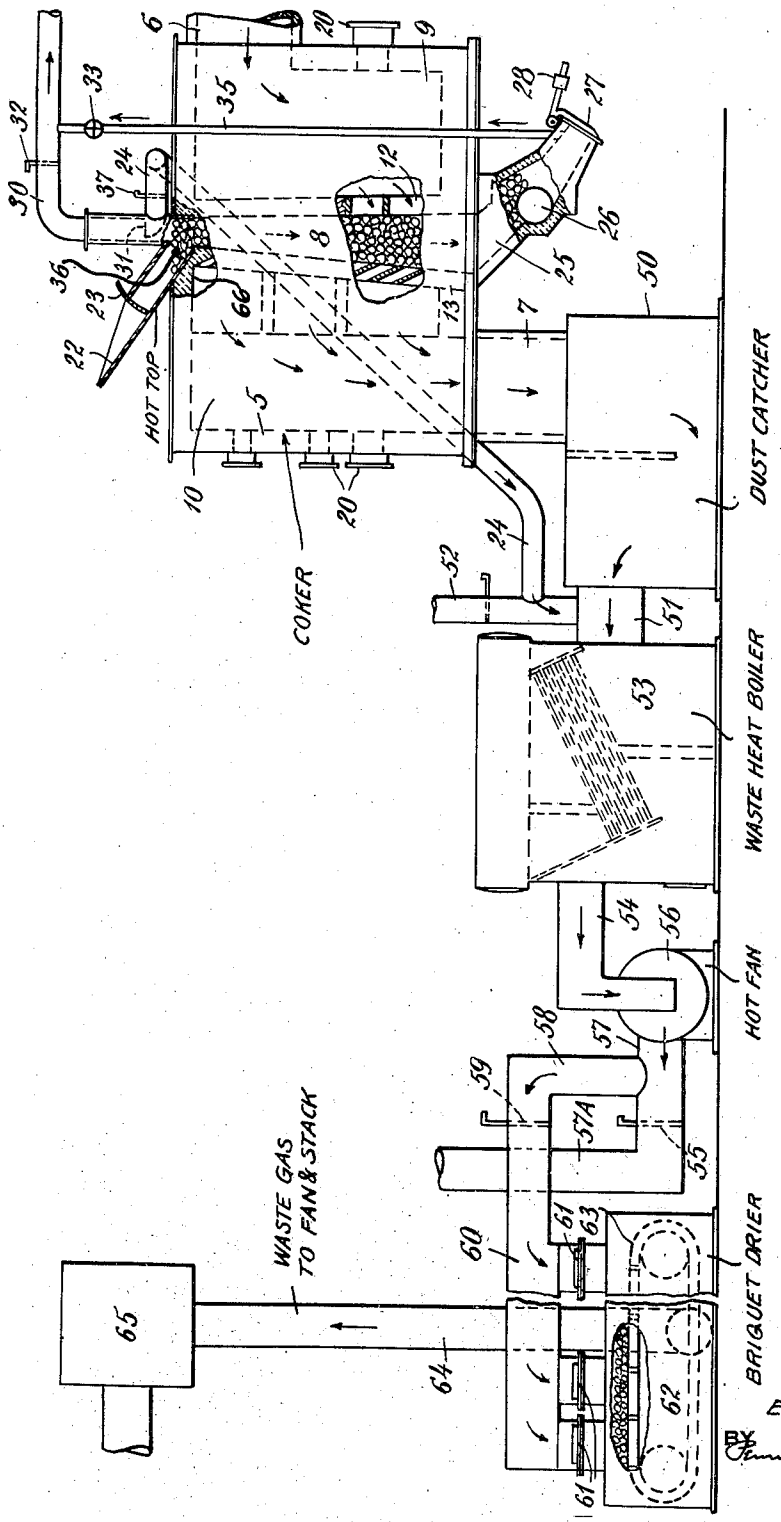
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COKING OF AGGLOMERATES

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COKING OF AGGLOMERATES

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This invention relates to the coking of agglomerates containing a coking agent, and has for its object the provision of an improved method of and apparatus for coking such agglomerates. The invention is particularly useful for the coking of agglomerates of metalliferous material and an appropriate coking agent; such, for example, as agglomerates of mixed zinciferous and carbonaceous materials; but it may also be used with advantage for coking fuel briquettes or agglomerates containing a suitable proportion of an appropriate coking agent.

