

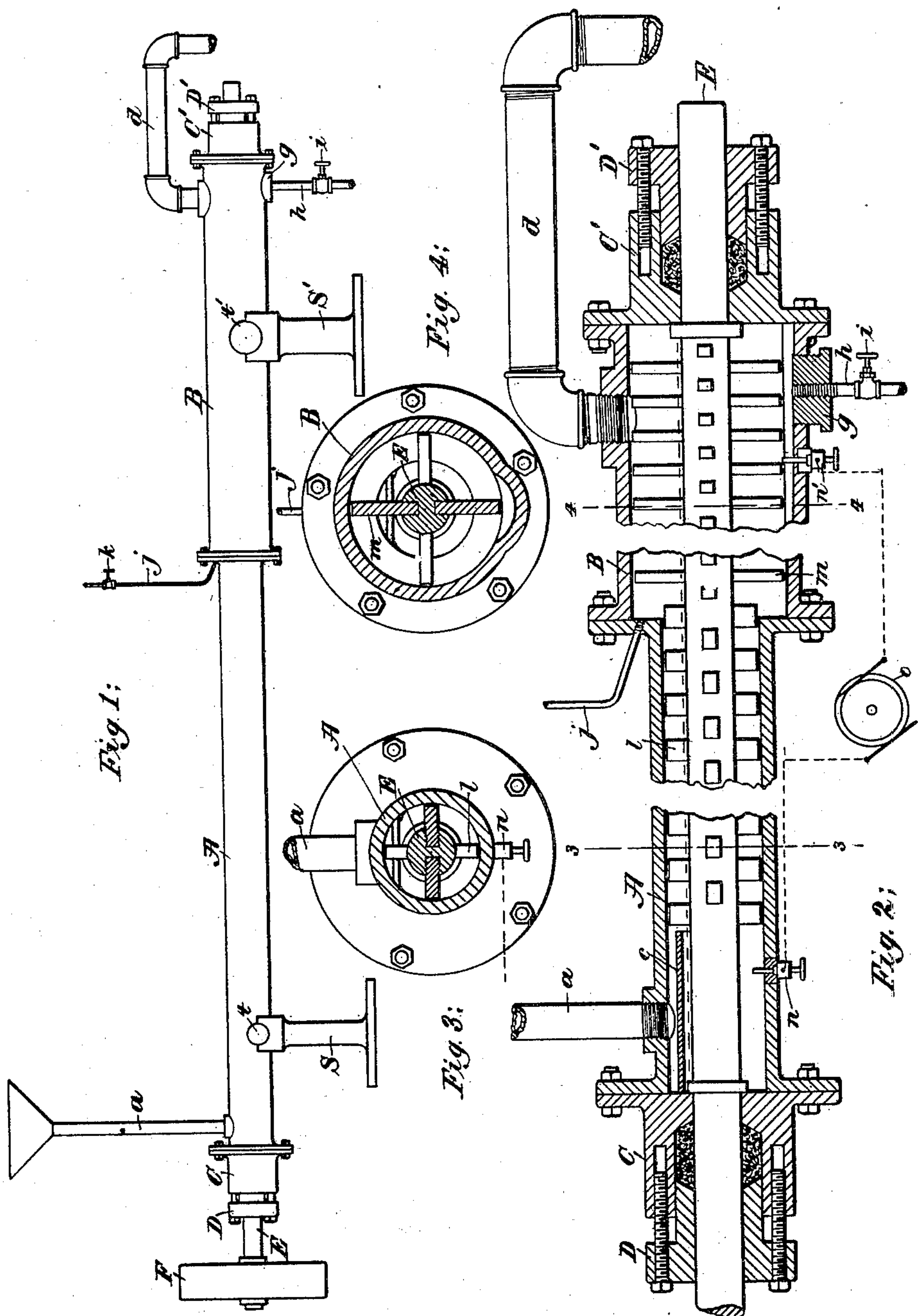
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P. A. KNAPPE.  
METHOD OF AMALGAMATING METALS.

(Application filed Mar. 7, 1902.)

(No Model.)



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# UNITED STATES PATENT OFFICE.

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## METHOD OF AMALGAMATING METALS.

SPECIFICATION forming part of Letters Patent No. 705,096, dated July 22, 1902.

Application filed March 7, 1902. Serial No. 97,036. (No specimens.)

