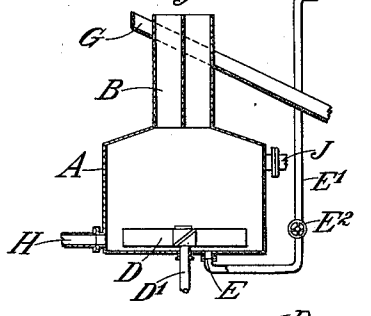
A. H. HIGGINS.

APPARATUS FOR ORE CONCENTRATION.

APPLICATION FILED APR. 15, 1914.

1,155,816. Patented Oct. 5, 1915.

Fig 4.



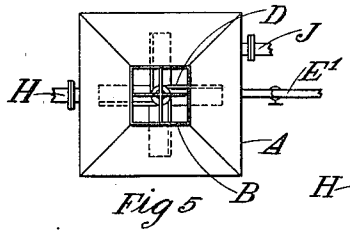


Fig 5

Fig 1

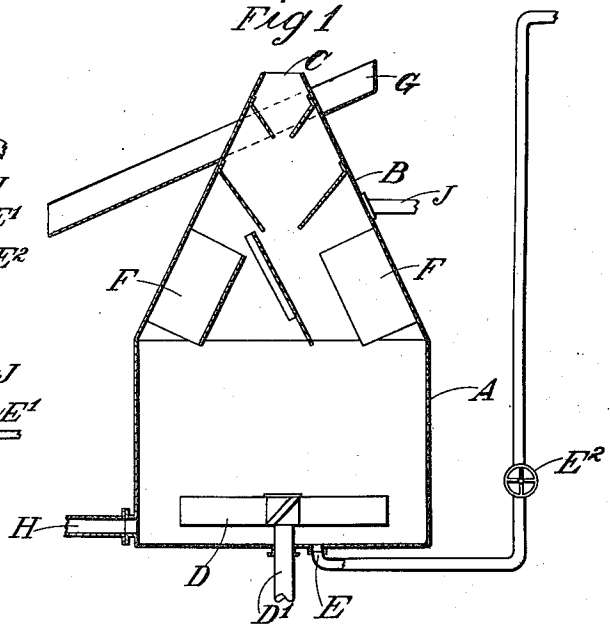
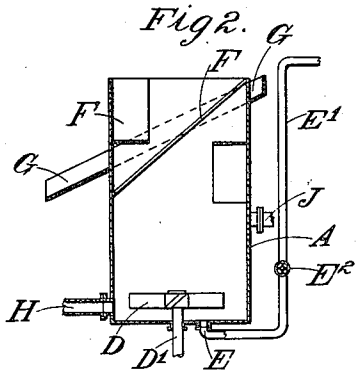


Fig 2.



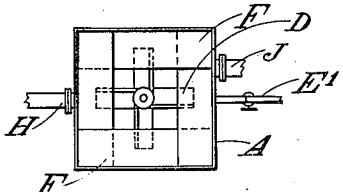


Fig 3.

Fig 7.

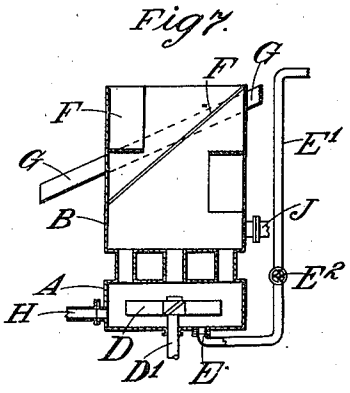
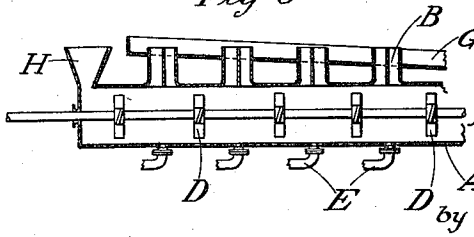


Fig 6



Witnesses:

Henry C. Dewey

M. M. Alcorn

Inventor:

Arthur Howard Higgins

By

Henry L. Williams

Attorney.

by

UNITED STATES PATENT OFFICE.

ARTHUR HOWARD HIGGINS, OF LONDON, ENGLAND, ASSIGNOR TO MINERALS SEPARATION AMERICAN SYNDICATE (1913) LIMITED, OF LONDON, ENGLAND.

APPARATUS FOR ORE CONCENTRATION.

1,155,816. Specification of Letters Patent. Patented Oct. 5, 1915.

Application filed April 15, 1914. Serial No. 831,940.

