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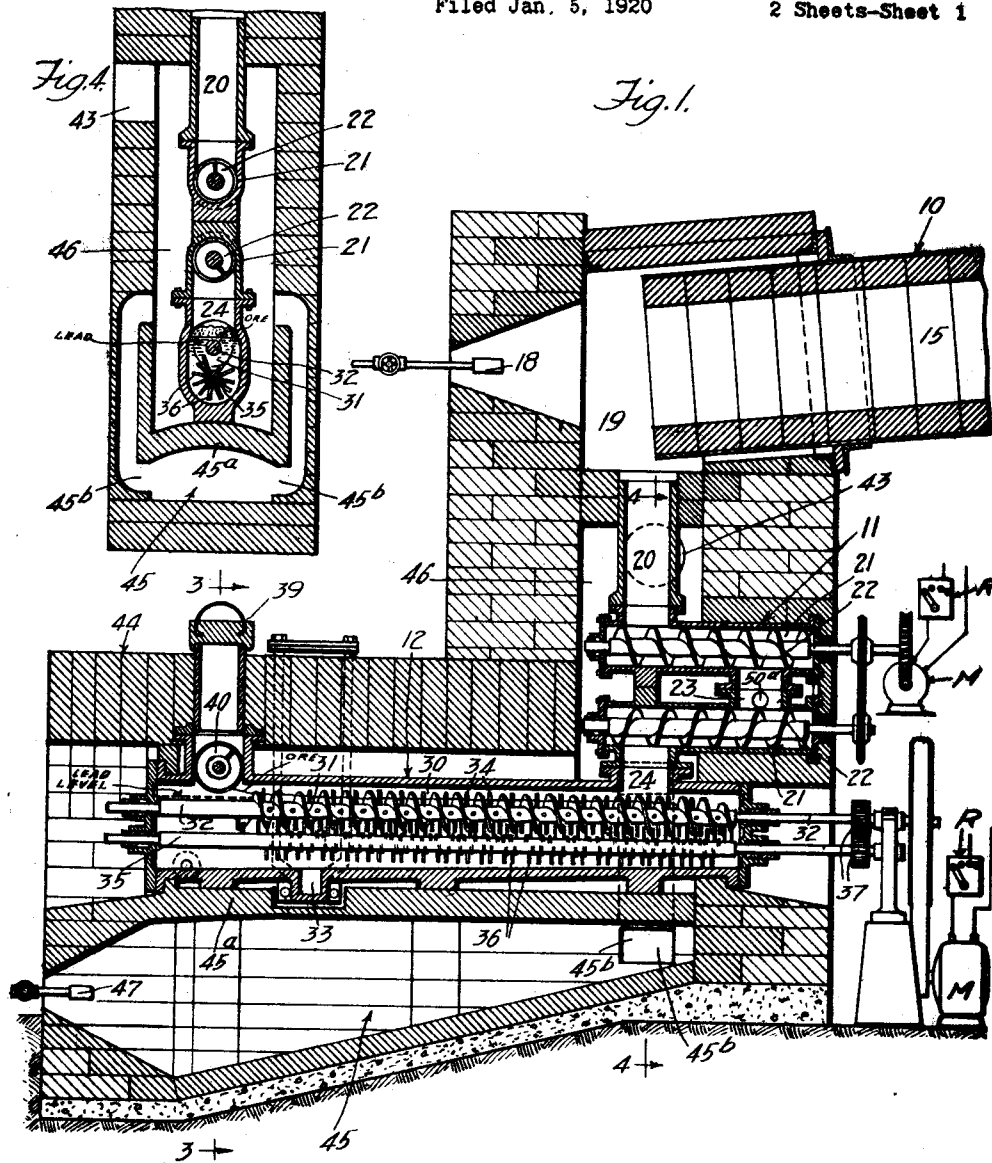
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H. N. TRACY

PROCESS AND APPARATUS FOR METALLIZING ORES

Filed Jan. 5, 1920

2 Sheets-Sheet 1



Inventor
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by *James T. Edwards*
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July 7, 1925.