The invention contemplates the coking of agglomerates by direct contact with non-oxidizing hot gas, the agglomerates being immediately subjected to contact with the hot gas after charging into the apparatus where the coking is carried out. The hot gas used to coke the agglomerates is withdrawn without dilution with air or steam, so that the heat remaining in the gas may be efficiently utilized; such as in the drying of agglomerates about to be coked, to heat waste heat boilers, or for other useful purposes. The practice of the present invention is particularly advantageous for coking agglomerates that contain only a small percentage of binder, or agglomerates that contain oil or tar as binder, or agglomerates that contain a relatively high percentage of bituminous coal.

In accordance with the present invention, the agglomerates to be coked are heated to the required coking temperature by passing a non-oxidizing gaseous heating medium transversely through and in direct contact with an appropriately supported body of agglomerates. In one of its aspects, the invention contemplates the use of an appropriate coking chamber, preferably vertical, through which the body or column of agglomerates is progressively advanced while non-oxidizing heating gases are passed through the body of agglomerates in a direction approximately transverse to the direction of travel of the agglomerates through the chamber. Appropriate devices are provided simultaneously for charging green agglomerates into the coking chamber and discharging coked agglomerates from the coking chamber; and means are provided for applying suction to both the charging and discharging devices to prevent the inflow of any oxidizing gas such as air into the active coking zone of the chamber. Furthermore, special means are provided for withdrawing continuously by suction air that leaks into the discharging opening of the coking chamber and leading such air off separately so that it does not mix with the hot exhaust gases from the coking chamber. Means are likewise provided for withdrawing separately by suction air that enters the charging opening of the coking chamber during the charging. These devices render it possible to secure exhaust gases of high temperature from the coking chamber, since they are not diluted with air entering the apparatus through the charging and discharging openings.

The novel features of the present invention will be best understood from the following description, taken in conjunction with the accompanying drawing, which shows a side elevation of a coking apparatus illustrative of a practice of the invention.

The coking apparatus shown comprises a brickwork structure 5, of oval horizontal section, having a gas inlet flue 6 and a gas outlet flue 7. Clean-out openings 20 are provided in the curved ends of the structure 5. A relatively narrow coking chamber 8 is built midway between the ends of the structure 5, thereby providing on one side a gas distributing chamber 9 communicating with the inlet 6 and on the other side a similar chamber 10 communicating with the outlet 7. One side wall 12 of the coking chamber is substantially vertical, while the other side wall 13 is slightly inclined outwardly so that the cross sectional area of the chamber increases from the top to the bottom. Both side walls of the coking chamber are permeable to the passage therethrough of gas in considerable volume. This permeability is preferably provided by uniformly distributed openings or slots in each side wall.

In the coking chamber illustrated, the vertical side wall 12 is built up of superposed tiles or plates having uniformly distributed slots. These tiles may be made of refractory material, such as silicon carbide alone or mixed with clay, or of temperature-resistant metal alloys, such as alloys of iron, chromium and nickel. The inclined wall 13 is built up of louvres positioned so that the gas streams leaving the coking chamber are directed upwardly into the gas-exiting chamber 10. This louvre construction minimizes the possibility of dust and broken pieces of agglomerates lodging in and choking the openings on the gas-exit side of the coking chamber. If desired, a more detailed description of the coking chamber itself may be obtained by referring to my copending application Serial No. 391,825, filed September 11, 1929. Reference may also be made to my copending application Serial No. 692,771, filed October 9, 1933, in which the apparatus of this invention is described.

The upper end of the coking chamber 8 extends through the roof of the structure 5 to form an extension 36, which should be thoroughly heat-insulated. This heat insulated extension is joined to the coking chamber at a point on a line with the lower edge of a roof 66 of the structure 5. A charging hopper 22 provided with a sliding gate 23 is mounted at one side of the extension 36. The extension 36 is provided with a by-pass connection to the exhaust gas pipe 51 by a pipe 24, which is provided with a control damper 37. The pipe 24 may also be closed by a damper 31. The top of the extension 36 is connected to the pipe 30 which discharges into the atmosphere and is placed under suction by a fan (not shown). The damper 31 is so mounted that it may be placed so as to close the pipe 30 and open the pipe 24; or close the pipe 24 and open the pipe 30.

A discharging device consisting of an inclined chute 25 and a rotatably mounted cylinder 26 is operatively associated with the lower end of the coking chamber 8. The lower end of the chute is closed by a pivotally mounted gate 27 biased to its closed position by a counterweight 28. A pipe 35 provided with a control damper 33 connects the lower end of the chute with the pipe 30.

