C. G. COLLINS.

PROCESS OF EXTRACTING COPPER FROM ORES.

APPLICATION FILED NOV. 27, 1907. RENEWED SEPT. 19, 1908.

919,130. **Patented Apr. 20, 1909.**

2 SHEETS—SHEET 1.

Fig. 1.

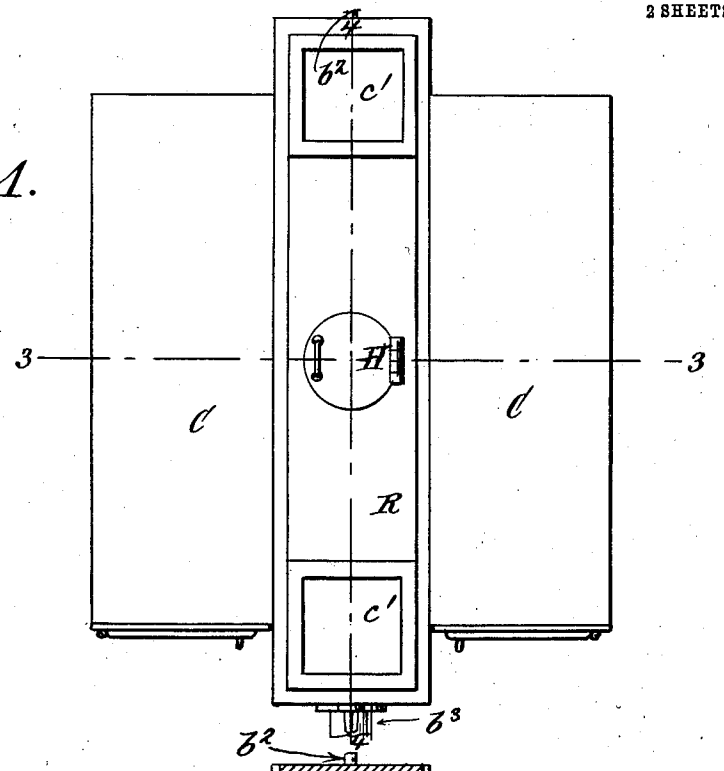
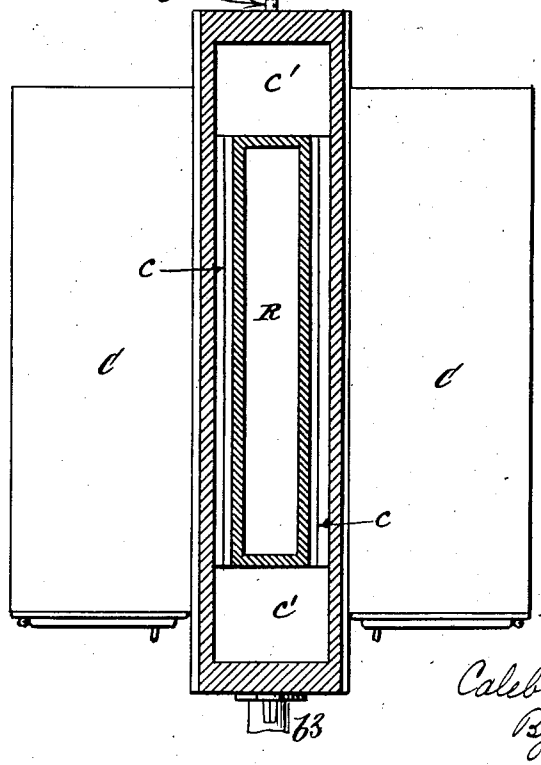


Fig. 2.



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2 SHEETS—SHEET 2.

Fig. 3.