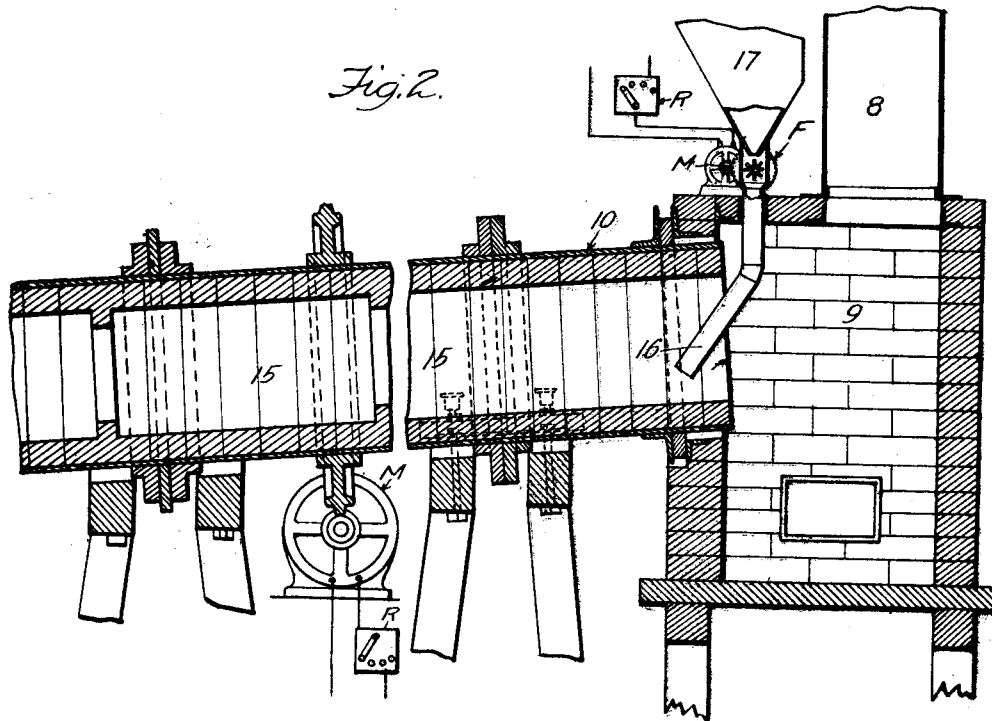
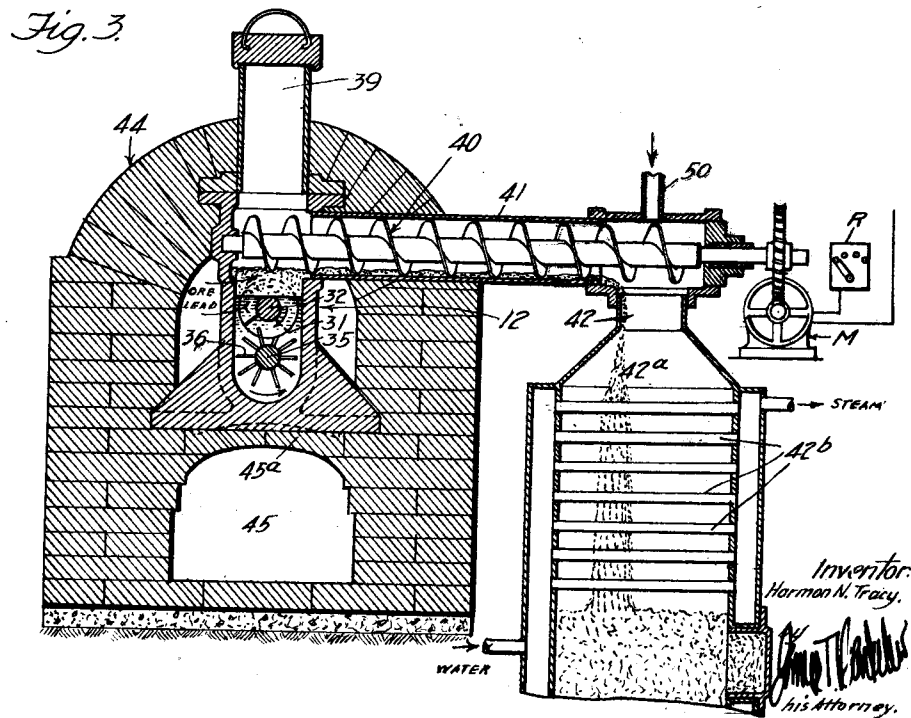
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2 Sheets-Sheet 2



UNITED STATES PATENT OFFICE.

HARMON N. TRACY, OF LOS ANGELES, CALIFORNIA, ASSIGNOR TO TRACY PROCESS COMPANY, A TRUSTEESHIP, HARMON N. TRACY, GEORGE MARTINSON, C. GLEASON, CHARLES L. ALLISON, AND WILLIAM A. MANSON, TRUSTEES.

PROCESS AND APPARATUS FOR METALLIZING ORES.

Application filed January 5, 1920. Serial No. 349,408.