*To all whom it may concern:*

Be it known that I, PAUL A. KNAPPE, a citizen of the United States, residing at Grantville, in the county of Coweta and State of Georgia, have invented an Improvement in Methods of Amalgamating Metals, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

My invention relates to the amalgamation of metals by the use of free mercury. Amalgamation by free mercury when carried out successfully possesses many advantages over other methods of extracting the precious metals; but in its practical application difficulties are encountered which have heretofore rendered the methods employed commercially inefficient. One of the essential requisites is that the pulp or mixture of comminuted ore and water should be so thoroughly intermingled with the mercury that the greatest possible portion of metal may have contact therewith to form the resultant amalgam. On the other hand, this intermingling must be carried out in such a manner as to prevent too violent an agitation of the mercury, since the latter is easily "floured" or finely dissipated, in which condition it is unfit for further amalgamation, being carried off with the waste product, resulting in a loss of the mercury as well as of the more precious amalgam with which it may be associated. During this intermingling process, owing to the difference in specific gravity, the bulk of the mercury tends to remain at the bottom of the receptacle in which the amalgamation is being carried on and the pulp tends to remain uppermost, there being a strong tendency to resist any force impelling the mercury upward or the pulp downward. It has heretofore been practically impossible to obtain a form of agitation that would cause proper mixture without "flouring" the mercury. The subsequent separation of the waste, commonly called "gangue" or "sand," from the amalgam is ordinarily a process of settling dependent upon the difference in specific gravity between the two

substances. The mixture during the separation must be undisturbed to the extent of permitting the particles to rise or descend, according to their relative specific gravity. On the other hand, some disturbance of the mass must still be maintained to free the intermingled particles of mercury and amalgam from the gangue or sand and admit of their free circulation and ready response to the laws of gravitation; otherwise a large percentage of the amalgam will pass off with the gangue.

My invention aims to provide a method of amalgamation which shall so combine the various essentials above mentioned as to produce better results than have heretofore been possible.

To enable my invention to be understood, I will describe, referring to the accompanying drawings, one means of carrying out the same, it being understood, however, that my invention is not limited to the particular means disclosed.

Figure 1 is a side elevation of an amalgamator constructed to carry out my improved method. Fig. 2 is a broken central longitudinal sectional view of the same, shown on a larger scale. Fig. 3 is a cross-sectional view taken on the line 3 3 in Fig. 2, and Fig. 4 is a similar sectional view on the line 4 4.

In the drawings, A represents a cylindrical tube having flanged ends by which it is coaxially bolted at one end to a similar tube B of greater diameter and at the other end to a head C. At the opposite end of the tube B is a similar head C', bolted through similar flanges. The heads C C' provide stuffing-boxes D D', forming therewith bearings for the shaft E, which passes throughout the length of the two tubes and is provided at one end with a suitable pulley F, through which proper rotary movement may be imparted to said shaft E. The amalgamator-tubes formed as above described carry trunnions  $t t'$ , resting in uprights S S'. An inlet or feed pipe  $a$  for the introduction of pulp enters near the leading end of the tube A through an opening in a boss cast on the upper side of said tube A. Directly beneath



the entrance of said tube *a* is placed a shield *c*, which may be of metal or other suitable material and is removably fitted in any convenient manner in the side of the tube A.

5 A gangue or waste discharge pipe *d* has communication with the tube B, preferably near the upper outer end thereof. At the under side of the tube B and preferably near its outer end is cast a boss, in which is screwed  
10 the plug *g*, containing a draw-off pipe *h* for the mercury, controlled by the valve *i*.

As a convenient means for draining the amalgamator, but forming no essential feature thereof, I have shown a slight trough-  
15 like depression, formed, preferably, in the under wall of the tube B and diminishing in depth from the outer end of said tube toward the initial end, where the cross-section of the tube is substantially circular. This depression is so slight as to be scarcely perceptible  
20 in the view shown in Fig. 1, but will be more readily understood by inspection of Fig. 2 and the cross-section shown in Fig. 4.

A pipe *j* for the discharge of water or other  
25 fluid into the amalgamator enters the same preferably at the point of juncture of the tube B with the tube A, being adapted to discharge its contents in a forwardly-inclined direction under the control of a valve *k*. It  
30 is to be understood, however, that I am not limited to the construction shown and that any suitable method of bringing the fluid into the amalgamator may be employed.

