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METHOD AND APPARATUS FOR CONCENTRATING ORES BY FLOTATION.

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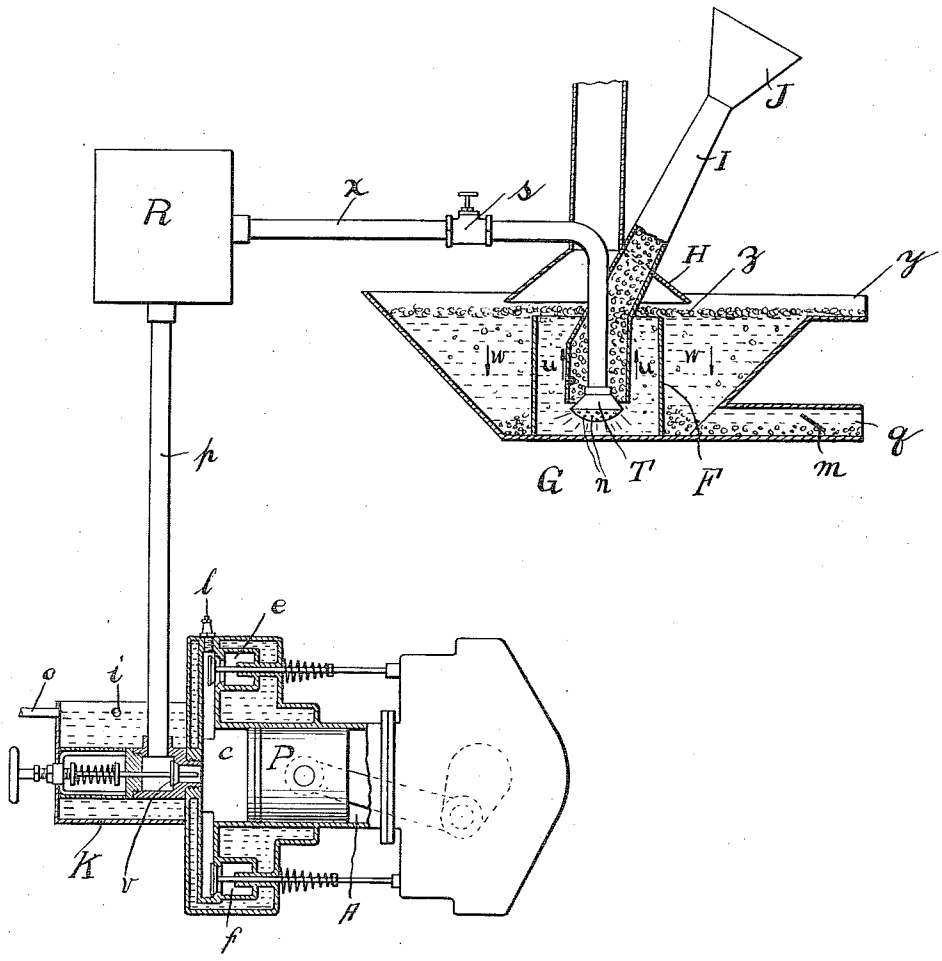

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METHOD AND APPARATUS FOR CONCENTRATING ORES BY FLOTATION.

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Application filed June 28, 1916. Serial No. 106,541.

To all whom it may concern:

Be it known that I, CARL C. THOMAS, a citizen of the United States, residing at Baltimore, State of Maryland, have invented certain new and useful Improvements in Methods and Apparatus for Concentrating Ores by Flotation; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

In the selective flotation of metallic sulfids from ore pulp of which they form a part, it has been heretofore proposed to supply to the flotation receptacle a body of air admitted continuously beneath a porous or pervious bottom, whereby a multiplicity of air bubbles passing through the pervious bottom and rising through the ore pulp in the flotation receptacle will carry to the surface the flotable sulfids, forming therewith a coherent froth which may then be removed, automatically and continuously, or intermittently, as desired.

In operations of this general character, it is customary, before subjecting the finely ground ore to flotation, to first bring it into intimate admixture with a suitable quantity of a flotation agent, as, for instance, a suitable oil, supplemented, in most cases, by an appropriate quantity of an acid. It is found that the particles of zinc blende, copper sulfid, or the like, after they have been subjected to this preliminary treatment, may be selectively floated by the air bubbling operation referred to, and that the accompanying gangue will, for the most part, sink to the bottom of the flotation receptacle, as tailings.

