This invention relates to improvements in the concentration of finely divided ores, by flotation, and has to do with an improved method.

Ore prepared for flotation treatment contains

what I will term "natural colloidal matter", which
is common to all ore when mined, and my
approved method is carried out either in the ab-
sence of such natural colloidal matter, or after the
same has been removed, so that when water
is added, the resulting altered pulp will contain
crystalline sulphide and oxide ore particles and
gangue.

In the method, a primary feature of this inven-
tion is a form of depressant which, in an al-
tered pulp, functions to depress all of the mineral
particles and also renders them susceptible of be-
ing selectively floated and frothed off, as a result
of the reaction of certain conditioning agents,
whereby in a continuous process of recovery from
one pulp, I can recover each of the several sul-
phides in commercial quantity and in a rapid and
efficient manner.

In one phase of the invention, the depressant
is in the form of an "artificial colloidal substance"
which is definable and definite, and which I can
selectively use, and which therefore eliminates
the indefinable, indefinite and quantity-uncer-
tain conditions inherent in the natural colloidal
matter that is removed from the ore.

By reason of this artificial depressant, I am
able, with certain conditioning agents, selectively
to float and froth the several sulphides, and after
these sulphides have been recovered, I am able
to float and froth oxide ore particles by reason
of a novel conditioning compound; the entire
process of recovery being completed in the altered
pulp which I form after the natural colloidal
matter has been removed.

My invention therefore involves the following
process:

The natural colloidal matter is first removed
from the normal pulp, if present, and this may be
accomplished by adding a de-flocculating agent to separate the natural colloidal mat-
ner from the crystalline matter by deflocculation and
then removing such colloidal matter by any well
known means such as filtration, decantation,
elutiation or centrifugal force, in a manner
clearly disclosed in my prior patent issued December 3, 1928, No. 1,737,716.

Water is then added to the crystalline matter
to form a de-flocculated pulp and my artificial
colloidal depressant is introduced into the de-
flocculated pulp, in the presence of agitation, and
functions to sink the sulphide ore particles in the
pulp. A frothing agent is next introduced and if
no minerals arise, the efficiency of the depressant
is proven.

A conditioning agent is then added which
functions with the artificial depressant in a man-
ner to float and froth the galena concentrate,
and the same is then removed. However, this
recovery of the galena concentrate does not in-
terfere with the action of the depressant in in-
hibiting the sphalerite from floating.

I next introduce a different kind of condition-
ing agent which functions to float and froth the
sphalerite concentrate, which I then remove,
and I then introduce a further and different
conditioning agent which functions with the de-
pressant to float and froth the pyrite concen-
trate, which I then remove. It will be under-
stood that when I speak of galena, sphalerite and
pyrite concentrates, I am speaking of concentrates
of commercial purity, as shown by the assay
hereinafter appended.

While I have stated the method steps in the
particular order, and on the particular sulphide
minerals, in which I first proved them by actual
test, I have since proven to my own satisfaction
that I can selectively float other sulphide minerals
in any desired order, and in the same manner,
hence the feature of selectivity is not confined
to the precise order of steps herein recited, as
this order is merely one way in which the method
can be carried out.

The remaining pulp, containing the oxide ore
particles, is then agitated and I introduce into
the pulp my conditioning compound, which also
functions as a frothing agent. This compound
is in the nature of a conditioning agent and func-
tions to activate and float the oxide ore particles
such as for instance as scheelite, cerussite, hematite,
siderite and malachite.

It will thus be understood that my invention,
as a method, involves the separation and recovery
of various sulphides, and the flotation and re-
cover of various oxides, as two broadly distinct
steps, as the oxides cannot be efficiently recov-
ered without first removing the natural colloidal
matter, and the oxides cannot be efficiently re-
covered until after the sulphides have been
frothed off. Hence, it will be understood that the
oxides remain inert until my combined condi-
tioning and frothing compound has been intro-
duced. However, it will be clear that I perform
all of these recovery steps in the one single pulp.