On the shaft E, within the tube A, except  
35 where they would conflict with the shield *c*, is placed a series of radial mixing-arms *l*. As shown in the drawings, they appear in staggered sets of two, screwed into the shaft E or otherwise suitably attached thereto and  
40 adapted to be revolved within the tube A with but slight clearance. The shaft E carries another series of freeing-arms *m*, adapted to revolve within the tube B. These arms *m* are suitably dimensioned and disposed to  
45 produce a disturbance of the contents of the tube B without producing any substantial intermingling of the mercury and the gangue. Other means for mixing and freeing may be  
50 employed, and I am not limited to those above described, which are merely such as I have found well adapted in practice to carry out my method.

In Fig. 2 is diagrammatically shown a generator of electric current *o*, which is omitted  
55 from Fig. 1 for the sake of clearness. This is electrically connected with the terminals *n n'*, which have access to the interior of the tubes A B, respectively, through suitable insulating-plugs and are adapted to have contact with the mercury therein contained to  
60 cause passage of the current through the mass of intermingled pulp and mercury in the mixing-chamber. The electric current is employed to increase and sustain the activity of  
65 the mercury and to prevent the latter from "sickening." Any means for the passage of a current through the intermingled pulp and

mercury may be used; but in practice I have found the employment of an interrupted or alternating current most effective. 70

This amalgamator is employed to carry out my method in the following manner: The two chambers are filled to the desired level with mercury, which, for the sake of illustration, may be indicated by the dotted line in Fig. 2, 75 but in practice is subject to variation. The pulp is fed through the inlet-pipe *a* to substantially fill the chamber of the tube A, but on entering the said chamber is prevented from dropping on the mercury immediately 80 below and flouring the same by the protecting-shield *c*. The pulp is preferably fed to the amalgator, conducted therethrough, and finally removed therefrom through the agency of pressure. As a convenient means for obtaining this pressure I have shown the pulp-  
85 inlet pipe surmounted by a hopper, suitably elevated above the outlet-passage, so that the desired pressure may be obtained on feeding the pulp to the hopper. Any other means, 90 however, for obtaining a suitable pressure may be employed. Under the influence of pressure the pulp is gradually worked from the initial end of the mixing-tube A to the settling or freeing tube B. During its passage through the mixing-tube it is subjected to the steady action of the mixing-arms *l*. This action is sufficiently mild to avoid the  
95 flouring of the mercury, and yet the available space within the mixing-chamber is so restricted that the particles of pulp are brought into contact with the mercury on slight movement, and the mixing-arms are so dimensioned and disposed that a thorough intermingling of the mercury and pulp is effected before the  
100 pulp reaches the settling-chamber. The proportions of the settling-chamber and the size and disposition of the freeing-arms are such that the mixing action ceases here and the particles of sand and pulp, now intermingled  
105 with bits of mercury and amalgam, are set into free circulation. This disturbance of the mixture and the resultant movement of the particles causes a freeing and separation of the heavier bits of mercury and amalgam, 115 which pass downward, while the lighter particles of sand rise and are carried off through the outlet. Since the outlet-passage is located at the top of the chamber and the pulp passes therethrough under the influence of pressure, 120 the settling-chamber is substantially filled with pulp above the line of mercury. It is to be understood, therefore, that the term "restricted" or "confined" space, as applied to the available space in the mixing-chamber, 125 is used in a relative sense, and, further, that it is only used to distinguish a space in which the particles of sand cannot move freely without coming into mixing contact with the mercury from a space in which 130 greater freedom of movement is allowed the sand particles for the separation therefrom of the mercury and the amalgam. It is also to be understood that this term has no reference



to the dimensions of such spaces, either actual or relative, for it is obvious that greater freedom in the movement of particles of pulp may be obtained in the settling-chamber by  
 5 a mere change in the shape or proportions of said chamber as well as by an actual change in the dimensions of the same. My invention is not, therefore, limited to chambers of the particular shape, size, or proportions shown  
 10 and described. The freeing action of the revolving arms employed in this larger chamber, as distinguished from the mixing action in the first chamber, is calculated to increase the circulation of the particles of sand and  
 15 amalgam and aid the settling process; but as various means may be employed for accomplishing this purpose I am not limited to any particular kind of agitation. It is only necessary that this step should be carried out  
 20 under such conditions as to aid the free circulation of the sand and the separation of the lighter from the heavier particles by gravitation. As the pulp passes through the settling-chamber it loses more and more of the  
 25 entrained mercury, and by the time it reaches a position near the outlet-pipe it is free from substantially all of the mercury and amalgam and is ready to be carried off through the outlet-passage in the form of gangue. In  
 30 addition to giving the particles of the mixture greater freedom of movement and a mild freeing action within this settling-chamber in distinction to a restricted movement and a mixing action in the amalgamating-chamber  
 35 I have found it sometimes advantageous to intermingle with the gangue a quantity of water or other vehicle fluid, preferably as it passes from the amalgamating-chamber into the settling-chamber. This I accomplish in  
 40 the above-described apparatus by admitting water through the pipe *j*. The addition of liquid at this point dilutes the pulp, aids the free circulation of the heavier particles, thereby materially improving the settling, and also  
 45 acts as a vehicle to carry off the gangue through the outlet-passage. I do not, however, regard this as an essential step in my process.