The pipe 7 connects the gas exiting chamber 10 to a dust catcher 50. An exhaust gas pipe 51 connects the dust catcher 50 with a waste heat boiler unit 53. As already pointed out hereinabove, the pipe 24 joins the upper extension 36 of the coking chamber to the exhaust gas pipe 51. The pipe 24 is provided with an air inlet 52, provided with appropriate means for regulation, at a point near the junction of pipe 24 and 51.

The waste heat boiler unit 53 is connected by a flue 54 to a hot fan 56 and through flue 57 provided with damper 55 to a stack 57—A. A branch flue 58 joins the flue 57 at a point between the damper 55 and the fan 56. The branch flue 58 is likewise provided with a control damper 59. The flue 58 is connected with a manifold 60 equipped with control dampers 61. The manifold 60 discharges into the top of a briquette drier 62, equipped with a traveling grate 63, of any appropriate conventional type, adapted for the support of a charge of briquettes. The briquette drier 62 is provided with an exhaust flue 64, operatively connected with an exhaust fan 65.

When the apparatus is in operation, the coking chamber 8 and part of the upper extension 36 are filled with agglomerates undergoing coking. The heating gas for coking is introduced through the gas inlet 6, by means of suction applied by fan 56 to the gas outlet 7. Any appropriate source of heating gas (inert to the charge under the conditions of coking) may be used. Thus the heating gases may be producer gas and similar fuel gases extraneously heated when necessary. The combustion gases provided by the burning of fuel gases may also be used; for example, the exhaust gases from a combustion chamber used to heat retorts in which the coked charge of agglomerates of a coking agent and zinciferous material coked in the coking chamber 8 are subsequently reduced, may be utilized to carry out the coking. The gas used for coking should not contain constituents capable of oxidizing any appreciable amount of the charge in the coking chamber 8.

The heating gas enters the chamber 9 and is distributed through the openings of the vertical wall 12 into the coking chamber 8. The gas flows transversely through the body of agglomerates in the coking chamber and out through the openings in the sloping side wall 13 into the chamber 10 and to the gas outlet 7. Part of the gas is diverted upward into the upper extension 36 of the coking chamber 8 by the suction applied through the pipe 24, which is connected to the exhaust gas pipe 51 on the suction side of the system. The amount of such hot gases diverted into the upper charging extension 36, or hot top, may be regulated by adjusting the damper 37. The briquettes entering the upper extension 36 of the coking chamber 8 are thus instantaneously exposed to the heat of the hot gases and are brought with rapidity to the coking temperature; in accordance with the method of my above-mentioned copending application Serial No. 391,825.

The charging of raw agglomerates and the discharging of coked agglomerates are, preferably, carried out simultaneously. During these operations the swinging gate 23 of the charging hopper 22 is opened for the insertion of raw agglomerates and the gate 27 opened for the discharge of coked agglomerates, the discharge of which is facilitated by rotating the cylinder 26. On opening the swinging gate 23 and the gate 27, the damper 31 is placed so as to close the pipe 24 and open the pipe 30. The suction in the pipe 30 withdraws and discharges to the atmosphere any air that may enter through the open gate 23. Likewise the suction created in the pipe 30 draws any air that may enter the discharge chute from the open gate 27 up into pipe 35, thence into pipe 30 and out to the atmosphere. Further, any leakage of air by gate 27 when closed is continuously drawn through pipe 35 into pipe 30 and out to the atmosphere. In this way any false air that may enter the system through these gates is removed so that it cannot enter the coking chamber 8 and oxidize the agglomerates undergoing coking, and likewise does not dilute the hot exhaust gases withdrawn by suction through the pipe 7, or burn the volatile matter in these gases.

When the charging and discharging operations are completed the gates 23 and 27 are closed and the damper 31 then placed so as to close the pipe 30 and open the pipe 24. The upper extension 36 of the coking chamber 8 then stands under suction produced in the pipe 24 on account of its connection with the exhaust gas pipe 51, which itself is under suction produced by the fan 56. The pipe 35 is continually under suction on account of the fact that it is connected to pipe 30. The suction produced at the discharge opening by the pipe 35 tends to withdraw from the coking system and discharge to the atmosphere any air that may leak in while the gate 27 is closed. The suction produced in the pipe 35 may be controlled by adjusting the damper 33. The exhaust gases from the pipe 7 enter the dust catcher 50 where entrained dust is separated from them, and then pass into the pipe 51, where they are joined by exhaust gases withdrawn through the pipe 24 from the upper extension 36 of the coking chamber 8 when the damper 31 is so placed as to open the pipe 24 so that the suction prevailing in the pipe 24 becomes operative in the extension 36.