I will next give a specific example of one of the
most approved ways in which my method can be
carried out.
A sample of current mill-feed of a lead-zinc, which is an extremely complex ore, was ground with water in a laboratory rod-mill to pass one hundred mesh, and the ground pulp was diluted with water and deflocculated by the addition of sodium silicate to the pulp in the proportion of 2 lbs. per ton of ore. The liquid containing the natural colloidal matter thus separated from the crystalline matter in this normal pulp was removed by decantation and the residual crystalline matter was diluted to 40% solids, with water to form a deflocculated pulp.

I next introduced into the laboratory flotation machine, in the presence of agitation, my artificial improved depressant which, in this instance, was in the form of a liquid commercial glue, the proportion being 0.3 lb. of glue per ton of ore.

To the best of my knowledge and belief, the action of this artificial depressant may be in accord with either one of two theories. It may be adsorbed on the crystal faces of the sulphide ore particles to form a wettable film which causes the particles to sink, and/or this depressant may function to modify the electrical charge on the sulphide ore particles to cause them to repel one another and disperse, or be dispersed, in the pulp. Irrespective of the precise manner in which it functions, I have conclusively proven that this depressant actually functions to cause the sulphide ore particles to sink in the pulp.

I next introduce a frothing agent consisting of 0.3 lb. per ton of a mixture of 10% pine oil and 90% of Barrett's cresosate and this formed a bright, brittle froth but no minerals arose on the froth. This proved the efficiency of my depressant. In fact, I have found this depressant to be the most efficient and positively acting depressant in resisting the action of a frothing agent, that I have ever used.

I next introduced a conditioning agent which consisted of 0.005 lb. per ton of ethyl xanthate, which produced a bright, clean froth of galena concentrate containing a minimum of sphalerite, which clearly proved that the action of the artificial colloidal depressant had inhibited the tendency of the sphalerite and pyrite to float. I then removed the galena froth.

I next introduced a conditioning agent which consisted of 1 lb. per ton of copper sulphate and a collecting agent, consisting of 0.1 lb. per ton of Barrett's cresosate, in the presence of agitation, and a bright, clean froth of sphalerite concentrate formed and was removed.

I next introduced a conditioning agent consisting of 0.2 lb. per ton of ethyl xanthate in the presence of agitation, and a bright, clean froth of pyrite concentrate formed and was removed.

The remaining pulp, containing the oxide particles, was agitated with 1.0 lb. per ton of my oxide conditioning-frothing compound previously prepared consisting of the following ingredients:

<table>
<thead>
<tr>
<th></th>
<th>Percent by weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oleic acid</td>
<td>57.17</td>
</tr>
<tr>
<td>Cresylic acid</td>
<td>28.7</td>
</tr>
<tr>
<td>Soda ash</td>
<td>7.7</td>
</tr>
<tr>
<td>Sodium silicate</td>
<td>7.1</td>
</tr>
</tbody>
</table>

and a bright, clean froth of siderite arose and was recovered.

The specific example just disclosed, showing one way of carrying out the method, resulted in the following commercial products:

<table>
<thead>
<tr>
<th>Product</th>
<th>Assay</th>
<th>Percent total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Per cent wt.</td>
<td>Per cent Pb.</td>
</tr>
<tr>
<td>Feed</td>
<td>100.0</td>
<td>4.0</td>
</tr>
<tr>
<td>Lead concentrate</td>
<td>11.0</td>
<td>30.0</td>
</tr>
<tr>
<td>Lead rgh. tailing</td>
<td>58.0</td>
<td>0.8</td>
</tr>
<tr>
<td>Zinc concentrate</td>
<td>12.9</td>
<td>4.5</td>
</tr>
<tr>
<td>Zinc rgh. tailing</td>
<td>77.0</td>
<td>0.7</td>
</tr>
<tr>
<td>Pyrite concentrate</td>
<td>58.1</td>
<td>1.2</td>
</tr>
<tr>
<td>Pyrite rgh. tailing</td>
<td>67.1</td>
<td>0.4</td>
</tr>
<tr>
<td>Sphalerite concentrate</td>
<td>11.5</td>
<td>0.6</td>
</tr>
<tr>
<td>Sphalerite rgh. tailing</td>
<td>58.1</td>
<td>0.3</td>
</tr>
</tbody>
</table>

