

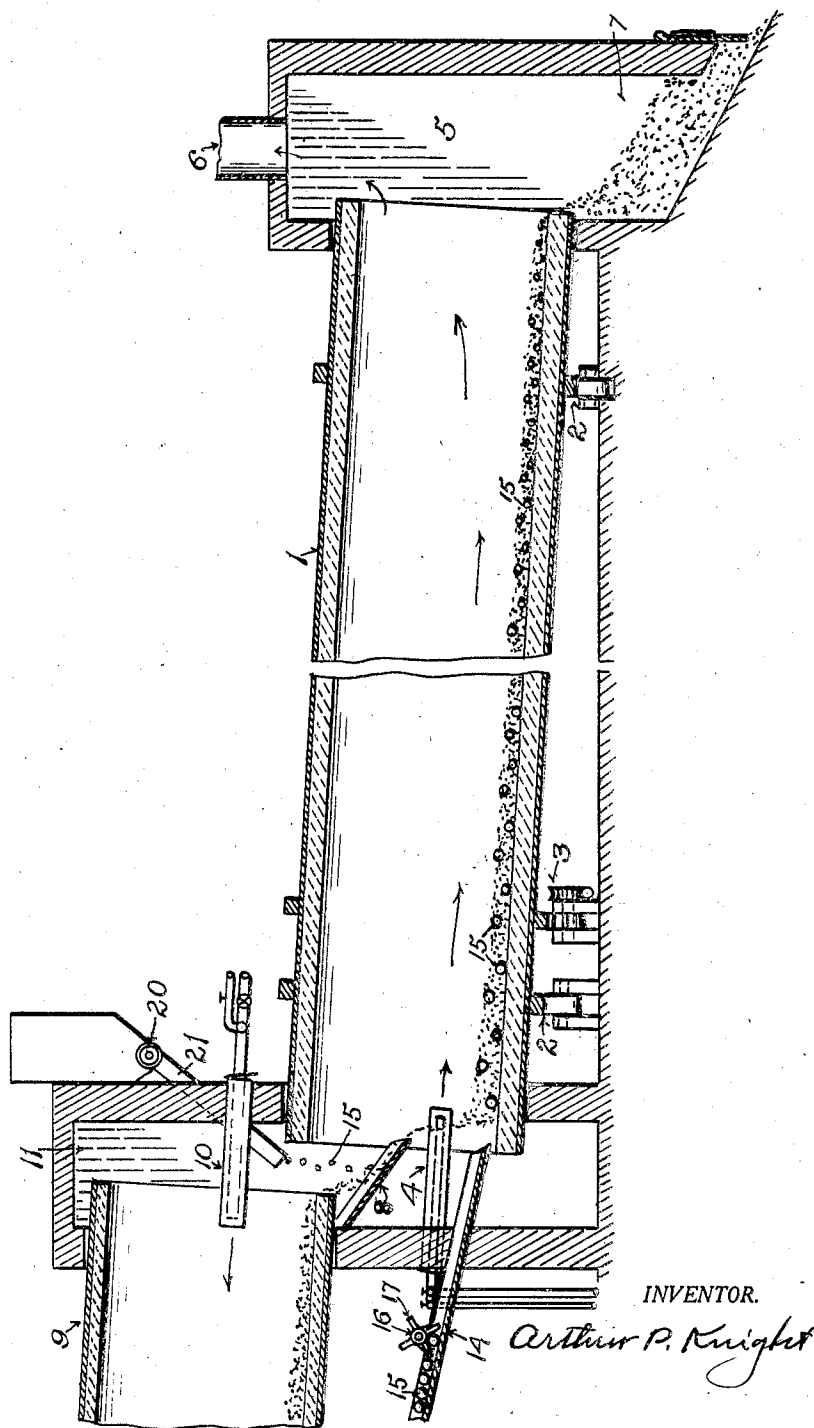
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PROCESS FOR VOLATILIZATION OF METALS FROM THEIR ORES

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PROCESS FOR VOLATILIZATION OF METALS FROM THEIR ORES.

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This invention relates to the recovery of metallic values from ores by the volatilization process, in which the ore is subjected to the action of heat in the presence of a suitable reagent (volatilizing agent) in such manner as to cause production of volatile compounds of the desired metal or metals, which are driven off and collected in any suitable manner. In carrying out such operations it has been found desirable to introduce the volatilizing agent gradually or in successive stages during the volatilizing operation, so as to effect the volatilization with maximum economy or with minimum consumption of such agent. One object of my invention is to provide for the gradual introduction of the volatilizing agent into contact with the ore during the volatilizing operation.

It has also been found desirable, in some cases, in the volatilization of metals, to pre-heat the ore before it passes to the volatilization furnace, and to deliver the ore in preheated condition to the volatilization furnace. With such procedure, it is advantageous to provide for introduction of the volatilizing agent into contact with the ore while the latter is in such pre-heated condition, and a further object is to enable such introduction to be effected without undue loss of such agent by premature volatilization thereof.

The accompanying drawing illustrates, in longitudinal section, an apparatus suitable for carrying out this invention.