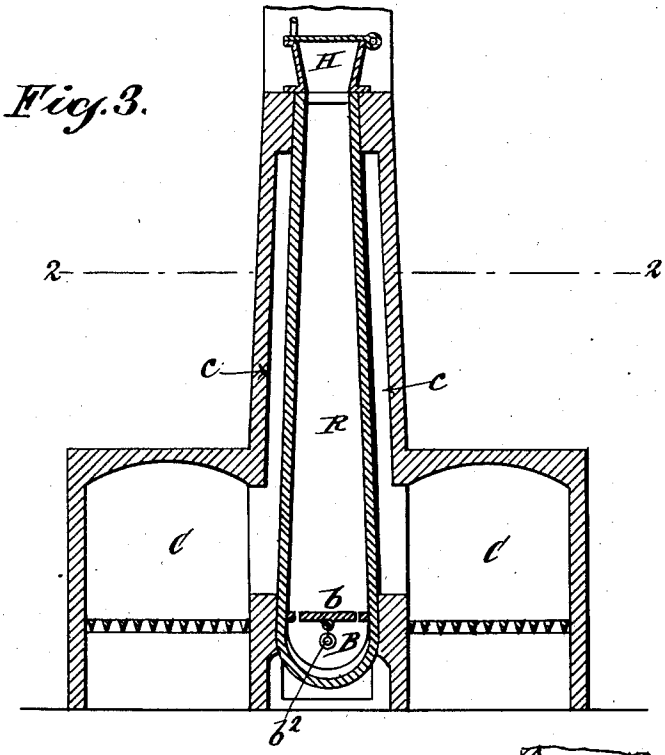
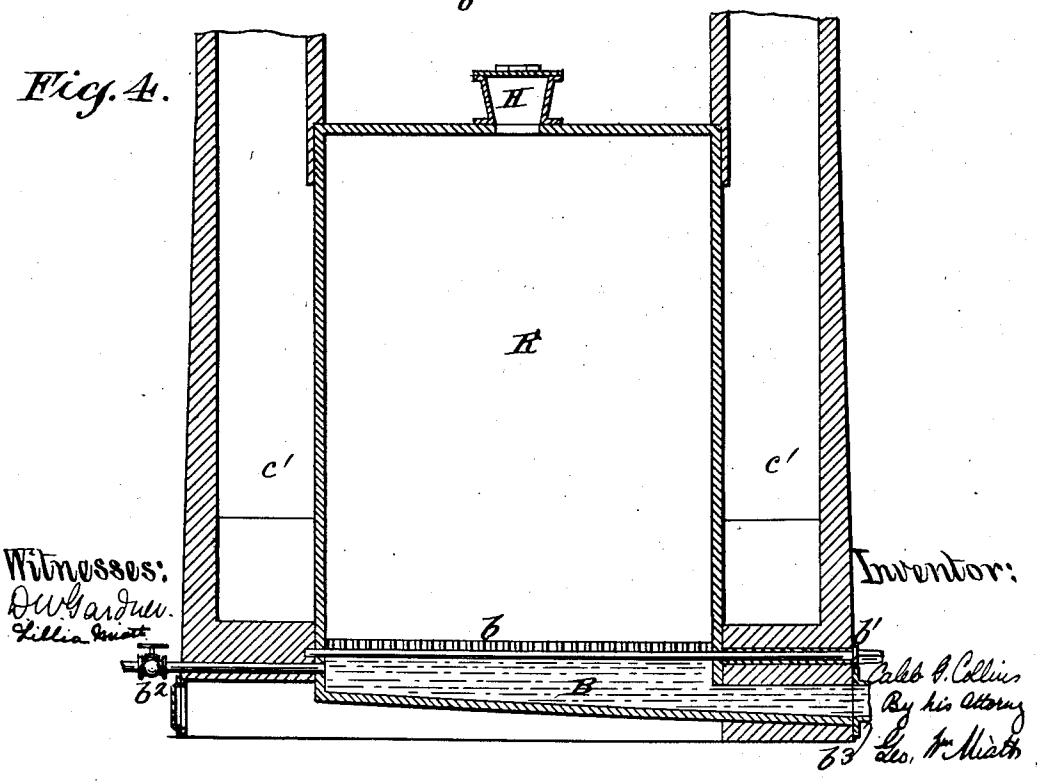


Fig. 4.