To all whom it may concern:

Be it known that I, ARTHUR HOWARD HIGGINS, a subject of the King of England, residing at London, England, have invented certain new and useful Improvements in Apparatus for Ore Concentration, of which the following is a specification.

This invention is for improvements in or relating to apparatus for ore concentration. The apparatus is suitable for carrying out a process of gaseous selection and gaseous flotation such as the agitation froth process as described, for example in United States Patents No. 835,120, of November 6, 1906, No. 962,678, of June 28, 1910 and No. 1,064,723, of June 17, 1913, and also for carrying out a process of selective or differential flotation for the purpose of separating different sulfids from one another as described for example in United States Patent 1,067,485 of July 15, 1913.

In the well-known agitation froth process as originally carried into practice and in the example thereof described with reference to the drawings in United States Patent No. 835120, the finely powered ore freely suspended in water so as to form a pulp was violently agitated in such a way that the supernatant air was beaten into the pulp for the formation of a froth. In the use of that form of apparatus the surface of the pulp in the agitation vessel is in a state of violent turbulence and in order to effect the formation and separation of the mineral bearing froth the agitated and aerated pulp was led into a spitzkasten in which the liquid was in a state of comparative rest, whereupon the gaseous bubbles and mineral particles adhering thereto rose to the surface and formed a persistent and co-herent froth. Many modifications of the apparatus have been devised, but prior to the date of my present invention aeration has customarily been effected mainly by the beating in of the supernatant air and the pulp in the upper part of the agitation vessel has been in a state of turbulence. In that method of beating in air, the amount of air introduced into the pulp is directly dependent upon the form of the agitator and its speed of rotation.

My invention consists of an ore concentration apparatus in which the air or other gas is introduced into the lower part of the apparatus and in which the agitation of the pulp and minute division of the air (or air emulsification) takes place in such lower part of the apparatus by means of an inclosed agitator and in which the agitated pulp and air emulsion are allowed to pass to the upper part of the apparatus where means are provided for maintaining the pulp in a state of comparative quiescence where the froth is permitted to rise to the surface of the pulp and the emulsified air is also allowed to leave the pulp thus subjecting the quiet zone of the pulp to a continuous stream of minute air bubbles.

My invention includes an apparatus in which the agitation and aeration of the pulp and the formation and flotation of the froth can take place in one vessel so that the mineral bearing froth can be produced continuously and removed from the surface of the pulp as soon as it is formed.

One form of apparatus according to this invention comprises a vessel provided at its lower part with an agitator suitable for subjecting the pulp to violent agitation and provided also at its lower part with means for introducing air into the vessel. Means are also provided for introducing ore pulp into the vessel and for removing the contents which have been more or less depleted of the desired mineral. The upper part of the vessel is provided with means such as baffles for bringing the upper part of the liquid to a state of comparative rest so that gaseous bubbles may rise through the still portion of the liquid and form a froth at its surface. At the top of the vessel is provided one or more froth outlets and each or all of such outlets is arranged to discharge into a concentrates launder.

The invention will be best understood from the practical embodiments thereof illustrated in the accompanying drawings in which—

Figure 1 illustrates in sectional elevation one form of ore concentration apparatus according to this invention; Fig. 2 is a vertical section and Fig. 3 a plan of a modified arrangement; Fig. 4 is a sectional elevation and Fig. 5 a plan of another modification; Fig. 6 is a vertical section of another form of apparatus embodying this invention, and Fig. 7 is a vertical section of another form of apparatus embodying this invention.

Referring to Fig. 1, A is a vertical prism,

say of square cross-section and B a tapering upper portion having an open outlet C at the top.

D is a propeller or agitator near the bottom of the vessel mounted on a vertical rotatable spindle D′.

E is an orifice for the introduction of air through a pipe E′ which may, if desired, be provided with a valve E². In the tapering upper portion of the vessel B are arranged baffles F to keep the pulp there in a state of comparative quiescence. Around the outlet C and leading away therefrom is a concentrates launder G. An inlet for pulp H may be arranged at any suitable position in the vessel and also an outlet for tailings J.

The operation of the apparatus is as follows:—Ore pulp is introduced into the vessel A through the pulp inlet H together with any agents necessary to assist in the formation of a mineral bearing froth. The agitator D is rapidly rotated to subject the pulp to violent agitation in the lower part of the vessel A and air is introduced through the inlet E under pressure or otherwise. In the upper part of the vessel B the pulp is brought to a state of comparative quiescence by the baffles F and at that part of the vessel the pulp is subjected to an upward current of minute air bubbles whereby the froth is formed at the surface of the pulp and passes through the outlet C into the concentrates launder G. The pulp may be introduced continuously through the inlet H and having been depleted more or less of the desired mineral the tailings may be removed continuously through the outlet J.

