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WALTER LANDON MAXSON, OF PALMERTON, PENNSYLVANIA, ASSIGNOR TO THE NEW JERSEY ZINC COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW JERSEY.

DESULPHURIZING ZINCIFEROUS SULPHIDE ORES.

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To all whom it may concern:

Be it known that I, WALTER LANDON MAXSON, a citizen of the United States, residing at Palmerton, in the county of Carbon, State of Pennsylvania, have invented certain new and useful Improvements in Desulphurizing Zinciferous Sulphide Ores; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to the desulphurizing of zinciferous sulphide ores, and has for its object the provision of an improved method of desulphurizing such ores.

Zinciferous sulphide ores, as mined, contain, in addition to zinc sulphide or blende, varying amounts of other metalliferous sulphides, such as galena, pyrite and the like, as well as varying amounts of gangue constitutents. The raw ore, crushed to suitable size for the particular mode of ore dressing employed, is usually subjected to appropriate treatment, such as jigging, tabling, magnetic separation, flotation, etc., for eliminating to the desired extent the gangue constitutents and, in some instances, one or more of the metalliferous constitutents other than zinc sulphide. The zinciferous sulphide concentrates resulting from such customary modes of ore dressing are in a finely divided condition, varying, according to the particular mode of concentration employed, from 1/4-inch mesh and finer, in the case of jig concentrates, to 1/100-inch mesh and finer, in the case of flotation concentrates.

The present invention contemplates an improved method of desulphurizing or roasting zinciferous sulphide ores or concentrates in a finely divided condition, that is, of 1/4-inch mesh and finer, and throughout this specification and the appended claims the expression "zinciferous sulphide ores" is to be understood as including raw ores, concentrates, or other materials containing a relatively high percentage of zinc sulphide or blende. In addition to zinc sulphide or blende, the zinciferous sulphide ore, concentrate or other material, may, and usually does, contain other metalliferous constitutents such as galena, pyrite, etc., and it is to be understood that the method of the invention is applicable to the treatment of zinciferous sulphide materials containing other metalliferous constitutents, generally in relatively small percentages, such as are ordinarily present in zinciferous sulphide ores or concentrates.

In accordance with the invention, the zinciferous sulphide ore, in a finely divided condition, that is of 1/4-inch mesh and finer, is subjected to a two-stage treatment, in the first stage of which an appropriate charge of the finely divided ore is agglomerated or sintered by the burning or combustion of sulphides in the charge, but with only partial and preferably very slight desulfurization, and without any substantial loss of zinc, and in the second stage of which the resulting sintered product, with or without a preparatory crushing operation to produce appropriately sized lumps, is subjected to a roasting or desulphurizing treatment to eliminate to the desired extent the remaining sulfur in the ore, also without any substantial loss of zinc. In the preferred practice of the invention, the sintering is carried out with a minimum loss of sulfur, for example, not exceeding one half of the total sulfur in the ore, and preferably with a considerably smaller loss of sulfur, for example, seven units or less of sulfur, a unit being twenty pounds per ton of ore. The subsequent roasting of the product of the sintering treatment may be carried out in any approved manner. I prefer, however, to conduct this roasting operation by passing a combustion-supporting gas, such as air, of which at least a portion is preheated, through a body of lumps, of substantial size, resulting from the sintering treatment.

The sintering operation is not primarily intended to effect any substantial desulphurization of the ore, but is in the nature of a preparatory step for conditioning the ore for subsequently roasting in the form of lumps or agglomerates. For this reason I prefer to conduct the sintering step of the method of the invention with only such loss of sulfur as is necessary, by the burning of sulphides in the charge, to produce the required degree of heat for obtaining a firm sinter. In practice, I have found that this result can be attained

with the loss of from 2 to 7 units of sulfur in the ore. The sulfur dioxide gas resulting from this sintering step may, of course, be collected and utilized, for example, in the manufacture of sulfuric acid.