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UNITED STATES PATENT OFFICE.

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PROCESS OF EXTRACTING COPPER FROM ORES.

No. 919,130. Specification of Letters Patent. Patented April 20, 1909.

Application filed November 27, 1907, Serial No. 404,189. Renewed September 19, 1908. Serial No. 453,823.

To all whom it may concern:

Be it known that I, CALEB G. COLLINS, a citizen of the United States, residing at Woodmere, Nassau county, and State of New York, have invented certain new and useful Improvements in Processes for Extracting Copper from Ores, of which the following is a specification.

My invention relates to the extraction of copper from its several ores, especially the more refractory thereof, such as those containing copper and silica, and is designed to afford an economical process by means of which practically all the copper may be separated from the ores and collected in a metallic state.

I am aware that heretofore comminuted carbonaceous material has been used in a closed furnace to reduce the oxids of copper to a metallic state, but I have found from practical investigation and experimentation that carbon alone is insufficient to effect the reduction of all the copper in the various ores, so that only imperfect results have heretofore been attained in this respect.

My invention consists primarily in the use of carbonates of the alkalies and alkaline earths in conjunction with carbonaceous material in the reduction of copper ore; and secondarily in the use in conjunction with carbonaceous material and carbonates of the alkalies and alkaline earths, of hypochlorites of the alkalies and alkaline earths, substantially as hereinafter set forth.

Incidentally my invention includes certain other features herein described and claimed.

In the accompanying drawings, Figure 1, is a top view of a furnace adapted to the requirements of my improved process of reducing copper ore; Fig. 2, is a horizontal section thereof, taken upon plane of line 2—2— Fig. 3; Fig. 3, a vertical section taken upon plane of line 3—3— Fig. 1; Fig. 4, a vertical section taken upon plane of line 4—4— Fig. 1.

While I do not restrict myself to the identical form and construction of furnace shown, I have found the same affords good practical results.

R represents an elongated vertical retort chamber terminating in a water basin B below from which it is separated by a movable bottom b, which may be rocked from the exterior by means of a bar b', (see Fig. 4). The upper portion of the retort R is provided with a hopper H capable of being sealed. Combustion chambers C, C, are located on each side of the retort chamber R, the products of combustion passing therefrom into the vertical side flues c, c, which in turn open into the end or chimney flues c', c'. It will be seen that the side flues c, c, and the end flues c', c', constitute practically a single chamber surrounding the greater portion of the retort R, so that the latter may be subjected to a relatively high uniform temperature throughout. The basin B is supplied with water (preferably a slowly running stream) by a pipe b^2, or other suitable means; and its bottom is inclined downward toward an outlet b^3, communicating with any suitable receptacle. The ore with the other admixed constituents forming the charge to be treated is fed into the retort R by gravity or otherwise, care being taken that the hopper H is well filled to exclude air.

In practice I grind the ore to the degree of fineness desired according to the hardness of the ore say, so that it will pass through a No. 10 mesh screen. With the comminuted ore I put ground charcoal, coal or other carbonaceous material; also comminuted carbonates of the alkalies or alkaline earths, which combination is suitable for the ores known as cuprite, malachite, and azurite. If the ore to be treated contains sulfur or silicate, as bornite or chrysocolla either alone or mixed with other ores, I add to the charge hypochlorites of the alkalies or alkaline earths to break up the combination of sulfur and silica with the copper, as otherwise such copper would pass through the furnace without being reduced to the metallic state. After the retort is filled with the charge it is sealed to exclude air and prevent the re-oxidization of the copper after it has been reduced to the metallic state. The water seal afforded by the basin B protects the lower end of the retort, and by receiving and cooling the copper as it descends from the retort retains it in the metallic state, so that it may be collected by any well known process of concentration. From five to twenty per cent. by weight of carbonaceous material and about the same proportion of pulverized lime stone (calcium carbonate) may be mixed with the ground ore, according to the nature and requirements of the latter.