Referring to Fig. 2 A is a vertical prism, say of square cross-section, open at the top. D is a propeller or agitator near the bottom of the vessel mounted on a vertical rotatable spindle D′. E is an orifice for the introduction of air through a pipe E′ which may, if desired, be provided with a valve E². In the upper part of the vessel A are arranged baffles F which in this case are inclined baffles projecting from the sides of the vessel, the objects of the baffles being to keep the pulp in the upper part of the vessel in a state of comparative quiescence. Around the top of the vessel and leading away therefrom is a concentrates launder G. An inlet for pulp H may be arranged at any suitable position in the vessel and also an outlet for tailings J.

Referring to Figs. 4 and 5 the arrangement is practically the same as before, but in this case the upper portion of the vessel consists of a vertical chimney B′ considerably narrower than the vessel A and provided with flat sides with or without the addition of baffles so that the pulp in the chimney B is maintained in a state of comparative rest.

In the case of apparatus of the type illustrated in Fig. 1, or in Figs. 2 and 3, or in Figs. 4 and 5 a plurality of such vessels may be employed in series, that is to say with the outlet J in the first vessel leading into the inlet H of the next vessel and so on.

Referring to Fig. 6 the apparatus illustrated in this case is one in which a single vessel A is provided with a number of agitators D, a number of air inlets E and a number of froth outlets consisting of flat sided vertical chimneys B′ in the upper part, otherwise the construction and operation are the same as above described.

Referring to Fig. 7 the arrangement is the same as in Figs. 1, 2 and 3 except that the agitator D is inclosed in the lower agitation and aeration section A′ of the apparatus from which the pulp passes freely into the upper zone B² of the apparatus through a plurality of passages L shown as vertically arranged and joining the lower section A′ and the upper section B′. These vertical passages act to some extent as baffles and their action is supplemented by inclined baffles F such as heretofore described to produce substantial quiescence at the upper part of the pulp. In every case the introduction of air or other gas may, if desired, be effected under pressure or may be effected by the action of the agitator itself.

In all cases it is characteristic of this apparatus that it has a continuous feed and overflow, a continuous admission of air at the bottom and continuous agitation of the pulp in its lower part, means for maintaining the upper part of the pulp in a state of comparative quiescence whereby a mineral bearing froth will be formed in the vessel at the surface of the pulp and a concentrates launder for continuously removing the froth as it is formed.

The advantages of this apparatus are *inter alia* as follows:—It is possible within wide limits to regulate the amount of gas employed for gaseous selection and flotation. It is also possible to regulate the degree of division of the air by the form and speed of the agitator. These are of great importance because I find that with different ores or with a different character of suspended particles the total amount of air or the degree of division of the air may have a considerable effect on the separation. Further the amount of frothing agent to be used may, when using this apparatus be considerably reduced from that necessary in employing the usual apparatus for the agitation froth process.

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

1. In an apparatus for concentrating ores by gaseous flotation, the combination of an agitation and separation vessel having a lower agitation zone and an upper separa-

tion zone, means for agitating and gasifying pulp in the agitation zone, and inclined and vertically elongated baffle plates in the separation zone whereby comparative quiescence is maintained at the upper surface of the pulp for the removal therefrom of mineral froth.

2. In an apparatus for concentrating ores by gaseous flotation, the combination of an agitation and separation vessel having a lower agitation zone and an upper separation zone, means for agitating and gasifying the pulp in the agitation zone, and a plurality of passages joining the agitation and separation zones and vertically elongated baffle plates in the separation zone whereby comparative quiescence is maintained at the upper surface of the pulp for the removal therefrom of mineral froth.

3. In an apparatus for concentrating ores by gaseous flotation, the combination of an agitation and separation vessel having a lower agitation zone and an upper separation zone, a rotatable agitator in the agitation zone and means for gasifying the pulp in said zone, and inclined and vertically elongated baffle plates in the separation zone whereby comparative quiescence is maintained at the upper surface of the pulp for the removal therefrom of mineral froth.

4. In an apparatus for concentrating ores by gaseous flotation, the combination of an agitation and separation vessel having a lower agitation zone and an upper separation zone, a rotatable agitator in the agitation zone and means for gasifying the pulp in said zone, and a plurality of passages joining the agitation and separation zones and vertically elongated baffle plates in the separation zone whereby comparative quiescence is maintained at the upper surface of the pulp for the removal therefrom of mineral froth.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

ARTHUR HOWARD HIGGINS.

Witnesses:

STANLEY R. MOORE,

W. E. ROGERS.