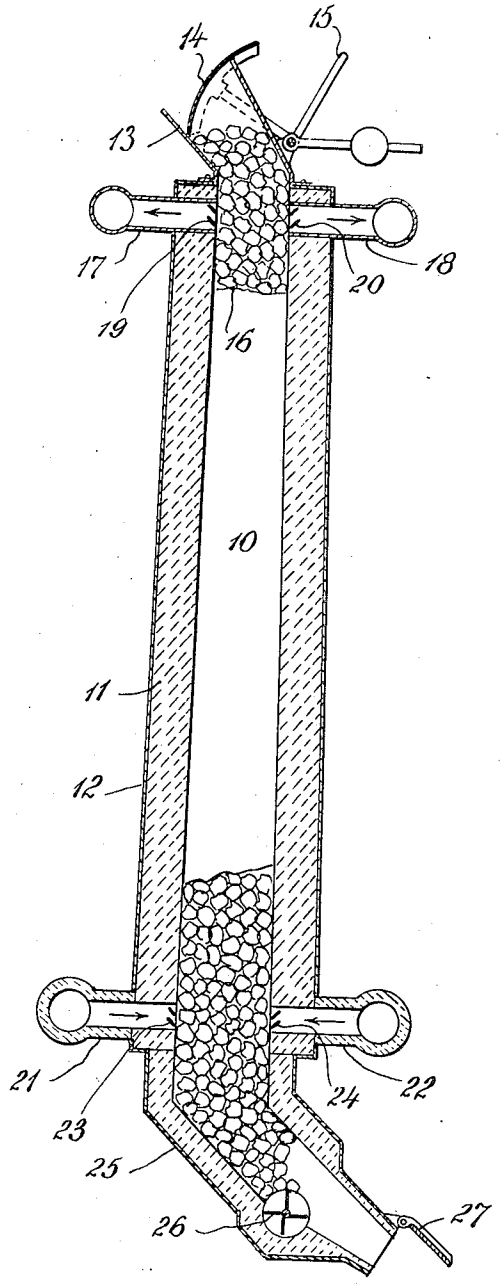
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PRODUCTION OF COKED AGGLOMERATES

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PRODUCTION OF COKED AGGLOMERATES

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This invention relates to the production of coked agglomerates of mixed metalliferous material and carbonaceous material, and has for its object the provision of certain improvements in the preparation and coking of such agglomerates. While the invention, in its broad aspect, aims to provide certain improvements in the production of coked agglomerates of mixed metalliferous and carbonaceous materials, it more especially contemplates the production of coked agglomerates of mixed zinciferous material and carbonaceous material, and will hence be herein described with particular reference to the production of such coked agglomerates.

Coked agglomerates of mixed zinciferous and carbonaceous materials constitute a peculiarly advantageous charge for the smelting or reduction of the zinciferous material particularly in vertical zinc distillation retorts. In the preparation of such coked agglomerates for vertical retort smelting, the major consideration is the strength of the residue after the zinc has been eliminated—briefly characterized as residue strength. Thus, the coked agglomerates must possess sufficient strength to pass progressively through the vertical retort without breaking down or sanding and to provide a residue of sufficient strength to prevent disintegration by crumbling, rupturing or abrading. Hence, it is always necessary to know the residue strength of the coked agglomerates in order to determine whether or not the agglomerates can be satisfactorily smelted in a vertical retort.

In the preparation of these coked agglomerates, it is customary to first separately crush the zinciferous material (e. g. zinc ore) and the carbonaceous material (e. g. coal) and then to knead these materials together in a Chilean mill or edge-runner (frequently called a chaser) to form a mixture that is suitable for agglomerating. The necessary intimate contact of the ore and coal particles for both reduction and ultimate residue strength is advantageously promoted by appropriate graded sizing of the ore and coal as described in the copending patent application of Earl H. Bunce and Thomas C. Routson, Serial No. 301,709, filed August 23, 1928. If necessary, a conditioning agent or a binder, such as sulphite liquor, tar, pitch or the like, may be added during the treatment in the edge runner. The mixture thus prepared in the edge-runner is next agglomerated, usually by briquetting, and then coked at temperatures insufficient to cause any substantial loss of zinc.

