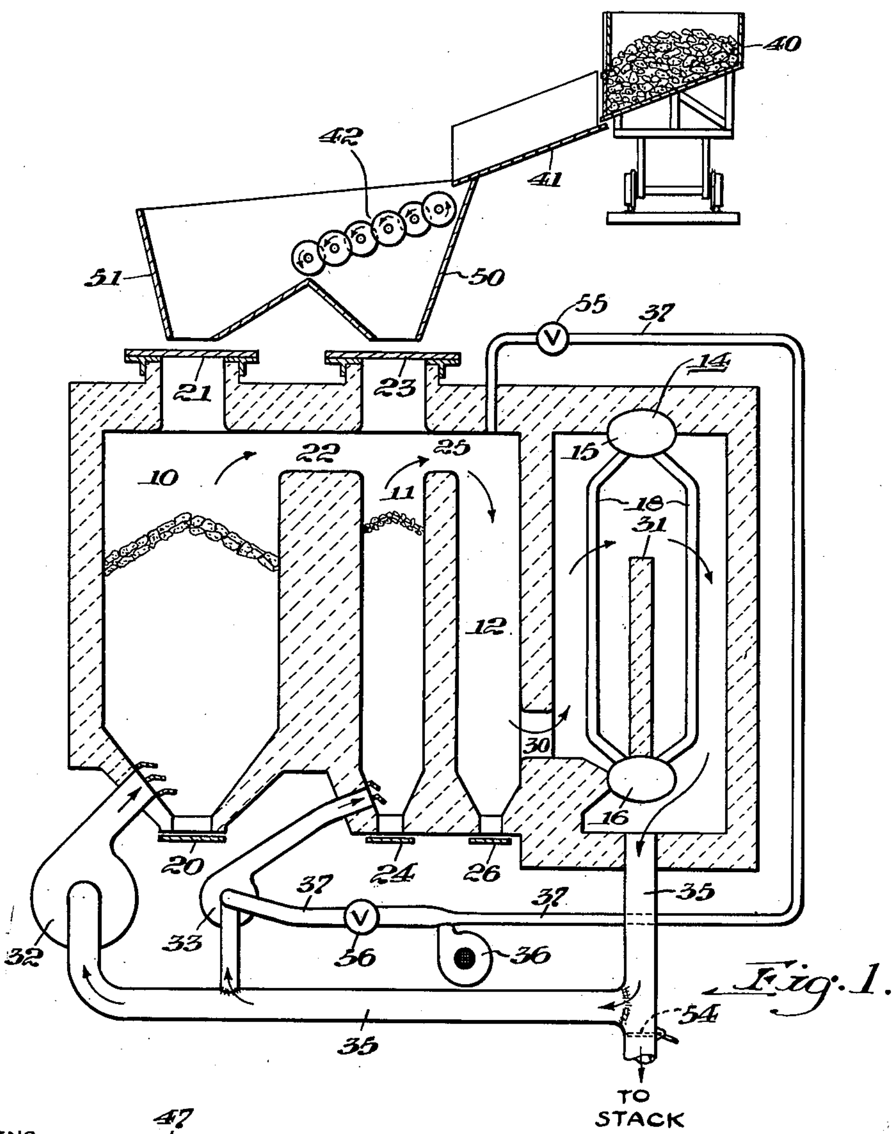
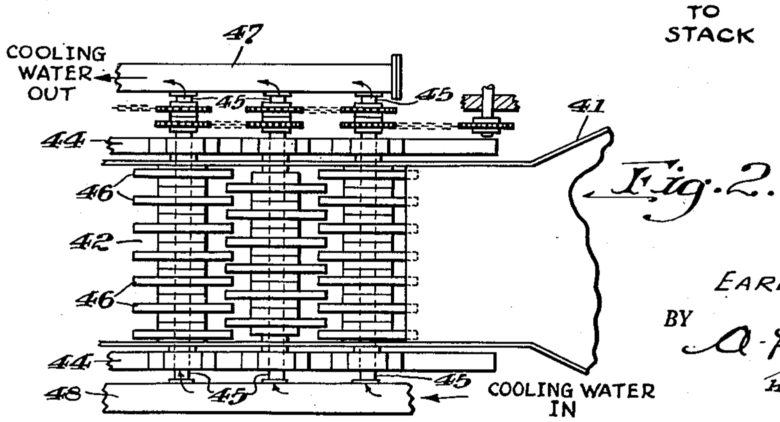
Jan. 8, 1952 E. V. HARLOW 2,581,409

