(No Model.)

A. JANIN.

ART OF AMALGAMATING SILVER ORE.

No. 473,395. Patented Apr. 19, 1892.

Fig. 1.

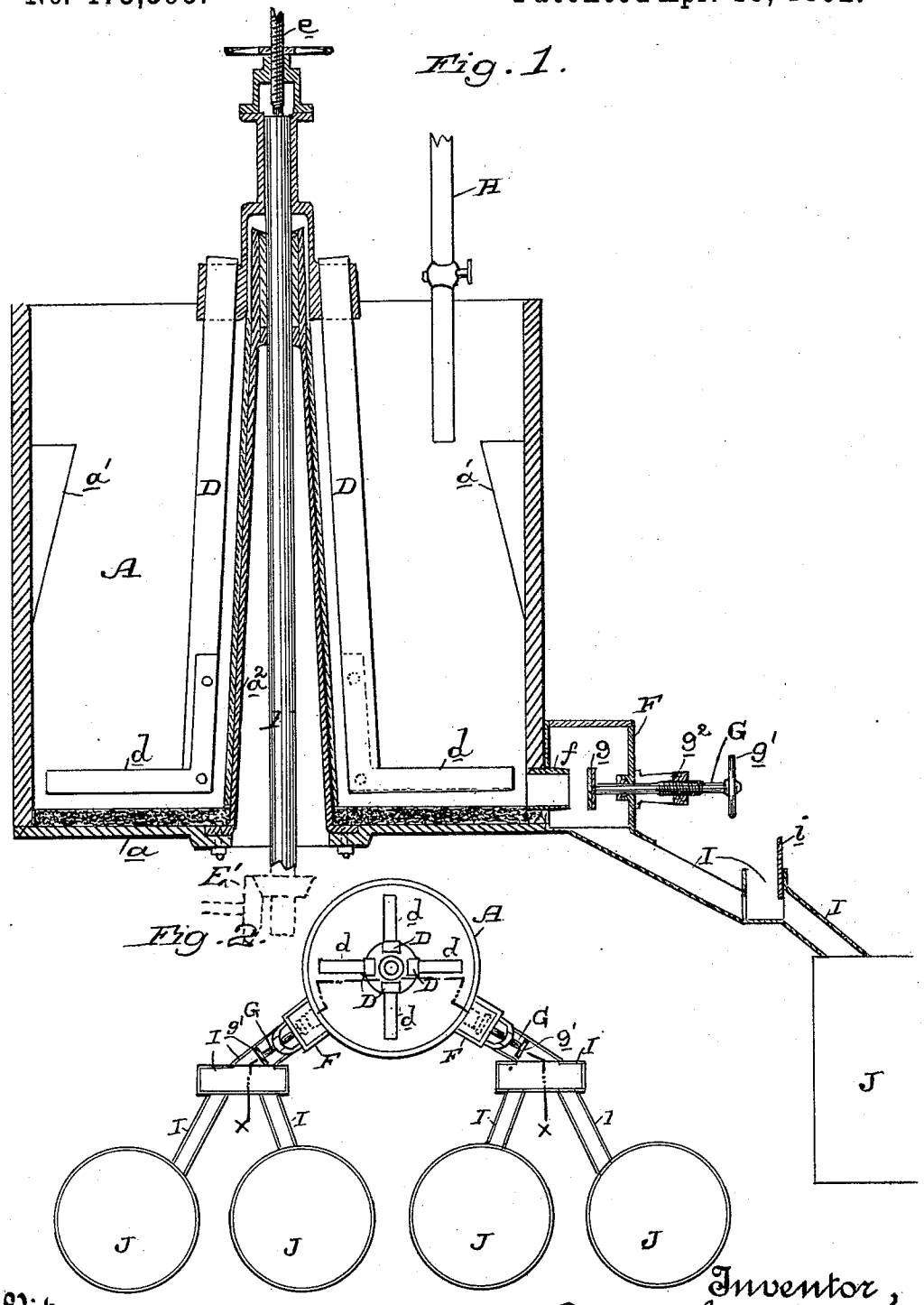

Fig. 2.

Witnesses,
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ART OF AMALGAMATING SILVER ORES.

SPECIFICATION forming part of Letters Patent No. 473,395, dated April 19, 1892.

Application filed September 1, 1891. Serial No. 404,453. (No model.)

