UNITED STATES PATENT OFFICE.

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ART OF TREATING ORES.

No. 858,667. Specification of Letters Patent. Patented July 2, 1907.

Application filed August 28, 1906. Serial No. 332,402.

To all whom it may concern:

Be it known that I, ROBERT MCKNIGHT, a citizen of the United States, residing at Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented new and useful Improvements in the Art of Treating Ores, of which the following is a specification.

My invention has reference to a treatment of ores by a chloridizing roasting, in which I effect the roasting by means of a superheated oxygen containing gas having a temperature of about 500° C. when entering the furnace, preferably without any outside source of heat. I project upon the ore while it is being roasted and agitated a superheated oxygen containing gas having a temperature of about 500° C. This greatly hastens and facilitates the necessary reactions, (which all require a large supply of oxygen) and by the heat produced by the superheated oxygen containing gas, by the fact that the roast is not cooled by the introduction of cold air, and by the heat caused by the increased rapidity of the reactions produced, renders a less degree of heat in the roasting furnace necessary or obviates entirely the need for this employment of exterior heat. It also, as can be seen readily makes the reaction much more thorough, and renders the volatile products free or nearly so from gases that interfere with the successful operation of the process.

I will describe now in detail, the manner in which I practice my invented art.

The ores suitable for treatment by my invented method are ores containing materials such as sulfur, silica, arsenic or any other of the well known materials that render the ore intractable when treated by an amalgamation process, but which can be rendered innocuous by combining them with sodium and oxygen. These ores include those where, for any reason, some of the materials are introduced into the ore. As an oxygen containing gas, I usually employ steam or atmospheric air or a mixture of steam and air.

I make a mixture of the ore to be roasted with salt. The ore is reduced to a fine consistency, most advantageously, to about 30 mesh. The ore and salt mixture should, of course be intimate. Practically salt to about 10% of the ore is added. This percentage however depends entirely upon the quantity of the materials to be converted into oxysodium salts.

The mixture is roasted with agitation. This roasting can be started either by the application of heat other than that produced by the heated oxygen containing gas such as air or steam, or the heated oxygen containing gas such as air or steam can be relied upon for this purpose from the beginning. In some cases, the ore can be more conveniently treated by the use of other heating means besides the hot oxygen containing gas such as air or steam during the entire roast. During this roasting and agitating a large and preferably continuous supply of superheated oxygen containing gas such as steam or air preferably having a temperature of about 500° C. is directed upon the roast.

The roasting is done, preferably in a revolving cylinder furnace, for, by so doing, the agitation produced is thorough, the superheated oxygen containing gas such as air or steam or mixture of the two is kept near the surface of the ore, a new surface is continually presented to the air and caking of the ore in the cylinder is prevented. Within reasonable limits the hotter the air or steam that is introduced the better. It can be introduced into the furnace if desired through the ore withdrawal port. Preferably it is introduced as a large jet or blast of air or steam. The supply of oxygen, whether derived from the air or steam supplies or helps to supply the large amount of oxygen required in the conversion of the materials that render the crude ore refractory and increase the temperature of the roast, both by its proper heat, and by the increased rapidity of the reactions produced. Another advantage derived by the use of the superheated air or steam consists in that the volatilized products are free from reducing gases present in ordinary roasting, such as carbon monoxid; and thus renders it easier to retain the volatilized metals in the form of soluble salts.

Like all reactions produced in the chloridizing roasting of ores, the reactions produced in any invented art are very complicated and, in their details, are uncertain. The sulfids are decomposed, and the sulfur united with the sodium of the salt to form sodium sulfate. This change is believed not to be immediate in the case of many of the metallic sulfids. Several at least seem to oxidize to sulfate which, with salt form metallic chlorids and sodium sulfate. Some metallic chlorids are decomposed by the roasting process and furnish free chlorin, which is, of course, very active. The silica seems to partly become sodium silicate directly with the liberation of chlorin, and thus even the gold becomes in part at least chloridized.

A typical probable reaction of an ore may be cited and is shown below. This ore contains as materials rendering the ore refractory zinc sulfid, lead sulfid, iron pyrites and silica.

(1) $ZnS+2O_2=ZnSO_4$
(2) $ZnSO_4+2NaCl=Na_2SO_4+ZnCl_2$
(3) $PbS+2O_2=PbSO_4$
(4) $PbSO_4+2NaCl=PbCl_2+Na_2SO_4$
(5) $4FeS_2+15O_2+2H_2O+16NaCl=4FeCl_3+4HCl+8Na_2SO_4$
(6) $4FeCl_3+3O_2=2Fe_2O_3+6Cl_2$
(7) $4NaCl+2SiO_2+O_2=2Na_2SiO_3+2Cl_2$
(8) $2Au+3Cl_2=2AuCl_3$.