The sintering of an appropriate charge of the finely divided ore may advantageously be carried out by progressive combustion, from one surface to the other, of an appropriately supported layer of the charge. To this end, a layer of the charge, preferably 3 to 4 inches in depth, may be supported upon a perforated metallic grate, of either the traveling or stationary type, and appropriately ignited at the exposed or outer surface and the desired progressive combustion effected by passing a combustion-supporting gas, such as air, inwardly through the layer of the charge. As soon as the combustion reaches the surface of the layer of the charge in contact with the perforated grate, the sintering should be complete, and the charge may be dumped and cooled prior to the subsequent roasting operation, or may be directly discharged while still hot into the roasting furnace or apparatus.

In order to effect the desired agglomeration or sintering, the ore should contain a sufficient amount of an appropriate sinterable constituent or agent which will fuse at the prevailing temperatures and thereby cement or bind the metalliferous particles together. In the case of many ores, such sinterable constituents will be naturally present in sufficient amount in the gangue associated with the ore. Where the ore does not naturally contain such a sinterable constituent in sufficient amount, an appropriate agent or material may be mixed with the ore for this purpose. Thus, I have found that the dust from the milling operations of the zinciferous ores mined at Franklin, New Jersey, U. S. A., pyrites, coal (particularly that having a high ash content) and in general any material which alone or in combination with the ore forms a sinterable agent, may be satisfactorily employed as a binding agent in the sintering step. The amount of binding agent to be thus mixed with the ore depends upon the particular ore undergoing treatment, but in general not more than about 5% of binding agent will be required.

The ore should be damp or slightly wet to form a satisfactory sinter for the subsequent roasting operation. To this end it is generally necessary to mix a certain small amount of water with the ore. With ordinary dry ores around 5% of water on the total weight of the ore (and binding agent when employed) will usually be found satisfactory for this purpose.

The agglomeration or sintering of the ore is brought about by the fusing or sintering of the fusible or sinterable constituents in the ore, or of the binding agent mixed therewith, which results from the heat of combustion of sulphides in the charge. The sinter thus produced is a coherent cellular mass of "coke-like" appearance and is very porous. The metalliferous particles are firmly cemented together into a mechanically strong mass which stands up well without disintegration, breaking or crumbling in the subsequent handling and roasting of the sintered product. The percentage of fines or unagglomerated particles is, with proper manipulation, relatively low, and such fines may advantageously be utilized as a grate dressing, say about 1/4-inch or less in depth, for the perforated grate of the sintering apparatus. Such a grate dressing protects the grate and makes possible the complete burning out of the bed or layer of charge, where under ordinary circumstances a layer of unburned charge 1/4-inch more or less in depth would have to be left on the grate in order to protect the grate from the prevailing high temperature. The grate dressing becomes a part of the finished sinter.

The sintering of the charge of finely divided zinciferous sulphide ore is carried on by heat derived substantially from the burning of the compounds of sulfur in the charge, and since the charge is composed for the most part of zinc sulphide, the heat for sintering is obtained chiefly at the expense of the sulfur in the zinc sulphide. Where the ore naturally contains sinterable or fusible constituents in sufficient amount to satisfactorily sinter or cement the ore particles together no additional binding agent need be added to the ore, and the charge will consist solely of the ore appropriately moistened as hereinbefore described. Of the binding agents which I have hereinbefore specifically mentioned, I have found that the dust resulting from the milling operations of such ores as those mined at Franklin, New Jersey, gives the best sinter under widely varying conditions. Pyrite, as a binding agent, gives a good product and is usable, although at the expense of an increase in the iron content of the charge. Where coal is added to the ore to furnish sinterable constituents in sufficient amount, the carbonaceous or combustible constituents of the coal are undesirable, since they tend to set up reducing conditions within the charge with consequent loss by volatilization of zinc during the sintering operation and more particularly during the subsequent roasting operation. It is to be understood, therefore, that where coal is employed as the binding agent only very small quantities may be used, in order that the sintering operation and more particularly the roasting operation may proceed under

conditions which will not result in any substantial loss of zinc.

