ORE CONCENTRATING APPARATUS

Fig. 1.

Fig. 2.

Fig. 3.

Witness

Inventor:

[Signatures]
To all whom it may concern:

Be it known that I, BENJAMIN H. DOSENBACH, a citizen of the United States, residing at Butte, in the county of Silver Bow and State of Montana, have invented certain new and useful Improvements in an Ore-Concentrating Apparatus, of which the following is a specification.

My invention is an improved appliance for conducting the concentration of ores by flotation and is especially designed for use in that process in which the concentration is brought about by the use of modifying agents in the gaseous form.

It has heretofore been discovered that flotation concentration is not dependent upon mixing the so-called modifying agents with the solids and liquid constituting the ore pulp and that flotation concentration can be effected without adding any liquid or solid modifying agent to the ore pulp and mixing it therewith for the purpose of coating certain of the particles with the modifying agent to the exclusion of other particles.

Growing out of this discovery a method of flotation has been devised wherein the modifying agent is introduced into the ore pulp in the form of a gas, the gas being either the vapor of some substance that normally assumes the liquid form at the temperatures and pressures prevailing in such operations, or a permanent gas, that is, a substance that at the ordinarily prevailing temperatures and pressures assumes a gaseous form and does not liquefy.

While a great variety of substances have been used as modifying agents, it has become customary to term these various substances "oils," notwithstanding that a great many of the substances suitable for the purpose mentioned are not, either strictly or in popular language, oils. The substances used for this purpose prior to the discovery of the fact that vapors and permanent gases could be used without admixture with the solids and liquids constituting the ore pulp include a large variety of reagents, which it is needless to completely enumerate here by reason of the fact that they are well known. Among the substances so used were animal, vegetable and mineral fats and oils, coal tar and wood tar, various derivatives of coal and wood tar, various distillation fractions of the various oils and fats, various alcohols, hydroxy compounds, alpha-naphthylamine, nitro- and beta-naphthylamine, xyliden and alpha- or beta-naphthol, and other substances.

Some of the substances were used in the solid form, being finely subdivided and intimately disseminated throughout the ore pulp.

I have discovered that the substances above mentioned and heretofore used in admixture with the solids and water constituting the pulp can be used advantageously in the form of a gas by the use of apparatus which I have devised and I have also discovered that a wide variety of other substances can be used in such apparatus. The construction and operation of the apparatus will be readily apparent from the following description and claims taken in connection with the accompanying drawings, in which—

Figure 1 is a longitudinal sectional view in elevation, and Figs. 2 and 3 are detailed views.

Referring to Fig. 1, letter A designates generally a flotation cell having a porous or permeable bottom of the type generally known as a Callow cell, the cell A as generally constructed has vertical walls 1 and an inclined bottom 2. Above the bottom of the cell and spaced therefrom is a porous or permeable wall 3 inclined parallel to the bottom 2. The porous medium 3 may consist of any material having fine pores or interstices through which gas may percolate upwardly into the pulp contained in the cell. As commonly constructed, the porous medium 3 consists of one or more plies of canvas or other fabric reinforced by wire screen or some other rigid structure for the purpose of imparting support thereto. The space between the bottom 2 and the porous medium 3 is generally divided by transverse partitions 4 into a series of separate compartments 5, and communicating with each of the compartments 5 so formed is a gas inlet pipe 6. The various inlet pipes 6 may be provided with valves 7 and communicate with a manifold 8 through which, in the process as generally practised heretofore, air has been supplied to the compartments 5 under just sufficient pressure to maintain the hydrostatic head of pulp in the
vessel A and to cause the air to pass through the pores in the medium 3. The air emerges above the medium 3 in the form of minute bubbles which gently rise through the pulp, collecting the desired mineral and carrying it to the surface where a column 9 of mineral bearing bubbles is formed and overflows, the overflow constituting the concentrate.

