H. W. KENT.

PROCESS OF TREATMENT OF ORES FOR RECOVERING METAL VALUES THEREFROM.

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1,009,906. Patented Nov. 28, 1911.

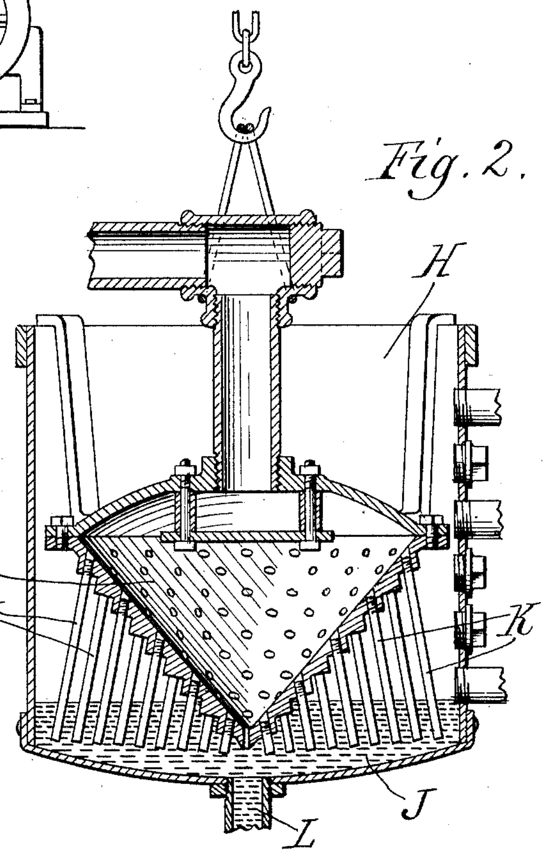

Fig. 2.

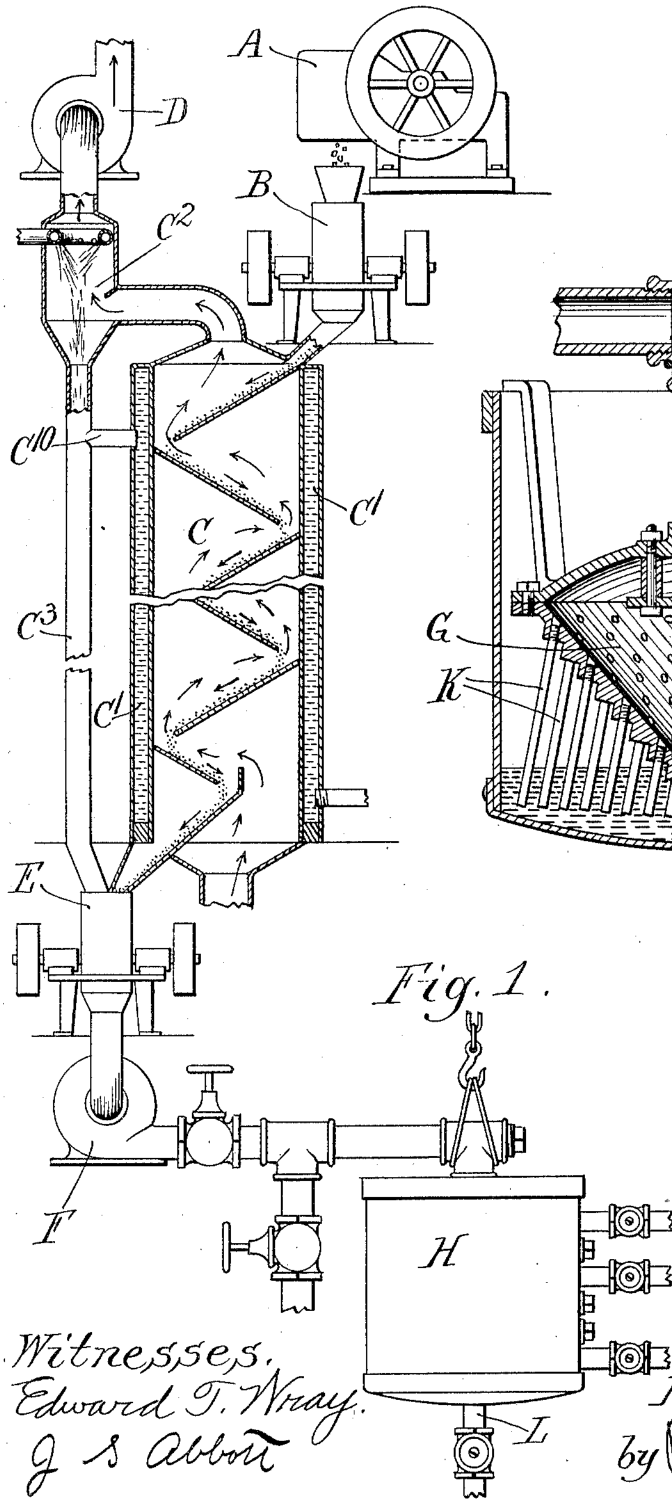

Fig. 1.