At this point, an amount of air regulated so as to be sufficient to burn the combustible constituents of the exhaust gases is drawn in through the air inlet 52. From the pipe 51, the exhaust gases enter the waste-heat boiler unit 53, where their palpable heat, and the heat of combustion of the combustible constituents that they contain,

are in part recovered and utilized to generate steam.

The exhaust gases leave the waste heat boiler unit through the flue 54 and fan 56 into flue 57. From flue 57 two means of escape for the exhaust gases are provided. The exhaust gases may pass either (a) directly through the flue 57 to the stack 57—A, or (b) through the branch flue 58 to the manifold 60 discharging into the briquette drier 62, whence the exhaust gases pass to the fan 65 through the flue 64. The exhaust gases may be distributed as desired between these two routes by appropriate regulation and adjustment of the control damper 55 (regulating the amount of exhaust gases going to the stack 57—A) and of the control damper 59 (regulating the amount of gases entering the flue 58 and the briquette drier 62).

In actual operation the suction draft required for the appropriate operation of the coking unit is provided by the fan 56. The dampers 59 and 55 are preferably so set that sufficient hot exhaust gases are drawn through the briquette drier 62 to dry the briquettes therein to the desired extent prior to charging them into the coking chamber 8. Thus, if it should develop at any time that the volume of exhaust gases going to the briquette drier 62 is too high for appropriate drying, the amount of exhaust gases entering the briquette drier can be checked by partially closing the control damper 59. A uniform pressure may be maintained on the system by opening the control damper 55, releasing more exhaust gases to the stack 57—A. If it should develop at any time that the temperature of the briquette drier 62 is too high for appropriate drying; cold diluting air may be introduced under pressure in regulated amounts to flue 58.

The control dampers 61, utilized ordinarily to regulate the distribution of the exhaust gases in the manifold 60 discharging into the briquette drier 62, may likewise be utilized to check the total amount of hot gases entering the briquette drier from the manifold, if desired.

The coking apparatus of the present invention is particularly applicable for the practice of the processes of the said application, Serial No. 391,825 and U. S. Patent 1,877,123 of September 26, 1932. In the use of the apparatus for practicing these processes, it may be desirable to dry the briquettes to 5% moisture content or less before charging them into the hopper 22. The exact moisture content permissible in the charged briquettes depends upon various factors, such, for example, as the wet strength of the briquette, the nature and kind of binder and the amount of bituminous coal present. Briquettes containing as much as 5% moisture have been satisfactorily coked in the apparatus of the invention, and in some cases mere skin drying is sufficient. The briquettes may be dried by exposing them to the exhaust gases exiting from the pipe 57, after a large part of the heat in these gases has been recuperated by waste heat boilers, for example, as described hereinbefore or by other means. Where the heat in the exhaust gases from the coking chamber is recuperated by waste heat boilers, it is desirable from the standpoint of efficient heat recovery to dry the briquettes down to a moisture content of 1 to 2% before charging them into the coking chamber, since it is better to drive off the bulk of the moisture in the briquettes with the low temperature gases exiting from the waste heat boilers than with the high temperature gas in the coking chamber.

The exclusion of air from the coking system by the application of suction to the charging and discharging openings of the coking chamber prevents the combustion in the coking chamber of the fuel gases generated therein during the coking of the charge. These fuel gases thus escape from the coking chamber along with the exhaust gases. Where waste heat boilers are employed to recover the heat from the exhaust gases, it is desirable to burn these fuel gases near the boilers in order to recover their heat of combustion. This may be effected by drawing regulated amounts of air into the system at the entrance to the waste heat boilers, so as to burn any combustible material in the exhaust gases at this point.