The cell illustrated in the drawing is provided in common practice, with a depression or well 10 at the lower end of the inclined bottom and in the base of the well 10 a valve 11 is provided for permitting and regulating the outflow of tailings through the tailing discharge outlet 12. The valve 11 is connected by vertical valve rod 13 to a lever 14 intermediate the fulcrum 15 of the lever and the end 16 thereof, from which a float 17 is suspended. By this arrangement the valve 11 is lifted when the level of the pulp in the vessel rises beyond a predetermined point and remains open until the discharge of pulp permits the float 17 to fall and close the valve. At the end of the cell, opposite the discharge valve 11, a partition 18 is provided extending from the top of the cell downwardly a short distance from the end wall of the cell and is provided to avoid disturbance of the pulp by the inflowing stream of pulp which is designed to be discharged between the partition 18 and the end of the cell.

The structure of the Callow cell as above described is in common use and I claim no novelty therein.

In the operation of the Callow cell as generally practised some oil, using the term oil in the generic sense hereinbefore referred to, is added to the pulp and thoroughly mixed therewith before the pulp is introduced into the flotation cell, and air supplied to the flotation cell through the porous medium, as hereinbefore described, causes flotation of the concentrate.

My improved apparatus is designed for use with that process of flotation hereinbefore referred to, wherein the preliminary mixing of oil with the pulp is dispensed with and where the oil or modifying agent is introduced into the pulp as a gas or vapor in admixture with the air. For the purpose of carrying out such procedure I provide a vessel B wherein the air forced by the blower C is mixed with the proper proportion of vaporized or gaseous modifying agent before being delivered to the Callow cell A. The air discharge pipe 19 from the blower communicates with the upper part of the vessel B and is provided with a control valve 20 which may be an ordinary globe valve. A discharge pipe 21 also communicates with the upper part of the vessel B and is in communication with the manifold 8. A secondary air discharge pipe 22 leads from the blower C to the lower part of the vessel B and this secondary air pipe is provided with a control valve 23.

The modifying agent or oil C, or the substance from which the gaseous or vaporized oil or modifying agent is to be derived, is placed in the vessel B to such a level that the secondary air pipe 22 extends beneath the surface thereof.

When the modifying agent or oil is a liquid, such as for instance pine oil, oleic acid, eucalyptus oil, or any of the other liquid modifying agents commonly used, the air entering the vessel B through the secondary air inlet pipe 22 bubbles upward through the liquid modifying agent and, together with the air entering through the air pipe 19 and passing over the surface of the liquid modifying agent, is discharged through the pipe 21 to the Callow cell. The bubbling through the liquid modifying agent of the air entering through the pipe 22 and the passage above the surface of the modifying agent of the air entering through the pipe 19 leads to the vaporization of a certain amount of the liquid modifying agent, and the vapor so formed in admixture with the air passes to the Callow cell. It has been found that the various oils or modifying agents used in flotation perform their useful function in the films surrounding the bubbles and that the admixture of the modifying agent with the solids and liquids constituting the pulp, as has been the general practice, is unnecessary. Due either to condensation or adsorption, or both, according to the nature of the gaseous or vaporous agent used, the bubble films formed in the use of the apparatus described, acquire the properties necessary for the collection of the desired mineral and the formation of a bubble column above the pulp. In the case of some modifying agents the application of heat to the vessel B is advantageous in assisting in the vaporization thereof, or the formation of gases from the constituents thereof, and for this reason I provide in connection with the vessel B a source of heat. In Fig. 1 the source of heat is shown as a series of gas burners 24, the flame from which impinges against the underside of the vessel.