The sintering operation is carried out as promptly as possible and, with a charge from 3 to 4 inches in depth, is generally completed in approximately 6 to 10 minutes. Detention of the charge at or near the maximum temperature characteristic of the sintering operation should be for as short a time interval as practicaable, and reducing conditions within the charge should be avoided, in order to prevent any loss by volatilization of zinc. When the sintering operation is conducted with due regard to these precautions there is substantially no loss of zinc by volatilization. This is an important matter, since any loss of zinc in either the sintering or roasting steps of the method of the invention is objectionable and reduces the amount of zinc recoverable from the original ore by the subsequent smelting of the finally roasted product. Any volatilization of zinc in either the sintering or roasting operation, moreover, interferes with the maximum economy in the use of the sulfur gases, as for instance in the manufacture of sulfuric acid.

The sinter, as it is discharged from the furnace, is in the form of cakes or lumps varying considerably in size. For the roasting operation, it may be desirable to break or crush the sinter into lumps of substantial size. For roasting in a shaft furnace, lumps or agglomerates 2 to 4 inches in thickness or diameter, and larger, may advantageously be employed. In any case any desired or necessary crushing operation is carried out with the view of producing as small a percentage of fines as possible, and the lumps or agglomerates for roasting will always be of substantial size, for example, no smaller than hens' eggs. Obviously, in breaking up the sinter to form appropriately sized lumps for roasting, a certain amount of undersized material will be produced, and may be charged into the roasting furnace. However, the percentage of such undersized material should be kept as low as practicable, and the charge for roasting consists for the most part of lumps of substantial size.

The roasting step of the method of the invention may be carried out in any approved manner. In practice, I have secured excellent results by roasting the sintered product, in the form of appropriately sized lumps, in a shaft furnace provided with appropriate instrumentalities for bringing a combustion-supporting gas, such as air, into intimate contact with the lumps of sinter undergoing roasting. By preheating at least a portion of the combustion-supporting gas thus brought in contact with the roasting charge, desulphurization of the charge to the desired extent may be readily effected without the application to the roasting furnace of other external heat. The preheating of the combustion-supporting gas may be effected by the hot gases resulting from the roasting operation, and the roasting of the sintered product may thus be carried out autogenously.

The sintered product is preferably given a dead or sweet roast in the roasting step of the invention, so that the roasted material is adapted to be utilized, without further treatment, in the manufacture of zinc oxide by the Wetherill process, or in the manufacture of spelter in the customary zinc distillation furnaces, or for any other purpose where roasted zinc sulphide ores are usable. Where the roasted product is to be employed in the manufacture of substantially lead-free zinc products, the roasting should be carried on until the fault sulfur in the charge is less than 3% and preferably not over 2%. In roasting leaded zinciferous sulphide ores, where the roasted product is to be employed in the manufacture of leaded zinc products, such as leaded zinc oxide, the fault sulfur in the roasted product may be as high as 10%, and in practice is frequently around 3 to 7%. In any case, in accordance with the present invention, the sinter in the form of lumps of substantial size is roasted to effect such desulphurization of the sulphides as is required in the subsequent treatment of the roasted material.

As a specific example of the practice of the invention, I will now describe the method which I have followed with excellent results in desulphurizing a particular ore by the principles of the invention. The ore in question is a concentrate generally known as Wisconsin magnetic separator ore and is generally of the following composition:

Zinc	58.0%
Sulfur	30.0%
Iron	2.5%
Lead	1.0%
Lime	3.0%
Magnesium oxide	1.5%

A screen analysis of this ore was as follows:

	Dir.	Cuml.
On 10 mesh	27.7%	27.7%
20	19.6%	47.3%
28	11.1%	58.4%
35	11.1%	69.5%
65	15.3%	84.8%
80	3.1%	87.9%
Minus 80	12.1%	100.0%

Wisconsin separator ore of the foregoing composition is deficient in gangue materials and an appropriate binding agent containing sinterable constituents must be mixed with the ore in order to provide an appro-

priate charge for the sintering step of the invention. For this purpose I have employed with excellent results the milling dust from the zinciferous ores of Franklin, New Jersey. The charge for sintering was made up in the following proportions:

Wisconsin separator ore	120 lbs.
Milling dust	6 lbs.
Water	6.3 lbs.