Of the above equations, 1, 3, 5, and 7 are primary and 2, 4, 6, and 8 secondary reactions.

From this as an example, a practical mining man would readily see how the other refractory materials,—the arsenides &c.—would act.

The chlorids, subchlorids, oxychlorids, etc. of the various metal are mostly volatile at the temperature and under the conditions of this invention. These

are therefore collected in a suitable condensing apparatus such as is described in my Patent No. 737,103.

After the roast has been continued until the ore is rendered non-refractory, which will be when the elements that render it refractory in its raw state are rendered innocuous through entering into compounds, chiefly oxysalts of sodium, the ore is removed from the furnace and preferably allowed to pass into a suitable amalgamator while it is still hot. A very suitable device for this purpose is the one invented by me and shown in my application for Letters Patent having the Serial Number 330887 filed Aug. 16, 1906; which enables also the resulting solution to be saved for further treatment by electrolysis or a suitable chemical precipitant for the purpose of saving any metals which may have remained in solution.

There may be of course cases in which the ores as taken from the ground ore not refractory but which are most easily treated by introducing elements that render them so and such ores are equally susceptible to treatment by the above described method.

Having now described my invention what I claim and desire to secure by Letters Patent is:

1. The art of reducing ores that contain elements rendering the same refractory, which consists in roasting a mixture of ground ore and salt by means of a superheated oxygen containing gas, the salt being in sufficient quantity to furnish sufficient sodium to substantially convert the elements rendering the ore refractory, in its crude state into oxysalts of sodium, roasting and agitating the mixture of ore and salt, and simultaneously directing upon the same, a superheated oxygen containing gas continuing the roast until the elements rendering the ore refractory are thoroughly oxidized and metallic chlorids of metals contained in the ore are produced, collecting and condensing these volatile chlorids when volatilized, and treating the residue of the ore by amalgamation, substantially as described.

2. The art of reducing ores that contain elements rendering the same refractory, which consists in roasting a mixture of ground ore and salt by means of a superheated oxygen containing gas having a temperature of about 500° C. on entering the furnace; the salt being in sufficient quantity to furnish sufficient sodium to substantially convert the elements rendering the ore refractory, in its crude state into oxysalts of sodium, roasting and agitating the mixture of ore and salt, and simultaneously directing upon the same, a superheated oxygen containing gas having a temperature of about 500 C., continuing the roast until the elements rendering the ore refractory, are thoroughly oxidized, and metallic chlorids of metal contained in the ore are produced, collecting and condensing these volatile chlorids when volatilized, and treating the residue of the ore by amalgamation, substantially as described.

3. The art of reducing ores that contain elements rendering the same refractory, which consists in roasting a mixture of ground ore and salt by means of a superheated oxygen containing gas without any other source of heat, the salt being in sufficient quantity to furnish sufficient sodium to substantially convert the elements rendering the ore refractory in its crude state into oxysalts of sodium, roasting and agitating the mixture of ore and salt, and simultaneously directing upon the same superheated oxygen containing gas such as air or steam, continuing the roast until the elements rendering the ore refractory are thoroughly oxidized, and metallic chlorids of metals contained in the ore are produced, collecting and condensing these volatile chlorids when volatilized, and treating the residue of the ore by amalgamation, substantially as described.

4. The art of reducing ores that contain elements rendering the same refractory, which consists in roasting a mixture of ground ore and salt by means of a superheated oxygen containing gas, the salt being in sufficient quantity to furnish sufficient sodium to substantially convert the element rendering the ore refractory, in its crude state into oxysalts of sodium, roasting and agitating the mixture of ore and salt, and simultaneously directing upon the same, a superheated oxygen containing gas continuing the roast until the elements rendering the ore refractory are thoroughly oxydized, and metallic chlorids of metals contained in the ore are produced, collecting and condensing these volatile chlorids when volatilized, and treating the residue of the ore by amalgamation and the resulting solution of the non-volatilized soluble chlorids by a wet method substantially as described.

5. The art of reducing ores that contain elements rendering them refractory to treatment by amalgamation, which consists in roasting a mixture of finely divided ore and salt with agitation in a closed chamber and simultaneously directing upon the said roasting ore, while thus inclosed and agitated, a superheated oxygen containing gas, continuing the roast until the elements rendering the ore refractory are oxidized, forming metallic chlorids, and treating the ore residue by amalgamation substantially as described.

6. The art of reducing ores containing elements rendering the ore refractory in its raw state, which consists in roasting the ore with sufficient salt to provide sufficient sodium to form oxysodium salts of the elements rendering the ore refractory until the elements rendering the ore refractory are formed into innocuous compounds, and then subject the ore while hot from the roasting, to an amalgamation process; substantially as described.

In testimony whereof I affix my signature in presence of two witnesses.

ROBERT McKNIGHT.

Witnesses:
ELIAS ELVOVE,
BEATRICE FITZGERALD.