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UNITED STATES PATENT OFFICE.

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PROCESS OF TREATMENT OF ORES FOR RECOVERING METAL VALUES THEREFROM.

1,009,906. Specification of Letters Patent. **Patented Nov. 28, 1911.**

Application filed June 1, 1908. Serial No. 436,090.

To all whom it may concern:

Be it known that I, HENRY W. KENT, a citizen of the United States, residing at Milwaukee, in the county of Milwaukee and State of Wisconsin, have invented new and useful Improvements in Processes of Treatment of Ores for Recovering Metal Values Therefrom, of which the following is a specification, reference being had to the accompanying drawings, forming a part thereof.

This invention relates to the treatment of ores, particularly those containing gold and silver.

In consists of the steps and groups of steps hereinafter described as indicated in the claims.

This invention may be understood without reference to any specific structure, but for the purpose of more specific description, the drawings illustrate, in part diagrammatically, a structure, or group or succession of structures which may be employed in carrying out the several steps of the process.

In the drawings:—Figure 1 is a diagrammatic view showing, without regard to their actual relative positions but with regard only to their order of use in the process, a succession of ore-treating appliances, each of familiar type and character, by means of which the successive steps of the process constituting this invention may be performed. Fig. 2 is an axial section of an amalgamator which may be employed as the last element in the system of devices for performing this process.

In order that the purpose to be accomplished by this invention may be understood in advance of the description of the process, and to the end that the process itself may be more clearly understood, the problem in ore treatment which it is the purpose of this invention to solve may be stated as arising out of the following facts and conditions: A very large percentage of gold and silver values in ores bearing these values occurs either in free metal, or in the form of simple or acid compounds from which they may be freed by heat. When the free metal is coarse, as is frequently the case in respect to gold and less frequently with other metals, it can be recovered largely by the ordinary process of plate amalgamation, but when it is very fine or in such form as is commonly called "flour", which when mixed with water produces what is called "slimes", treatment by plate amalgamation is not effective, and cyaniding or other process of that class has hitherto been found most effective if not the only effective method. When gold and silver amalgams are found in what is commonly called "refractory ore",—that is, ore in which the valuable metal is enveloped in, or in chemical combination with acid compounds,—the elimination of the envelop or matrix by heat or chemical treatment leaves the gold and silver in the condition of flour or very fine almost impalpable particles, not recoverable,—practically, or to any large extent,—by plate amalgamation. Usually, such ores also contain a considerable proportion of baser metals, particularly lead and copper, which defeat practical treatment by the cyanid process, and for this reason, these refractory ores have usually heretofore been treated by smelting.

The expense of the smelting process is too great to be applied to low grade refractory ores.

The starting point for the present invention is the conception that if the entire body of the ore can be reduced to the flour or pinpoint size of the gold and silver whose recovery is difficult, substantially every particle of the gold and silver will be exposed, and if in the process, or subsequent to the process of reducing the ore to this fine condition, the necessary amount of heat to drive off the acid compounds with which some portion of the gold or silver may be associated, but without involving any such amount of heat as is required for smelting, the result would be the same as is obtained with what is known as "free milling ore". and that a pulp produced by mixture of water with such finely ground ore, discharged finely subdivided into mercury, under favorable conditions for amalgamation, will be deprived of all the gold and silver values by exposure of each and every fine particle directly to the mercury in its passage therethrough.

Roasting processes have two results: First, the acid compounds are driven off from the surface of each particular fragment exposed to roasting, and to that extent the gold and silver values are left exposed or separated. Second, the expansion and contraction due to heating and subsequently cooling the ore in the roasting process tends to crack the fragments of whatever size into fragments of smaller size, or in any event, to render them more brittle and more easily crushed in any subsequent mechanical treatment.

The mechanical process of reducing ore by crushing or grinding from fragments of any size to the size of coarse sand, or what is commonly called "forty-mesh size", requires very much less expenditure of power than is required for reducing the same class of ore mechanically from coarse sand or forty-mesh size to flour size, because in this latter grinding step the friction becomes very great and constitutes a resistance requiring very much more power to overcome than is required for the mere process of crushing or overcoming the tenacity of the ore itself.

