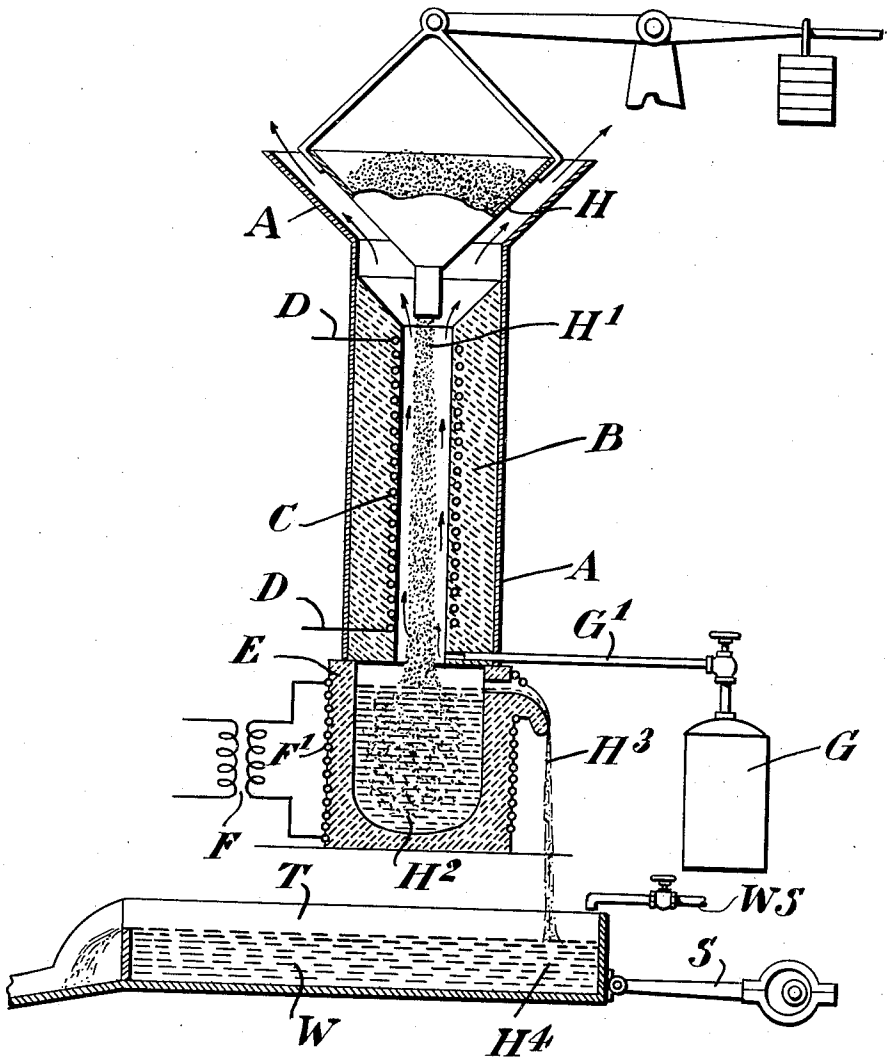
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ELECTRIC FURNACE

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ELECTRIC FURNACE

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6 Claims. (Cl. 13—5)

This invention relates to apparatus useful among other things in a process of recovering metals from ores according to the process described and claimed in my prior Patent No. 2,067,006, dated January 5, 1937 wherein the ore is a gold bearing ore in which the gold is contained in quartz or is found associated with other metallic substances as for instance in an iron bearing ferric sulphide ore and is useful likewise in any process for recovering metals from other materials wherein there are non-metallic constituents which have to be separated out to allow the gold or other metal contents to be recovered.

Generally stated the apparatus forming the subject of the present application for patent is useful in bringing to a high temperature any materials or ores which have to be roasted or otherwise treated by intensive heat in order to break up or assist in breaking up the combination.

The present invention will be described as employed in heating the ore or other metal bearing material to high temperature sufficient to render the same fluid or semi-fluid preparatory to plunging the heated mass into a cooling fluid for the purpose of disassociating the non-metallic content, such for instance as siliceous matter from the metallic portion, as a step before a treatment of the material to dissolve out the iron constituent to leave the gold free.