The charge was thoroughly mixed in order to intimately distribute the milling dust and water uniformly throughout the mass of the ore. The charge, thus prepared, was placed on a perforated grate, the openings of which form 25% of the total area of the grate. The depth or thickness of the charge was about 3½ inches. While the charge might have been ignited in other ways, as, for example, by a gas or oil burner, in the particular runs now being described the charge was ignited by a surface layer of charcoal, and air was then drawn downwardly through the charge. For the first minute after ignition the suction beneath the grate was in the neighborhood of 3½ inches of water to better ignite the charge and was then raised to 6 to 10 inches of water for the duration of the sintering operation. When the zone of combustion reached the bottom of the charge, the sintering operation was completed and the charge was dumped. Usually this operation required about six minutes when the higher suction (10 inches) was used and about eight minutes when the lower suction (6 inches) was used.

The resulting sinter was next broken up into appropriately sized lumps for the roasting operation. These sintered lumps were "coke-like" in appearance and were very firm and very porous. The percentage of fines was relatively low and, in whole or in part, were returned to the sintering apparatus for use as grate dressing. The units of sulfur removed during the sintering operation varied from 2 to 7, and I have demonstrated that it is feasible to form a very satisfactory sinter with an average loss of sulfur not exceeding four units.

The sinter when cold was broken into lumps, about two or three inches or more in diameter, for the better handling in the roasting furnace. These pieces or lumps of sinter were charged into a vertical tapered shaft furnace and progressively traveled through the furnace so as to give the desired roasting period. I have found that such lumps of sinter may be given a sweet or dead roast in this type of furnace in about nine hours. The roasting was initiated and carried on by supplying air heated to a temperature of around 400° C., the air entering near the base of the shaft furnace through suitable tuyeres. If desired a certain quantity of cold air may be introduced into the shaft furnace near the top thereof for the purpose of appropriately controlling the reaction temperature within the furnace, as well as the temperature of the exit gases. In the roasting operations now being particularly described the reaction temperatures within the shaft furnace were so controlled that the average temperature at the top of the furnace was approximately 740° C. while the average temperature at the bottom of the furnace a short distance above the incoming air was approximately 737° C., and the evolved gases contained an average sulfur dioxide content of 7.33%, and a finally roasted product of the following composition was obtained:

Total zinc	63.0 %
Total sulfur	3.43%
Fault sulfur	1.78%

As is well understood in the art, the fault sulfur is the sulfur in the roasted product which might have been driven off under ideal roasting conditions.

From the foregoing description it will be seen that the method of the invention involves a two stage process of desulphurizing zinciferous sulphide ores in which the first or sintering stage is in the nature of a preparatory or conditioning step for the second or main desulphurizing stage. The purpose of the first stage is primarily to form the finely divided ore into suitable agglomerates or lumps of such a uniformly porous nature and of such mechanical strength that the ore contained therein may be roasted to deadness in this form without material disintegration or crumbling of the agglomerates or lumps. The sintering step is thus designed to form uniformly porous agglomerates or lumps of the finely divided ore having sufficient mechanical strength to withstand (without material disintegration, crumbling or breaking) such subsequent handling and treatment as is encountered in the roasting operation. No attempt is made to effect any substantial desulphurization of the ore in the sintering operation, and this operation is accordingly conducted with only such loss of sulfur as is necessary to form a satisfactorily sintered product by heat derived substantially from the burning of sulphides in the charge.