The purpose of coking the agglomerate is to utilize the coke bond for holding the ore and coal particles together. In coked agglomerates for vertical retort smelting, it is very desirable, if not essential, that the coke bond be a cellular or lattice structure intimately bonded with and enveloping the particles of zinc ore and of sufficient strength to prevent both splitting up of the agglomerates during coking and disintegration during the subsequent smelting or reduction. The active bonding or coking constituent of the agglomerate mixture (e. g. zinciferous and carbonaceous materials) is the bituminous coal or equivalent coking agent included in the mixture. The amount of bituminous coal, or equivalent coking agent, necessary to give satisfactory residue strength is dependent entirely upon the nature of the coal or equivalent coking agent used. These and economic considerations determine the character of the carbonaceous material of the agglomerate mixture, and usually make it desirable in practice to make up the carbonaceous material of a mixture of coals.

The method used in coking the agglomerates is dependent, to a very large extent at least, upon the amount and nature of the bituminous coal constituting all or part of the carbonaceous material of the agglomerate mixture. In certain localities it is desirable, for economic reasons, to use as little bituminous coal as possible. In other localities, it may be economically advantageous to use all bituminous coal. The present invention is concerned primarily with the provision of an improved method of coking these ore and coal agglomerates, and is particularly applicable in those localities where it is desirable to use a relatively large proportion of bituminous coal, although the invention is by no means limited to the coking of agglom-

erates containing a relatively large proportion of bituminous coal.

The method of coking contemplated by the invention may be characterized as "slow coking" since the aim is to slowly and gradually heat the agglomerates to the requisite temperature for coking. The initial application of heat to the agglomerates is at a temperature considerably below the finishing temperature of coking. The heat is applied so slowly that the whole agglomerate tends to come to the same temperature so that there is relatively little difference in temperature between the surface and the core of the agglomerate. It is of course practically impossible, under commercial operating conditions, to heat the agglomerate so slowly that the surface and core are at identically the same temperature, but in practicing the invention the heat is applied so slowly that there is little temperature differential between the surface and the core of the agglomerate after the moisture has been expelled.

The invention is particularly applicable to the coking of agglomerates which become mushy, deformed or disrupted when subjected to the prevailing customary coking practices. When such agglomerates are subjected to heat for the purpose of coking, they pass through three stages, namely: (1) a drying out stage, (2) a plastic stage, and (3) the coking stage proper. It is during the first and second stages that such agglomerates tend to become mushy, deformed or disrupted. The first stage may be thought of as a steaming stage in the course of which moisture is driven out of the agglomerates. In the second stage, the resinous constituent of the bituminous coal, or equivalent coking agent, begins to soften and flow and the agglomerate tends to become plastic throughout. In accordance with our present invention, the agglomerates are, during these two critical stages, so slowly, gradually and uniformly heated that they attain the coking stage proper without objectionable softening or deformation.

Particular care should be taken during the first or steaming stage to prevent condensation of moisture driven out from relatively hot agglomerates upon relatively cool agglomerates, as such condensed moisture causes the agglomerate upon which it condenses to become soft and deformed. The inherent difficulties of this stage may be ameliorated, to some extent at least, by a pre-drying step, in the course of which all, or a substantial part of, the free moisture may be driven off. For economic reasons, the coking operation should immediately follow the pre-drying step, and if desired the pre-drying and the coking may be combined in one procedure. Where the agglomerates are subjected to a separate pre-drying step, it has been found desirable to include a temporary binder or conditioning agent, such, for example, as about 3% by weight of sulphite liquor.

In the coking operation, the agglomerates are initially subjected to heat at a temperature considerably below the requisite temperature of coking. The initial or starting temperature of the coking operation depends upon the porosity of the agglomerates, the porosity of the charge as a whole, the amount of volatile material therein, and the flowing quality of the bituminous or equivalent coking constituent in the agglomerate. In some cases, it is desirable to start at relatively low temperatures, say 100–200° C., and gradually raise the temperature to the ultimate coking temperature of 800–900° C. In other cases, the coking operation may be started at temperatures as high as 550° C. In every case, it is desirable for economic reasons to start the coking operation at as high a temperature as possible.

