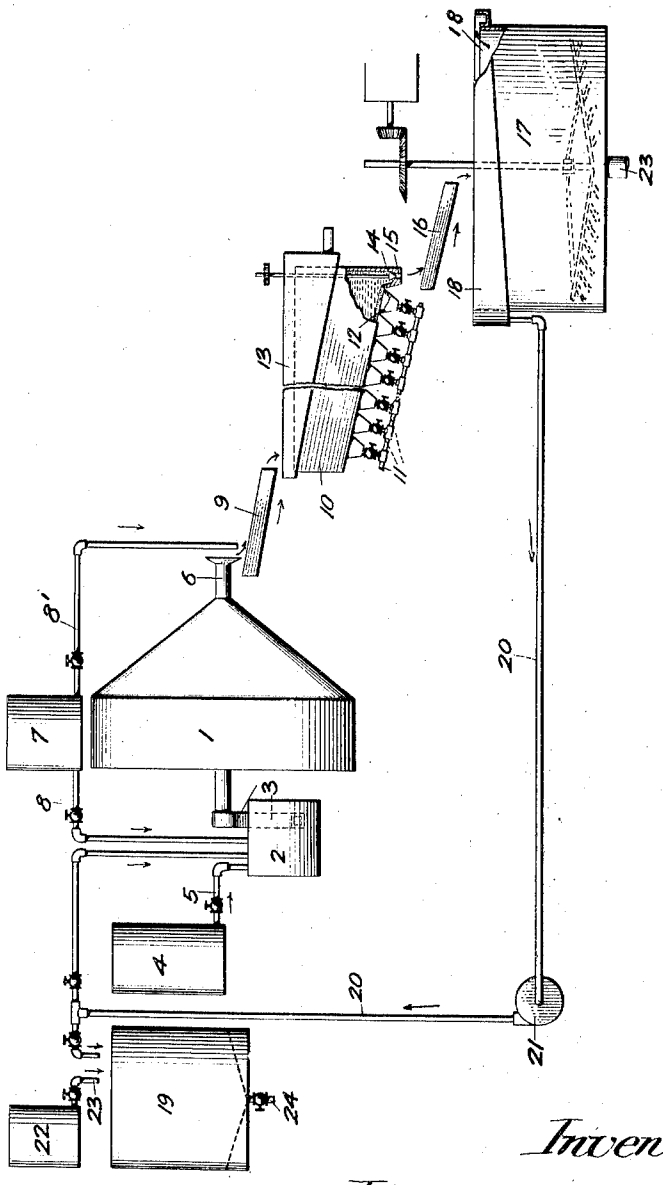
J. T. TERRY, JR.

PROCESS OF CONCENTRATING ORES.

APPLICATION FILED JAN. 16, 1919.

**1,334,420.** Patented Mar. 23, 1920.




*Inventor:*

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# UNITED STATES PATENT OFFICE.

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## PROCESS OF CONCENTRATING ORES.

1,334,420. Specification of Letters Patent. Patented Mar. 23, 1920.

Application filed January 16, 1919. Serial No. 271,429.

*To all whom it may concern:*

Be it known that I, JOSEPH T. TERRY, Jr., a citizen of the United States, residing at Salt Lake City, in the county of Salt Lake and State of Utah, have invented certain new and useful Improvements in Processes of Concentrating Ores, of which the following is a specification.

My invention relates to certain new and useful improvements in buoyant processes; that is processes of concentrating the metallic elements of finely crushed ore contained in pulp composed of such ore, water and a froth producing agent. Primarily, the present invention has reference to a process of concentrating the metallic elements of finely crushed ore by means of the combined action of certain chemicals and mechanical devices, the invention having for its essential object certain improvements of known flotation methods and the attainment of an unusually high percentage of the metal recovery and to render more effective the oils and froth-forming agents which are used in the process.

With the above and other objects in view my invention consists of the process and the steps thereof which I will hereinafter describe and claim.