It is to be observed that by placing the settling-chamber in open communication with  
 50 the mixing-chamber I obtain an unimpeded circulation of the sand or pulp throughout the entire process and that there is no interruption in its passage from the mixing to the settling chamber. The process, as above described, is a continuous one. The pulp fed  
 55 into the hopper is brought into contact with a body of mercury and mingled therewith. Under pressure it is carried through the mixing-chamber, and while still under the moving influence of pressure it is so acted upon  
 60 as to permit a complete separation by settling and a removal of the gangue. The amalgamation is carried on without interruption until it is desired to withdraw the mercury  
 65 and replace it with a fresh charge. The with-

drawal of the mercury is readily effected through the pipe *h*.

It is to be understood that the structure described and shown, though well adapted, as  
 70 I have found, to carry out my method in practice, is submitted for illustrative purposes only, and that I am not limited to any particular structure or means for carrying it  
 75 into effect.

I claim—

1. The herein-described method for amalgamating metals, which consists in producing a pulp, bringing the same into contact with  
 80 mercury, enforcing an intermingling of the mercury and the pulp, confining the mixed pulp and mercury within a restricted space during such intermingling, thereafter freeing  
 85 the intermingled pulp and mercury from said restricted space, separating the heavier particles from the lighter by gravitation in a space less restricted for the circulation of the pulp particles, and preventing further intermingling.

2. The herein-described method for amalgamating metals, which consists in producing  
 90 a pulp, filling a space with said pulp and with mercury in the presence of pressure, and enforcing an intermingling of the two, placing said filled space in communication with a second  
 95 space, and permitting the latter to be filled with the intermingled pulp and mercury from the first, also in the presence of pressure, freeing the mixture in said second space from the mixture-enforcing action of the first  
 100 space, settling the amalgam and mercury in said second space, and carrying off the lighter sand and gangue under the pressure therein.

3. The herein-described method for amalgamating metals which consists in producing  
 105 a pulp, bringing the same into contact with mercury, intermingling the mercury and pulp within a confined space, freeing the intermingled pulp and mercury from said confined  
 110 space, opening up and freeing the materials thereof in a space less restricted for the circulation of the pulp particles, separating the heavier particles from the lighter by gravitation, and preventing further intermingling.

4. The herein-described method for amalgamating metals which consists in producing  
 115 a pulp, bringing the same into contact with mercury, enforcing an intermingling of the mercury and the pulp, confining the mixed pulp and mercury within a restricted space  
 120 during such intermingling, freeing the intermingled pulp and mercury from said restricted space, diluting the same with liquid, separating the heavier particles from the lighter, and settling the same by gravitation, and preventing  
 125 the reintermingling of the settled particles.

5. The herein-described method for amalgamating metals, which consists in producing  
 130 a pulp, bringing the same into contact with mercury, intermingling the mercury and pulp within a confined space, freeing the inter-



mingled mass from said confined space, diluting the intermingled pulp and mercury, opening up the materials in the mass thus freed in a less restricted space, separating the heavier particles thereof by gravitation, and preventing the reintermingling of the settled particles.

6. The herein-described method for amalgamating metals, which consists in producing a pulp, introducing the same into a space containing mercury, said space being such that a slight movement of the pulp particles in certain directions results in contact with the mercury, causing such movement of the pulp as to enforce an intermingling of the same with the mercury, passing the mixed pulp and mercury into a space such that the pulp particles may move with relative freedom without contact with mercury, opening up the material of the mixture by disturbing the same while in this space, permitting the separation of the heavier particles therefrom by gravitation, and preventing further intermingling.