To all whom it may concern:

Be it known that I, HARMON N. TRACY, a citizen of the United States, residing at Los Angeles, in the county of Los Angeles, California, have invented new and useful improvements in Processes and Apparatus for Metallizing Ores, of which the following is a specification.

This invention relates to such processes and apparatus as I have set forth in my Patent No. 1,214,844, dated February 6, 1917, Apparatus for reducing and metallizing ores; the present invention relating generally to such a process of metallizing or extracting the metal from ores in the general manner therein set forth. This present application is also in part a continuation of my prior application for process and apparatus for metallizing ores, filed January 30, 1919, under Serial No. 273,982; this present application taking the place of said prior application.

The apparatus shown in Patent No. 1,214,844, is designed more particularly to be effective with ores which are not so finely crushed that they have a great tendency to clog or choke. The operation in that apparatus embodies the downward passage of a column of ore into and through a U-shaped structure, through which the ore passes in a more or less continuous mass; passing through the metallizing liquid (molten lead) in the U-shaped passage. With certain kinds of ores, and in order to effect a high percentage of extraction, I find it desirable to crush the ores very finely, and then, instead of feeding the ores through the apparatus in a comparatively solid, or continuous mass, I find it desirable, in order to prevent clogging or massing or "balling" of the ores, to pass the ores through the apparatus relatively loosely, instead of in a continuous mass, so that the ores are at all times kept loose and free from any liability to clog or choke in the apparatus. The present invention is distinguished by a process in which the ore is carried more or less loosely, as specified, and further, specifically, (although not limited to this) the ore is carried over the surface of the molten lead and is moved down into the lead in intimate contact therewith.

Now, in order effectually to carry out this

new process, I carry on the extracting or collecting operation in a non-oxidizing atmosphere; and preferably carry the ores through the operations of reduction and of collection in a continuous atmosphere, which continuous atmosphere may be either the same throughout or it may be, in part, the spent gases of the reduction process. This kind of operation is carried out both for the purpose of preventing reoxidization of the de-oxidized metal while it is hot, and also for the purpose of preventing oxidation of the lead or other molten metal. If the heated ore, after reduction, is allowed to come into an oxidizing atmosphere, the metal will re-oxidize. If the lead is allowed to be oxidized, a considerable quantity of it will be carried out of the apparatus in the form of lead oxide, and the loss of lead is thus very great. As is hereinafter explained, it is possible to carry on the whole combined process of initial heating, or roasting, and of de-oxidizing and collection of the metal, all in a single piece of, or arrangement of, apparatus; and in this single organization of apparatus, the ores are carried continuously, during reduction and collection, in a continuously non-oxidizing atmosphere.

I speak herein of a bath of molten lead as being suitable as a collection liquid; but my invention applies to any suitable metal which will perform the functions herein stated. Also while I describe herein certain particular kinds of apparatus elements, my process and apparatus are not at all limited to such particular kinds of apparatus elements.

With these preliminary observations in mind, the invention will be best understood, both in its broad and specific aspects, from the following detailed description of preferred forms of the process, and apparatus in which the process may be carried on, reference for this purpose being had to the accompanying drawings in which—

Fig. 1 is a central vertical longitudinal section showing a portion of a suitable form of apparatus in which my process may be carried out; Fig. 2 is a similar central vertical longitudinal section of the remaining portion of the apparatus; Fig. 3 is a cross section taken on line 3-3 of Fig. 1; and Fig. 4 is a section taken on line 4-4 of Fig. 1.

In the drawings I illustrate generally at 10 a pre-heater or roaster in the form of a revolving drum; generally at 11 a de-oxidizer or reducer; and, generally at 12 a collector or amalgamator, being an apparatus for absorbing or amalgamating the reduced metal into a body of molten metal, such as molten lead. For the purposes of the present invention, the preheater 10, and the reducer 11, have, as their functions, the initial heating of the ore and the reducing of the ore to reduce the metal therein to a metallic state; in which reduced heated state the ore is delivered to the collector 12. Broadly speaking, it will be seen that any form of preheater and of de-oxidizer (reducer) may be utilized; but in some cases it may not be necessary or desirable to use the three devices in combination. It may or may not in any particular case be necessary to roast an ore before reducing or de-oxidizing it. And it is not an essential of the present invention, as considered in some of its aspects, that the ore be reduced and then immediately be passed into the collector. And it is possible to both heat and reduce the ore in the collector without previous action; or it is of course possible to put into the collector ore which has already been reduced in some independent manner, and this ore will then be heated in the collector and its metal extracted. And it is also possible to use a previously reduced ore and heat it in such a preheater as here shown, and then deliver the heated ore to the collector. In any such case, the non-oxidizing, or de-oxidizing atmosphere, may be introduced to the collector in any suitable manner and in any suitable form. However, the combination of a de-oxidizer or reducer with the collector apparatus is a convenient, economical and desirable one because the de-oxidizer then furnishes a non-oxidizing atmosphere for the collector, because one and the same provision of de-oxidizing or non-oxidizing atmosphere will serve both for the de-oxidizer or reducer and the collector. The de-oxidizing gas used in the reducer may be passed also through the collector; or the spent gas from the de-oxidizer may be passed through the collector. Also one heating fire will serve for both the de-oxidizer and the collector. I find it economical and convenient to have a separate pre-heater for the ore, even if ore which has been independently reduced or de-oxidized is used, and if no de-oxidizer is used in the combination.

