This invention relates to aeration machines as constructed primarily for flotation purposes in the separation of diverse solid particles contained in an aqueous pulp. It applies especially to the metallurgical field, but is applicable, also, to a variety of industrial operations utilizing flotation techniques. In its application to heavier solids, such as are usually encountered in mineral dressing, the machine of the invention has particular utility as applied to what are normally regarded as the finer grinds of such solids.

Processes of flotation are carried out by the use of flotation machines, wherein an aqueous pulp of the particles to be separated is subjected to aeration. Most commercially used machines are of so-called sub-aeration type, wherein air is introduced to the pulp coincidentally with vigorous agitation of the pulp by means of a submerged impeller.

Mechanical arrangements for achieving desired aeration and agitation of a flotation pulp have been developed in great profusion. Yet, conditions necessary for the obtaining of maximum recoveries of valuable particles of a pulp as against unwanted particles component there-to, or for achieving clean separation between several valuable components of a flotation pulp, are so exacting that throughout the history of the flotation art there have been and currently there are constant efforts to improve the operation of flotation machines.

A particular type of machine which has achieved widespread use throughout the industry is illustrated and described in U. S. Patents Nos. 2,055,065 and 2,182,442, granted to Lionel E. Booth under dates of September 22, 1936, and December 5, 1939, respectively, each being entitled “Aerating Machine.”

The first of these patents discloses, in combination with a flotation cell, a type of impeller provided with a circular top and a multitude of elongate fingers or teeth depending from the rim of such top in mutually spaced relationship, forming, in effect, a circular denture. The second is concerned with an improvement on the first, wherein a stationary peeler blade structure encircles an impeller corresponding to that of the first patent, for coaction therewith in establishing advantageous bubble column conditions in the flotation cell, it being realized that the bubble column of any flotation cell is the effective working agency in the carrying out of the flotation process.

While these patented machines and variations thereof conforming to the general concepts taught by the patents have produced excellent results in practice, compared to competitive types of flotation machines, certain difficulties have been present. For example, there has been undesirable “boiling” action of the pulp at the corners of the cell, and undesirable turbulence of the pulp at the surface.

Heretofore, no way has been found to overcome these difficulties, which have long been known to reduce the effectiveness of results otherwise possible of achievement in the practice of a flotation operation. The impeller of my copending application Serial No. 236,712, now Patent No. 2,675,724, issued March 30, 1954, is the only exception known to me in this respect.

The construction of these patented machines has been dominated by the thought that the peeler blades must be mutually spaced apart relatively widely, as in approximately the manner shown by the aforesaid Booth Patent No. 2,182,442, in order to prevent accumulation of sands at the bottom of the cell, the action being one of keeping the sands in active suspension.

In accordance with the present invention, however, it has been found that, if the spacing between peeler blades in any given machine is reduced by the addition of more than the conventional number of such blades for any given size and capacity of machine, not only are the sands of the more common, finer grinds of material, e.g. 65 mesh, still effectively maintained in suspension, but the undesirable corner boiling and surface turbulence mentioned above are practically eliminated. Furthermore, the elimination of these difficulties are accompanied by finer bubble formation, which is always desirable in flotation practice, and by a reduction of wear on those structural parts of the cell which are exposed to pulp activity.

Thus, objects long sought in connection with a flotation machine of the type concerned, namely, greater quiescence of pulp, greater dispersion of air in the pulp to effect finer bubble formation, resulting in greater recovery of values and reduction of wear on structural components of the flotation cell, are achieved for the more common types of pulp without accompanying undesirable consequences, by the relatively simple expedient of reducing the width of openings between adjacent peeler blades relative to the internal diameter of the peeler blade structure. It is only where relatively coarse grinds of heavier solids are being treated, e.g. below 20 mesh for metallic ores, that sanding occurs with the machine of the invention.

Further objects and features of the invention will become apparent from the following detailed description of the particular preferred form thereof illustrated in the accompanying drawings.

