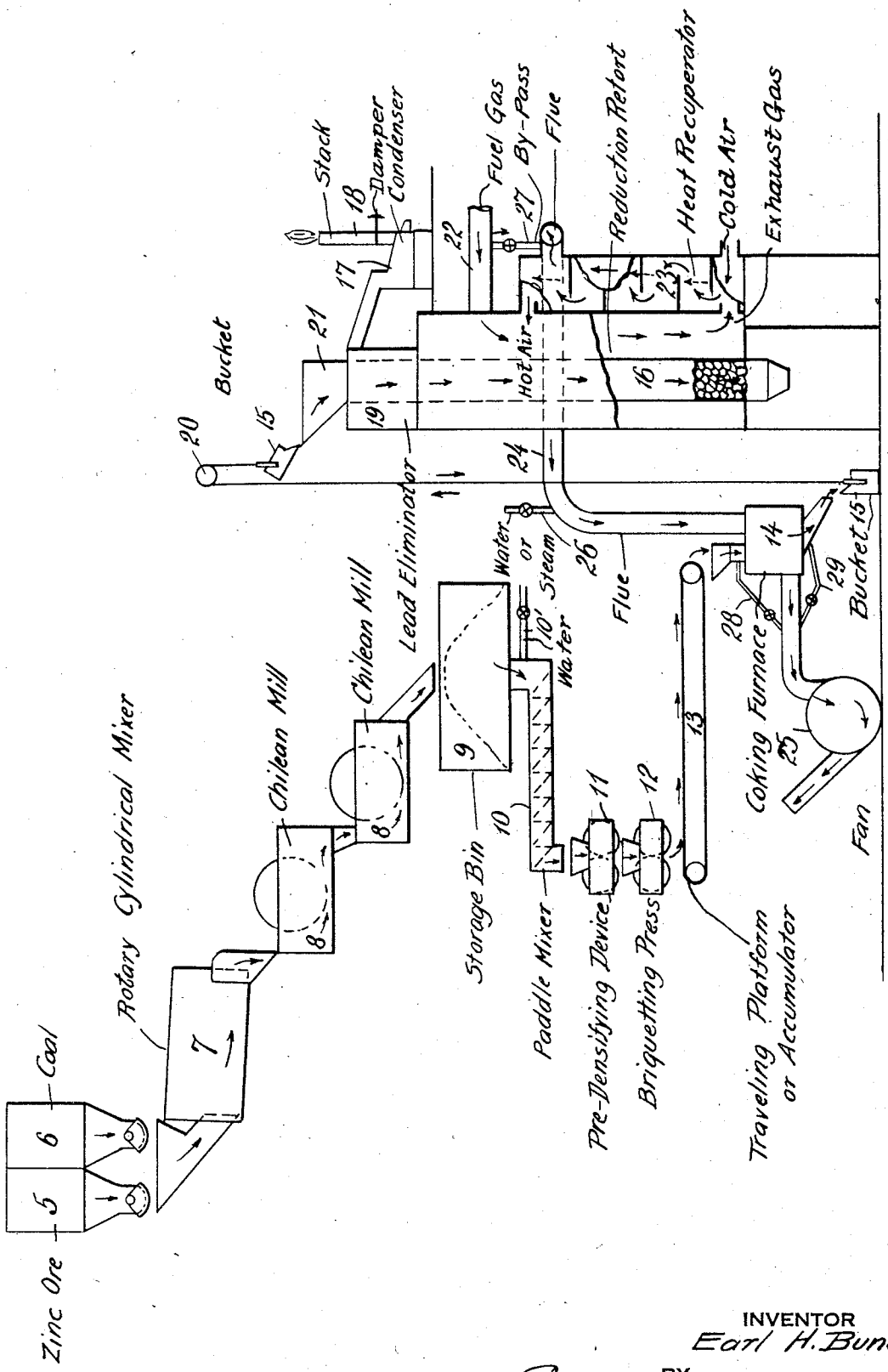
Feb. 7, 1933. E. H. BUNCE 1,896,221

REDUCING ZINCIFEROUS MATERIALS

Filed July 2, 1931



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Patented Feb. 7, 1933

1,896,221

UNITED STATES PATENT OFFICE

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REDUCING ZINCIFEROUS MATERIALS

Application filed July 2, 1931. Serial No. 548,389.