In the practice of the present invention it is possible to coke agglomerates of the character mentioned in such a way as to make them substantially uniform in quality. This result is obtained because each agglomerate may be subjected to substantially the same type of heat treatment. To this end a shallow body of the agglomerates is preferably subjected to the heat treatment operation. Large volumes of hot gases are passed through the body of agglomerates and in contact with them. In a preferred practice of the invention, in the case of agglomerates containing zinciferous material, the heating gas enters the body of agglomerates at a temperature of at least 800° C. and leaves the body of agglomerates at a temperature not less than about 550° C. At high operating temperatures of this kind, the agglomerates are substantially instantaneously coked at their surfaces to produce a shell of coke. This serves to strengthen the agglomerates and prevent their deformation; which would ordinarily occur if the agglomerates were permitted to pass through their softening stage slowly. The net result is to obtain coked agglomerates containing zinciferous material, if carefully blended with appropriate carbonaceous materials, that have unusual strength; and that may be subjected to an appropriate reduction operation in such a manner that the resulting residues are still in the form of agglomerates having substantially the same size and shape as originally. This desirable result is in large part obtained when the fresh or green agglomerates introduced into the coking chamber have sufficient initial strength to withstand the compression and abrasion to which they are subjected in their passage to and into the chamber. To this end, the agglomerates, after they are formed, are dried out or baked with the relatively hot gas withdrawn from the coking operation, which serves to give them the initial strength required.

The factors tending to disrupt an agglomerate during coking are the steam generated within the agglomerate, due to moisture, and the volatile matter liberated by the bituminous and other carbonaceous material.

By drying before coking, moisture is driven off the agglomerate that otherwise would be driven off during the coking operation tending to disrupt the agglomerate. Therefore, drying makes it possible to increase the amount of volatile matter that may be liberated within the briquette without disrupting it, thereby permitting a greater percentage of coking material in the green agglomerate, resulting in increased strength in the final coked agglomerate and a decidedly increased strength in the residue resulting from an appropriate reducing operation.

I claim:

1. In the method of coking briquets containing

a coking agent by passing hot substantially non-oxidizing gases transversely through a column of briquets in a vertical coking chamber provided with a heat insulated charging extension at the top, the improvement which comprises maintaining the said charging extension hot by diverting hot gases upwards therethrough by applying suction thereto and subjecting briquets introduced into said heat insulated charging extension to sudden heat with said diverted hot gases.

2. In the method of coking agglomerates of mixed zinciferous and carbonaceous materials containing a coking agent by passing hot substantially non-oxidizing gas transversely through a column of the agglomerates in a vertical coking chamber charged at the top and discharged at the bottom, the improvement which comprises protecting the agglomerates from oxidation during the coking and at the same time avoiding loss of heat by dilution of the said hot gas with air by subjecting the lower end of the column of agglomerates to suction and withdrawing air leaking into the discharge opening separately from the main current of hot gas leaving the column of agglomerates.

3. In the method of coking agglomerates of mixed zinciferous and carbonaceous materials containing a coking agent by passing hot substantially non-oxidizing gas transversely through a column of the agglomerates in a vertical coking chamber charged at the top and discharged at the bottom, the improvement which comprises protecting the agglomerates from oxidation during coking and at the same time avoiding loss of heat by dilution of the said hot gas with air by subjecting the upper end of the column of agglomerates to suction during the charging of said vertical coking chamber, and withdrawing air entering the charging opening and steam evolved from the freshly charged agglomerates separately from the main current of hot gas leaving the coking chamber while the charging opening of the coking chamber is open.

4. In a method of coking agglomerates of mixed zinciferous and carbonaceous materials containing a coking agent by passing hot substantially non-oxidizing gas transversely through a column of the agglomerates in a vertical coking chamber charged at the top and discharged at the bottom, the improvement which comprises protecting the agglomerates from oxidation during coking and at the same time avoiding loss of heat by dilution of the said hot gas with air, by subjecting the upper end of the column of agglomerates to suction during the charging of said vertical coking chamber, withdrawing air entering the charging opening and steam evolved from the freshly charged agglomerates separately from the main current of hot gas leaving the coking chamber while the charging opening of the coking chamber is open, then after closing the charging opening of the coking chamber withdrawing gas by suction from the top of the column of agglomerates, subjecting the top of the agglomerate column to sudden heating by hot gases diverted upwards from said coking chamber by said suction, and returning the gas so withdrawn to the main current of hot gas leaving the coking chamber.

5. In a method in which agglomerates of zinciferous material, carbonaceous material and a coking agent are coked in a column which is heated by a current of hot substantially non-oxidizing gas passing transversely through said column, fresh agglomerates being supplied at one end of the column and coked agglomerates being withdrawn from the other end of the column, the improvement which comprises preventing the loss of heat in the end of the column to which the agglomerates are supplied and diverting a substantial portion of the transverse gas current into this end of the column so that said fresh agglomerates are rapidly brought to their coking temperature.