The finishing or ultimate temperature of the coking operation should be as high as practicable, since the higher the finishing temperature the stronger will be the resulting coke, and good coke strength is highly desirable, if not essential, where the coked agglomerates are subsequently subjected to a pyro-metallurgical treatment. In the case of agglomerates of zinciferous and carbonaceous materials, the limiting factor with respect to high temperature coking is the temperature at which volatilization of zinc becomes uneconomical. In practice, we have determined that the finishing temperature should be at least 800° C. and preferably 900° C. or even slightly higher.

The agglomerates may be heated indirectly, that is in a muffle or retort, or directly by passing an appropriate heating gas through and in contact with the agglomerates. Indirect heating takes longer for the applied heat to reach the agglomerates and is less efficient than direct heating. Furthermore, the heat treatment of individual agglomerates is less readily controlled with indirect heating, and hence non-uniformity of coking frequently results. However, under some circumstances, indirect heating is advantageous, as, for example, where there is available a large quantity of hot waste gas of relatively high oxygen content, that is too high in oxygen for direct heating. Indirect heating may also be of advantage where it is desirable to collect the volatile constituents given off during coking, although even in such a case it would be possible to use such volatile constituents, appropriately heated, as the heating gas for direct heating. Indirect heating may be necessary where the heating gases (if used for direct heating) would deleteriously react with the agglomerates, as, for example, where the car-

bonaceous or metalliferous material is affected by the heating gas.

Any appropriate source of heating gas (inert to the charge under the conditions of coking) may be used in coking the agglomerates by direct heating. The heating gas must be substantially devoid of oxidizing influences. During the early or formative stage of coking, oxygen or oxidizing influences deleteriously affect the coking constituent or friction of the agglomerate, and it is particularly important that this stage of the coking operation be conducted in the absence of such oxidizing influences. Oxidizing influences should also be avoided during the later stages of the coking operation, since they tend to consume the coke.

The heating gas may be producer gas, illuminating gas, oil gas, natural gas, coke-oven gas, water gas, and similar fuel gases, extraneously heated where necessary. The combustion gases resulting from burning such fuel gases, oil or coal (or similar solid carbonaceous fuel) may be used as the heating gas. Such combustion gases may be the exhaust or waste gases from a contiguous thermic operation. When using such combustion gases, it may be desirable or even necessary to add a small quantity of unburnt fuel gas to the combustion gases in order to react with or neutralize any oxidizing gases, such as excess oxygen, therein. Other inert gases, such as nitrogen, superheated steam, and the like, may also be used as the direct heating gas.

The heating gas may as a result of its method of production or previous use be of appropriate temperature for the coking operation. Where the gas is too hot for the contemplated coking operation, it should be appropriately cooled, as for example, by steam, water, or the like. If the heating gas is not of a sufficiently elevated temperature for the coking operation, it must be appropriately heated. This may be advantageously accomplished by recuperation or by regeneration, or by adding thereto an appropriate volume of a hotter gas, or by combusting some of the gas itself or a combustible constituent added thereto for the purpose.

Any appropriate apparatus may be employed in practicing the invention. In the case of indirect heating, the coking chamber is of the muffle or retort type, and may be disposed vertically or horizontally or may be inclined. The operation may be conducted intermittently or the agglomerates may be progressively passed through the coking chamber. With direct heating the coking chamber may be disposed vertically, horizontally or may be inclined. We prefer to employ a vertically disposed coking chamber through which the agglomerates are progressively passed by the action of a gravity from the top to the bottom and through which the heating gases pass from the bottom to the top countercurrent to the travel of the agglomerates. In such an apparatus, there is in effect a relatively deep bed of charge with the heating gas entering the body of charge (at the bottom of the coking chamber) at the highest coking temperature and leaving the body of charge at the entrance or charging end of the coking chamber at the temperature at which it is desired to start the coking operation. If desired, the charge of agglomerates to be coked may be divided into zones through which heating gases of appropriately different temperatures, ranging from the starting to the finishing temperature of coking, are simultaneously passed.

The coked agglomerates are preferably transferred without substantial loss of heat after coking to the zinc distillation retort or other apparatus in which they are to be subsequently treated. Where this practice is not followed and it is necessary to store and hence cool the coked agglomerates before their subsequent treatment, they should be cooled, directly upon discharge from the coking operation, under reducing or non-oxidizing conditions, such for example as in an atmosphere of non-oxidizing or reducing gas or in a mass of carbonaceous material, or in receptacles, such as sealed cans, from which air is excluded.

