Aug. 23, 1938. H. K. NAJARIAN 2,127,633

SMELTING OF ZINCIFEROUS MATERIALS

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Fig. 1.

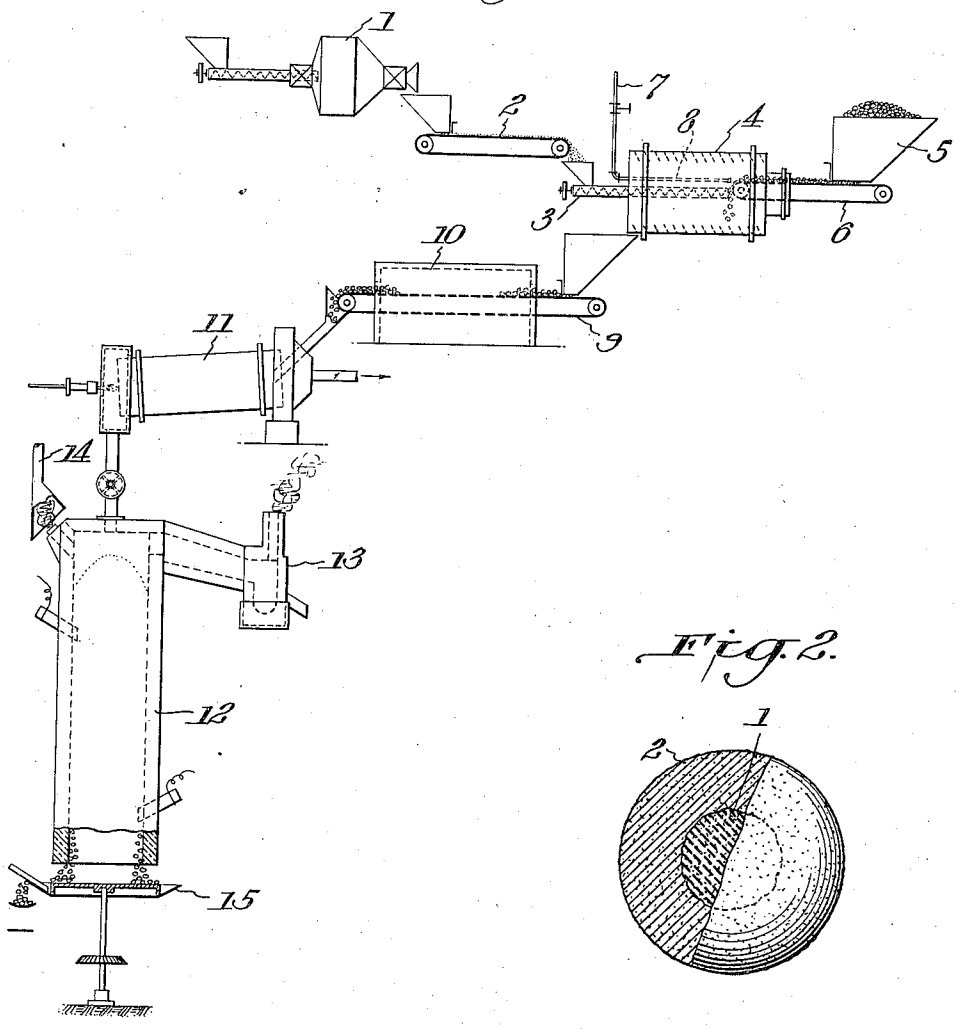


Fig. 2.

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SMELTING OF ZINCIFEROUS MATERIALS

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Application May 8, 1935, Serial No. 20,507

9 Claims. (Cl. 75—14)

This invention relates to a method of treating and smelting zinciferous materials, such as ores, residues, sinters, slags, drosses and the like for the production of zinc metal, zinc oxide and similar products.

A principal purpose of the invention is to provide an economical and efficient method for the smelting of zinciferous materials.

Another object of the invention is to provide a method whereby zinciferous materials and reducing agents, together with any desired modifying agents, may be brought into a condition for efficient smelting and the values contained therein economically separated.