It has been determined that the concentration of ores by flotation processes is best carried out in electrolyte as for example water solutions of alkali metals or earth metals, hydroxids, acids or acid salts. It has also been determined and known generally that copper salts of a mineral acid such as copper sulfate are extremely detrimental to the flotation of copper sulfid minerals. Mineral acid salts of copper such as copper sulfate have been used in small amount in flotation of zinc sulfids but are decomposed and the copper precipitated by fixed alkalis such as soda, potash and lime whereas copper-ammonium salts are not decomposed under the same conditions and may be used in alkaline ore pulps.

My invention is based on the discovery that the concentration of metalliferous constituents of ores is more effectively accomplished in water containing in solution a metal-ammonia salt such as copper-ammonium-hydroxid or other copper ammonium compound.

I have further discovered that ammonium-hydroxid and copper-ammonium salts decompose and dissolve certain organic substances such as oils derived from wood or coal, taking into solution froth-forming elements such as phenols and their homologues and precipitating certain hydrocarbon constituents such as naphthalene which is colloidal in character and serves to stiffen, and give body to a metal bearing froth. The ammonia soluble hydrocarbon compounds such as ammonium phenolate, etc., are effective froth-forming agents which in conjunction with the precipitated hydrocarbon compounds and oils are more effective than when used in an undecomposed state.

I have also discovered that copper-ammonium salts in solution break up and dissipate oil emulsions and prevent the absorption of oils and frothing agents by gangue colloids which would be floated with the concentrate and lower its grade or percentage of metal contents.

Other objects and advantages will become apparent upon consideration of the following portions of the specification and the appended claims.

In the accompanying drawing I have illustrated, more or less diagrammatically, one embodiment of apparatus by which the present process may be carried out, but it will be understood that I do not limit my invention to association with this apparatus, or in fact to any particular machines or group of machines, as the process is capable of being carried out by other and more or less different apparatus, although for present purposes I prefer that the apparatus shall be similar to the one disclosed.

In said drawing the figure represents a side elevation with parts broken away, of an apparatus which is applicable to all ores susceptible of concentration by flotation.

Referring to said figure, 1 denotes a common type of ball-mill in which the rough ore collected from a hopper, 2, by a scoop 3 is finely crushed in the presence of water containing in solution a copper-ammonium salt which may be introduced with the ore from a tank, 4, through a spout, 5, leading therefrom. The crushed ore and water hereinafter referred to as "pulp" issues from the mill at 6. If the ore contains copper minerals soluble in ammonia, reagents containing or capable of producing ammonia may

be introduced and the copper-ammonium salts or compounds formed *in situ*. Copper salts and reagents containing or capable of producing ammonia may be introduced separately or at the same time.

I have found it advantageous to grind with the ore in the mill an appreciable amount of burnt-lime or other alkali to render the pulp slightly alkaline thereby neutralizing mineral acids which would decompose the copper-ammonium salts.

A froth-forming and mineral-collecting agent, such as distillates from coal or wood or derivates therefrom may be introduced with the ore into the hopper, 2, or into the pulp issuing from the mill at 6, from a tank, 7, through the pipes 8 or 8′, and mixes with the pulp.

The pulp is then conveyed through launder, 9, to a suitable flotation apparatus, as for example, a "Callow" cell 10, wherein uprising air bubbles are created by air under pressure introduced through pipes, 11, and a porous medium, 12, as is well known in the art of flotation.

The uprising air bubbles and frothing agents cause the metal sulfid to be buoyed to the surface of the pulp forming a froth which discharges as an overflow at 13 while the gangue and water hereinafter referred to as "tailings" passes out at 14 through channel 15. The tailings may then be conveyed through launder, 16, to a thickening tank, 17, wherein the solids settle and the water containing copper-ammonium salts separated as an overflow at 18 and returned to the mill, or to the tank, 19, through pipes, 20, by pump, 21. The copper in the water separated from the tailings may be recovered by introducing a suitable precipitating reagent such as sodium sulphid into the tank, 19, from tank, 22, through spout, 23, and the precipitated copper sulphid drawn off at 24. When the tailings discharging from tank, 17, at 23 contain commercial quantities of soluble copper salts, the copper may be precipitated within the pulp by a suitable precipitating agent such as sodium sulfid and the precipitated copper recovered by flotation.

While I have herein referred to sodium sulfid as the agent for precipitating the copper in the tailings, I do not limit my invention thereto; as a matter of fact I prefer the use of hydrogen-sulfid as the agent for the purpose mentioned.