METHOD OF DRY QUENCHING COKE

Filed Aug. 17, 1948





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Patented Jan. 8, 1952

2,581,409

UNITED STATES PATENT OFFICE

2,581,409

METHOD OF DRY QUENCHING COKE

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Application August 17, 1948, Serial No. 44,663

1 Claim. (Cl. 202—37)

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My invention relates to improvements in the method of dry cooling hot coke.

It has heretofore been proposed to cool coke by placing the hot coke in a chamber and circulating inert gas over the coke and thence through a waste heat boiler in a substantially closed cycle.

In systems of this type hot coke is added to the top of the chamber and cooled coke is removed from the bottom of the chamber. It is necessary for the coke to remain in the cooling chamber long enough for all of the coke passing therethrough to be cooled below the ignition point in order to prevent spontaneous ignition of the coke when it is discharged from the cooling chamber.

The coke discharged from a coke oven includes a quantity of relatively small or fine pieces, and if the entire product of an oven is supplied to a cooling chamber, the fine material has a tendency to concentrate and form a zone or area through which the circulation of the inert gas is restricted so that these areas or zones cool more slowly than the other areas or zones in which only larger pieces of coke are present and through which the inert gas circulates more freely. In order to insure adequate cooling of all of the coke, it has been necessary to have the coke remain in the cooling chamber long enough to cool to the desired temperature, the portions of the coke which cool least rapidly. The small or fine pieces of coke are a comparatively small proportion, such as 10% of the total volume of the coke, but necessity for retaining all of the coke in the cooling chamber until the relatively small portion which cools relatively slowly has been adequately cooled has made it necessary for the cooling chamber to be large and expensive.

The steam generated in the waste heat boiler of an installation of this type may be employed for any desired purpose. If for any reason the pushing schedule of the associated coke oven battery is interrupted, the supply of hot coke to the cooling chamber will be interrupted and there will be a decrease in the supply of steam from the waste heat boiler. This may interfere with the equipment operated by the steam from the waste heat boiler, and may make it necessary to provide standby apparatus to supply steam at such times or to substitute for the equipment operated by the steam from the waste heat boiler.

The invention provides an improved dry quenching process for coke, in which the coke is segregated into fine and coarse components and in which some of the fine coke is burned to maintain the output of steam from the waste heat

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boiler at a constant value when the rate of supply of hot coke is diminished or interrupted.

In practicing my invention I screen the hot coke as it is received from the coke ovens. For this purpose I employ a grizzly screen comprising sets of interlaced disks proportioned to permit coke below a selected size, such as ⅝'', to pass between the discs, and to hold larger pieces. The interlaced discs are mounted on hollow shafts through which cooling water is circulated, so that the grizzly screen is not damaged by contact with the hot coke. The coarse and fine components of the coke are supplied to separate compartments or cooling chambers through which an inert gas is circulated to heat water in a waste heat boiler. Separate fans or blowers are provided for circulating the inert gas through the compartments containing the two types of coke. A dust settling chamber is provided between the cooling compartments and the waste heat boiler and the equipment is preferably arranged so that inert gas passing from the cooling chamber for the fine coke to the dust settling chamber does not pass through the cooling chamber for the coarse coke, and thus cannot cause dust or ashes to be deposited on the coarse coke. I also provide means for at times supplying air to the cooling chamber containing the fine coke so that some of this coke burns and thus heats the waste heat boiler during periods in which the supply of fresh coke is inadequate for the purpose. In addition, I provide means for supplying air to the inert gas after it leaves the cooling chambers but before it reaches the waste heat boiler to thereby burn or consume hydrogen given off by the hot coke, hydrogen and carbon monoxide present in the inert gas as a result of decomposition of the moisture present in the air supplied to the cooling chamber containing the fine coke, and carbon monoxide present because of incomplete combustion of the coke.