The volatilization furnace shown in the drawing consists of a rotary kiln 1, mounted to rotate on supporting means 2 and rotated slowly by operating means 3 in the usual manner of rotary kilns. A burner 4 is adapted to direct a blast of hot products of combustion into the rotary kiln, such products of combustion, after having communicated heat to the interior of the kiln and to the ore therein, being conducted, along with any metallic vapors carried thereby, through a chamber 5 to an outlet flue 6, which may lead to any suitable fume collecting means, for example, and electrical precipitator. Kiln 1 is slightly inclined so as to cause the material fed thereto to travel gradually toward the lower end, and at the upper end of the kiln there is provided means, such as a chute 8, for supplying ore in suitably divided condition to the

interior of the kiln, constituting the heating and volatilizing chamber. The residual gangue is discharged from the lower end of the kiln to any suitable receiving means, indicated at 7.

The ore may be supplied to chute 8 by any suitable means. I have shown the ore as supplied from a preheating furnace, which may be a rotary kiln, a portion of which is shown at 9, said kiln having a burner 10 for heating same. A single hood or burner chamber 11 may enclose the burners 4 and 10 for the respective kilns, and the kilns may be constructed and arranged as shown, so that the preheated material passes by gravity from the lower end of kiln 9 over chute 8 to the upper end of kiln 1. With such a construction, the burner means 4 is preferably located at the upper end of the volatilizing kiln 1, so that the hot gases therefrom pass through the kiln 1 parallel with, or in the same direction as, the ore passing in the kiln, whereas the combustion gases from the burner 10 pass through the preheating kiln 9 in opposite direction, or counter-current, to the ore.

Means are provided for supplying volatilizing agent to the kiln 1 in such manner that such agent is only gradually brought under the influence of the heat of the kiln. For this purpose the volatilizing agent, which may consist of a salt such as sodium chloride, calcium chloride, magnesium chloride, or the like, is molded or otherwise incorporated into bodies of more or less refractory or heat resistant material; that is to say, a material which will not readily fuse under the conditions existing in the volatilizing furnace, and such bodies are fed into the said furnace along with the ore so that the salt is to a certain extent protected from full exposure to the heat of the furnace, and is gradually brought into contact with the ore by wearing away of the bodies or by gradual volatilization of the salt or otherwise. As a heat resistance material for mixing with salt in this manner, I may use lime, clay, sand, ore, gangue, charcoal, or a mixture of any two or more of such substances, or any other suitable refractory material may be used. For example salt may be mixed with lime in any desired proportion (say one part of salt to two parts of hydrated lime) sufficient water being added to enable the mass

to be molded or formed into suitable shape, for example, into balls; or the salt may be mixed in a similar manner with clay to form balls or bodies which may be dried and, if desirable, may be baked. Or such bodies may consist of porous refractory material, such as diatomite, chalk, charcoal, etc., impregnated with the salt by wetting with salt solution and drying.

The salt-containing bodies, indicated at 15 in the drawing, are supplied to the upper end of kiln 1, so as to come into contact with the ore therein, and to pass gradually downward along the kiln and to gradually release the salt in contact with the ore, by reason of gradual disruption or wearing away of the bodies by the grinding action due to movement of the bodies in contact with the ore or with the sides of the kiln; or by reason of the effect of the heat of the kiln in gradually evaporating the salt, or in causing decrepitation or cracking to pieces of the said bodies. In case the bodies 15 are made of friable material, such as lime or clay, together with salt, they may be made to wear away rapidly as they pass along the kiln, so as to continually bring fresh salt into contact with the ore, while such salt is in solid condition, or in fused condition. In some cases, however, part or all of the salt may be released from the salt-carrying bodies in the form of vapor, this being particularly the case when the material of such bodies is of a hard or non-friable nature, the gradual release of the salt then resulting from the gradual penetration of the heat to the interior of such bodies.

The balls or bodies 15 may be supplied to the upper end of kiln 1 in any suitable manner, for example, by a chute 14 through or on which said bodies pass downwardly from any desired supply means to the interior of said kiln. Means may be provided for automatically feeding said bodies, said means comprising, for example, a rotary member 16 having projections 17 for engaging said bodies so as to deliver them intermittently to the chute leading to the kiln, as said member 16 is slowly rotated by suitable operating means.

The invention may also be carried out by feeding the bodies containing the volatilizing agent to the chute which conducts the ore to the volatilizing furnace. Means for this purpose may comprise a feed hopper 20 adapted to feed the bodies mechanically to a chute 21 discharging onto the chute 8 aforesaid.

In the operation of the apparatus, ore in suitably divided condition passes to the upper end of kiln 1 and moves downwardly along the kiln, the gradual rotation of the kiln facilitating such downward movement, as well as continually turning over and agitating the ore so as to expose it to the heat

of the gases from burner 4. The salt carrying bodies are fed to the upper end of the kiln at such rate as to supply the required amount of volatilizing agent and pass downwardly along the kiln together with and in contact with the ore and gradually deliver the salt to the ore either by gradual evaporation of the salt, or by gradual exposure of the salt in solid or fused form by reason of abrasion of the bodies by mechanical action, disruption by the action of heat, or a combination of such mechanical and thermal actions. The balls or bodies 15 may thus be enabled to deliver the salt into contact with the ore throughout the length of the kiln or any desired part thereof. Such balls or bodies, if made of sufficient weight, may also serve to effect a grinding or crushing action on the ore, tending to break up any agglomerations due to incipient fusion.