To all whom it may concern:

Be it known that I, ALEXIS JANIN, a citizen of the United States, residing in the city and county of San Francisco, State of California, have invented certain new and useful Improvements in the Art of Amalgamating Silver Ores, of which the following statement is a specification, reference being had therein to the accompanying drawings, which form part of this specification.

Figure 1 is a vertical section on the line *x x* of Fig. 2. Fig. 2 is a plan view of Fig. 1.

My invention relates to an improved method of and apparatus for chloridizing silver ores by means of an acid solution of ferric chloride prior to the amalgamation of the ore in iron pans. By an acid solution I mean one that will not deposit iron when heated or which contains or is used in connection with enough free acid to overcome the action of substances in the ore to be treated, which would otherwise decompose the solution of ferric chloride.

It is well known that ferric chloride is a powerful chloridizing agent; but its use in connection with the pan amalgamation process has hitherto been precluded, owing to the fact that both the iron of the pan and the mercury or amalgam constantly remaining in the pan will reduce the ferric chloride to ferrous chloride, which latter salt has little, if any, effect in chloridizing silver minerals. When the chloridizing of the ore by means of ferric chloride and its subsequent amalgamation are both carried out in wooden apparatus—such as revolving barrels—then the grinding action and violent motion of the iron pan are forfeited, and the practical operations require more time and are more expensive than by the method I have invented. This consists in heating the ore, together with an acid solution of ferric chloride, in a preparatory apparatus constructed of material that will not destroy or which will only be slightly affected by the solution of ferric chloride, and then completing the amalgamation in iron pans in the usual way. If there still remain an excess of ferric chloride in the pulp after the chloridizing of the silver minerals in the preparatory apparatus has been effected, I add to the pulp a substance or substances which will neutralize the free acid present and reduce the ferric chloride to ferrous chloride or precipitate its iron as an oxide prior to the introduction of mercury into the pulp, and which will also precipitate in harmless forms other metallic salts which may have been brought into the solution by the action of free acid or of ferric chloride on baser minerals contained in the ore, which salts would otherwise have an injurious effect upon the mercury used in the amalgamation of the ore. This is notably the case when chloride of copper is present in the solution, and my method of precipitating metallic salts from their solution prior to the introduction of mercury into the pulp can also be applied with advantage when silver ore is chloridized by means of sulphate of copper and salt prior to its amalgamation in iron pans.

My process is applicable to ores of which the gangue is mainly silicious. When substances which would decompose ferric chloride—such as carbonate of lime—are also present in the ore, their action must be overcome by the addition of acid to the ore. The small cost at which the solution of ferric chloride can be produced permits of its use in large proportions, and my method of rendering any excess of free acid or of metallic salts harmless before discharging the pulp into the iron pan or before the introduction of mercury into the pulp reduces to a minimum the consumption of that metal and of the iron of the pan.

An acid solution of ferric chloride will chloridize most of the nobler silver minerals, and is especially adapted to the treatment of arsenical compounds and fahl-ores. It has also the advantage of producing fine bullion, whereas when sulphate of copper and salt are used in chloridizing silver ores the copper will be partially amalgamated, whether the chloridizing action takes place in a separate apparatus or not. Neither will the use of a separate chloridizing apparatus prevent the injurious action of chloride of copper upon the mercury added in the iron pan, unless the copper be first precipitated from its solution by the method I have invented.

The chloridizing of the silver minerals by

my method, including the time consumed in charging and discharging the chloridizing tub, can be thoroughly effected in from two to two and one-half hours. Double that amount of time is generally required for thorough amalgamation in the pan.

It is customary in amalgamating-mills to use one settler for two pans and to discharge each pan in the row at an interval from its neighbor equal to half the time required for the pulp to remain in any one pan. Therefore one chloridizing-tub having the same capacity as an amalgamating-pan and running two and one-half hours on each charge can supply two amalgamating-pans running five hours and charged alternately at intervals of two and one-half hours.

By giving the chloridizing-tub double the capacity of an amalgamating-pan four of the latter can be supplied by one of the former, two alternate pans in the row being charged at one time and the other two two and one-half hours later.

The chloridizing-tub A is placed at a higher level than the amalgamating-pan J, and the two are connected by means of a system of troughs I or pipes provided with gates *i* or switches, which connection permits of the simultaneous charging of two pans. These gates *i* may be of any ordinary form of adjustable or movable plates controlling the flow of the material through the troughs into the pans.