In all the processes of amalgamation of slimes or flour gold by intermixing the pulp with mercury when such intermixture is effected by mechanical agitation, if the mercury is cold the amalgamation is very largely defeated, because the mercury tends itself to become floury and passes off with the gangue. In order to effect economical amalgamation of slimes or flour pulp by intermixture with mercury, the mercury must be maintained at a temperature at least above one hundred degrees Fahrenheit, and preferably between one hundred and two hundred degrees. Furthermore, when ore is reduced only to coarse-sand or forty-mesh size, the fragments are still large enough to have indentations or pockets or cavities in their surfaces adapting them to serve as vehicles for the mechanical engagement and deportation of mercury when the latter is in floury condition and of amalgam after it has formed; and in process of forced amalgamation,—that is, in which the mercury is forced into the presence of ore-bearing pulp or the ore-bearing pulp is forced into the mercury,—if the ore is of such size as still to present on its surface such pockets or cavities, very considerable loss of mercury and also amalgam may occur by such purely mechanical deportation. But when the ore is reduced to flour or pin-point size, the possible irregularities, cavities or pockets in the surface, if any exist, are so small that the flour mercury or amalgam cannot be physically engaged in or by them, and such loss by deportation may therefore be prevented by reducing the ore to such-pin size, even though other conditions should not be such as to prevent flouring.

In the roasting of ore, only a small proportion of the heat units developed in the furnace pass into the ore. A large proportion passes off in radiation from the furnace. Another large proportion passes with the gaseous and vaporous products of combustion through the stack. For convenience of reference, the heat units developed are accounted for by (*a*) absorption by the ore; (*b*) radiation from the furnace; (*c*) ventilation through the stack. In the process which constitutes this invention which will now be described, it is the purpose to produce the most favorable conditions in each of the respects above indicated at each of the steps or stages of the process of treatment; that is to say:—1. To reduce the entire ore to the condition of substantially flour or pin-point sizes by the most economical method, which, in view of the above stated facts, involves (*a*) breaking up mechanically to coarse sand or forty-mesh size; (*b*) roasting and cooling the whole for reducing the forty-mesh sand to flour or pin-point sizes, or rendering brittle and easy to grind the grains which are not then reduced to flour, and (*c*) grinding the whole with water for thorough intermixture and completing the reduction to flour or pin-point sizes. 2. Utilizing the heat ordinarily radiated from the roasting furnace and that which is lost by ventilation through the stack for maintaining the mercury in the amalgamator at proper temperature to prevent flouring. 3. Recovering from the stack the metal values which would pass off in dust or vapor by the same step and means adopted for conserving the heat units liable to be wasted through the stack. 4. Discharging the pulp in finely subdivided jets within the mercury body for amalgamation under conditions which cause the mercury to be contemporaneously maintained at the necessary temperature to prevent flouring.

In carrying out the process along the lines indicated, it is possible to make the same step contribute to more than one of the subsidiary processes or component elements of the total process above indicated, as will appear from the following description:—I first discharge the ore in the form, as to size of fragments, which is commonly known as "mine run", into a crusher or breaker, A, from which it is discharged into a coarse grinder, B, from which it emerges in the form of coarse sand and is delivered into the roaster, C, through which it passes exposed to the hot products of combustion in a familiar manner, sliding from shelf to shelf and being discharged at the bottom of the roaster more or less cracked or reduced to flour and deprived of a large proportion of the acid compounds with which the metal has been associated or enveloped, and rendered brittle even when it has not been actually cracked into finer condition. This roaster has a water jacket, C^1, for preventing the loss of heat by radiation, the units of heat which would be thus lost being taken up by the water. The products of combustion from the roaster are drawn off, preferably by the operation of a positive fan or blower, D, by which they are compelled to pass through a chamber, C^2, through which a shower of water is discharged across the path of the gaseous current, carrying with it into the water discharge pipe, C^3, the fine dust of the ore which may have been carried up from the furnace, and also more or less liquid matter resulting from condensation or vapors driven off by the heat from the ore, some of which have value. A circulation of water is maintained through the water jacket, C^1, by any familiar means, and the outlet pipe, C^{10}, of the water jacket discharges into the water discharge pipe, C^3, which receives the water by which the gaseous output of the furnace has been washed, as above described. The water from both these sources may be very hot, nearly reaching the boiling point. Preferably, the amount of water supplied for the shower should be sufficient to effect the purpose without being raised to the boiling point. The combined currents of hot water are conducted to a fine grinder, E, into which the ore is discharged from the roaster, and the hot water and hot ore in passing through the grinder become thoroughly intermixed while all the ore not previously reduced to flour is brought into that condition and the product which may be termed "flour pulp" is discharged very hot, but below the boiling point, to a force pump, F, by which it is pumped through as short a passage as can be conveniently arranged into a spray head, G, of the amalgamator shown in section of Fig. 2. This amalgamator is substantially of the form shown in the pending application of Smith & Kent, Serial No. 385,915, filed July 27, 1907, and need not be herein particularly described beyond calling attention to the fact that said spray-head is a conical chamber mounted apex downward within a receptacle, H, the lower part of which is occupied by a body of mercury, J, and which is deep enough to substantially inclose the spray head; that the spray-head itself is closed, except as to the connection for discharge of the pulp thereinto at the top, and the fine spray nozzles or discharge terminals, K, which lead off from its conical surface with a downward trend, and terminate deeply below the surface of the mercury for discharge of the pulp in fine jets within the body of the latter. All solid matter contained in the pulp being of practically uniform size, referred to as "flour size" or "pin-point size" the momentum of the different particles will be in proportion to their specific gravity, and being all ejected downward under the same impulse, the particles of greatest specific gravity will penetrate deeper into the mercury than the particles of lesser specific gravity, and each will penetrate a distance substantially in proportion to its specific gravity, thus effecting automatically a separation of the different minerals, the lighter, constituting refuse, rising almost immediately to the surface of the mercury, the gold and silver penetrating farthest and their amalgam settling. The receptacle has draw-off connections at different heights above the level of the mercury for taking off the concentrates and gangue separately, according to their specific gravities; and from the bottom of the receptacle, which is preferably dished or hollowed toward the center, provision is made for drawing off through a pipe, L, the amalgam which will accumulate at the bottom of the mercury body.