The invention comprises forming zinciferous materials and carbonaceous materials into concretionary aggregates by contacting solid nuclear particles with finely divided zinciferous and carbonaceous materials while subjecting the nuclear particles to continuous rolling and subjecting the concretionary aggregates to a smelting temperature.

A preferred method of making the concretionary aggregates is described in application Serial No. 20,505 filed May 8, 1935, and suitable apparatus for making the concretions is described in application Serial No. 20,506, filed May 8, 1935.

The invention will be described for the purpose of illustration with reference to the accompanying drawing showing a flow sheet of one embodiment of the method of the invention.

In the drawing, 1 is a ball mill wherein zinciferous materials, such as calcined zinc sulphide ore, are ground together with a reducing fuel, such as coke, and fluxes or other desired modifying agents, preferably to a fineness of about 80% —200 mesh U. S. standard screen. The ground materials are conveyed by belt conveyor 2 to screw conveyor 3 which carries the materials into rotary drum 4. Nucleus material, for example, lumps of coke about ½ to ¾ inch in size, is fed from hopper 5 into drum 4 by conveyor 6. A binder material, such as sulphite liquor diluted to 15° Baumé, is fed into the drum through conduit 7 and sprayed on the nucleus particles through nozzles 8.

By the action of the alternate spraying with binder liquid and coating with the finely divided ore and coke, and the continuous rolling in drum 4, the ore and coke are built up into a shell around the nuclei, as described more fully in the applications above referred to, forming concretions of, for example, 1 to 1⅛ inches in diameter.

A typical concretion is shown in Fig. 2, wherein 1 represents the nucleus, for example, of coke, and 2 represents the shell of zinciferous and carboniferous material.

The formed concretions are then passed through drying chamber 10 by means of conveyor 9 and thence preferably into preheater 11 wherein the concretions may advantageously be heated to nearly the reduction point, for example, 600 to 700° C., by any suitable heating means. By this operation the volatile content of the binder used, or of the carbonaceous material, is driven off.

The preheated concretions are then fed into a furnace 12 which may be an externally heated retort, a blast furnace, an electric arc furnace, or an electric resistance furnace. The furnace shown in the drawing by way of example is an electric resistance furnace of the type described in U. S. Patent 1,775,591 to Gaskill.

When the concretions have reached smelting temperature in the furnace, zinc vapor is freely and evenly evolved and may be condensed to metallic zinc in condenser 13, or oxidized to zinc oxide at 14.

The residues may be discharged from the retort or furnace by any convenient means, as, for example, rotating table 15. The residues may then be separated and any substantial values therein returned to the process.

The following are several examples of formulas for zinciferous concretions, which are illustrative of the wide variety of zinciferous materials which may be utilized in the invention:

Example No. 1

Material	Size	Composition	Weight
		Percent	*Pounds*
Roasted zinc ore	99% −100 M.	Zn 69.00 Pb .05 Fe 7.00 S .30	900
Coke, ground with ore (reclaim)	91% −200 M.	Zn 7.00 Fe 5.00 S .10	100
Coke nuclei	+3/8" −5/8"	Fe 5.00 S .10	80
Sulphite liquor, 10° Baumé			185

Example No. 2

Material	Composition		Weight
		Percent	*Pounds*
Dross	Zn	65.00	120
	Other metals	27.00	
Drop ZnO	Zn	72.00	317
	Other metals	21.00	
Magnetic zinc residue	Zn	27.20	413
	SiO_2	23.40	
	Fe	18.70	
	C	7.20	
Coke ground with ore			150
Sinter nuclei	Zn	59.80	210
	Fe	7.90	
Sulphite liquor, 10° Baumé			185

Example No. 3

Material	Composition		Weight
		Percent	*Pounds*
Drop zinc oxide	Zn	72.00	260
	Other metals	21.00	
	C	2.00	
Magnetic zinc residue	Zn	27.20	615
	Other metals	4.00	
	SiO_2	23.40	
	Fe	18.70	
	C	7.20	
Reclaim coke ground with ore	Zn	7.00	110
	Fe	4.00	
Lime rock ground with ore			30
Coke nuclei	Fe	3.00	70
	S	.85	
Sulphite liquor, 10° Baumé			185

The above Exampes 1–3 are useful in the manufacture of lead-free zinc oxides, zinc metals, and other zinc products.