In the drawings, Fig. 1 is a sectional elevation of coke cooling apparatus constructed in accordance with my invention, and

Fig. 2 is a fragmentary top plan view of the grizzly screen and associated equipment employed in the apparatus shown in Fig. 1.

Referring to the drawings, there is shown in Fig. 1 thereof a structure including a first cooling chamber 10, a second cooling chamber 11, a dust settling chamber 12, and a chamber containing a water tube boiler indicated generally at 14. The boiler 14 has an upper drum 15 and a lower drum 16 which are connected by a plurality of boiler tubes 18. The structure shown in Fig. 1 may be built of any appropriate material, such as fire-brick.

The cooling chamber 10 is a relatively tall chamber having bottom walls which slope towards each other and form a central discharge opening which is normally closed by any suitable means, such as the sliding door 20. The door 20 may be held in position by any desired means and preferably fits tightly so as to prevent the escape of gas from the cooling chamber to the atmosphere.

An opening in the roof of the chamber 10 is closed by a sliding door 21 which fits snugly so that gas from the cooling chamber 10 cannot escape to the atmosphere.

A horizontal passage 22 connects the upper portion of the chamber 10 with the upper portion of the chamber 11, while an opening in the roof of the chamber 11 is closed by a tightly fitting sliding door 23. The bottom walls of the chamber 11 slope towards each other and form a central discharge opening which is closed by a tightly fitting sliding door 24.

A horizontal passage 25 connects the upper portion of chamber 11 with the upper portion of the dust settling chamber 12, the bottom wall of which is provided with a discharge opening which is closed by a tightly fitting sliding door 26. A horizontal passage 30 leads from the dust settling chamber 12 to the chamber containing the boiler 14. The passage 30 communicates with chamber 12 at a point a short distance above the bottom of the chamber so that dust settling out of the gas passing through this chamber can collect in the space below the passage 30. The dust collecting chamber 12 is of such cross-sectional area as to have substantially greater floor capacity than the passages 25 and 30 so that the rate of flow of gas through the chamber 12 is much less rapid than through the passages 25 and 30 with the result that solid particles carried by the gas flowing through the chamber 12 will drop out of suspension and collect in the idle area at the bottom of the chamber 12.

A vertical baffle 31 extends upwardly from the lower drum 16 of the boiler 14 to a point some distance below the upper drum 15. The baffle 31 is located between the tubes 18 and causes gas from the passage 30 to flow upwardly over one set of tubes and then downwardly over another set of tubes with the result that good contact between the gas and the boiler tubes is secured and there is effective transfer of heat from the gas to the water in the boiler.

A first blower 32 is provided for circulating cooling gas through the chamber 10, while another or second blower 33 is provided for circulating cooling gas through the chamber 11. The discharge opening of these blowers is connected by a suitable conduit with the lower portion of the associated cooling chamber through a suitable grating, while the inlet opening of each of the blowers is connected by a conduit or duct 35 with the chamber containing the waste heat boiler 14.

The blowers 32 and 33 are of sufficient size and capacity to circulate a volume of gas effective to cool the coke in the chambers 10 and 11. The blowers are preferably driven by separate motors so the output of the blowers may be independently varied by varying the speed of the driving motors for the blowers. The fine coke in chamber 11 offers substantially greater resistance to flow of gas therethrough than the coarse coke in chamber 10. Hence, the blower 33 is of a type which will operate against substantially higher pressures than the blower 32. In like manner, as the quantity of coarse coke to be cooled is much greater than the quantity of fine coke, the blower 32 has much greater capacity than the blower 33.