Where sulfid or silicate of copper is present in the ore chlorite of lime in the proportion approximately of from 12 to 13 per cent. of calcium hypochlorite to each 1 per cent. of sulfur in the ore may be added to the combination, all the ingredients being in any case thoroughly mixed together before the charge is introduced into the retort. After the retort is charged and sealed, fires are built in the combustion chambers C, C, the heat being continued, the ore in the retort is brought to a bright red state of incandescence. The bottom *b*, is then rocked and tilted to allow of the descent of the metallic copper into the water in the basin B, where it is cooled and from which it is collected for concentration as before stated. The metallic copper is thus removed from time to time as may be found expedient. When the metallic copper descends into the basin B, it causes the formation of steam which rises into the retort where it is united with the calcium and results in the generation of internal heat which materially aids in the reduction of the ore and effects a saving of fuel. In other words the reduced metal and the gangue both red hot as they drop from the furnace into the water under the furnace generate steam which coming in contact with the red hot carbon mixed with the ore is decomposed into hydrogen and an exactly equal volume of carbon monoxid gas both of which are when heated powerful reducers of metallic oxids and sulfids to the metallic state.

Considering the process technically, the first action under influence of heat of the mixture of copper sulfid, alkaline carbonates and carbon is to produce copper carbonate and calcium sulfid thus:

$$CuS+CaCO_3+C_2=CuCO_3+CaS+C_2$$

which by continued interaction of the materials present aided by the heat produces metallic copper and carbon monoxid gas,—the insoluble calcium monosulfid produced in the first part of the reaction remaining as before; thus:—

$$CuCO_3+CaS+C_2=Cu+CaS+3CO.$$

When the carbonate and silicate of copper unmixed with or uncombined with sulfur is in the case the reaction is in some respects more simple, metallic copper, calcium silicate and carbon monoxid gas being produced thus:

$$CuCO_3+CuSiO_3+CaCO_3+C_4=Cu_2+CaSiO_3+6CO.$$

In treating some copper sulfids and silicates by the above described method they are much more refractory to reduction, from some cause not yet determined, than other copper ores of apparently the same character. In cases like this I add to the mixture from five to fifteen per cent. the weight of the copper ore of calcium hypochlorite or bleaching powder $CaOCl_2$ in which case the reactions may be represented thus:

$$CuS+CaOCl_2+CaCO_3+C=Cu+SO_2+CaCl_2+CaO+CO,$$

and where an unusually refractory copper silicate is to be treated, thus

$$CuSiO_3+CaOCl_2+CaCO_3+C_3=Cu+CaSiO_3+CaCl_2+4CO.$$

Where there is much silica mixed or combined with the copper ore I find it advantageous to replace a part of the carbonate of calcium used in the reduction by an equivalent of carbonate of barium, which occurs rather abundantly in nature as the mineral witherite. In cases where witherite is not conveniently obtained I use in its stead the carbonates of potassium or sodium. The reactions of all these carbonates of the alkaline earths and alkalies being the same as previously hereinbefore written where the only alkali used was carbonate of calcium substituting of course the symbols of the carbonates of barium, potassium or sodium according to which is used. When the carbonates of barium, potassium or sodium are used with the carbonate of calcium the reduction of the copper ore to the metallic state, especially if the ore be silicious, is effected at a lower temperature than when the only alkali used is carbonate of lime, but as before indicated there are some ores in which carbonate of calcium alone is the only alkali necessary. Where powdered limestone is used on the charge as before stated it is reduced to quicklime during the roasting process so that the steam evolved during the operation of dumping a portion of the charge into the water in the basin B, slakes the lime and thereby contributes materially to the heat of the sealed retort. In this connection it is to be noted that I am the first to utilize the heat of the reduced ore to form steam which is decomposed within the retort producing hydrogen which, being in a nascent state, is most effective in producing the desired chemical reactions within the retort.