I illustrate an ore roasting or pre-heating drum at 15, of any suitable type and revoluble by any suitable mechanism. Ore is fed into this drum at its upper end through a chute 16 from a feeder bin 17. Heat is supplied by an oil or other burner at 18 which throws a flame through a chamber

19 into the lower end of the drum. The upper end of drum 15 communicates with a flue chamber 9 communicating with stack 8, which provides means for exit of the gases of combustion and provides the desired draft. This draft should not be too large—as otherwise the fine ore dust will be carried out the stack; and for this reason I vent the collector and de-oxidizer heating furnace independently of the drum.

The chamber 19 at the lower end of drum 15 communicates with a downwardly extending pipe 20 which, at its lower end, communicates directly with reducing apparatus 11.

The reducing apparatus 11 I show constructed in a form which is particularly adapted to handling such finely crushed ores as are adapted for the extraction of silver and lead, for instance, by this process. I employ a plurality of cylindrical chambers 21, each provided with a screw-conveyer 22. The lower end of vertical pipe 20 communicates with one end of the upper chamber 21; the spiral conveyer in that chamber conveys the ore toward the other end of the chamber where it then falls through a vertical connecting passage 23; and the conveyer 22 in the next chamber carries the ore through that chamber to the vertical passage 24 through which the ore passes into the collector apparatus 12. It will be understood of course that the chambers 21, with their screw conveyer 22, may be made as long as desired; that there may be as many such chambers arranged in series relation as may be desired; so that the time period of the ore in the de-oxidizing or reducing apparatus may be suitable for the ore being treated.

The collecting or amalgamating apparatus comprises essentially a liquid metal holding chamber 30, of a suitable length, and preferably somewhat oval in cross section with its longer section axis vertical. Through the upper part of this chamber there is a spiral screw conveyer 31 on a shaft 32. The chamber is kept filled with lead to a level preferably just over the top of shaft 32, the lead being introduced and withdrawn through a passage shown at 33. Shaft 32 is also provided with beater or muller arms 34 to carry the ore into the lead bath.

Below the spiral screw conveyer there is another longitudinal shaft 35 which carries on it a plurality of radial cleaner bars 36. These cleaner bars are arranged in such a manner on shaft 35, so that, when the two shafts 32 and 35 are driven at equal speeds in opposite directions, (by gears 37) the cleaner bars 36 will pass and scrape against the opposite faces of the spiral, as will be readily understood. These cleaner bars thus perform the office of

scraping from the spiral any ore which otherwise would adhere to the spiral, and, once adhering, gradually gather more and more until the spiral is completely "balled up" with a mass of the ore.

At or near the end of chamber 30 there is arranged a cross-conveyor 40 in the form of a screw-conveyor which extends outwardly from the chamber through a pipe 41. Over the cross conveyor, or at any other place on the lead chamber 30, there may be an inspection opening 39. The spent ore or gangue is finally discharged at the outer end of this conveyor through a pipe or chute 42, which, in this case, preferably leads downwardly to a cooler 42^a. Cooler 42^a may comprise a suitable shell with water tubes 42^b arranged across it. The hot ore comes into contact with the tubes; steam is thereby generated which may be used for motive power, etc. about the plant. At the same time, by this arrangement, air is excluded from the ore until it has cooled.

The lead chamber 30 is supported in a furnace chamber 45 embodied in the brick-work structure 44 which encloses and forms the support for the various parts of the apparatus herein described. An oil or other burner 47 furnishes heat to the furnace 45 to heat the collector apparatus 12 and to keep the lead in proper molten condition and at a proper operating temperature. It is preferred to keep the lead at a temperature high enough to keep it freely liquid; and yet of course not high enough to volatilize the lead, nor high enough to heat the ore so much as to cause it to have an undue tendency to stick or "ball".