This invention relates to the reduction or smelting of zinciferous materials and has for its object the provision of certain improvements in the reduction or smelting of such materials. The invention is particularly concerned with that method of zinc reduction or smelting in which a mixture of zinciferous and carbonaceous materials is agglomerated and coked and the coked agglomerates are subjected to a reducing operation carried out in a substantially continuous manner, as for example in a vertical retort. The invention is characterized by a new combination of operative features and manipulative steps never before so combined and producing results not heretofore achieved in commercial zinc smelting.

The improved method of the invention, in its entirety, comprises five main operations, viz:—(1) appropriate preparation of a suitable mixture of zinciferous and carbonaceous materials, (2) agglomerating (as by briquetting) the mixture, (3) coking the agglomerates, (4) reducing or smelting the coked agglomerates in a substantially continuous manner and (5) recovering zinc from the reducing operation, preferably after elimination of lead and similar contaminating metals from the gaseous product of the reducing operation. It is characteristic of one aspect of the invention that the operations of agglomerating, coking and reducing are individually carried out in a substantially continuous manner and are so correlated each to the other that the material undergoing treatment passes directly and in a substantially continuous manner from a preceding operation to the next succeeding operation. Preferably, the entire method from the preparation of the agglomerate mixture to the recovery of the zinc is closely articulated, with each operation so correlated to the others that the progress of material is substantially continuous from each operation to the next succeeding operation with no substantial intermediate accumulation of material.

In a method of zinc reduction in which the various operations are so closely articulated as is contemplated in the preferred practice of the present invention, it has been found that a certain operating reserve of the mixed zinciferous and carbonaceous materials should be maintained in advance of the agglomerating operation. The maintenance of this operating reserve, as well as the transfer of the mixed zinciferous and carbonaceous materials, has been found to lower the moisture content of the mixture below that required for satisfactory agglomerating especially by briquetting. To overcome this difficulty, the present invention contemplates the treatment of the mixture with the addition thereto of an appropriate amount of water in a paddle type of mixer followed by compacting of the resulting mixture preparatory to agglomerating for coking.

Another feature of the invention involves accumulating the product of the substantially continuous agglomerating operation in units corresponding in amount to a single charge for the subsequent coking operation and timed to meet the periodic charging requirements of the coking operation. It will be understood that the agglomerating operation, such as briquetting, is most conveniently and economically carried out in a substantially continuous manner. On the other hand, while the coking operation as a whole may be substantially continuous, the charging of the coking furnace or furnaces is for practical reasons carried out periodically, say at twenty-minute intervals. The accumulation of the product of the continuous agglomerating operation in units suitable for charging into and substantially timed to meet the periodic charging requirements of the subsequent coking operation materially promotes the closely articulated conduct of the operations of agglomerating and coking.

The foregoing and other novel features of the invention will be best understood from the following description taken in conjunction with the single figure of the accompanying drawing. This figure diagrammatically illustrates a plant adapted for the practice of the invention.

The zinciferous material (e. g. zinc ore) and the carbonaceous material (e. g. coal) are separately crushed and stored in appro-

priate bins 5 and 6, respectively. From these bins, the zinc ore and coal, in appropriate predetermined proportions, are continuously supplied to and mixed in a rotary cylindrical mixer 7, or other appropriate mixing device. The mixed charge will usually contain from 65 to 35% by weight of zinciferous material, and from 35 to 65% by weight of carbonaceous material. In general, the higher the zinc content and the more finely divided the zinciferous material the more carbonaceous material will be needed in the mixture.

From the rotary mixer 7, the mixture of ore and coal is conveyed, in any appropriate manner, to two or more Chilean mills or edge-runners 8 in series, in which it is subjected to the characteristic kneading action of that apparatus. If necessary, a conditioning agent or a binder, such as sulfite liquor, tar, pitch, or the like, may be added during the treatment in the edge-runner. From the second or last edge-runner, the kneaded mixture is appropriately conveyed to a briquetting press. It is to be understood that the plant may, and usually will, have several mixing devices, edge-runners and briquetting presses. The progress of the materials through these preparatory operations is as nearly continuous as practicable. Between the edge-runners and the briquetting presses, it is advisable to provide a certain storage 9 of the kneaded mixture as an operating reserve in order to insure continuity of the succeeding operations in the event of temporary interruptions in the contemplated continuous supply of the zinciferous or carbonaceous materials.