The screening or segregation of the coke into its fine and coarse components, therefore, facilitates the circulation of the cooling gas and permits the use of blowers of different types and capacities in accordance with the characteristics and quantities of the two kinds of coke. This reduces the cost of operation of the blowers to the minimum.

The equipment includes a third blower 36 which is employed at times to supply air through a branched duct 37 to the inlet opening of the blower 33 and to a port in the top of the dust settling chamber 12.

The coke to be cooled is brought from the coke ovens by a coke car 40 which may be of conventional construction. As shown, this car has a body including an inclined floor together with a hinged or sliding door which may be opened under the control of an operator to permit coke in the car to slide off the sloping car floor. The coke discharged from the coke car 40 slides down an inclined chute 41, the upper end of which is of subsantially the lengths of the coke car, and the lower end of which is of substantially the length of the grizzly screen or separator indicated generally at 42.

The grizzly screen or separator 42 is of the type shown in U. S. Patent 1,677,838, issued July 17, 1928, to A. G. Molin, and in U. S. Patent 1,785,841, issued December 23, 1930, to A. J. Myers.

Referring to Fig. 2, it will be seen that the grizzly screen has parallel supporting frames 44 at the sides and that a plurality of parallel shafts 45 are journaled on these supporting frames. Each of these shafts has non-rotatably mounted thereon a series of discs 46, the peripheries of the discs of each shaft being interleaved with those of the adjacent shafts in such manner that free spaces exist at the ends of the discs. These free spaces are of appropriate size to permit the passage of the finer particles of coke which it is desired to separate from the main body of the coke. The shafts are driven from a common source of power by means of chains which pass over sprockets on the shafts. To facilitate movement of coke across the screen the grizzly screen slopes away from the chute 41.

The grizzly screen 42 employed in this apparatus differs from those of usual construction in that the shafts 45 are hollow and that means is provided for circulating cooling water through the shafts. Referring to Fig. 2 it will be seen that one end of each of the shafts 45 extends into an intake manifold or header 48 to which cooling water is supplied from any suitable source, while the other end of each of the shafts 45 extends into an exhaust header or manifold 47 from which the cooling water is discharged to any convenient receiver, such as a drain or a cooling pond. Suitable packing is provided where the ends of the shafts enter the manifolds to prevent leakage of the cooling water.

In operation, hot coke from the coke ovens is delivered by the coke car 40, and while the car is in front of the chute 41, the doors on the lower side of the car are opened so that coke from the car slides onto the chute 41 and thence onto the grizzly screen 42, the shafts of which are continuously rotated in a counterclockwise direction as viewed in Fig. 1 of the drawings. As previously explained, the various parts of the grizzly screen 42 are proportioned so that particles of coke below a predetermined size, such as ⅝", pass through the screen, while particles larger than this pass over over the screen. The fine coke which passes through the grizzly screen is collected by a chute or hopper 50 and is discharged through the opening governed by the door 23 to the cooling chamber 11. The larger pieces of coke which pass over the grizzly screen 42 are collected by the chute or hopper 51 and are discharged through the opening governed by the door 21 into the cooling chamber 10. It is to be understood that the doors 21 and 23 may be controlled in any suitable manner, either manually or automatically, so as to be normally closed and to be opened only when coke is being added to the cooling chambers.

It will be seen that the coke is screened as it is received from the ovens, that is, while the coke is still hot. The hot coke, however, will not injure the grizzly screen 42 since the shafts 45 of this screen have cooling water circulating through them, and, therefore, do not become hot enough to lose their strength, while the cooling of the shafts 45 insures that the bearings and the discs 46 will not become overheated.

In addition, it will be seen that the coke is screened while it is dry so there is no tendency for the coke breeze to adhere to the larger pieces. Hence, the coke can be effectively screened with a minimum of handling and with a minimum of breakage of the coke.