Furthermore, it is of prime importance that both the sintering and roasting operations be conducted with no substantial loss of zinc. Therefore, if a sinterable or binding medium containing reducing agents, such as carbonaceous material, is mixed with the ore, for the purposes hereinbefore described, only a very small amount of such binding medium may be used, because the presence in the charge of reducing agents in any substantial amount during the sinter-

ing operation will cause a substantial loss of zinc. What is more serious, however, is the fact that the presence of a reducing agent in any substantial amount in the sintered product will cause a very much more substantial loss of zinc in the subsequent roasting operation than in the sintering step, since the roasting period is generally a matter of hours whereas the sintering operation is completed in a few minutes. Since the desulphurizing process of the invention is intended to prepare a zinciferous sulphide ore for subsequent smelting, as for example by the Wetherill process or in zinc distillation furnaces, in which the aim is to recover as large a percentage as possible of the zinc content of the original ore, it will be obvious that any loss of zinc is objectionable, and in the practice of the invention due precautions are taken during both the sintering and main desulphurizing or roasting stages to prevent any substantial loss of zinc.

It will, therefore, be seen from the foregoing discussion that the product of the sintering operation, in addition to being uniformly porous and mechanically strong, must be of such a character that it can be subsequently roasted without substantial loss of zinc. Thus, the sinter is devoid of reducing agents in amount sufficient to effect any substantial loss of zinc during the roasting operation. It is, accordingly, to be understood that in the appended claims the sintering step set forth is a sintering operation conducted under such conditions that no substantial loss of zinc results therefrom and as the result of which there is produced a uniformly porous and mechanically strong sinter which can be subsequently dead roasted, or substantially so, in the form of lumps without substantial loss of zinc.

I claim:

1. The process of desulphurizing zinciferous sulphide ores which comprises sintering an appropriate charge of the ore, said sintering operation being carried on by heat derived substantially from the burning of compounds of sulfur in the charge, and subjecting the resulting sinter for the most part in the form of lumps of substantial size to a roasting operation and thereby eliminating to the desired extent the remaining sulfur in the charge.

2. The process of desulphurizing zinciferous sulphide ores which comprises sintering an appropriate charge of the ore, said sintering operation being carried on by heat derived substantially from the burning of compounds of sulfur in the charge and with only such loss of sulfur as is necessary to produce the required degree of heat for obtaining a firm sinter, and subjecting the resulting sinter for the most part in the form of lumps of substantial size to a roasting operation and thereby eliminating to the desired extent the remaining sulfur in the charge.

3. The process of desulphurizing zinciferous sulphide ores which comprises sintering an appropriate charge of the ore, said sintering operation being carried on by heat derived substantially from the burning of compounds of sulfur in the charge and with the loss of not more than one half of the total sulfur in the charge, and subjecting the resulting sinter for the most part in the form of lumps of substantial size to a roasting operation and thereby eliminating to the desired extent the remaining sulfur in the charge.

4. The process of desulphurizing zinciferous sulphide ores which comprises sintering an appropriate charge of the ore, said sintering operation being carried on by heat derived substantially from the burning of compounds of sulfur in the charge and with the loss of not more than seven units of the sulfur in the charge, and subjecting the resulting sinter for the most part in the form of lumps of substantial size to a roasting operation and thereby eliminating to the desired extent the remaining sulfur in the charge.

5. The process of desulphurizing zinciferous sulphide ores which comprises sintering an appropriate charge of the ore, and effecting a further desulphurization of the resulting sinter by passing a combustion-supporting gas at least a portion of which is preheated through a body of appropriately sized lumps thereof.

6. The process of desulphurizing zinciferous sulphide ores which comprises sintering an appropriate charge of the ore, said sintering operation being carried on by heat derived substantially from the burning of compounds of sulfur in the charge and with only such loss of sulfur as is necessary to produce the required degree of heat for obtaining a firm sinter, and effecting a further desulphurization of the resulting sinter by passing a combustion-supporting gas at least a portion of which is preheated through a body of the sinter for the most part in the form of lumps of substantial size.

7. The process of desulphurizing zinciferous sulphide ores which comprises sintering an appropriate charge of the ore, said sintering operation being carried on by heat derived substantially from the burning of compounds of sulfur in the charge and with the loss of not more than one half of the total sulfur in the charge, and effecting a further desulphurization of the resulting sinter by passing a combustion-supporting gas at least a portion of which is preheated through a body of the sinter for the most part in the form of lumps of substantial size.