In the accompanying drawings, Figure 1 is a vertical section, and Fig. 2 a plan, of the chloridizing-tub A, showing the method of connecting the same with four amalgamating-pans J, which are themselves connected with two settlers, the latter being unnecessary to show. The valve arrangement is for opening and closing the discharge-orifice of the chloridizing-tub without using loose plugs. By means of this valve the flow of pulp from the tub to the pan can be regulated or interrupted at any moment, and when the preparatory-tub holds a charge for two amalgamating-pans permits drawing off a charge for one pan only, if the other should be temporarily out of order. The sides of the chloridizing-tub are formed of wooden staves, resting on a cast-iron bottom *a*, provided with a flange. Wooden wings *a'* are attached to the sides of the tub.

The stirring apparatus may be of any suitable character. To it I give a speed of thirty-five revolutions per minute when the tub has a diameter of six feet. It is driven by a vertical shaft E, passing through a cone a^2, and can be raised or lowered by means of set-screws *e*. The legs D of the stirring apparatus are of scantling of suitable dimensions and have horizontal arms *d*. These arms, as well as the iron cone and the iron bottom of the pan, should be suitably protected from the action of the chemicals by covering them with any material, such as wood for the arms, a sheathing of lead or wood for the cone, and a layer of cement for the iron bottom. These portions of the apparatus are, however, but little acted upon by chemicals when the pulp is thick, and there being no grinding action in the chloridizing-tub a removable iron die may be used to protect the permanent bottom, or the cone and shaft may be dispensed with and the stirring apparatus run on a collar above the tub and be driven by overhead gearing, all such modifications being well known and requiring no illustration. In the present instance I have shown the shaft E as being driven by means of gearing E' from below. The valve arrangement for discharging the contents of the chloridizing-tub, as shown in the drawings, consists of a box F, fitting closely against the side of the tub, beyond which the iron discharge-nozzle *f* projects, and a valve-stem G, entering the box at right angles to the side of the tub and terminating in a head *g* of greater diameter than the discharge-orifice, against which it presses when the valve is closed. The head of the valve-stem is covered with leather or other flexible material. The stem has its threaded bearing in a nut g^2 outside the wooden box, and by means of the hand-screw *g'* the discharge-orifice can be opened or closed, as desired. This construction avoids contact of the thread of the valve-stem with the pulp, and also allows the stem to be cleaned off when required, as it is easily accessible by removing the cover of the box. By having two discharge-holes in each tub the emptying of the tub can be more rapidly effected. The valve arrangement can be constructed in its details in other forms than I have described; but its essence lies in the application to a chloridizing apparatus of the method of regulating or interrupting the outflow of the pulp without the use of loose plugs, for the purposes described.

When the ore naturally contains ferric oxide, easily soluble in dilute acid, or if such be added to the ore, the solution of ferric chloride can be formed by adding hydrochloric acid or salt and sulphuric acid to the ore. When this method is not available, the solution of ferric chloride may be economically formed by adding chloride of lime to a solution containing hydrochloric acid or sulphuric acid in excess of the amount necessary to liberate the chlorine of the chloride of lime as gas, in the presence of iron vitriol in solution with common salt, or of iron sulphides, either in contact with the ore or prepared separately. In this way three pounds of commercial chloride of lime will oxidize to ferric chloride the iron contained in about eight pounds of iron vitriol in solution with common salt. By the same method iron sulphides contained in the

ore can be converted into ferric chloride. It is advisable to use both salt and acid in some excess.

The absolute amount of ferric chloride which may be required to chloridize the silver minerals in a given weight of ore will vary with the nature of the ore. Many sulphides of the baser metals—such as sulphides of copper, lead, antimony, and arsenic—are slowly decomposed by a solution of ferric chloride, which is itself at the same time reduced to ferrous chloride, which latter combination has no further action in chloridizing silver minerals. It is therefore necessary that ferric chloride be present in such quantity that there will always remain enough in solution to effect the chloridizing of the silver minerals present in the same ore with baser sulphides. Sulphides of iron, however, are not acted upon by a solution of ferric chloride. When the ore contains a large excess of sulphides of the baser metals other than the sulphides of iron, it is not well adapted to treatment by this method. In a given case the exact strength of the ferric chloride solution is to be determined by the yield of the ore when using solutions of different strength.