A certain amount of moisture is necessary for satisfactory agglomeration especially by briquetting; from 6 to 12% of moisture on the dry weight of the mixture being usually satisfactory. Where the kneaded mixture has been stored or conveyed any distance in shallow layers, its moisture content is likely to be reduced below that required for satisfactory briquetting. In accordance with one aspect of the present invention, additional water is incorporated in the kneaded mixture by passing the mixture in the presence of the added water through a paddle type of mixer 10 provided with a valved water pipe 10'. While the paddle mixer effectively incorporates the added water uniformly throughout the kneaded mixture of ore and coal, paddle mixing tends to fluff up the mixture to such an extent that it is not dense enough to form good briquettes. It is essential in briquetting in a roll press machine to feed to the press a material so dense that the entire pressure of the machine is taken by the material confined within the depressions or pockets in the rolls. Consequently, I have found it advantageous, if not in fact necessary, to follow the paddle mixing with a compacting or densifying treatment such as results from passing the mixture through a briquette press, grooved or corrugated rolls, or a similar densifying device. It is preferable that the agglomerates formed by the densifying device be of smaller size than the final agglomerates for coking. In the apparatus illustrated in the accompanying drawing, the densifying treatment, following the paddle mixing, is effected by grooved rolls 11 forming agglomerates smaller than the final briquette size.

The moisture added at the paddle mixer appears to be particularly effective in that it moistens the surfaces of any lumps or granules that are present so that in the pre-pressing rolls these moist surfaces join together and form coherent masses whose surfaces are likewise wet. Such surface wet masses form very hard coherent agglomerates in the final briquetting press. In the case of both the mixture fed to the pre-pressing rolls and the pre-pressed material fed to the final briquetting press, it is essential to have moist, wet surfaces in order to get good coherence and the strongest briquette.

The compacted or densified mixture is fed to the briquetting press or presses 12. The agglomerates are dropped from the briquetting press or presses 12 onto a traveling platform or accumulator 13 adapted to hold the predetermined amount of agglomerates introduced into a coking furnace at each charging. The briquetting press or presses are so operated that a charge of agglomerates is always in readiness on an accumulator 13 whenever required for the charging of a coking furnace. Some such storage, as provided by the accumulator 13, is necessary in the closely articulated operation, since a coking furnace is generally charged every twenty minutes, and the briquetting press or presses run more or less continuously, so that there must be some way of storing the briquettes over the twenty-minute period. Also, it is advantageous to charge the coking furnaces as fast as possible, and it is therefore desirable to have a full charge on hand, so that it can be quickly fed into the furnace ready for charging.

The accumulator 13 may conveniently be of the form of an endless conveyor moving beneath the discharge of the briquetting press. It will be understood that the accumulator is movable transversely as a whole, so that it can be moved into operative position to receive the briquettes as dropped from the press and also into operative position to feed the accumulated charging unit of agglomerates into the hopper of the coking furnace to be charged. The accumulator is thus a larry (movable along a track at right angles to the drawing) equipped with a conveyor belt. The traveling platform or conveyor of the accumulator should be capable of movement at different speeds, for example

relatively slow when accumulating the charging unit of agglomerates, and relatively fast when feeding the accumulated unit of agglomerates into a coking furnace.

The coking furnaces 14 are preferably of the cross-current vertical type, such as disclosed in my copending application, Serial No. 391,825, filed September 11, 1929, although other appropriate types of coking furnaces may of course be used. In the cross-current vertical coking furnace, the agglomerates are progressively passed through an upright or vertical coking chamber and are heated to the requisite temperature of coking by direct contact with hot gas passed transversely through the vertical column of agglomerates. Periodically, an appropriate amount of coked agglomerates is withdrawn from the bottom of the coking chamber and simultaneously a corresponding amount of fresh agglomerates is introduced (from an accumulator 13) into the top of the chamber.