8. The process of desulphurizing zinciferous sulphide ores which comprises sintering an appropriate charge of the ore, said sintering operation being carried on by heat derived substantially from the burning of compounds of sulfur in the charge with the loss of not more than seven units of the sulfur in the charge, and effecting a further desulphurization of the resulting sinter by passing a combustion-supporting gas at least a portion of which is preheated through a body of the sinter for the most part in the form of lumps of substantial size.

9. The process of desulphurizing zinciferous sulphide ores low in sinterable constituents which comprises mixing the ore with a relatively small percentage of a material containing sinterable constituents, subjecting a layer of the charge thus formed to a sintering operation carried on by heat derived substantially from the burning of compounds of sulfur in the charge, and subjecting the resulting sinter for the most part in the form of lumps of substantial size to a roasting operation and thereby eliminating to the desired extent the remaining sulfur in the charge.

10. The process of desulphurizing zinciferous sulphide ores low in sinterable constituents which comprises mixing the ore with a relatively small percentage of a material containing sinterable constituents, subjecting a layer of the charge thus formed to a sintering operation carried on by heat derived substantially from the burning of compounds of sulfur in the charge with only such loss of sulfur as is necessary to produce the required degree of heat for obtaining a firm sinter, and subjecting the resulting sinter for the most part in the form of lumps of substantial size to a roasting operation and thereby eliminating to the desired extent the remaining sulfur in the charge.

11. The process of desulphurizing zinciferous sulphide ores which comprises sintering an appropriate charge of the ore, said sintering operation being carried on by heat derived substantially from the burning of compounds of sulfur in the charge and without substantial loss of zinc, and subjecting the resulting sinter for the most part in the form of lumps of substantial size to a roasting operation and thereby eliminating to the desired extent the remaining sulfur in the charge.

12. The process of desulphurizing zinciferous sulphide ores which comprises sintering an appropriate charge of the ore, said sintering operation being carried on without substantial loss of zinc and with only such loss of sulfur as is necessary to produce the required degree of heat for obtaining a firm sinter and resulting in the production of a sinter which can be subsequently roasted without substantial loss of zinc, and subjecting the resulting sinter for the most part in the form of lumps of substantial size to a roasting operation and thereby eliminating to the desired extent the remaining sulfur in the charge.

13. The process of desulphurizing zinciferous sulphide ores which comprises sintering an appropriate charge of the ore, said sintering operation being carried on without substantial loss of zinc and resulting in the production of a sinter which can be subsequently roasted without substantial loss of zinc, and subjecting the resulting sinter for the most part in the form of lumps of substantial size to a roasting operation and thereby eliminating to the desired extent the remaining sulfur in the charge with no substantial loss of zinc.

14. The process of desulphurizing zinciferous sulphide ores which comprises sintering an appropriate charge of the ore, said sintering operation being carried on without substantial loss of zinc and with the loss of not more than one half of the total sulfur in the charge and resulting in the production of a sinter which can be subsequently roasted without substantial loss of zinc, and subjecting the resulting sinter for the most part in the form of lumps of substantial size to a roasting operation and thereby eliminating to the desired extent the remaining sulfur in the charge.

15. The process of desulphurizing zinciferous sulphide ores which comprises sintering an appropriate charge of the ore, said sintering operation being carried on without substantial loss of zinc and with the loss of not more than seven units of the sulfur in the charge and resulting in the production of a sinter which can be subsequently roasted without substantial loss of zinc, and subjecting the resulting sinter for the most part in the form of lumps of substantial size to a roasting operation and thereby eliminating to the desired extent the remaining sulfur in the charge.

16. The process of desulphurizing zinciferous sulphide ores which comprises sintering an appropriate charge containing the ore mixed with a relatively small percentage of a material containing sinterable constituents and devoid of reducing agents or combustible material other than compounds of sulfur in amount sufficient to effect any substantial loss of zinc, said sintering operation being carried on by heat derived substantially from the burning of compounds of sulfur in the charge, and subjecting the resulting sinter for the most part in the form of lumps of substantial size to a roasting operation and thereby eliminating to the desired extent the remaining sulfur in the charge.