6. In a method of coking agglomerates of mixed zinciferous and carbonaceous materials containing a coking agent, the improvement which comprises introducing a charge of fresh agglomerates into the top of a vertically disposed coking chamber in which the charge is heated by a transverse current of hot substantially non-oxidizing gas, separately withdrawing from the top of said coking chamber air which enters the coking chamber with the charge and steam liberated from the charge immediately after its introduction into the coking chamber, diverting a portion of the transverse current of heating gas into the top of the chamber after the air and steam have been removed to bring the agglomerates rapidly to the coking temperature, and returning the diverted portion of the gas current undiluted by air into the main gas current at a point beyond the exit of the gas currents from the coking chamber.

7. In a method of coking agglomerates of mixed zinciferous and carbonaceous materials in a vertically disposed coking chamber heated by a current of hot substantially non-oxidizing gas passing transversely therethrough, the improvement which comprises withdrawing separately by suction air which enters the coking chamber with fresh agglomerates, diverting a portion of the transverse gas stream into that portion of the coking chamber in which fresh agglomerates are introduced after the air has been withdrawn in order to bring the agglomerates rapidly to the coking temperature, and returning the diverted portion of the gas current undiluted by air into the main gas current at a point beyond the exit of the gas currents from the coking chamber.

8. In a method of coking agglomerates of mixed zinciferous and carbonaceous materials in a vertically disposed coking chamber heated by a current of subustantially non-oxidizing gas passing transversely therethrough, fresh agglomerates being supplied to the coking chamber near the top and coked agglomerates being withdrawn near the bottom of the coking chamber, the improvement which comprises withdrawing separately by suction air which enters the coking chamber at a point near which the coked agglomerates are discharged so that the gas stream is not diluted by said air.

9. In a method of conserving heat for utilization in a waste heat boiler operatively associated with a vertical coking chamber into the top of which agglomerates of mixed zinciferous and carbonaceous materials containing a coking agent are charged and coked by passing hot substantially non-oxidizing gas transversely through a column of the agglomerates within the vertical coking chamber, the coked agglomerates being withdrawn from a discharge opening at the bottom of the vertical coking chamber, the improvement which comprises protecting the agglomerates from oxidation during the coking and at the same time avoiding loss of heat by dilution of the said hot gas with air by subjecting the lower end of the column of agglomerates to suction, and withdrawing air leaking into the discharge open-

ing separately from the main current of hot gas leaving the column of agglomerates.

10. In a method of conserving heat for utilization in a waste heat boiler operatively associated with a vertical coking chamber whereing agglomerates of mixed zinciferous and carbonaceous materials containing a coking agent are coked by passing hot substantially non-oxidizing gas transversely through a column of the agglomerates within the vertical coking chamber, the coking chamber being charged at the top and discharged at the bottom through gates, the improvement which comprises protecting the agglomerates from oxidation during coking and at the same time avoiding loss of heat by dilution of the said hot gas with air by subjecting the upper end of the column to suction during the charging of said vertical coking chamber, and withdrawing air entering the charging gate and steam evolved from the freshly charged agglomerates separately from the main current of hot gas leaving the coking chamber while the charging gate of the coking chamber is open.

11. In a method of conserving heat for utilization in a waste heat boiler operatively associated with a vertical coking chamber wherein agglomerates of mixed zinciferous and carbonaceous materials containing a coking agent are coked by passing hot substantially non-oxidizing gas transversely through a column of the agglomerates in the vertical coking chamber which is charged at the top and discharged at the bottom through gates, the improvement which comprises protecting the agglomerates from oxidation during coking and at the same time avoiding loss of heat by dilution of the said hot gas with air by subjecting the upper end of the column of agglomerates to suction during the charging of said vertical coking chamber, withdrawing air entering the charging opening and steam evolved from the freshly charged agglomerates separately from the main current of hot gas leaving the coking chamber while the charging gate of the coking chamber is open, then after closing the charging gate of the coking chamber withdrawing gas by suction from the top of the column of agglomerates, subjecting the top of the briquet column to sudden heating by hot gases diverted upwards from said coking chamber by said suction, and returning the gas so withdrawn to the main current of hot gas leaving the coking chamber.

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