The ferric chloride should always be present in such quantity as to effect the chloridizing of the silver minerals before the ferric chloride itself be decomposed by sulphides of the baser metals, if any such be present.

The practical operations in treating the ore are essentially as follows: The pulp is charged into the chloridizing-tub A while the stirring apparatus is in motion. Steam is then introduced directly into the pulp by suitable means, as by the pipe H. If the ore contains substances which would decompose ferric chloride, their action is neutralized by the addition of free acid to the ore. The ore is now subjected to the action of a solution of ferric chloride, and the introduction of steam is continued until the temperature reaches 150° Fahrenheit or more. The steam is then shut off, and the mixing of the pulp by the stirring apparatus is continued until the silver minerals are chloridized, which will generally require from two to two and one-half hours from the time of charging. I then add to the pulp a substance or substances that will reduce the ferric chloride present to ferrous chloride or precipitate the iron as hydroxide. If other metallic salts which would have an injurious effect on mercury are present in solution, they are precipitated by similar means. For this purpose there may be used iron borings, which will reduce the ferric chloride to ferrous chloride or carbonate of manganese or carbonate of lime or caustic lime or other similar substances, which will precipitate the metallic salts as carbonates or hydroxides. The reduction of ferric chloride to ferrous chloride can also be accomplished by adding to the pulp granulated zinc or sodium sulphite or by introducing, slowly, sulphurous-acid gas into the mixture of ore and solution until the reduction of the ferric chloride is effected. The valve *g*, attached to the chloridizing-tub, is then opened, and the pulp is discharged through the conveying-troughs I directly into one or more amalgamating-pans J.

If ferric chloride is only present in small amount in the chloridizing-tub when the same is to be discharged, the reduction of the iron to harmless forms by added substances can be dispensed with, as it would be effected by the iron of the amalgamating-pan; but if present in large quantities the iron of which the pan is composed would be rapidly consumed, and the method I have described should be followed.

Having fully described my invention, I do not claim in its entirety the method of first chloridizing silver ore by means of metallic chlorides in a preparatory apparatus and then amalgamating it in iron pans; but

What I do claim is—

1. The improvement in the art of amalgamating silver ores, which consists in subjecting the ore in a preparatory or chloridizing apparatus to the action of an acid solution of ferric chloride, with assistance of heat, agitating the mixture of ore and solution until the silver minerals are chloridized, then discharging the pulp into an amalgamating-pan, adding mercury, and concluding the amalgamation in the usual way, substantially as described.

2. The improvement in the art of amalgamating silver ores, which consists in heating the ore in a preparatory or chloridizing apparatus, together with a solution of metallic chlorides, agitating the mixture of ore and solution until the silver minerals are chloridized, then adding a substance or substances that will neutralize free acid present and reduce ferric chloride to ferrous chloride or precipitate the metallic salts in solution as carbonates or hydroxides, then adding mercury, and concluding the amalgamation in an amalgamating-pan in the usual way, substantially as described.

3. The improvement in the art of amalgamating silver ores, which consists in first heating the ore in a preparatory or chloridizing apparatus, together with an acid solution of ferric chloride formed by mixing common salt and sulphuric or hydrochloric acid with chloride of lime in the presence of ferrous sulphate or of sulphides of iron, and then concluding the amalgamation in an amalgamating-pan in the usual way, substantially as described.

4. The combination of a chloridizing-tub having a discharge-opening, a stirring mechanism within said tub, a box inclosing the discharge-opening of the tub, a valve-stem passing through the outer wall of the box, hav-

ing a valve on its inner end, and a bearing exterior of the outer wall of the box and threaded to receive a threaded portion of the stem, substantially as herein described.

5. The combination of a chloridizing-tub having stirring mechanism and discharge-outlet, amalgamating-pans at a level below the chloridizing-tub, a box inclosing the outlet of the tub, and troughs interposed between the tub and pans, a valve-stem passing through the outer wall of the box, having a valve on its inner end and a hand-wheel at its outer end, and a bearing exterior of the box for said stem, substantially as herein described.

In witness whereof I have hereunto set my hand.

ALEXIS JANIN.

Witnesses:
S. H. NOURSE,
J. A. BAYLESS.