17. The process of desulphurizing zinciferous sulphide ores which comprises sintering

an appropriate charge containing the ore mixed with a relatively small percentage of a material containing sinterable constituents and devoid of reducing agents or combustible material other than compounds of sulfur in amount sufficient to effect any substantial loss of zinc, said sintering operation being carried on by heat derived substantially from the burning of compounds of sulfur in the charge and with only such loss of sulfur as is necessary to produce the required degree of heat for obtaining a firm sinter, and subjecting the resulting sinter for the most part in the form of lumps of substantial size to a roasting operation and thereby eliminating to the desired extent the remaining sulfur in the charge.

18. The process of desulphurizing zinciferous sulphide ores which comprises sintering an appropriate charge containing the ore mixed with a relatively small percentage of a material containing sinterable constituents and devoid of reducing agents or combustible material other than compounds of sulfur in amount sufficient to effect any substantial loss of zinc, said sintering operation being carried on by heat derived substantially from the burning of compounds of sulfur in the charge and with the loss of not more than one half of the total sulfur in the charge, and subjecting the resulting sinter for the most part in the form of lumps of substantial size to a roasting operation and thereby eliminating to the desired extent the remaining sulfur in the charge.

19. The process of desulphurizing zinciferous sulphide ores which comprises sintering an appropriate charge containing the ore mixed with a relatively small percentage of a material containing sinterable constituents and devoid of reducing agents or combustible material other than compounds of sulfur in amount sufficient to effect any substantial loss of zinc, said sintering operation being carried on by heat derived substantially from the burning of compounds of sulfur in the charge and with the loss of not more than seven units of sulfur in the charge, and subjecting the resulting sinter for the most part in the form of lumps of substantial size to a roasting operation and thereby eliminating to the desired extent the remaining sulfur in the charge.

20. The process of desulphurizing zinciferous sulphide ores which comprises sintering an appropriate charge of the ore, said sintering operation being carried on without substantial loss of zinc and resulting in the production of a uniformly porous and mechanically strong sinter which can be subsequently dead roasted without substantial loss of zinc, and subjecting the resulting sinter for the most part in the form of lumps of substantial size to a roasting operation in the course of which the ore is roasted to deadness.

21. The process of desulphurizing zinciferous sulphide ores which comprises sintering an appropriate charge of the ore, said sintering operation being carried on without substantial loss of zinc and with only such loss of sulfur as is necessary to produce the required degree of heat for obtaining a firm sinter and resulting in the production of a uniformly porous and mechanically strong sinter which can be subsequently dead roasted without substantial loss of zinc, and subjecting the resulting sinter for the most part in the form of lumps of substantial size to a roasting operation in the course of which the ore is roasted to deadness.

22. The process of desulphurizing zinciferous sulphide ores which comprises sintering an appropriate charge of the ore, said sintering operation being carried on without substantial loss of zinc and with the loss of not more than one half of the total sulfur in the charge and resulting in the production of a uniformly porous and mechanically strong sinter which can be subsequently dead roasted without substantial loss of zinc, and subjecting the resulting sinter for the most part in the form of lumps of substantial size to a roasting operation in the course of which the ore is roasted to deadness.

23. The process of desulphurizing zinciferous sulphide ores which comprises sintering an appropriate charge of the ore, said sintering operation being carried on without substantial loss of zinc and with the loss of not more than seven units of sulfur in the charge and resulting in the production of a uniformly porous and mechanically strong sinter which can be subsequently dead roasted without substantial loss of zinc, and subjecting the resulting sinter for the most part in the form of lumps of substantial size to a roasting operation in the course of which the ore is roasted to deadness.

24. The process of desulphurizing zinciferous sulphide ores which comprises sintering an appropriate charge containing the ore mixed with a relatively small percentage of a material containing sinterable constituents and devoid of reducing agents in amount sufficient to effect any substantial loss of zinc, said sintering operation being carried on without substantial loss of zinc and resulting in the production of a porous sinter which can be subsequently dead roasted without substantial loss of zinc, and subjecting the resulting sinter for the most part in the form of lumps of substantial size to a roasting operation in the course of which the ore is roasted to deadness with no substantial loss of zinc.