It will be noticed that in this process, the conservation of the heat units liable to be lost in ventilation from the roasting furnace, and the recovery of the ore dust and vaporous mineral liable to be lost in the same way, is effected by the spraying from which there is derived hot water for mixing with the flour ore to produce pulp. It will be noticed also that while roasting applied to ore in large fragments is only moderately effective for reducing it, and operates only to scale off an outer portion of the large fragments, the same amount of heat applied to roasting the ore when it has first been reduced to coarse sand size penetrates each grain of sand so as to produce the effect of cracking it and rendering it brittle, as well as driving off the acid compounds throughout; and that by combining the two steps of course grinding and roasting, in that order, the greatest efficiency of both steps is obtained. It will be noticed, also, that the cracking of the roasted sand which is partly effected in the heating is further carried forward in the cooling which results from delivering it from the roaster into water, and is still further effected by the absorption of the water; and that by dropping the hot ore into the water, the heat of the ore is conserved for the purpose for which it is to be subsequently utilized to prevent flouring of the mercury.

Obviously, it is not absolutely necessary to the process that the heat for preventing the mercury from flouring should be that developed in the roasting furnace, the waste of which is avoided by the expedients above described; but the entire process herein described, when employed in the most economical form, involves such a utilization of this heat. It will be obvious also that the success of the process does not depend absolutely upon utilizing the heat derived from the water jacket and thereby prevented from waste by radiation should be utilized in the pulp for heating the mercury, but again the process will be most economically practiced by including this step. I do not, however, limit myself to deriving the heat for preventing the mercury from flouring from the roasting furnace, although whether this heat be thus derived by the employment of a water jacket or the employment of a spray in the stack, or by both of these means, I regard the most economical form of the process to be one in which the heat units developed in the roasting furnace are utilized for subsequently heating the mercury; and for the purpose of the most economical practice of this invention, therefore, the grinding after the roasting for the purpose of producing the flour pulp should be performed immediately upon the discharge of the ore from the furnace, and the pulp should be pumped immediately from the grinder in which it is thus reduced to flour pulp or slimes into the amalgamator for discharge therefrom in fine jets as described.

I claim:—

1. The process of treatment of ores which consists in the following steps; (1) reducing the ore mechanically to coarse sizes, (2) roasting said coarsely reduced ore, (3) subjecting the gaseous and vaporous products of the roaster on their path of discharge therefrom, to a shower of water, absorbing the heat units tending to escape with said products in said water, precipitating the impalpable metallic values therein, (4) combining the reduced ore hot from the roaster and the hot slimes derived from the vaporous products and conveying them to a closed receptacle, (5) grinding the mixture to a flour pulp in said receptacle to conserve the heat units and (6) discharging said hot pulp through a closed conduit deeply within a body of mercury and thereby heating the mercury to effect hot amalgamation.

2. The process of treatment of ores which consists in the following steps: (1) reducing the ore mechanically to coarse sizes, (2) roasting said coarsely reduced ore and thereby still further reducing it by utilizing the expansive force of the heat, (3) breaking and brittlizing said reduced ore by dropping it while still hot into water in a closed receptacle (4) mechanically reducing said mixture to pulp in said receptacle, without material loss of heat, and (5) immediately conveying said hot pulp through a closed conduit and discharging it deeply within a body of mercury, and thereby raising the temperature of said mercury to and maintaining it at the proper temperature for hot amalgamation, without the application of any additional heat units.

In testimony whereof, I have hereunto set my hand at Chicago, Illinois, this 28th day of May, 1908.

HENRY W. KENT.

Witnesses:
JULIA S. ABBOTT,
M. GERTRUDE ADY.