Examples 4, 5 and 6 are used in the manufacture of leaded zinc oxide and relatively high lead zinc metal.

Example No. 4

Material	Composition		Weight
		Percent	*Pounds*
Flue dust	Zn	54.00	890
	Pb	15.10	
	Fe	7.00	
	S	1.10	
Reclaimed coke	Zn	7.00	110
Coke nuclei			70
Sulphite liquor, 10° Baumé			185

Example No. 5

Material	Composition		Weight
		Percent	*Pounds*
Flue dust	Zn	54.00	890
	Pb	15.10	
	Fe	7.00	
	S	1.10	
Reclaimed coke	Zn	7.00	190
Sinter nuclei	Zn	59.80	210
	Metallics	9.40	
	SiO_2	8.80	
	Fe	7.90	
	S	.10	
Sulphite liquor, 10° Baumé			185

Example No. 6

Material	Composition		Weight
		Percent	*Pounds*
Flue dust	Zn	54.00	1000
	Pb	15.10	
	Fe	7.00	
	S	1.10	
Sinter nuclei	Zn	59.80	210
	Metallics	9.40	
	SiO_2	8.80	
	Fe	7.90	
	S	.10	
Sulphite liquor, 10° Baumé			165

Included among the numerous advantages of the method of the invention for the smelting of zinciferous materials is the small excess of reduction fuel required over the theoretical amount. In the reduction of zinciferous metals, for example, where it is customary to use from 35 to 40 percent carbonaceous fuel, based on the zinc charge, the concretions of this invention require only from 15 to 30 percent, depending upon the zinc content of the materials under treatment. In spite of the low carbon content of the concretions, the time and temperature necessary to complete reduction are materially reduced. For example, in the ordinary Belgian type zinc retort, reduction of the zinc-bearing concretion will be complete in from 6 to 8 hours at a temperature of 1200° C., contrasted with a time of from 16 to 18 hours when smelting the ordinary loose charge which is commonly used.

Furthermore, due to the intimate mixture of the carbonaceous and zinciferous materials, the temperature at which reduction reactions have comparable efficiencies would be 975° C. for the concretions and 1225° C. for the loose charges of ordinary practice. This is due to the fact that in the reduction of an aggregate, such as a lump of ore, sinter, or an agglomerate of ore alone, the reduction progresses from the outside surface inwardly, the difficulties of bringing about contact with the carbonaceous material, or of effecting carbonaceous gas penetration being greatly increased as the size of the particle increases, inasmuch as the inert materials carried by the ore when it is in the form of lumps or agglomerates having appreciable size, serve to segregate as reduction proceeds on the surface of the particles, preventing free carbon contact and making the penetration of the carbonaceous gases difficult. Therefore, the time and temperature required for the final efficient reduction of such ores is greatly increased over that required by the finely ground metalliferous materials intimately mixed with finely ground carbonaceous materials in the concretions of this invention.

With a carbonaceous nucleus, considerable vapor pressure at the temperature of reduction must be exerted from that direction and reduction proceeds rapidly, inasmuch as the novel conditions of structure of the concretion promote the realization of nearly ideal reduction.

The concretions being spherical, or nearly so, in form, the space between the bodies for the circulation of the gases and vapors is at a maximum, thus resulting in a very rapid heat transfer from one part of the retort to the other and the assurance, due to the open charge, that local pressures will not be built up, which seriously impair smelting efficiency. Inasmuch as, referring particularly to zinciferous ores, the preferable carbonaceous content is metallurgical coke containing relatively low sulphur and very low residual volatile