The coked agglomerates are discharged from the bottom of the coking furnace into buckets 15. These buckets are hoisted by a charge larry 20 and carried over to hoppers 21 feeding the vertical reduction retorts, and the hot coked agglomerates are dumped directly into a hopper 21, with as little loss of heat as possible between their discharge from the coking furnace and their introduction into the reduction retort. The charging hopper 21 is provided at its bottom with a gate of any conventional design, for dumping the charge from the hopper into the retort below. This gate serves to seal the top of the retort when it is closed, so that zinc vapor will not escape from the top of the retort at any point other than the orifice leading to the condenser.

The coking furnaces are appropriately operated to supply the charging requirements of the reduction retorts. Thus, an appropriate amount of coked agglomerates is withdrawn from a coking furnace as and when required for charging a reduction retort. At predetermined intervals, an appropriate amount of worked-off or exhausted agglomerates is withdrawn from the bottom of a reduction retort while simultaneously introducing a corresponding amount of hot freshly coked agglomerates into the top of the retort.

The reduction retorts 16 are preferably attached to the furnace structure at one end only, so that they can expand and contract freely. The retorts may advantageously be built up of circle or other appropriate brick shapes of temperature-resistant material bonded together into a substantially zinc-vapor-tight chamber supported at its lower end and free to expand and contract independently of the furnace structure, as described in United States patent of Frank G. Breyer and myself No. 1,680,726.

The reduction furnaces illustrated in the accompanying drawing are of the gas-fired recuperator type, similar in general to the furnace illustrated in the aforementioned Patent No. 1,680,726. Thus, the vertical reduction retorts of the furnace are externally heated by the hot products of combustion resulting from the burning of an appropriate fuel gas supplied to the furnace by a pipe 22. A heat recuperator 23 is operatively associated with each reduction furnace, and the exhaust gases pass from the combustion chamber of the reduction furnace through the recuperator to a flue 24 connected to the gas-inlet of the coking furnaces. Air for the combustion of the fuel gas is introduced into the combustion chamber of the furnace through the heat recuperator, the air being entered at the bottom of the recuperator and passing upwardly through a flue within the recuperator and thence into the combustion chamber. During its passage upwardly through the flue within the recuperator, the air is placed in heat exchange relationship with the relatively hot exhaust gases passing upwardly through the recuperator and along the outside of the air supply flue. The gases initially exhausted from the recuperator 23 are ordinarily too hot for coking the ore-fuel agglomerates because of the zinc loss that such high temperatures would cause. Regulated and controlled cooling of these exhaust gases may, therefore, be necessary, as for example by radiation of heat in the passage through the metallic transfer flue 24 or by the introduction of steam or other appropriate cooling medium. Thus a valved pipe 26 advantageously connects with the flue 24, whereby a cooling medium such as water or steam may be introduced and mixed with the hot gases to lower their temperature.

The heating gas passed through the coking furnaces must be substantially devoid of oxidizing influences, and it may therefore be desirable, or even necessary, to add a small quantity of unburnt fuel gas to the exhaust combustion gases of the recuperator in order to react with or neutralize any oxidizing constituent therein. This may advantageously be accomplished by means of a by-pass valved pipe 27 connecting at one end with the fuel gas main 22 and at the other end with the flue 24. The heating gases are drawn through the recuperator 23, the transfer flue 24 and the coking furnaces 14 by a hot fan 25 on the gas-exit side of the coking furnaces. The heat of the exhaust gases of the coking furnaces may be used in waste heat boilers, or otherwise economically utilized.

The charging and/or discharging ends of the coking chamber 14 are advantageously equipped with devices for excluding the entrance of air in the coking chamber. Valved suction lines 28 and 29 preferably connect the charging and discharging ends of the coking chamber, respectively, with the suction side of the hot fan 25. In this manner oxidiz-

ing air may be drawn from the entrance and the exit ends of the coking chamber to the exhaust gas outlet of the coking chamber without being drawn through the coking chamber.

While I have hereinbefore particularly described a high temperature rapid coking operation, it is to be understood that the agglomerates may, where necessary, or desirable, be subjected to a slow coking operation, such as described in the copending application of Mahler and Handwerk, Serial No. 394,134, filed September 20, 1929. Appropriate modification of the construction and arrangement of the coking furnaces for practicing slow coking will be apparent to those skilled in the art.