It will be understood, however, that the apparatus is not limited to use with any particular ore or material but may be used in connection with any or all ores or materials that can be fused by intensive heat.

My present invention relates among other things to the construction of heating furnace and material feeding passageway and arrangement thereof in connection with the means for feeding the ore or other material thereto as described in the above identified application.

A construction of apparatus suitable for practicing the invention herein claimed is illustrated in the accompanying drawing which is a general vertical section and partial elevation of an apparatus embodying my improved construction and of a character adapted for use in carrying out my improved process of ore reduction.

As shown in the drawing the ore to be treated is supplied from any suitable source as for instance from a hopper H to a preheater comprising as indicated an outer shell A surrounding a shell of non-fusible or refractory material of any desired character indicated at B having a vertical central duct or passageway arranged above and in axial alinement with the induction furnace proper as shown for feeding the ore downwardly and a heating electrical resistance wire or coil C preferably wound on a form and having the surrounding material B moulded around it to hold it in shape and in position for furnishing heat as directly as possible to the material flowing or passing through the centre of the heater. This coil may be practically exposed on the inside so as to be in intimate heating relation to the material to be heated thereby. The tubular passage also acts as a flue or chimney through which the ascending gases or heat from the heated material in the crucible E of the induction furnace below the same will flow. Below this resistance heater, constituting the device which I term a preheater because its object is mainly to raise the temperature of the material to a high degree or even and preferably to fusion before it is delivered to the induction furnace or other means for further heating (although this pre-heater can be used separately or independently of the present process for calcining ores) lies the crucible or melting pot E of said induction furnace. I prefer to use for said induction furnace the type known as the coreless type, said crucible E being located within the coil F' which is itself the seat of high frequency currents supplied from a transformer F or from other suitable source of current. The ore in the induction furnace is indicated at H^2 and the stream of ore passing from the hopper H is indicated at H'. The tubular preheater A preferably has a conical mouth as indicated at the upper end of its passageway into which the hopper H for the ore partially extends. The escaping gases from the induction furnace pass through the mouth to greater or less extent depending upon the level at which the hopper H is adjusted. The hopper has at its base a restricted outlet through which a regulated stream of the material is discharged into the preheater duct for passage to the furnace. Said outlet is of less cross section than the duct so that a free stream of the material flows downward through the duct. The preheater duct, as shown, is of substantially uniform cross section so as to be heated to the most effective degree by the coil C and of such cross section relative to that of the feeding stream of material as to allow the gaseous products from the furnace to not only pass upward through the particles of the stream but also between the stream and walls of the duct, or completely about the stream, whereby

all the available heat of the waste products will be utilized to heat the stream with resulting conservation in the use of current for preheating and melting operations. The rate of feed of the material is preferably equal or in definite proportion to the melting rate and discharge, or to the maximum amount which may be melted and discharged in melted form from the crucible within any given period of time.

The crucible itself may be made of any suitable refractory material as well understood in the art, proper for resisting the high temperatures of the molten mass melted within the same by the inductive action of the currents circulated in the coil F' around the same. I do not describe in detail the means for raising the frequency of the current in the coil F' to the desired extent as this particular part of the apparatus may take any form desired. As well known in the art the setting up of the currents in the charge of material in this crucible has a tendency to stir up the molten mass so that it may flow out through a proper channel it being understood that the material fed through the heater is fed in sufficient amount to keep the crucible filled to overflowing. The overflowing fused mass of melted material may be delivered from said crucible over the edge thereof as shown, continuously into a bath or receptacle containing a chilling substance like water where the final stage of the treatment forming my invention may take place. A receptacle or bath for water into which the material is fed is indicated at T and may be of any desired form. The body of water into which the material is fed is indicated at W and the receptacle T is preferably made as a trough which may be properly suspended and shaken by a cam or eccentric or other suitable mechanism and having the function of jarring the particles towards the depressed end to make space for fresh material fed from the furnace. A source of liquid supply is indicated at W—S and the material delivered into the bath of water from the furnace is indicated at H^4 which is replenished by the stream H^3 of material overflowing the edge of the crucible.