The size and shape of the salt carrying bodies may be varied according to circumstances. For example, they may be formed as balls of from six inches to one-half inch in diameter, or they may consist of irregular, granular material formed by crushing the refractory material, either before or after it is mixed or impregnated with the salt; and such crushing may be to any size, preferably not smaller or finer than the ore, say 20 mesh, or coarser, in case the ore is crushed to twenty mesh. In case the salt carrying material is supplied in such granular form it is essential that the composition of the material should be more refractory or infusible than the ore, and this is also desirable in all cases, even when the salt carrying bodies are formed as relatively large balls or masses.

The invention is of especial advantage when applied in connection with a process in which the ore is pre-heated before it is supplied to the volatilizing furnace, for the reason that such pre-heated ore tend to cause such rapid volatilization of the salt, when the latter is brought suddenly in contact with the heated gases and ore, that a large part of the salt passes off as vapor without having an opportunity to come in contact with the metallic constituents of the ore, resulting in a large loss of salt and of the heat required for volatilizing same; such loss being obviated by this process by reason of the protection of the salt from direct or sudden exposure to the heat by means of the heat resisting and insulating material of which the salt containing bodies are largely composed, and the gradual release of the salt into contact with the ore and the heat as above described.

My invention may, however, be used to advantage when the ore is not preheated, and in that case the ore may be fed to the volatilizing furnace with or without admixture of salt therewith. For example, a part

of the salt required for the reaction may be mixed with the ore before it passes to said furnace, the remainder of the salt required being supplied during the passage of the ore through the furnace, by means of the salt containing refractory bodies, as above described.

The volatilizing agent referred to in the above description of my process, generally consists of sodium chloride, calcium chloride, or other salt containing chlorine, such salt operating under the heat of the furnace and in the presence of the ore, to form a chloride of the metal or metals, such as copper, silver, gold or other metal, contained in the ore, such chloride or chlorides passing off and being collected in the form of fume, which is treated in any suitable manner, either by smelting or by hydrometallurgical operation, to produce the metal or metals desired. More than one of such volatilizing agents may be used in the same process, if desired. Thus sodium chloride may be supplied in refractory bodies fed by means 20, and calcium chloride may be supplied by the means 14.

What I claim is:—

1. The process which consists in subjecting ore to heat in the presence of bodies of refractory material containing an agent capable of reacting with a metal-bearing constituent of the ore under the action of such heat to form a volatile metal-bearing compound, withdrawing the volatilized compound from the ore, and condensing and collecting such compound.

2. The process for volatilization of metallic values from ore, which consists in heating the ore in the presence of bodies of refractory material containing a salt capable of reacting with the desired metallic values in the ore to form volatile compounds.

3. The process of volatilizing metallic values from ores, which consists in passing the ore in a hot volatilizing chamber in contact with bodies of refractory material containing a salt capable of reacting with the ore at the heat of such chamber to form a volatile compound, withdrawing the resulting vapor from the chamber and collecting fume from such vapor.

4. The process which consists in passing ore through a volatilizing furnace in contact with bodies of refractory friable mate-

rial containing a volatilizing agent, subjecting the ore and such bodies to agitation while passing through said furnace, to gradually wear away said bodies and release the volatilizing agent in contact with the ore, conducting metal bearing gases and vapor from said furnace, and collecting metal bearing fume therefrom.

5. The process which consists in pre-heating ore and then passing the ore, while still hot, into a volatilizing furnace, and introducing into said furnace, in contact with the ore, bodies of refractory material containing a salt capable of reacting with the ore in the furnace to form metal bearing vapors, and conducting away such vapors and collecting fume therefrom.

6. The process which consists in passing ore through a volatilizing furnace in contact with bodies of refractory friable material containing a salt capable of reacting with a constituent of the ore to form a volatile compound, subjecting the ore and such bodies to agitation while passing through said furnace to gradually wear away said bodies and release the said agent in contact with the ore, withdrawing the resulting vapor of the compound so formed from said furnace and condensing and collecting such vapor.

7. A process which consists in passing ore containing metallic values through a volatilizing furnace in contact with bodies of refractory friable material containing a volatilizing agent consisting of a salt adapted to react with the ore when heated to produce vapor containing metallic values originally present in the ore and passing through said furnace hot combustion gases to heat the ore and said bodies of refractory material and volatilizing agent, subjecting the ore and said bodies to agitation while passing through said furnace to gradually wear away said bodies and release the volatilizing agent in contact with the ore, and withdrawing from the furnace the said combustion gases and the vapor resulting from reaction of volatilizing agent with the ore, condensing such vapor to form a metal bearing fume and collecting such fume.

In testimony whereof I have hereunto subscribed my name this 10th day of April, 1922.

ARTHUR P. KNIGHT.