While in the apparatus shown in Fig. 1 I have included a secondary air pipe 22 designed to dip beneath the surface of the liquid modifying agent in the vessel B, I have found that the use of such secondary air supply pipe is not necessary when using certain oils. If the valve 23 in the pipe 22 be closed none of the incoming air is conducted beneath the surface of the modifying agent, but the entire air supply merely passes over the surface of the modifying agent from the end of the inlet pipe 19 to the end of the outlet pipe 21, and with many oils the mere passage of the air over the surface of the
modifying agent leads to the vaporization of sufficient thereof to accomplish the desired flotation. In Fig. 3 I have diagrammatically illustrated an apparatus in which the secondary air inlet pipe 22 is omitted, the apparatus including merely a vessel B' provided with air inlet and outlet pipes 19' and 21' which terminate near the upper part of the vessel and above the surface of the modifying agent C'. The arrangement illustrated in Fig. 3 is simply that which would result from closing the valve 23 of the apparatus shown in Fig. 2 and leaving the valve 20 open. In some instances it is found desirable to cause all of the air supplied to the Collow cell to be discharged beneath the level of the liquid modifying agent and to bubble therethrough. In the apparatus shown in Fig. 1 this result is accomplished by closing the valve 20 and leaving the valve 23 open, which adjustment of the valves leads, in effect, to such an arrangement as shown in Fig. 2, where a single air inlet pipe 19'' is shown, together with an outlet pipe 21''.

The proportion of the air which is discharged beneath the level of the modifying agent and the necessity of discharging any of the air beneath the level of the liquid modifying agent will depend upon a variety of factors, such as the volatility of the liquid modifying agent, the temperature, the size of the vessel B, the rate at which the air is forced therethrough, etc.

My improved apparatus is adapted not only for the vaporization of liquid modifying agents, but also for use in those instances where the vapors or permanent gases used in admixture with air are formed by distillation from solid substances. Several of the modifying agents, or so-called oils, referred to above, are solid at ordinary temperatures and a variety of other solid substances yield vapors or permanent gases when heated, that in admixture with air bring about efficient flotation. For instance, I have conducted the flotation process with gases distilled from coal, asphaltic substances, gilsonite, etc. When solid substances are used as the source of modifying vapor or permanent gas, the vapors or gases formed may be simply the vapor of the solid substance distilled, or the operation of distillation may be accompanied by chemical change resulting in the formation of vapors or permanent gases of different chemical composition from the substance from which they are distilled. The same is true, of course, of the distillation of liquid or some liquid substances.

By the use of my improved apparatus the various substances hereinbefore mentioned, such as coal and wood tar, any of the oils and fats, coal, asphalt, gilsonite, etc., may be used as the source of vaporous or gaseous modifying agent, it being simply necessary to place the substances referred to in the vessel B and to apply such degree of heat thereto by means of the gas burners 24, or other source of heat as may be necessary to distill the requisite amount and proper fraction or substance from the material used. The air current passing through the vessel B under such circumstances, the vessel being arranged for operation as indicated in Fig. 3, will commingle with the gases formed by distillation and the mixture so formed will be conducted to the Collow cell, as hereinbefore described.

While I have quite specifically described the apparatus shown in the drawings, it will be obvious that the principle of my invention is not restricted to apparatus of the specific form illustrated and described and that wide variations may be made therein without departing from the principle of my invention.

What I claim is:

1. In a device of the class described, a vaporizing vessel, means for forcing air into contact with a modifying agent therein to form a mixture of air and vaporized modifying agent, means for controlling the proportion of air and modifying agent in said mixture and the pressure of the mixture and means for introducing said mixture under said regulated pressure into ore pulp contained in a flotation cell.

2. In a device of the class described a vaporizing vessel, means for forcing air beneath the level of a modifying agent contained in said vessel, means for forcing air through said vessel above the surface of said agent, forming a mixture of air and vaporized modifying agent in said vessel, means for regulating said air supply so as to secure the desired proportion of air and modifying agent in the mixture and the desired pressure for the mixture and means for introducing the mixture under said regulated pressure into ore pulp in a flotation cell.

In testimony whereof I have subscribed my name.

BENJAMIN H. DOSENBACH.