It is characteristic of the invention that the application of heat to the agglomerates is slow and gradual. In practice, this involves gradually increasing the temperature of the applied heat from the initial or starting temperature up to the finishing temperature of coking over a period of from 2 to 4 hours. In the course of this slow and gradual heat treatment, the surface of the agglomerate gradually dries while the center is still wet. Then next the entire briquette dries but there is as yet no indication of softening. The next indication is softening at the surface only, followed by the entire briquette becoming plastic. As yet, no coke has formed. The entire plastic zone then changes to a solid mass at a temperature between 500–700° C. after say 1 to 3 hours of coking, and from this point on the operation involves driving off the remaining volatile matter. At the end of the coking operation, there is no indication of any zoning or layer formation, and, with an appropriate agglomerate mixture, the coke is homogeneous, dense and strong.

The following table is a log of a coking operation conducted in accordance with the principles of the invention. The agglomerate mixture was made up of about 60% by weight of zinciferous material and 40% by weight of bituminous coal. The zinciferous material and coal were of the graded size and were mixed and briquetted (four inch loaf briquettes) in accordance with the

practice described in the aforementioned Routson and Bunce application, Serial No. 301,709. The briquettes were charged directly into the coking furnace. This furnace consisted of a chamber containing horizontally disposed grate bars and a flue for conducting the heating gas to the chamber below the grate bars. The briquettes were placed on the grate bars and the heating gas from the flue passed upwardly through the bed of briquettes and was exhausted to the atmosphere. The temperature of the heating gas was gradually raised over the three-hour coking period from room temperature to 900° C. Sample briquettes were removed at approximately twenty-minute intervals and were broken in half and examined.

Log of coking operation

Sample No.	Min. after charging	Temp. °C.	Appearance of briquette when removed and broken in half
1	20	100	Surface drying only.
2	40	200	Dry shell, center wet.
3	60	320	All dry except wet spot in center.
4	80	400	All dry—none plastic.
5	100	450	Partly plastic—rest dry.
6	115	475	All plastic.
7	140	530	Some coke—bulk plastic.
8	160	540	Entire briquette coked. Some volatile being removed.
9	200	640	Entire briquette coked. Color changing to steel gray.
10	240	800	Entire briquette coked. Color steel gray. No volatile left.
11	260	900	Entire briquette coked. Color steel gray. No volatile left.

The coking method of the invention is particularly applicable for coking agglomerates in which the carbonaceous material consists wholly, or in large part, of bituminous coal having little, or no, free-flowing properties. Where the bituminous coal itself possesses some slight free-flowing property, or where a small amount (say up to 15% by weight on the agglomerate mixture) of a free-flowing coal is included in the carbonaceous material, the initial or starting temperature of coking may be somewhat higher than where the carbonaceous material consists wholly of a non-free-flowing bituminous coal. While it is our preferred practice to effect the contemplated coking action by bituminous coal, any equivalent carbonaceous coking agent may be substituted in whole or in part for the bituminous coal, such as tar, pitch and the like.

In the foregoing discussion, we have described our invention with particular reference to the production of coked agglomerates of mixed zinciferous and carbonaceous materials. Such coked agglomerates, while peculiarly adapted for smelting in vertical retorts, may be treated by any other appropriate metallurgical operation. Moreover, the invention is not restricted to zinciferous materials but may be practiced with advantage in producing coked agglomerates of any other metalliferous material.

The present invention may be better understood if reference is made to the attached drawing, taken in conjunction with the following description, in which is shown a side elevation in section of an apparatus adapted for a practice of the invention. A coking chamber 10 is defined by a vertically disposed refractory retort 11 surrounded on its side by a sheet metal casing 12. The retort may have any desired configuration; for example, it may be circular or rectangular in shape.

A charge hopper 13 communicates with the coking chamber at its upper end. The charge hopper is provided with a charging gate 14 operated by a system of levers 15. The charging gate is placed in its open position when introducing a fresh charge of agglomerates or briquettes 16 into the hopper, after which the gate is placed in its closed position; so that gases introduced into and generated within the retort cannot readily escape through the charge hopper.