In the drawing:

Fig. 1 represents a central vertical section taken through a conventional flotation cell of the type concerned, embodying the invention;

Fig. 2, a horizontal section taken on the line 2—2 of Fig. 1;

Fig. 3, a horizontal section taken on the line 3—3 of Fig. 1; and

Fig. 4, a perspective view looking from above of the peeler blade structure, per se.

Referring now to the drawing:

The flotation cell, indicated generally by the numeral 10, is typical of flotation cells presently manufactured under the teachings of the aforesaid Booth U. S. patents. As is customary, the flotation cell 10 embodies a container or tank 11 for the flotation pulp, the same having froth overflow lips 12 and being provided with the usual pulp inlets and tailings outlets means (not shown). An impeller 13, conforming in general with that disclosed by the said Booth patents, but, as is usual in more recent commercial practices, provided with a flat top of disk formation, rather than the bell-shaped or conical top specifically shown in the Booth patents, is provided at the lower end of a hollow impeller shaft 14, which depends deep in the container 11 from a rotatable suspension mounting in the usual bearing structure 15. Air is introduced within the impeller 13 through the hollow impeller shaft 14 by means of a blower (not shown) and by way of supply piping 16 and the bearing structure 15, all in conventional fashion. The impeller and impeller shaft are rotated by means of an electric motor 17 and a multiple V-belt drive 18, which are also conventional.

Encircling the impeller 13 is peeler blade structure 19, the same being supported in slightly raised position rela-
The peeler blade structure 19 is conventional in all respects, except in the number of blades and the width of the entrance openings between adjacent blades relative to the internal diameter of the structure. Thus, the peeler blade structure 19 is made up of a plurality of individual peeler blades 21 held rigidly together in radial, mutually spaced relationship by means of frame members 22, to which they are individually rigidly attached, as by means of welding. Such blades extend radially inwardly of the structure a limited distance to define a circular space 23 for receiving the impeller 13. The diameter of such circular space 23 is the inside diameter of the peeler blade structure heretofore referred to in relation to the spacing between the individual blades. Such inside diameter is determined by the outside diameter of the impeller used for any given size and capacity of machine. So far as this invention is concerned, no change in inside diameter is made over conventional practices.

The improvement resides in the ratio of the rectilinear width of the entrance to the pocket between adjacent blades 21 (see the widths spanned by applied arrows and indicated 24 in Fig. 4) to the inside diameter of the peeler blade structure. It is not necessary that all of such widths be uniform, for, in some instances, it is desirable to reduce the widths of the entrances to corner pockets over those of the other pockets. It is only necessary that the width of each pocket entrance be less than a particular width which bears a certain ratio to the inside diameter of the peeler blade structure.

The certain ratio referred to above is one to ten, that is to say, the inside diameter of the peeler blade structure is always greater than ten times the width of the entrance of any particular pocket formed between any two mutually adjacent blades 21.

It is not practical to specify an exact number of blades, since that varies in accordance with the size of the machine concerned. Nevertheless, it can be said that, in any given machine, the ratio of the closed portion of the circumferential area defining the circular space 23 centrally of the peeler blade structure, to the open portion thereof, may vary within the range of from 1:3 to 1:4.

The following table gives specific examples of these ratios for peeler blade structures corresponding to this invention as compared with those corresponding to accepted standards, with respect to four different machine sizes.