The present invention is based upon the discovery that the preliminary treatment of the finely divided ore with oil or with oil and an acid may be, in some instances, entirely dispensed with, and, in other instances, materially diminished, thereby effecting a saving of all or a large proportion of the oil and acid heretofore employed, by utilizing in the flotation receptacle, in lieu of air, the products of combustion, incident to the operation of an internal combustion engine of the oil or gas type while still in a highly heated condition. For this purpose, the highly heated exhaust gases of such an engine may be employed, that is to say, the exhaust from the gas engine cylinder at the end of the working stroke of the piston; but I prefer to employ a portion of the high pressure and high temperature gases taken off during the early part of the working stroke of the piston. These gases are at a high temperature and consist principally of carbon dioxid and nitrogen, together with some steam.

I have ascertained that the hot, high pressure gases, containing carbon dioxid are particularly favorable to the flotation of the sulfids in the ore pulp and that they form a froth of substantial consistency amply sufficient to support the sulfid particles until they are floated or skimmed off as concentrates from the surface of the liquid in the flotation receptacle. The practice of the invention also permits the operator to dispense with the air compressor required in flotation by the air bubbling procedure, and avoids the use of any other means of agitation as, for example, the propellers or paddles employed in the so-called agitation froth process wherein air is drawn into the pulp from the outer atmosphere through the intermediacy of a vortex produced in the body of ore pulp by the rotation at a high speed of a mechanical agitator. The gas or oil engine is at the same time available for use for any of the motive purposes of utility in and about the mining plant, and the avoidance of the necessity for using oil, acids, or other emulsifier agents to anything like the same extent, if at all, in the preliminary treatment of the ore contributes further to the utility and economy of the invention.

In the accompanying drawing, I have illustrated more or less diagrammatically, a form of apparatus adapted to the practice of the invention, said apparatus being shown in sectional elevation.

In the drawing, A indicates the cylinder of an internal combustion engine, fitted with a piston P for compressing the charge of gas or vapor and air or oxygen. The combustion space *c* is fitted with the usual igniting device indicated at *l*, and with the usual inlet and outlet valves *e*, *f*. The combustion and explosion of the charge may be effected by any of the well known means familiar to present gas engine practice, and as such means are well understood in the art, they need not be further described.

A spring-loaded relief valve *v* is inclosed in a casing K, which casing is provided with means to water-cool the valve body and, at the same time, to prevent the temper of the

spring from being drawn by the heat of the gases. The casing K may have an open top and may be supplied with cooling water through the inlet pipe *o*, a suitable overflow being provided, as, for instance, at the aperture *i*.

The spring load of the valve is so adjusted that the valve may yield at the desired period in the stroke of the piston and deliver a corresponding quantity of the high temperature and high pressure gases into the valve body and thence through the pipe connection *p* into the steadying or equalizing chamber R, which serves as a pressure reservoir to supply a constant body of the hot gases through the pipe *x*, provided with a control valve *s* to the atomizing or spraying nozzle T which extends well down toward the bottom of the flotation receptacle G.

The atomizing or spraying nozzle T is provided with a series of small holes *n* so arranged as to agitate all of the pulp. These holes may, to advantage, be directed downwardly, but whatever their inclination, or whether they be horizontal, they should be near enough to the bottom of the tank to effectively perform their agitating function. Encircling the atomizing or spraying nozzle is a cylindrical receptacle F, into which the pulverized ore is fed by means of a supply pipe I having a funnel J at its upper end. The lower end of the pipe extends nearly to the bottom of the receptacle and preferably should be arranged to surround the nozzle T in order to conduct the ore pulp to the immediate vicinity of the gas issuing from the nozzle. To protect those operating the apparatus from gases a hood H is placed above the receptacle F. In some instances, an emulsifying agent such as oil, or oil and acid, or creosote, or the like, may be associated with the water to assist in the formation of the froth.

The bubbles formed by the passage of the gases through the water and other contents of the receptacle F rise in said receptacle as indicated by the arrows *u*, and form a froth *z*, which supports the burden of the ore richest in metallic particles, according to the well-known phenomena of flotation, as practised in connection with mining operations. The particles of ore which do not contain appreciable amounts of floatable mineral descend as indicated by the arrows *w* and form the tailings *q*. The froth *z* is skimmed off into any suitable trough or launder *y* and may be subsequently treated as required to recover the metal particles suspended in it. The tailings may be removed through the valve outlet *m*, either continuously or from time to time as occasion may require.