The furnace chamber 45 communicates at its rear end with the chamber 46 in which the reducing apparatus 11 is mounted; and from the upper end of this chamber 46 there is a draft opening 43 which leads to any suitable stack, for carrying off the gases of combustion. Chamber 46 does not communicate with chamber 19; the gases of combustion from the burner at 47 are not, in this form of apparatus, passed through the preheating drum 15; because in this particular instance the preheating drum 15 is designed to be a roasting drum as well as a preheater, and because excessive draft is not wanted in the drum.

The various parts of the apparatus may be driven from any suitable source; and means may be provided in the driving arrangement for so regulating and controlling, or fixing for any particular ore, the relative speeds of operation, as will be hereinafter described. For the purposes of illustration, although of course it will be understood that my apparatus is not limited to this particular provision; I show the

various parts of the apparatus driven by motors M. and controlled by reostats R. Thus the feeder at F which feeds the ore into the roasting drum, and the roasting drum, may be controlled in speed, and also the spirals 22 in the reducing apparatus 11 may be controlled in speed and the spiral conveyor and other parts in the collector may be controlled in speed; and also the final discharge spiral conveyor 40 may be controlled in speed.

Of course it will be readily understood that the apparatus herein shown may be varied in size and arrangement; and the parts may be assembled in any desired degree of duplication in one plant, all as may be desired for any particular installation or for the treatment of any particular kind of ore, all as will be readily understood by those skilled in the art.

In the operation of my apparatus as now described, and preferably, I introduce the reducing fluid; preferably in the form of a gas, through the pipe 50 at the outer end of discharge conveyor 41. The reducing gas is either forced by its pressure or drawn by the draft through the apparatus, through the conveyor pipe 41; and thence into the collector and thence through the collector 12 and through passage 24 into the reducing apparatus. It passes through the reducing apparatus and thence through the pipe 20 into the chamber 19; where any gases (such as CO) coming unused from the reducing apparatus are burned and become a part of the fuel; and thence through the drum 15 and into and through the discharge stack 8. Now the operation of the various parts is preferably so regulated that the roasted and heated ore discharged from the drum 15 and discharged through the pipe 20 into the reducing apparatus 11, is not sufficient to clog the reducing apparatus 11. That is; the cylindrical chambers 21 of the reducing apparatus are preferably never completely filled with the ore; but the ore is fed through the cylindrical chambers more or less loosely by the spiral conveyors therein; so that there is at all times sufficient space for free passage of the reducing gas, and of the spent gas resulting from the reducing gas after it has acted upon the ores in the reducer. The ore dropping through connections 23 and 24 sifts down through a reducing atmosphere. The ore passing from the reducing apparatus 11 passes directly down through the passage 24 into the collector and rests upon the surface of the liquid lead. Now the parts are preferably rotated at such speed that the ore preferably forms only a relatively thin layer over the surface of the liquid lead; the ore being fed forwardly, at all times by the conveyor 31, so that the ore is spread in a uniform layer over the surface of the lead. It will be

seen that the devices at 10—11 form, in effect, a feeder for the collector apparatus. At the discharge end of the collector chamber the ore may be piled up somewhat to perhaps
 5 a little higher level than it is throughout the length of the collector chamber; and the discharge conveyor 40 takes the ore out of the collector chamber as fast as it is moved to the discharge end of that chamber.