7. The process of amalgamating metals, which consists in forming a pulp, bringing the same into contact with mercury, enforcing an intermingling of the mercury and the pulp, confining the mixed pulp and mercury within a restricted space during such intermingling, thereafter freeing the mixed pulp and mercury from said restricted space, separating the heavier particles by gravitation in a less restricted space, and causing the passage of an electric current through the intermingled pulp and mercury.

8. The herein-described method for amalgamating metals, which consists in producing a pulp, bringing the same into contact with mercury, agitating the pulp and mercury within a confined space to thoroughly intermingle the same, freeing the intermingled pulp and mercury from said confined space, subjecting the mass to a milder form of agitation in a less restricted space, separating the heavier particles from the lighter by gravitation, and preventing further intermingling of the same.

9. The herein-described method of amalgamating metals, which consists in producing a pulp, passing the same through a confined space containing mercury, intermingling the mercury and the pulp therein, passing the intermingled mercury and the pulp through a less restricted space, opening up the materials thereof, separating by gravitation the heavier particles from the moving mass, and preventing the further intermingling of the same, said passage of the materials through the two spaces being continuous.

10. The herein-described method for amalgamating metals, which consists in producing a pulp, passing the same through a confined space containing mercury, enforcing an intermingling of the mercury and the pulp therein, passing the intermingled mercury and pulp through a less restricted space, separating

therein the heavier particles from the lighter by gravitation, settling the same out of the path of the moving mass, and preventing further intermingling of the settled particles.

11. The herein-described method for amalgamating metals, which consists in passing pulp through a restricted space containing mercury, intermingling the two substances therein, passing the intermingled pulp and mercury to a less restricted space, diluting the same with liquid, separating the heavier particles from the lighter by gravitation, and settling said particles out of the line of flow of the moving mass.

12. The herein-described method for amalgamating metals, which consists in producing a pulp, bringing the same into contact with mercury, intermingling the mercury and pulp within a confined space, freeing the intermingled mass from said confined space, diluting the intermingled pulp and mercury with liquid, opening up the materials in the mass thus freed in a less restricted space, separating the heavier particles thereof by gravitation, and settling the same out of the line of flow of the moving mass.

13. The process of amalgamating metals, which consists in forming a pulp, bringing the same into contact with mercury, enforcing an intermingling of the mercury and the pulp, confining the mixed pulp and mercury within a restricted space during such intermingling, thereafter freeing the mixed pulp and mercury from said restricted space, separating the heavier particles by gravitation in a less restricted space, settling the same out of the line of flow of the moving mass, and causing the passage of an electric current through the intermingled pulp and mercury.

14. The herein-described method of amalgamating metals, which consists in producing a pulp, passing the same through a confined space containing mercury, intermingling the mercury and the pulp therein, causing the intermingled mass to travel in a substantially horizontal direction through a less restricted space, opening up the materials thereof during its passage through said less restricted space, and separating the heavier particles from the lighter by gravitation.

15. The herein-described method for amalgamating metals, which consists in producing a pulp, bringing the same into contact with mercury, enforcing an intermingling of the mercury and the pulp, confining the mixed pulp and mercury within a restricted space during such intermingling, causing the intermingled mass to travel in a substantially horizontal direction through a less restricted space, diluting the same with liquid, separating the heavier particles from the lighter by gravitation, and preventing the reintermingling of the settled particles.

16. The herein-described method of amalgamating metals, which consists in feeding a pulp by gravitation to a confined mercury-



containing space, causing the passage of the pulp therethrough by the pressure of the incoming pulp alone, intermingling the pulp and mercury during the passage of the pulp, 5 passing the mixture by the pressure of the incoming pulp through a less restricted space, opening up the materials thereof, separating the heavier particles therefrom, preventing further intermingling of the same, and causing the removal of the lighter sand and gangue 10 by the pressure of the incoming pulp.

17. The herein-described method for amalgamating metals, which consists in causing pulp to travel in a substantially horizontal 15 direction through a mercury-containing confined space, intermingling the pulp and mer-

cury in said space, thereafter causing the intermingled pulp and mercury to travel in a like direction through a less restricted space, opening up the materials of said mixture in 20 said less restricted space, separating the heavier particles from the lighter out of the path of travel by gravitation, and removing the lighter sand or gangue therefrom.

In testimony whereof I have signed my 25 name to this specification in the presence of two subscribing witnesses.

PAUL A. KNAPPE.

Witnesses:

THOMAS B. BOOTH,  
EVERETT S. EMERY.