The hot coke which is supplied to the cooling chambers is added to the coke already present in these chambers, while cooled coke is removed from the chambers at times to maintain the coke therein at the proper level. When it is desired to remove coke from the cooling chambers, the doors 20 and 24 are opened and coke falls by gravity from the cooling chambers. The coke thus discharged from the cooling chambers may fall into cars or onto conveyor belts, or may be handled in any other desired manner. After a suitable quantity of coke has been released from the cooling chambers, the doors 20 and 24 are closed to prevent further discharge of coke.

The coke in cooling chamber 10 is cooled by flow of inert gas circulated by the blower 32. This gas enters the lower part of the cooling chamber 10 and flows upwardly in countercurrent to the coke which moves downwardly. Hence, the gas contacts the cool or partially cooled coke first and contacts the fresh or hot coke last so that the gas is at a relatively high temperature when it emerges from the bed of coke.

As all of the coke in the chamber 10 is in pieces of substantial size, there are paths throughout the coke bed through which the cooling gas can readily flow. Hence, the cooling gas penetrates to all portions of the bed of coke and all of the coke in this chamber is reduced to a satisfactorily low temperature in a relatively short time. This not only results in effective extraction of the heat from the coke, but also insures that all of the coke released from the chamber 10 will be below the ignition temperature and will not ignite when exposed to the atmosphere. As all of the coke in chamber 10 is exposed to cooling gas and is quickly reduced in temperature, the period during which the coke must remain in this chamber is held to a minimum since it is not necessary to allow for the cooling of coke which cannot be reached by the cooling gas. Accordingly, the chamber 10, which cools the largest part of the coke, has a relatively large capacity or throughput in relation to its cubical capacity, thereby keeping the cost of the equipment at a minimum.

In like manner, the fine coke in the cooling chamber 11 is cooled by the flow of inert gas circulated by the blower 33. This gas enters the lower part of the chamber 11 and flows upwardly in countercurrent to the coke which moves downwardly. As the inert gas is last engaged by the freshly added coke, the gas is at a relatively high temperature as it emerges from the bed of coke.

The relatively fine coke in the chamber 11 offers considerable resistance to flow of gas therethrough so the blower 33 is selected so as to be able to operate against substantial pressure. In order to prevent channelling of the inert gas passing through the coke in chamber 11, that is, the flow of this gas through limited paths offering the least resistance, the chamber 11 is of relatively great vertical height and of minimum cross section. This insures that gas introduced into the bottom of the chamber will spread throughout the entire cross sectional area of the chamber and thus cool all of the coke in the chamber.

The hot gas emerging from the coke in chamber 10 flows through the passage 22 to chamber 11 and mixes with the gas emerging from the coke in this chamber. The gas from both chambers then flows through the passage 25 to the settling chamber 12, where it flows downwardly and thence through the passage 30 to the chamber containing the boiler 14. The gas then flows upwardly over one set of boiler tubes 18, over the baffle 31, and thence downwardly over the other set of boiler tubes 18 to the duct 35 through which the gas flows to the blowers 32 and 33 and is recirculated. In passing over the boiler tubes 18 the heat in the gas is transferred to the water in the boiler so that steam is formed in the boiler. At the same time, the temperature of the gas is reduced to a value such that the gas will cool the coke below its ignition point. The steam generated in the boiler may be employed for any desired purpose.

The cooling gas is originally air, but after one or two passages through the coke the air is spent by combustion of a small amount of the coke and the resulting gas which is thereafter circulated is inert to the coke.

Under normal conditions the operation of a battery of coke ovens is such that an oven of coke is pushed every few minutes, so there is a regular supply of hot coke for the coke quenching apparatus. Accordingly, there is a regular and substantially constant volume of steam available from the boiler 14. If for any reason the pushing schedule of the coke ovens is interrupted so that the supply of hot coke is interfered with, the heat available from this source for heating the boiler 14 will be reduced. This apparatus includes means for supplementing the heat available for heating the boiler at these times so that the normal or usual amount of steam is available from the boiler 14 and the equipment operated by the steam from this boiler will function continuously, thereby making it unnecessary to provide expensive stand-by equipment which will be used only a small part of the time.