10 Now, in the mode of procedure as hereinabove outlined, it will be seen that the ore, at all times when it is in the collector apparatus, is in a non-oxidizing atmosphere; in fact, in an atmosphere of the reducing or
 15 de-oxidizing gas. This reducing or de-oxidizing gas first passes through the collector apparatus, then passes into the de-oxidizing apparatus where it de-oxidizes the fresh unreduced and heated ore coming into
 20 the de-oxidizing apparatus from the pre-heater 10. The spent gas then passes on out through the pre-heater. However, it is possible, and particularly so with some kinds of ores which need not be so finely crushed, or
 25 with ores which do not have any great tendency to clog, to feed the de-oxidizing gas into the de-oxidizer at such a point as designated 50^a. In all cases it will of course be understood that the de-oxidizing gas is
 30 fed in under a pressure sufficient to exclude atmosphere from all the parts. If a sufficient quantity of ore is fed into the de-oxidizing apparatus, so as to more or less partially fill the chambers 21; or if the screw conveyor in the upper chamber 21 is, for
 35 instance, run a little more slowly than the screw-conveyor in the lower chamber 21 so that the upper chamber is somewhat more filled with ore than the lower chamber; then
 40 when the de-oxidizing gas is fed in at 50^a under a sufficient pressure, a part of it would of course pass upwardly and a part pass downwardly. This gas, or at least a
 45 part of it, is used up in de-oxidizing the ore; so that the gas which then passes downwardly along with the ore into the collector is in that case, or partially is, the spent gas from the de-oxidizing operation. In this
 50 case it will be seen that the ore in the collector is in an atmosphere of spent gas from the de-oxidizer, which spent gas is of course a non-oxidizing gas, under the conditions in the collector. The temperature in the re-
 55 ducer is usually higher than in the collector, to maintain an efficient reducing temperature; and I protect the collector with a brick arch at 45^a, so that it does not get the full heat of furnace 45. Arch 45^a I now
 60 make of loosely laid brick; it is not completely tight. The collector 12 is heated mainly by radiation from the heated brick of the furnace. At the rear end of the furnace the gases are led through flues 45^b
 65 into the chamber 46 above the arch and above the collector; and in this chamber 46

the reducer 11 is directly exposed to the heat of the gases of combustion.

In practice, the reducing gas is, in any case, fed to the apparatus somewhat in excess over that required for actual theoretical
 70 operation of reduction, so as to be sure of supplying the various parts of the apparatus, and particularly the collector apparatus, with a sufficient quantity of non-oxidizing atmosphere; and at a pressure suffi-
 75 cient to exclude atmospheric air from the whole interior of the apparatus.

I have said that one of the functions of the apparatus at F, 15, 11 is as a feeder for the collector apparatus 12. This apparatus
 80 is so regulated as to feed the ore to the apparatus 12 at a speed so that the apparatus 12 can keep the ore spread out over the surface of the lead in a relatively thin layer. The ore thus is maintained at all times in a
 85 comparatively thin layer floating above the lead. The buoyancy of this ore—the resistance which is opposed to sink the ore in the lead—prevents the ore from being merely
 90 carried around with the conveyor. Thus the ore must be moved forwardly over the surface of the lead at all times by the action of the conveyor. There is thus no tendency to
 95 choking of the ore, the ore is at no time under any great pressure and is always loose and free; but at the same time the lead surface provides the necessary element to cause the ore to be moved longitudinally by the
 100 rotation of the conveyor screw.

The radial beater or muller rods at 34
 105 provide means for carrying the ore into intimate contact with the lead. Their function is to agitate the layer of ore so that every particle of ore will be brought into contact with the liquid metal surface; and they of course to a certain extent carry the ore somewhat below the liquid metal surface. I preferably keep the molten lead level
 110 just slightly over the top of shaft 32, so as to prevent the ore from coming into direct contact with the shaft, and thus prevent any tendency of the ore to stick to the shaft. The whole apparatus is to be so designed and the conditions of operation are to be so
 115 maintained, to suit any particular kind of ore, that the ore is carried through the apparatus in as large quantity as possible, and that each particle of ore is carried into intimate contact with the liquid lead. Under
 120 these conditions the ore which emerges from the final discharge pipe at 42 is entirely spent; or practically entirely so. I have found by actual operation of an apparatus of the kind herein described, carrying on my
 125 process as herein described, that I am enabled to obtain extractions better than ninety percent from lead and silver ores, for instance.

The spirals and the beater fingers slip
 130 through the ore comparatively easily and do

not exert any great pressure against it; although the spirals have a tendency at times to pick up a piece of ore; and if this piece of ore were left upon the spiral it would of course immediately form the nucleus for gathering other particles of ore and the spiral would soon become "balled up". The cleaner fingers on the shaft 35 effectually prevent this. The spiral does not have to exert any great longitudinal pressure against the ore to move it; and the beater fingers disturb the ore slightly each time they pass through the layer of ore. There may be a large number of these beater fingers.

The spent ore at times carries with it small particles of the lead; but these may be recovered easily by cooling the gangue below the melting point of lead (in the cooler 42^a) and then separating the lead out by any suitable mechanical methods. A dry concentrator will do this effectively. The values are taken out of the apparatus by withdrawing a part of the lead bath from time to time. In fact, from time to time a part of the lead bath may be withdrawn and new lead put into the bath.

By my process of operation the ore is kept free flowing and capable of coming into intimate contact with the liquid metal and giving up its metal. And at the same time I provide means for effectually moving the ore and for saving the lead from loss by oxidization; and also for preventing any re-oxidization of the metal in the ore.