A plurality of waste gas exits 17 and 18 extend laterally from the coking chamber through the walls of the retort at or near its upper end. These gas exits preferably connect with a stack or chimney (not shown). Spaced louvres 19 and 20 are provided in the gas exits 17 and 18, respectively, to permit the ready escape of waste gases, while at the same time preventing charge materials from entering the exits.

A plurality of heating gas inlets 21 and 22 communicate with the coking chamber through the retort walls at or near its lower end. These inlets connect with a source of heating gases for coking (not shown), spaced louvres 23 and 24 fit into the inlets 21 and 22, respectively, to permit the entrance of hot heating gases into the chamber while at the same time preventing charge materials from entering the inlets.

The lower end of the retort terminates in a coked charge discharge 25, preferably of rectangular configuration. A revolving discharge roll 26 is located at or near the lower end of the coked charge discharge, which is adapted to be turned or revolved continuously or intermittently, as desired, to effect a removal of coked charge materials from the system. A discharge gate 27 fits at the extreme end of the discharge 25, and is preferably held in a closed position when coked charge materials are not being withdrawn from the system, so that outside air, which is oxidizing, may not seep into the hot interior of the coking chamber and consume carbonaceous reducing agent present in the agglomerates.

In practicing the process of the invention, with the apparatus just described, the chamber 10 is preferably filled with a charge of agglomerates or briquettes of mixed zincifer-

ous material and carbonaceous reducing agent. The discharge gate 27 is kept closed during the charging of the retort; and, after the chamber has been filled, the charging gate 14 is closed. Suitable non-oxidizing heating gases are introduced through the inlets 21 and 22 into the interior of the coking chamber 10, where the hot gases are brought in contact with the agglomerated charge materials 16.

As the heating gases rise upwardly through the coking chamber in and among the agglomerates, heat interchange takes place. By the time the heating gases reach the louvres 19 and 20 to escape into the exits 17 and 18, respectively, a substantial amount of their heat will have been given up to the agglomerates.

Coked agglomerates are withdrawn through the discharge 25 from time to time by revolving the discharge roll 26. Fresh charge materials should be introduced into the retort at the top from time to time to keep the chamber filled. On removing coked agglomerates from the bottom of the retort, the upper column of agglomerates tends to settle, thus progressively moving the agglomerates from the coolest to the hottest zone within the chamber.

When practicing coking in the manner described, the agglomerates are slowly and gradually brought to their temperature of coking. The length of time to which the agglomerates are subjected to the heat treatment operation may be controlled by regulating the rate of withdrawal of coked agglomerates from and the rate of introduction of coked agglomerates into the system. The agglomerates are in contact with one another and provide interconnecting passageways through which hot gases may freely circulate. The agglomerates are heated to their coking temperature by applying the heat to the contacting agglomerates slowly and at gradually increasing temperatures, to cause the whole of each agglomerate to tend to come to the same temperature, so that there is relatively little difference in temperature between the surface and core of each agglomerate whereby the agglomerates are brought to their coking stage without objectionable softening or deformation.

We claim:

1. The method of producing coked agglomerates which comprises preparing and agglomerating a mixture of metalliferous material and an appropriate coking agent, and subjecting the agglomerates while in contact with one another to a coking operation characterized by such a slow and gradual application of heat that the entire mass of each agglomerate is slowly and gradually heated from a temperature considerably below the requisite temperature of coking to a temperature sufficiently high to effect complete coking of the agglomerate without objectionable softening or deformation, said agglomerates having been blended with metalliferous material and coking agent in amount adapted to render the agglomerates sufficiently strong substantially to prevent both splitting-up of the agglomerates during coking and disintegration during a subsequent smelting or reduction operation.

2. The method of producing coked agglomerates which comprises preparing and agglomerating a mixture of metalliferous material and an appropriate coking agent, and subjecting the agglomerates while in contact with one another to a coking operation characterized by an initial application of heat at a temperature considerably below the requisite temperature of coking and the continued application of heat at gradually increasing temperatures until the agglomerates are heated to a sufficiently high temperature to effect complete coking thereof without objectionable softening or deformation, said agglomerates having been blended with metalliferous material and coking agent in amount adapted to render the agglomerates sufficiently strong substantially to prevent both splitting-up of the agglomerates during coking and disintegration during a subsequent smelting or reduction operation.