<table>
<thead>
<tr>
<th>Machine</th>
<th>No. of Blades</th>
<th>Effective Width of 1 Opening</th>
<th>T. D. of Peeler Blade Structure</th>
<th>Ratio of Closed Area to Open Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>45° Invention</td>
<td>24</td>
<td>3.0</td>
<td>9.60</td>
<td>0.62</td>
</tr>
<tr>
<td>45° Standard</td>
<td>22</td>
<td>2.65</td>
<td>20.75</td>
<td>13.9</td>
</tr>
<tr>
<td>30° Invention</td>
<td>24</td>
<td>2.34</td>
<td>29.2</td>
<td>14.1</td>
</tr>
<tr>
<td>30° Standard</td>
<td>20</td>
<td>2.04</td>
<td>20.75</td>
<td>10.4</td>
</tr>
<tr>
<td>24° Invention</td>
<td>24</td>
<td>2.05</td>
<td>14.25</td>
<td>10.35</td>
</tr>
<tr>
<td>24° Standard</td>
<td>10</td>
<td>2.05</td>
<td>14.25</td>
<td>9.7</td>
</tr>
<tr>
<td>18° Invention</td>
<td>24</td>
<td>2.65</td>
<td>14.75</td>
<td>10.35</td>
</tr>
<tr>
<td>18° Standard</td>
<td>10</td>
<td>2.65</td>
<td>14.75</td>
<td>10.35</td>
</tr>
<tr>
<td>15° Invention</td>
<td>24</td>
<td>2.65</td>
<td>19.25</td>
<td>13.3</td>
</tr>
</tbody>
</table>

In the above table, the dimension given under "Machine" applies to both the width and length of the particular cell concerned.

What I have accomplished, in effect, by the improved structural combination of this invention is a division of the energy output of the impeller into smaller increments by reason of the increase in the number of pockets in the peeler blade structure, it being realized that, as clearly indicated in the drawing, the spaces between the depending fingers of the impeller are each several times less in width than the respective pocket openings defined between the stator blades. In this manner, I am able to more effectively disperse the air and suspend the solids in the pulp with any given energy output of the impeller. Thus, without increasing impeller speed over that normally employed, I am able to achieve new results from a performance standpoint.

The more effective performance of the machines achieved without appreciable standing through the range of fine grind pulps up to what are generally considered to be coarse grind pulps, e.g. a grind of 20 mesh or below, for most metallic ores. With the latter coarse grind metallic ore pulps, some difficulty may be encountered from a tendency to sand, and, generally speaking, the machines of the invention are not recommended for such pulps. Nevertheless, it can be seen that a wide field of usefulness is open to the machine of the invention, there being achieved smoother cell action, generally, by the elimination of corner boil and more complete air dispersion, as well as a less turbulent surface with less pulp carried mechanically over the froth lips by the discharging froth.

In instances of relatively light solids to be processed, e.g. many non-metallic solids, such as phosphate rock, coal, etc., and organic substances, such as grain, etc., even the largest particle size can be handled to advantage by the machine.

An especially effective combination conforming to this invention is had for many instances of use by employing the perforate impeller of my aforementioned copending application Serial No. 236,712 filed July 14, 1951, now Patent No. 2,673,724, issued March 30, 1954, see Fig. 3 where that impeller is shown in place of the conventional impeller.

Whereas this invention is here illustrated and described with respect to a particular preferred form thereof, various changes may be made therein without departing from the scope of the teachings hereof and of the claims which here follow.

I claim:

1. In a flotation machine, an impeller-stator combination, comprising an aeration impeller having a top member of substantially closed, circular formation, and a multiplicity of closely spaced fingers depending from the rim of said top member in mutually spaced relationship to define a multiplicity of side-discharge ports, the bottom of said impeller being substantially entirely open; and a stator in the form of a peeler blade structure, said structure being made up of a multiplicity of mutually spaced blades radiating outwardly from and defining a circular space within which said impeller is mounted for rotation on a vertical axis concentric with the axis of said structure, the said blades defining a circumferential area of a multiplicity of pockets opening into the said circular space, the open entrance of each of said pockets having a rectilinear width less than one-tenth of the diameter of said circular space, and the ratio of closed area to open area of that circumferential portion of said structure which defines said circular space being within the range of from 1:3 to 1:4, the spaces between the depending fingers of said impeller being each several times less in width than the respective pocket openings defined between the stator blades. The combination recited in claim 1, wherein a plurality of openings are distributed throughout the closed top member of the impeller, said openings having relatively low discharge capacity as compared to said side delivery ports and being fewer in number, whereby major discharge capacity is disposed sidewardly of the impeller.

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