It will now be readily seen that ore which has been already independently reduced by any means may be introduced to the collector or amalgamator apparatus through the feeder apparatus, as typified at 11; and this ore may be heated and raised to the requisite operating temperature by any suitable preheating or roasting means, or by the heat supplied at 47; and then the reducing substance, as a gas, may be fed into the apparatus in the manner here described, and the temperature in the apparatus may then be raised to such a point as to heat the ore sufficiently to then cause the reducing action on the ore; and then the collection operation, as hereinbefore described, will take place. In such a case the collecting or amalgamating apparatus, becomes, in itself, an apparatus complete in itself for reducing, metalizing and collecting the metal from the ore.

It is not a requisite of my invention, in its broader aspect, that a preheating or reducing apparatus must be used with the collecting or amalgamating apparatus, as separate elements of the operation.

Having described a preferred form of my invention, I claim:

1. A method of extracting metal from ores containing metal in metallic state, embodying passing the ore over the surface of a liquid metal, and moving the ore into inti-

mate contact with the liquid metal as it passes over it.

2. A method of extracting metal from ores containing metal in metallic state, embodying passing the ore over the surface of a liquid metal, moving the ore into intimate contact with the liquid metal as it passes over it, and maintaining a non-oxidizing atmosphere on the ore and liquid metal.

3. A method of extracting metal from ores containing metal in metallic state, embodying passing the ore over the surface of a liquid metal in a relatively thin body.

4. A method of extracting metal from ores containing metal in metallic state, embodying passing the ore over the surface of a liquid metal in a relatively thin body, and moving the ore into intimate contact with the liquid metal as it passes over it.

5. A method of extracting metal from ores containing metal in metallic state, embodying passing the ore over the surface of a liquid metal in a relatively thin body, moving the ore into intimate contact with the liquid metal as it passes over it, and maintaining a non-oxidizing atmosphere on the ore and liquid metal.

6. A method of extracting metal from ores containing metal in metallic state, embodying passing the ores into contact with heated molten metal, and maintaining upon the ores and upon the heated molten metal throughout the period of contact between them a non-oxidizing atmosphere.

7. A process, embodying reducing metallic ores, passing the reduced ores into contact with liquid metal to extract the reduced metal, and maintaining a non-oxidizing atmosphere on the ores, throughout the operations of reduction and extraction.

8. A process, embodying continuously reducing metallic ores, continuously passing the reduced ores into contact with liquid metal to extract the reduced metal, and continuously maintaining a non-oxidizing atmosphere on the ores throughout the operations of reduction and extraction.

9. A process, embodying continuously reducing metallic ores, continuously passing the reduced ores into contact with molten metal to extract the reduced metal, and continuously maintaining a non-oxidizing atmosphere on the ores and on the entire body of molten metal during the operations of reduction and extraction.

10. A process, embodying reducing metallic ores in a reducing atmosphere, passing the reduced ores into contact with the upper surface of a body of liquid metal and maintaining a non-oxidizing atmosphere upon the ores throughout the period of contact with the metal.

11. A process, embodying reducing metallic ores in a reducing atmosphere, passing the reduced ores over the surface of a liquid

metal and maintaining a non-oxidizing atmosphere upon the ore and upon the liquid metal.

12. A process, embodying reducing metallic ores in a reducing atmosphere, passing the reduced ores over the surface of a body of liquid lead, and maintaining a non-oxidizing atmosphere upon the ores and upon the liquid lead.

13. A process, embodying reducing metallic ores, passing the reduced ores immediately across a body of liquid metal, and maintaining a non-oxidizing atmosphere upon the ores throughout such operations and upon the liquid metal.

14. A process, embodying reducing metallic ores, passing the reduced ores immediately across a body of heated molten metal, effecting intimate contact between the ore and metal, and maintaining a non-oxidizing atmosphere upon the ores throughout such operations and upon the heated molten metal.

15. A process, embodying reducing metallic ores in a reducing atmosphere, then passing the reduced ores over the surface of a liquid metal, and maintaining a non-oxidizing atmosphere throughout the contact area of the metal.

16. A process, embodying reducing metallic ores in a reducing atmosphere, and then passing the reduced ores over the surface of a liquid metal, and maintaining thereon an atmosphere of the spent reducing atmosphere used to reduce the ores.

17. A process, embodying reducing metallic ores in a reducing atmosphere, and then passing the reduced ores over the surface of a liquid metal, and supplying a surplus of such reducing atmosphere at a pressure to exclude atmospheric air and maintaining an atmosphere over the liquid metal of the surplus and of the spent parts of the reducing atmosphere used to reduce the ores.