In treating some ores the addition of a soluble silicate such as sodium silicate to the pulp is beneficial as ammonia and ammonia salts causes precipitation of colloidal silica which carries down with it argillaceous constituents that tend to float with the metalliferous concentrate thereby lowering the percentage of metal contents.

A flotation test made on copper ore assaying 3.59% copper yielded a concentrate assaying 15.4% copper and a tailing assaying 0.40% copper. A flotation test made on the same ore with the addition of copper-ammonium sulfate yielded a concentrate assaying 15% copper and a tailing assaying 0.25% copper.

A flotation test made on a zinc ore assaying 3.41% zinc with addition of copper sulfate yielded a concentrate assaying 19.15% zinc and a tailing assaying 0.62% zinc. A flotation test made on the same ore with addition of copper-ammonium sulfate yielded a concentrate assaying 23.10% zinc and a tailing assaying 0.35% zinc.

From the foregoing, it will be apparent that in the new process hereinbefore described I agitate the ore in comminuted form in the presence of water containing in solution a metal-ammonia salt, or its equivalent, and that I then recover the concentrate by the step of flotation and also recover the dissolved metal in the water separated from the tailings by a suitable precipitating agent, thus producing a simple process of flotation having an unusually high percentage of metal recovery.

Having thus described my invention what I claim as new and desire to secure by Letters Patent is:

1. The herein described process of concentrating metals in ores consisting of treating the ore in comminuted form in water containing a metal-ammonia salt and then by flotation recovering the concentrate.

2. The herein described process of concentrating metals in ores consisting of treating the ore in comminuted form in water containing a metal-ammonia salt and a frothing agent and then by flotation recovering the concentrate.

3. The herein described process of concentrating metals consisting of treating the ore in comminuted form in water containing in solution copper-ammonium salts and then by flotation recovering the concentrate.

4. The herein described process of concentrating metals in ores consisting of treating the ore in comminuted form in water containing in solution copper-ammonium salts and a frothing agent and then by flotation recovering the concentrate.

5. The herein described process of concentrating metals in ores consisting of treating the ore in comminuted form in water containing an alkali, a metal-ammonia salt and then by flotation recovering the concentrate.

6. The herein described process of concentrating metals in ores consisting of treating the ore in comminuted form in water containing an alkali, a copper-ammonium salt and then by flotation recovering the concentrate.

7. The herein described process of concentrating metals in ores consisting of treating the ore in comminuted form in water containing an alkali, a copper-ammonium salt and a frothing agent and then by flotation recovering the concentrate.

8. The herein described process of concentrating metals in ores consisting of treating the ore in comminuted form in water containing a metal-ammonia salt and then recovering the concentrate by flotation, and recovering the dissolved metal by precipitation.

9. The herein described process of concentrating metals in ores consisting of treating the ore in comminuted form in water containing a metal-ammonia salt and a frothing agent and then recovering the concentrate by flotation and recovering the dissolved copper by precipitation.

10. The herein described process of concentrating metals in ores consisting of treating the ore in comminuted form in water containing in solution copper-ammonium salts and then recovering the concencentrate by flotation and recovering the dissolved copper by precipitation.

11. The herein described process of concentrating metals in ores consisting of treating the ore in comminuted form in water containing in solution copper-ammonium salts, and a frothing agent and then recovering the concentrate by flotation and recovering the dissolved copper by precipitation.

12. The herein described process of concentrating metals in ores consisting of treating the ore in comminuted form in water containing in solution copper-ammonium salts and alkali and a frothing agent and then recovering the concentrate by flotation and recovering the dissolved copper by precipitation.

13. The herein described process of concentrating metals in ores consisting of treating the ore in comminuted form in water containing in solution ammonia to dissolve the soluble metals and then by flotation recovering the concentrate.

14. The herein described process of concentrating metals in ores consisting of treating the ore in comminuted form in water containing in solution ammonia to dissolve the soluble metals, and a frothing agent and then by flotation recovering the concentrate and by precipitation recovering the dissolved metals.

In testimony whereof I affix my signature.

JOSEPH T. TERRY, JR.