The water may be allowed to flow slowly through the tank T carrying with it the non-metallic material separated out and consisting for instance of the siliceous matter or other impurities intimately associated with the metallic content of the ore undergoing treatment. The sudden cooling of the melted mass in the water results in "exploding" the same and any fused siliceous or other impurities are thrown off and conveyed beyond the remaining metallic melted globules or particles or metallics comprising the iron sulphide and gold. The remaining impurities or fused slags may be passed onward by the stream of water. The globules of metallic substance freed from the siliceous or other impurities appear as particles of irregular shape or surface which is very desirable for the final step of separating the precious metal as gold from the baser metal as the iron content. This final operation or dissolution when my process is applied to material containing iron sulphides may be effected in any suitable receptacle by the use of a sulphuric acid solvent converting the iron into a ferrous sulphate and releasing the entailed gold when the process is applied to treating primary or auriferous sulphide ores to which my process is particularly adapted. The resulting gold is found as a sludge precipitated in the bottom of the dissolution tank from which it is recovered, dried, fluxed and melted in the usual prescribed manner.

In this process of flowing the melted ores or concentrates into water to remove the waste materials adhering to the fused metallics I have nothing to contend with in the way of foreign substances and treat only iron sulphide. This method of treating the primary or sulphide ores is advantageous because it renders it unnecessary to grind the ore to an exceedingly fine mesh as in former practice (which is costly and requires rather high grade gold ore to pay for such ore dressing), preparatory to treating with a cyanide of potassium or soda solution of proper density as a means of converting entire gold into a cyanide of gold which then is recovered by well known methods.

I find in practice that quite coarse concentrates are readily and easily fused in such a furnace as I have described and results are obtained quickly without the expense or delay of fine grinding and of dissolving the solution with cyanide solution.

In my improved process I accomplish another very desirable object in that I recover the iron as ferrous sulphate which has a commercial market value and is therefore not wasted as in all other methods or processes and the entire removal of all cyanicides.

It will be noted that the hopper H of my improved apparatus may be raised or lowered to act as a stopper and thereby adjustably check the upward flow and escape of heat from the furnace. This hopper is an intermediate one and the materials to be smelted or fused are to be supplied from a stock hopper or bin which feeds the smaller one, the latter then having a dual mission which is to regulate the flow of heat by regulating the draft and to concentrate the material to be fused or calcined into a stream directed down through the center of the heater. This preheating preheats the materials such as ores ground fine enough to be fed through the furnace and raise the temperature to such a point that the reactance furnace will readily supply the final heat when necessary to fuse the mass. In this furnace the coils F and F' may be in the form of hollow wires or tubes through which water may be passed if required to keep down their temperature. The general object in causing the other materials to strike the water is to suddenly contract and in a sense explode the same. As described in my original application showing my present invention, the result is that the particles of material assume a subdivided condition in which the metallic particles assume irregular or amorphous shapes and at the same time the well fused waste coverings such as silicates or slags are exploded off to leave a clean bright surface. The adhering silica or other foreign substances exploded off is carried away in the flow of water which is regulated in amount to that purpose.

At G, I indicate a gas tank or generator from which any active gas chosen for any particular purpose may be introduced through the pipe G' to maintain a reducing atmosphere during the heating period and aid in the disassociation of the materials to be fused or calcined or otherwise heat treated. If the gas chosen is hydrogen and introduced into the chamber in the presence of iron it would have a great affinity for sulphur conveying this element into the sulphurated form or sulphide of hydrogen. Another gas might be employed which would tend to eliminate some

of the atoms of sulphur or a gas, like oxygen, could be used to effect oxidization of the material by chemical combination therewith and at the same time raise or tend to raise the temperature.