25. The process of desulphurizing zinciferous sulphide ores which comprises sintering

an appropriate charge containing the ore mixed with a relatively small percentage of a material containing sinterable constituents and devoid of reducing agents in amount sufficient to effect any substantial loss of zinc, said sintering operation being carried on without substantial loss of zinc and with only such loss of sulfur as is necessary to produce the required degree of heat for obtaining a firm sinter and resulting in the production of a porous sinter which can be subsequently dead roasted without substantial loss of zinc, and subjecting the resulting sinter for the most part in the form of lumps of substantial size to a roasting operation in the course of which the ore is roasted to deadness with no substantial loss of zinc.

26. The process of desulphurizing zinciferous sulphide ores which comprises sintering an appropriate charge containing the ore mixed with a relatively small percentage of a material containing sinterable constituents and devoid of reducing agents in amount sufficient to effect any substantial loss of zinc, said sintering operation being carried on without substantial loss of zinc and with the loss of not more than one half of the total sulfur in the charge and resulting in the production of a porous sinter which can be subsequently dead roasted without substantial loss of zinc, and subjecting the resulting sinter for the most part in the form of lumps of substantial size to a roasting operation in the course of which the ore is roasted to deadness with no substantial loss of zinc.

27. The process of desulphurizing zinciferous sulphide ores which comprises sintering an appropriate charge containing the ore mixed with a relatively small percentage of a material containing sinterable constituents and devoid of reducing agents in amount sufficient to effect any substantial loss of zinc, said sintering operation being carried on without substantial loss of zinc and with the loss of not more than seven units of the sulfur in the charge and resulting in the production of a porous sinter which can be subsequently dead roasted without substantial loss of zinc, and subjecting the resulting sinter for the most part in the form of lumps of substantial size to a roasting operation in the course of which the ore is roasted to deadness with no substantial loss of zinc.

28. The process of desulphurizing zinciferous sulphide ores which comprises sintering an appropriate charge of the ore, said sintering operation being carried on without substantial loss of zinc and resulting in the production of a porous sinter which can be subsequently roasted without substantial loss of zinc, and effecting a further desulphurization of the resulting sinter with no substantial loss of zinc by passing a combustion-supporting gas at least a portion of which is preheated through a body of the sinter for the most part in the form of lumps of substantial size.

29. The process of desulphurizing zinciferous sulphide ores which comprises sintering an appropriate charge of the ore, said sintering operation being carried on without substantial loss of zinc and with only such loss of sulfur as is necessary to produce the required degree of heat for obtaining a firm sinter and resulting in the production of a porous sinter which can be subsequently roasted without substantial loss of zinc, and effecting a further desulphurization of the resulting sinter with no substantial loss of zinc by passing a combustion-supporting gas at least a portion of which is preheated through a body of the sinter for the most part in the form of lumps of substantial size.

30. The process of desulphurizing zinciferous sulphide ores which comprises sintering an appropriate charge of the ore, said sintering operation being carried on without substantial loss of zinc and with the loss of not more than one half of the total sulfur in the charge and resulting in the production of a porous sinter which can be subsequently roasted without substantial loss of zinc, and effecting a further desulphurization of the resulting sinter with no substantial loss of zinc by passing a combustion-supporting gas at least a portion of which is preheated through a body of the sinter for the most part in the form of lumps of substantial size.

31. The process of desulphurizing zinciferous sulphide ores which comprises sintering an appropriate charge of the ore, said sintering operation being carried on without substantial loss of zinc and with the loss of not more than seven units of the sulfur in the charge and resulting in the production of a porous sinter which can be subsequently roasted without substantial loss of zinc, and effecting a further desulphurization of the resulting sinter with no substantial loss of zinc by passing a combustion-supporting gas at least a portion of which is preheated through a body of the sinter for the most part in the form of lumps of substantial size.

In testimony whereof I affix my signature.

WALTER LANDON MAXSON.