It will be understood that the explosive engine is to be operated under such conditions as to supply to the atomizing or spraying device T high temperature gases of sufficient pressure to not only overcome the liquid head in the receptacle F, but to thoroughly agitate the ore pulp therein, maintaining its particles in constant suspension, so that not only a coherent and consistent froth will be delivered at the top of the receptacle F into the body of flotation liquid outside, but also so that the tailings will likewise be lifted and will pass upwardly and outwardly into the receptacle G, thereby keeping the bottom of the inner receptacle F continually clear of tailings which would otherwise settle therein.

Having thus described my invention what I claim is:

1. The method of concentrating ores by flotation, which comprises subjecting ore pulp to agitation by highly heated products of combustion supplied thereto, under pressure, producing a froth thereby in which the mineral particles to be separated are sustained, and removing the froth thus formed together with said mineral particles; substantially as described.

2. The method of concentrating ores by flotation, which comprises subjecting ore pulp to agitation by products of combustion supplied thereto in a highly heated condition, under pressure, from the exploded charge of an internal combustion engine, producing a froth thereby in which the mineral particles to be separated are sustained, and removing the froth thus formed together with said mineral particles; substantially as described.

3. The method of concentrating ores by flotation, which comprises subjecting ore pulp to agitation by products of combustion supplied thereto in a highly heated condition from the high pressure gases present in the cylinder of an internal combustion engine during the early part of the stroke of the piston, producing a froth thereby in which the mineral particles to be separated are sustained, and removing the froth thus formed together with said mineral particles; substantially as described.

4. Flotation apparatus, comprising an explosive engine, a flotation cell or tank, and means for conveying the high temperature and high pressure products of combustion from said engine and discharging the same into the flotation cell to form a froth therein; substantially as described.

5. Flotation apparatus, comprising an explosive engine, a flotation cell or tank, and means for discharging from the engine, early in the working stroke thereof, high temperature and high pressure products of combustion, and for conveying such products of combustion to the flotation cell and discharging the same therein to form a froth; substantially as described.

6. Flotation apparatus, comprising an explosive engine, a flotation cell or tank, a

pressure equalizing chamber, and means for conveying the high temperature and high pressure products of combustion from the engine through the equalizing chamber and discharging the same into the flotation cell to form a froth therein; substantially as described.

7. Flotation apparatus, comprising an explosive engine, a flotation cell or tank, a pressure equalizing chamber, and means for discharging high temperature and high pressure products of combustion from the engine early in the working stroke thereof, and for conveying such products of combustion through the equalizing chamber and discharging the same into the flotation cell to form a froth therein; substantially as described.

8. Flotation apparatus, comprising an explosive engine, a conduit leading from said engine to convey the high temperature products of combustion therefrom, an atomizing or spraying device forming a continuation of said conduit, an ore pulp receptacle at whose bottom the atomizing or spraying device discharges, and an outer water receptacle for receiving the overflow of the ore pulp receptacle and for floating the froth produced therein; substantially as described.

9. Flotation apparatus, comprising an explosive engine, a conduit leading from said engine to convey products of combustion therefrom, an atomizing or spraying device forming a continuation of said conduit, an ore pulp receptacle at whose bottom the atomizing or spraying device discharges, an outer water receptacle for receiving the overflow of the ore pulp receptacle and for floating the froth produced therein, said outer receptacle serving likewise to receive the unfloated tailings; substantially as described.

10. Flotation apparatus, comprising an explosive engine, a conduit leading from said engine to convey products of combustion therefrom, a pressure equalizing chamber in said conduit, an atomizing or spraying device forming a continuation of said conduit, an ore pulp receptacle at whose bottom the atomizing or spraying device discharges, and an outer water receptacle for receiving the overflow of the ore pulp receptacle and for floating the froth produced therein; substantially as described.

11. Flotation apparatus, comprising an explosive engine, a conduit leading from said engine to convey products of combustion therefrom, an atomizing or spraying device forming a continuation of said conduit, an ore pulp receptacle at whose bottom the atomizing or spraying device discharges, a pipe for supplying ore pulp to said receptacle extending to the vicinity of the atomizing or spraying device, and an outer water receptacle for receiving the overflow of the ore pulp receptacle and for floating the froth produced therein; substantially as described.

12. Flotation apparatus, comprising an explosive engine, a conduit leading from said engine to convey products of combustion therefrom, an atomizing or spraying device forming a continuation of said conduit, an ore pulp receptacle at whose bottom the atomizing or spraying device discharges, a pipe for supplying ore pulp to said receptacle extending to the vicinity of the atomizing or spraying device, an outer water receptacle for receiving the overflow of the ore pulp receptacle and for floating the froth produced therein, and means above said ore pulp receptacle through which gases may be conducted away from above the froth; substantially as described.

In testimony whereof, I affix my signature.

CARL C. THOMAS.