As will be seen my improved process practically reverses the usual process of recovering gold or other precious metals in that instead of using a cyanide to unite with the gold and leave the iron as in the old process I use a sulphuric or other acid to dissolve the iron out and leave the gold or precious metals as a bi-product of the bath. The result of converting the iron content of the bath by the use of sulphuric acid would be the production of ferrous sulphate commercially known as copperas.

My improved apparatus may be used in a calcining process by mixing the pulp or material with a carbon (coal or charcoal) and removing the ferric and ferrous bases (red paint, oxide or iron and copperas) leaving but a small portion of the pulp as highly refined concentrate which would carry the auric contents. The carbon so added is for the purpose of aiding in the fusion or reduction of the ore and elimination of foreign elements as in metallurgical operations generally and will naturally vary according to the nature of the ore treated. Ordinarily with the ores mentioned an addition of 10% of carbon to the total mass will serve although in some cases about one sixth will be found more satisfactory. By this means a resultant mass of treated ore is produced that will readily dissolve by treatment with sulphuric acid as herein described to remove the ferric and ferrous bases.

It will be understood that materials H′ are fed down until they rest in the crucible E where they remain until fused or melted and that they then start to flow off through the outlet as shown at H^3 the said materials being replenished from the hopper H periodically as required or as a continuous regulated flow to give a continuous operation.

It will be understood that the present case is intended to cover one of the forms of apparatus useful in carrying out the process described in my original application before referred to filed June 6, 1934, Ser. No. 729,211 but that said apparatus might be used generally for other processes or purposes.

The invention claimed is:

1. An apparatus for treating ores having gold and ferric content, a high frequency induction furnace having a vent adjacent its upper portion through which the treated material passes, a preheater superimposed on said furnace through which the material to be treated passes to the furnace, independent electrical means encircling said preheater for heating the same, a feeding device suspended in the upper portion of said preheater for holding the material which is fed to the furnace, means for raising or lowering said feeding device to adjust the size of the opening between the same and a wall of said preheater through which the ascending gases from the heater are discharged, means connected to the lower end of the preheater for introducing an active gas therein, a trough for receiving the treated material flowing from the aforesaid vent, means for rocking said trough and means for supplying a liquid to said trough.

2. An apparatus for melting, heating or reducing material to fluid condition comprising a furnace, a preheater through which the material is fed to the furnace and through which the heated gases or vapors ascending from the furnace are discharged, and an adjustable feeder forming a control valve for feeding material to the preheater and regulating the discharge of the gases or vapors therefrom.

3. The combination with a furnace for heating material to a high temperature, of a feed tube or passageway comprising a preheater through which the material is fed to the furnace and providing means through which the heated gases or vapors from the furnace are discharged, said tube having a conical outlet for said gases or vapors, and a conical feeder for feeding material to the preheater and adjustable with relation to said outlet to regulate the discharge of the vapors or gases therethrough.

4. The combination with a material heating furnace, of a tubular preheater arranged for the feed of the material therethrough to the furnace, and a feed hopper located at the mouth of the preheater in the path of the heated gases or vapors ascending from the furnace and mounted to be capable of being raised or lowered to vary the size of the opening intermediate the preheater and the mouth of the hopper and thus regulate the flow of the heat from the furnace through the material being fed thereto.

5. The combination with a material heating furnace, of a tubular feedway for the material to be heated in the furnace, said feedway comprising a preheater arranged to permit circulation of the heated gases or vapors passing upwardly from such furnace, a feed hopper for feeding the material into said feedway, said hopper being mounted to be capable of being raised or lowered to regulate the flow of heat from the furnace through the material being fed thereto, and means for raising or lowering said hopper.

6. An apparatus for heating material to a high temperature comprising a furnace, a preheater arranged above the furnace and having a passageway through which the material is fed to the furnace and through which heated gases or vapors ascending from the furnace are discharged, said passageway being provided with a flaring outlet for the gases or vapors at its upper end, and a material feeder arranged above and adjustable with relation to the outlet end of the passageway, said feeder having a restricted feed outlet to feed a regulated quantity of material to the passageway and having a surface about said feed outlet shaped to form a valve for cooperation with the outlet of the passageway to control the discharge of the gases or vapors therefrom.

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