The purpose of coking the agglomerates is to utilize the coke bond for holding the ore and coal particles together. Where the coked agglomerates are smelted in a vertical retort, they must possess sufficient strength to pass progressively through the retort without substantial breaking down or sanding and to provide a residue of sufficient strength to prevent disintegration by crumbling, rupturing or abrading. The preparation of the agglomerate mixture exercises a marked influence on the ultimate properties of the coked agglomerates. Accordingly, in the practice of the present invention, I preferably prepare the agglomerate mixture with graded sizing of the ore and coal and blending of the coal, as described in the pending application of Thomas C. Routson and myself, Serial No. 301,709, filed August 23, 1928. Where the zinciferous material is a flotation concentrate I preferably sinter the material as described in my United States Patent No. 1,810,070.

It is characteristic of the reduction operation that the coked agglomerates pass through the vertical retort without disintegration or breaking down and without slagging or fusing, as described in the United States patent of Frank G. Breyer and myself No. 1,712,132. The gaseous product of the reducing operation is appropriately treated for the recovery of its zinc content as zinc metal, zinc oxide, zinc dust, or the like. In the apparatus illustrated in the drawing a condenser 17 is shown for the recovery of zinc metal, this condenser being advantageously of the type disclosed in my copending application Serial No. 400,064, filed October 16, 1929.

The reduction retorts may be sealed or closed at the bottom only to the extent that they are filled with worked-off or exhausted agglomerates. In practice, it has been found advantageous to permit some air to be drawn into the bottom of the retort by the stack draft, in order to prevent down-draft of gas within the retort due to the gas pressure generated therein, as disclosed in the copending patent application of Frank G. Breyer, Serial No. 180,107, filed April 1, 1927. The air is drawn in contact with the incandescent carbon of the agglomerates near the bottom of the retort and sufficient heat is generated by combustion to volatilize any condensed zinc metal and/or to reduce any residual compounds of zinc in the agglomerates near the bottom of the retort. The stack draft is conveniently controlled by throttling the gas exhausted from the condenser stack or chimney 18. It will, of course, also be clear that the reduction retort may be sealed at its bottom to prevent seepage of outside air into the retort.

Contaminating metals, such as lead, in the gaseous product of the reducing operation can be effectively and advantageously eliminated by passing the gaseous product through a body of fresh agglomerates, or an equivalent medium, maintained at a temperature sufficiently low to effect substantial removal of lead and similar contaminating metals from the gaseous product without condensing any substantial amount of zinc vapor, as described in United States Patents Nos. 1,749,126 and 1,749,127, of George T. Mahler and myself. The contaminating metal or deleading eliminator is arranged intermediate the vertical retort and the zinc recovery apparatus (e. g. the condenser 17). The eliminator may consist of an upper prolongation 19 of the vertical retort, above the reducing zone thereof, adapted to confine an appropriate body of the deleading agglomerates. The charging hopper 21 above the prolongation 19 of the retort is then charged with agglomerates transferred from the coke oven 14 by the hoist buckets 15. On opening the gate at the bottom of the hopper 21, the agglomerates enter the eliminator, that is to say, the prolongation 19 of the vertical retort. The agglomerated charge as a whole then progressively passes through the eliminator into and through the vertical retort and is heated in the reducing zone of the retort to a sufficiently high temperature to reduce compounds of zinc and volatilize the resulting metallic zinc and in the prolongation of the retort is maintained at an appropriate temperature to effect substantial removal of lead and similar contaminating metals from the gaseous product of the reducing operation.

The residues from the vertical retort will contain not only any lead that may be present in the ore but likewise any silver, gold or copper. The agglomerated form and the high carbon content of these residues render them highly suitable for subsequent smelting by known methods to recover the lead, silver, gold, copper and the like that were present in the original ore.

This application is a continuation in part of my copending application Serial No. 417,471, filed December 30, 1929.

I claim:

1. In an apparatus for reducing zinciferous material, the combination comprising an externally heated zinc reduction retort, a coking chamber, and a flue in association with said coking chamber and said reduction retort for the passage of partially spent heating gases from the retort to the coking chamber.