A blower 36 is provided and may be manually controlled so as to operate only when required. This blower supplies air through the duct 37 to the inlet of the blower 33 which supplies gas to the cooling chamber 11. The air thus supplied to the chamber 11 consumes some of the fine coke in this chamber while this combustion of the coke heats the gas passing through the coke so that the gas emerging from the coke is relatively hot and is of such volume as to maintain the supply of steam from the boiler 14. A damper 54 may be opened to vent from the duct 35 to a stack an amount of gas equal to that represented by the air added by the blower 36.

The air added by the blower 36 will normally contain some water vapor or moisture. This moisture will react with the hot coke in chamber 11 to form carbon monoxide and hydrogen, and these gases will be present in the gas flowing through the passage 25 to the dust settling chamber 12. Carbon monoxide may also be present in the gas flowing to chamber 12 because of incomplete combustion of the coke, while hydrogen may be present because of emission of hydrogen by the hot coke. A branch of the duct 37 supplies air to a port in the top of the chamber 12. A valve 55 in the duct 37 regulates the amount of air supplied to this port and the air supplied is controlled so as to be sufficient to oxidize the carbon monoxide and hydrogen in the gas supplied to the chamber 12. The oxidation of the carbon monoxide and hydrogen generates heat and increases the temperature of the gas in chamber 12 and increases the heat available for heating the boiler.

The blower 36 may also be employed to supply air to the port in the top of chamber 12 to burn hydrogen and/or carbon monoxide present in the cooling gas for other reasons, as for example, because of the presence of moisture in the air leaking into the system, or because of the incomplete combustion of the coke by air supplied thereto. A valve 56 prevents the supply of air to the blower 33 at this time.

The combustion of the hydrogen and carbon monoxide in the cooling gas not only produces heat but it prevents the building up of an explosive mixture in the installation and it eliminates flaming when the doors 21 and 23 are opened to permit the addition of coke.

It will be seen that this equipment includes means for supplementing the heat available for heating the boiler during periods in which the normal amount of heat is not supplied by the hot coke. This supplemental heat is provided by burning some of the fine coke, and the amount of supplemental heat can be regulated by varying the amount of air supplied to the chamber 11. The burning of the fine coke reduces its value, but it has little value so the reduction in value is not important. As the supplemental heat is provided by supplying air to the chamber containing the fine coke, the coarse coke, which is relatively valuable, is not consumed or impaired in value and remains unaffected.

The equipment is arranged so that the gas emerging from the fine coke in chamber 11 passes to the dust collecting chamber 12 without passing through the chamber 10 in which the coarse coke is located. This insures that dust from the fine coke, or fly ash resulting from the burning of the fine coke, will not be deposited on the large coke. If the dust or fly ash should be deposited on the large coke, it would give it an undesirable appearance and would reduce its value for some purposes.

Although I have herein illustrated and described in detail one form of apparatus for dry cooling hot coke, it should be understood that the invention is not limited to these details and that numerous changes and modifications may be made without departing from the spirit and scope of the following claim.

Having thus described my invention, what I claim is:

In a process wherein hot coke is cooled by recycling an inert gas through a bed of said coke and through an indirect heat transfer zone, the improvement which comprises segregating the hot coke into fine and coarse components, passing said coarse and fine components through individual zones as separate downwardly moving beds, passing separate streams of cool inert gas upwardly through each of said beds, mingling the streams of heated inert gas from the tops of said beds and thereafter passing the commingled stream to and through the indirect heat transfer zone and maintaining the amount of heat supplied to said indirect heat exchange zone constant during variations in the rate of flow of the coke by adding a regulated amount of air to the stream of inert gas passing upwardly through the bed of fine components of the coke and thus burning a portion of the fine components of the coke.

EARL V. HARLOW.

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