By my process I am enabled to extract practically all the copper from all the several copper ores, and to accomplish this desirable result in the most economical manner. By the use in combination with the carbon and carbonates of the alkalies and alkaline earths powerful bases having a stronger affinity than copper for sulfur and silica, I render ores containing either or both of the latter tractable and profitable,—a result not heretofore attained, so far as I am aware.

What I claim as my invention and desire to secure by Letters Patent is,

1. The herein described process of separating copper from its ore which consists in mixing the ore in a comminuted state with comminuted carbonaceous material, and with comminuted carbonates of the alkalies and the alkaline earths, and subjecting the mixture to heat in a closed retort.

2. The herein described process of separating copper from its ore which consists in mixing the ore in a comminuted state with comminuted carbonaceous material, and with comminuted carbonates of the alkalies and the alkaline earths, subjecting the mixture to heat in a closed retort, and discharging the resultant metallic copper into water, for the purpose described.

3. The herein described process of separating copper from its ore which consists in mixing the ore in a comminuted state with comminuted carbonaceous material, and with comminuted carbonates of the alkalies and the alkaline earths, together with hypochlorites of the alkalies and the alkaline earths, and subjecting the mixture to heat in a closed retort.

4. The herein described process of separating copper from its ore which consists in mixing the ore in a comminuted state with comminuted carbonaceous material, and with comminuted carbonates of the alkalies and the alkaline earths, together with hypochlorites of the alkalies and alkaline earths subjecting the mixture to heat in a closed retort, and discharging the resultant metallic copper into water, for the purpose described.

5. The herein described process of separating copper from its ore which consists in mixing the ore in a comminuted state with comminuted carbonaceous material, and with comminuted calcium carbonate, and subjecting the mixture to heat in a closed retort.

6. The herein described process of separating copper from its ore which consists in mixing the ore in a comminuted state with comminuted carbonaceous material, and with comminuted limestone, subjecting the mixture to heat in a closed retort, and discharging the resultant metallic copper into water, for the purpose described.

7. The herein described process of separating copper from its ore which consists in mixing the ore in a comminuted state with comminuted carbonaceous material, and with comminuted calcium carbonate and hypochlorite of calcium, subjecting the mixture to heat in a closed retort.

8. The herein described process of separating copper from its ore which consists in mixing the ore in a comminuted state with comminuted carbonaceous material, and with comminuted calcium carbonate and hypochlorite of calcium, subjecting the mixture to heat in a closed retort, and discharging the resultant metallic copper into water, for the purpose described.

9. The herein described process of separating copper from its ore consisting in mixing the ore in a comminuted state with comminuted carbonaceous material and comminuted limestone, subjecting the mixture to heat in a closed retort, and admitting steam to the retort to slake the quicklime resultant from the heating of the limestone, for the purpose described.

10. The herein described process of separating copper from its ore consisting in mixing the ore in a comminuted state with comminuted carbonaceous material and with comminuted carbonates of the alkalies or the alkaline earths, subjecting the mixture to heat in a closed vessel, discharging the resultant metallic copper into water, and utilizing the steam thereby generated to form hydrogen within the retort for the purpose described.

11. The herein described process of separating copper from its ore consisting in mixing the ore in a comminuted state with comminuted carbonaceous material and with comminuted carbonates of the alkalies or the alkaline earth together with hypochlorite of lime or hypochlorites of the other alkalies subjecting the mixture to heat in a closed vessel, discharging the resultant metallic copper into water, and utilizing the steam thereby generated to form hydrogen within the retort, for the purpose described.

12. The herein described process of separating copper from its ore consisting in mixing the ore in a comminuted state with comminuted carbonaceous material and with a base having an affinity stronger than that of the copper for sulfur and silica, and then subjecting the mixture to heat in a closed retort.

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