3. The method of producing coked agglomerates which comprises preparing and agglomerating a mixture of metalliferous material and an appropriate coking agent, and slowly and gradually applying heat to the agglomerates while in contact with one another so that the entire mass of each agglomerate is substantially uniformly heated from a temperature considerably below the requisite temperature of coking to a temperature sufficiently high to effect complete coking of the agglomerate, whereby the agglomerates first undergo a drying stage without softening and next become plastic throughout and finally become coked throughout, said agglomerates having been blended with metalliferous material and coking agent in amount adapted to render the agglomerates sufficiently strong substantially to prevent both splitting-up of the agglomerates during coking and disintegration during a subsequent smelting or reduction operation.

4. The method of producing coked agglomerates which comprises preparing and agglomerating a mixture of metalliferous material and an appropriate coking agent, and subjecting the agglomerates while in contact with one another to a coking operation characterized by an initial application of heat at a temperature not exceeding 550° C. and the continued application of heat at gradually increasing temperatures until the agglomerates are heated to a sufficiently high temperature to effect complete coking thereof without objectionable softening or defor-

mation, said agglomerates having been blended with metalliferous material and coking agent in amount adapted to render the agglomerates sufficiently strong substantially to prevent both splitting-up of the agglomerates during coking and disintegration during a subsequent smelting or reduction operation.

5. The method of producing coked agglomerates which comprises preparing and agglomerating a mixture of metalliferous material and an appropriate coking agent, subjecting the agglomerates while in contact with one another to a drying operation in the course of which a substantial proportion of the moisture content of each agglomerate is driven off, and subjecting the resulting dried agglomerates preferably without substantial cooling to a coking operation characterized by such a slow and gradual application of heat that the entire mass of each agglomerate is slowly and gradually heated from a temperature considerably below the requisite temperature of coking to a temperature sufficiently high to effect complete coking of the agglomerate without objectionable softening or deformation, said agglomerates having been blended with metalliferous material and coking agent in amount adapted to render the agglomerates sufficiently strong substantially to prevent both splitting-up of the agglomerates during coking and disintegration during a subsequent smelting or reduction operation.

6. The method of producing coked agglomerates which comprises preparing and agglomerating a mixture of metalliferous material and an appropriate coking agent, and subjecting the agglomerates while in contact with one another to a coking operation characterized by an initial application of heat at a temperature not exceeding 550° C. and the continued application of heat for a period of 2 to 4 hours at temperatures gradually increasing to the requisite temperature of coking, whereby the agglomerates first undergo a drying stage without softening and next become plastic throughout and finally become coked throughout without objectionable softening or deformation, said agglomerates having been blended with metalliferous material and coking agent in amount adapted to render the agglomerates sufficiently strong substantially to prevent both splitting-up of the agglomerates during coking and disintegration during a subsequent smelting or reduction operation.

7. The method of producing coked agglomerates of a mixture of zinciferous material and carbonaceous material capable when subjected to the coking treatment herein defined of producing coked agglomerates possessing satisfactory residue strength for vertical retort smelting, which comprises subjecting the agglomerates while in contact with one another to a coking operation characterized by such a slow and gradual application of heat that the entire mass of each agglomerate is slowly and gradually heated from a temperature considerably below the requisite temperature of coking to a temperature sufficiently high to effect complete coking of the agglomerates without objectionable softening or deformation, said agglomerates having been blended with metalliferous material and coking agent in amount adapted to render the agglomerates sufficiently strong substantially to prevent both splitting-up of the agglomerates during coking and disintegration during a subsequent smelting or reduction operation.

8. The method of producing coked agglomerates of a mixture of zinciferous material and carbonaceous material capable when subjected to the coking treatment herein defined of producing coked agglomerates possessing satisfactory residue strength for vertical retort smelting, which comprises subjecting the agglomerates while in contact with one another to a coking operation characterized by an initial application of heat at a temperature considerably below the requisite temperature of coking and the continued application of heat at gradually increasing temperatures until the agglomerates are heated to a sufficiently high temperature to effect complete coking thereof without objectionable softening or deformation, said agglomerates having been blended with metalliferous material and coking agent in amount adapted to render the agglomerates sufficiently strong substantially to prevent both splitting-up of the agglomerates during coking and disintegration during a subsequent smelting or reduction operation.