18. Apparatus of the character herein described, embodying a liquid metal holding chamber adapted to hold a charge of liquid metal partially filling it, a conveyor adapted to move ore into contact with said liquid metal, means to supply ore to the conveyor, and means to maintain a non-oxidizing atmosphere in the chamber.

19. Apparatus of the character herein described, embodying an element in which an ore is reduced, an element in which metallic metal is extracted from such reduced ore, means for discharging reduced ore from the first mentioned element into the second mentioned element; and means for feeding a reducing gas into both elements in common, so as to form a continuous atmosphere of reducing gas for the ore throughout both elements.

20. Apparatus of the character herein de-

scribed, embodying an element in which an ore is reduced, an element in which metallic metal is extracted from such reduced ore, means for discharging reduced ore from the first mentioned element into the second mentioned element; said elements being in communication with each other so that they may have a common atmosphere; and means for feeding a non-oxidizing gas into the elements to provide a non-oxidizing atmosphere throughout both of them.

21. Apparatus of the character herein described, embodying a liquid metal holding chamber adapted to hold a charge of liquid metal partially filling it, a conveyor adapted to move ore over the surface of said liquid metal, means to supply ore to the chamber, and means to maintain a non-oxidizing atmosphere in the chamber.

22. Apparatus of the character herein described, embodying a liquid metal holding chamber adapted to hold a charge of liquid metal partially filling it, a conveyor adapted to move ore over the surface of said liquid metal, means to supply ore to the chamber, regulatable so as to maintain at all times a thin layer of ore over the surface of the liquid metal, and means to maintain a non-oxidizing atmosphere in the chamber.

23. Apparatus of the character herein described, embodying a liquid metal holding chamber adapted to hold a charge of liquid metal partially filling it, a conveyor adapted to move ore over the surface of said liquid metal means to supply ore to the chamber regulatable so as to maintain at all times a thin layer of ore over the surface of the liquid metal, means to maintain a non-oxidizing atmosphere in the chamber, and means in conjunction with the conveyor to beat the ore into the liquid metal during its movement over it.

24. Apparatus of the character herein described embodying a liquid metal holding chamber adapted to hold a charge of liquid metal partially filling it, a screw conveyor extending longitudinally of the chamber and horizontally therein, and adapted to move ore over the surface of said liquid metal, means to supply ore to the conveyor, and means in co-operation with the conveyor to disturb the ore and to cause it to be carried into intimate contact with the liquid metal.

25. Apparatus of the character herein described, embodying a liquid metal holding chamber adapted to hold a charge of liquid metal partially filling it, a screw conveyor extending longitudinally of the chamber and horizontally therein, and adapted to move ore over the surface of said liquid metal, means to supply ore to the conveyor, and means in co-operation with the conveyor to disturb the ore and to cause it to be carried into intimate contact with the liquid metal,

said means embodying radial beater fingers mounted upon the screw conveyor.

26. Apparatus of the character herein described, embodying a horizontal liquid metal chamber adapted to hold a charge of liquid metal partially filling it, a horizontally extending conveyor adapted to move ore over the surface of said liquid metal, means to supply ore to the conveyor, and cleaner means in said chamber adjacent said conveyor and operatable with said conveyor to clean from it any ore which may adhere to the conveyor.

27. Apparatus of the character herein described, embodying a horizontal liquid metal chamber adapted to hold a charge of liquid metal partially filling it, a horizontally extending conveyor adapted to move ore over the surface of said liquid metal, means to supply ore to the conveyor, and cleaner means in said chamber adjacent said conveyor and operatable with said conveyor to clean from it any ore which may adhere to the conveyor, said cleaner means embodying a shaft parallel to the conveyor and close to it, and a plurality of cleaner bars mounted

upon said shaft, and adapted to rotate into contact with the spiral conveyor.

28. A process of extracting metal from ores containing metal in metallic state, embodying passing the ores in comparatively small mass into intimate contact with a metal, which is maintained in molten and oxidizable condition by heat, and maintaining a non-oxidizing atmosphere upon the entire body of ores and upon the liquid metal.

29. A process of extracting metal from ores containing metal in metallic state, embodying introducing the ores together with a non-oxidizing atmosphere into intimate contact with a metal which is maintained in molten and oxidizable condition by heat, and maintaining the non-oxidizing atmosphere on the surface of the liquid metal.

In witness that I claim the foregoing I have hereunto subscribed my name this 29th day of December, 1919.

HARMON N. TRACY.

Witness:

VIRGINIA BERINGER.