content, the concretions of the invention may be used in the direct production of the metallic oxides from the volatile metals, and a high grade product obtained, which cannot be realized, particularly in the manufacture of zinc oxides or the basic lead sulphates by the fuming process, when the raw zinciferous or plumbiferous materials are briquetted with the coking bituminous coals. Inasmuch as the limitations placed upon the coking process by the reduction temperature of these metalliferous materials are such that the volatile content of the briquette or agglomerate cannot be reduced below about 2%, the result is that as this material is subsequently reduced in the smelting furnace, the remaining volatile hydrocarbon of the briquette or agglomerate is distilled off in the reduction process and carried out with the gases and vapors, excessively discoloring the oxides produced by these processes and making them unfit for commercial use in many of the arts. Furthermore, a briquette made without the aid of the flowing or coking coals, or an excessive amount of tar or pitch, has not proved satisfactory in shaft furnaces, due largely to the fact that, although great pressures are used by the numerous briquette pressing devices, the moisture content at the time of pressing must be kept relatively low, with the result that the particles are not thoroughly wetted, that the binder and the matrix formed by the subsequent reaction due to heat or chemical reaction are poorly distributed, and that when the briquette is highly heated it sands rapidly, causing a loss of furnace porosity and a consequent loss of smelting efficiency due to the difficulties of obtaining uniform heat penetration to all parts of the charge.

In blast furnace smelting, if the charge consists of concretionary agglomerates, made by using the fuel portion of the charge in the form of lumps of coke, coal, or charcoal as nuclei, and coating them with the finely ground mixture of ores, fluxes, flue dust and the like, improved operation and reduction in fuel consumption are obtained due to the fact that the concretions permit free and more uniform circulation of reducing gases in the furnace while the coating on the fuel inhibits the dissolution of the carbon in the fuel at the upper zones of the blast furnace by ascending carbonic acid gas.

The solid nucleus of the concretion of this invention—whatever it may be composed of—greatly reinforces the structure and prevents breakage and crumbling.

I claim:

1. A method of smelting zinciferous materials which comprises forming concretions of finely divided zinciferous material and carboniferous material about solid nuclei of a material entering into the smelting reaction and subjecting the concretions to smelting temperature.

2. A method of smelting zinciferous materials which comprises forming concretions of finely divided zinciferous material and carboniferous material about solid nuclei of reducing fuel and subjecting the concretions to smelting temperature.

3. A method of smelting zinciferous materials which comprises forming concretions of finely divided zinciferous material and carboniferous material about solid nuclei of coke and subjecting the concretions to smelting temperature.

4. A method of smelting zinciferous materials which comprises forming concretions of finely divided zinciferous material and carboniferous material about solid nuclei of sintered zinciferous material and subjecting the concretions to smelting temperature.

5. A method of smelting zinciferous materials which comprises forming concretions of finely divided zinciferous material and carboniferous material about solid nuclei of a material entering into the smelting reaction, preheating the concretions to below smelting temperature, and subjecting the preheated concretions to smelting temperature.

6. A method of smelting zinciferous materials which comprises forming concretions of finely divided zinciferous material and carboniferous material about solid nuclei of a material entering into the smelting reaction and subjecting the concretions to smelting temperature by passing an electric current through a column of the concretions.

7. A method of smelting zinciferous materials which comprises forming concretions of finely divided zinciferous material and carboniferous material about solid nuclei of a material entering into the smelting reaction, preheating the concretions to below smelting temperature, and subjecting the preheated concretions to smelting temperature by passing an electric current through a column of the concretions.

8. A method of smelting zinciferous materials which comprises contacting solid particles of a material entering into the smelting reaction with finely divided zinciferous material and carboniferous material and with a binder material while subjecting the particles to continuous rolling until a shell of desired size has built up about the solid particles, thereafter continuing the rolling operation until the substance of said shell is well plasticized, indurating the concretions thus formed by heating and subjecting the indurated concretions to smelting temperature.

9. A method of smelting zinciferous materials which comprises contacting solid coke particles with finely divided zinciferous material and carboniferous material and with a binder material while subjecting the particles to continuous rolling until a shell of desired size has built up about the solid particles, thereafter continuing the rolling operation until the substance of said shell is well plasticized, indurating the concretions thus formed by heating and subjecting the indurated concretions to smelting temperature.

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