2. An apparatus for reducing zinciferous material according to claim 1, in which the retort is disposed within a fuel combustion chamber, and a heat recuperator is located adjacent to and in operating association with said combustion chamber.

3. An apparatus for reducing zinciferous material according to claim 1, in which the retort is disposed within a fuel combustion chamber, and a heat recuperator is located adjacent to and in operating association with said chamber, said flue connecting with said heat recuperator.

4. An apparatus for reducing zinciferous material according to claim 1, in which the retort is vertically disposed within a fuel combustion chamber whereby the retort may be externally heated, and a suction fan is in association with said coking chamber whereby partially spent heating gases may be drawn from the fuel combustion chamber to and through said coking chamber.

5. An apparatus for reducing zinciferous material according to claim 1, in which a fuel supply conduit communicates with said flue for the passage of partially spent heating gases whereby to admit unconsumed fuel to combine with and thereby remove oxidizing constituents present in the partially spent heating gases.

6. An apparatus for reducing zinciferous material according to claim 1, in which a pipe for the passage of a cooling medium communicates with said flue for the passage of partially spent heating gases whereby the heating gases may be reduced in temperature before they reach said coking chamber.

7. An apparatus for reducing zinciferous material according to claim 1, in which a fuel supply conduit communicates with said flue for the passage of partially spent heating gases whereby to admit unconsumed fuel to combine with and thereby remove oxidizing constituents present in the partially spent heating gases, and a pipe for the passage of a cooling medium communicates with said flue for the passage of partially spent heating gases whereby the heating gases may be reduced in temperature before they reach said coking chamber.

8. An apparatus for reducing zinciferous material according to claim 1, in which the charging end of the coking chamber is provided with a suction device to inhibit the entrance of oxidizing air into the coking chamber.

9. An apparatus for reducing zinciferous material according to claim 1, in which the discharging end of the coking chamber is provided with a suction device to inhibit the entrance of oxidizing air into the coking chamber.

10. An apparatus for reducing zinciferous material according to claim 1, in which the charging and discharging ends of the coking chamber are provided with suction devices to inhibit the entrance of oxidizing air into the coking chamber.

11. An apparatus for reducing zinciferous material according to claim 1, in which a hot suction fan is connected to said coking chamber for drawing partially spent heating gases to and through the coking chamber, and suction lines connecting the charging and discharging ends of the coking chamber to inhibit the entrance of oxidizing air to the chamber.

12. In an apparatus for reducing zinciferous material, the combination comprising a vertically disposed externally heated zinc reduction retort disposed within and extending completely through a heating chamber, a fuel supply main connecting with said heating chamber, a heat recuperator in association with said heating chamber, a coking chamber, a flue connecting said heat recuperator and said coking chamber, and a hot suction fan connected with said coking chamber.

13. An apparatus for reducing zinciferous material according to claim 12, in which a bypass connects said fuel supply main to said flue whereby regulated amounts of unconsumed fuel may be admitted into the flue.

14. An apparatus for reducing zinciferous material according to claim 12, in which a valved pipe connects with said flue whereby a cooling medium such as water or steam may be introduced into the flue to cool heating gases moving therethrough before they reach the coking chamber.

15. An apparatus for reducing zinciferous material according to claim 12, in which pipe connections are provided between the charging and discharging ends of the coking chamber and said suction fan through which oxidizing air may be sucked and thus be prevented from entering the coking chamber.

16. In an apparatus for reducing agglomerates of mixed zinciferous material and carbonaceous reducing agent, the combination comprising a coking chamber, a zinc reduction furnace, and a hot suction fan for drawing hot exhaust gases from the combustion chamber of said zinc reduction furnace through said coking chamber.

17. An apparatus according to the preceding claim, in which pipe connections are provided between the charging and discharging ends of the coking chamber and said suction fan through which oxidizing air may be sucked and thus be prevented from entering the coking chamber.

18. An apparatus according to claim 16, in which a hot-gas supply conduit connects with the coking chamber, said hot-gas supply conduit being provided with a cooling medium supply connection whereby the temperature of hot gases entering the coking chamber may be lowered in temperature.

In testimony whereof I affix my signature.

EARL H. BUNCE.