9. The method of producing coked agglomerates of a mixture of zinciferous material and carbonaceous material capable when subjected to the coking treatment herein defined of producing coked agglomerates possessing satisfactory residue strength for vertical retort smelting, which comprises slowly and gradually applying heat to the agglomerates while in contact with one another so that the entire mass of each agglomerate is substantially uniformly heated from a temperature considerably below the requisite temperature of coking to a temperature sufficiently high to effect complete coking of the agglomerate, whereby the agglomerates first undergo a drying stage without softening and next become plastic throughout and finally become coked throughout said agglomerates having been blended with metalliferous material and coking agent in amount adapted to render the agglomerates sufficiently strong substantially to prevent both splitting-up of the agglomerates during coking and disintegration during a subsequent smelting or reduction operation.

10. The method of producing coked agglomerates of a mixture of zinciferous material and carbonaceous material capable when subjected to the coking treatment herein defined of producing coked agglomerates possessing satisfactory residue strength for vertical retort smelting, which comprises subjecting the agglomerates while in contact with one another to a coking operation characterized by an initial application of heat at a temperature not exceeding 550° C. and the continued application of heat at gradually increasing temperatures until the agglomerates are heated to a sufficiently high temperature to effect complete coking thereof without objectionable softening or deformation, said agglomerates having been blended with metalliferous material and coking agent in amount adapted to render the agglomerates sufficiently strong substantially to prevent both splitting-up of the agglomerates during coking and disintegration during a subsequent smelting or reduction operation.

11. The method of producing coked agglomerates of a mixture of zinciferous material and carbonaceous material capable when subjected to the coking treatment herein defined of producing coked agglomerates possessing satisfactory residue strength for vertical retort smelting, which comprises subjecting the agglomerates to a drying operation in the course of which a substantial proportion of the moisture content of each agglomerates is driven off, and subjecting the resulting dried agglomerates while in contact with one another and preferably without substantial cooling to a coking operation characterized by such a slow and gradual application of heat that the entire mass of each agglomerate is slowly and gradually heated from a temperature considerably below the requisite temperature of coking to a temperature sufficiently high to effect complete coking of the agglomerates without objectionable softening or deformation, said agglomerates having been blended with metalliferous material and coking agent in amount adapted to render the agglomerates sufficiently strong substantially to prevent both splitting-up of the agglomerates during coking and disintegration during a subsequent smelting or reduction operation.

12. The method of producing coked agglomerates of a mixture of zinciferous material and carbonaceous material capable when subjected to the coking treatment herein defined of producing coked agglomerates possessing satisfactory residue strength for vertical retort smelting, which comprises subjecting the agglomerates while in contact with one another to a coking operation characterized by an initial application of heat at a temperature not exceeding 550° C. and the continued application of heat for a period of 2 to 4 hours at temperatures gradually increasing to the requisite temperature of coking, whereby the agglomerates first undergo a drying stage without softening and next become plastic throughout and finally become coked throughout, said agglomerates having been blended with metalliferous material and coking agent in amount adapted to render the agglomerates sufficiently strong substantially to prevent both splitting-up of the agglomerates during coking and disintegration during a subsequent smelting or reduction operation.

13. A method of coking agglomerates of mixed zinciferous material and carbonaceous reducing agent, which consists in heating a body of the agglomerates in contact with one another until the agglomerates are coked, the heat being applied to the agglomerates over an extended period of time and at gradually increasing temperatures so that each agglomerate may have substantially the same temperature throughout its entire mass to insure uniformity of coking.

14. A method of coking agglomerates of mixed zinciferous material and carbonaceous reducing agent, which consists in heating a body of the agglomerates in contact with one another to provide interconnecting passageways through which hot gases may freely circulate, applying the heat to the contacting agglomerates slowly and at gradually increasing temperatures to cause the whole of each agglomerate to tend to come to the same temperature so that there is relatively little difference in temperature between the surface and core of the agglomerate whereby the agglomerates are brought to their coking stage without objectionable softening or deformation.

In testimony whereof we affix our signatures.

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