While the oxide conditioning-frothing compound, previously set forth, is useful irrespective of the particular percentages, I have found in actual practice that it is far more efficient if compounded in the manner which I will now set forth.

The cresylic acid and oleic acid are mixed together and I next stir slowly into this mixture a ten percent solution of soda ash in water. If the soda ash solution is added too rapidly, the whole compound will froth badly. I next stir in a ten percent solution of sodium silicate in water, which forms an amber jelly, the latter being the reagent. I use this reagent in a ten percent emulsion in water, for convenience.

It is desired to emphasize the fact that my artificial depressant acts, in a deflocculated pulp, with extreme rapidity whereas standard depressants, as far as known to me, require a very considerable time period in which to act. For instance, in my use of this artificial novel depressant, it has acted in a period of contact of not more than one minute, while many standard depressants require a period of contact of as much as an hour. In addition to its quick acting qualities, it is an extremely low cost depressant.

While I have stated that this artificial depressant may consist of commercial glue, I wish to state that I consider starch, sodium silicate, gum arabic and glucose, and many other colloidal substances as an operative equivalent or glue.

Throughout the specification and claims, wherever I have used the phrase "artificial colloidal substance" or, "artificial colloid" or "artificial depressant", I mean to designate any colloidal substance not naturally present in the ore, and which is capable of performing this depressant function.

I have herein disclosed one specific form of my improved method, but I do not wish to be limited thereto except for such limitations as the claims may import.

I claim:

1. A method of concentrating different kinds of finely divided ore by flotation, the steps of substantially completely removing all of the natural colloidal matter by adding a de-flocculating...
agent to substantially completely release the ore from any depressing action of such matter in the subsequent pulp, adding water to the residual crystalline matter to form a de-flocculated pulp free from any depressant, and in adding to the de-flocculated pulp in the presence of agitation an artificial colloidal substance in such selective quantity to definitely depress all the different kinds of ore particles contained in the pulp, and to permit the depressed particles to be subsequently acted upon and rendered floatable by the respective conditioning agents, whereby the one may be selectively floated.

2. In a method of concentrating different kinds of finely divided ore by flotation and selectively recovering the different varieties, the steps of substantially completely removing all the natural colloidal matter by adding a de-flocculating agent to substantially completely release the ore from any depressing action of such matter in the subsequent pulp, adding water to the residual crystalline matter to form a de-flocculated pulp free from any depressant, and in adding to the de-flocculated pulp in the presence of agitation an artificial colloidal substance in such selective quantity to definitely depress all the different kinds of ore particles contained in the pulp by causing said substance to become adsorbed on the ore particles and depress the same by altering the electric charge, adding a frothing agent to the de-flocculated pulp, in successively adding different kinds of conditioning agents to the de-flocculated pulp dependent upon the particular sulphid desired and thereby activate and successively float such sulphide ore particles from the action of the colloidal depressant, in respectively and successively removing the selected sulphide ore particles frothed, and in adding a conditioning agent to activate and float the oxide ore particles and thus separate them from the gangue, and finally removing the frothed oxide ore particles.

ROYAL S. HANDY.
CERTIFICATE OF CORRECTION.

ROYAL S. HANDY.


It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 3, first column, line 12, claim 1, for "one" read "ore"; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 7th day of January, A. D. 1936.

Leslie Frazer
Acting Commissioner of Patents.