

Dec. 5, 1967

H. L. PODMORE
GRINDING OPERATIONS

3,356,302

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Fig. 1.

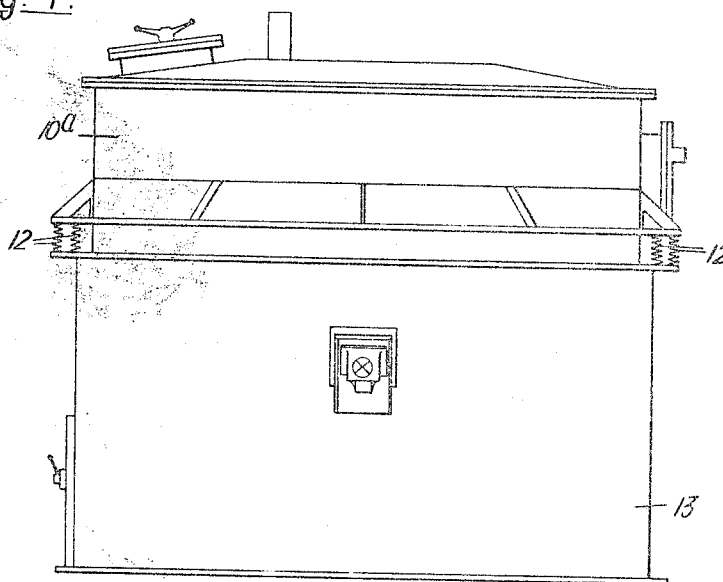
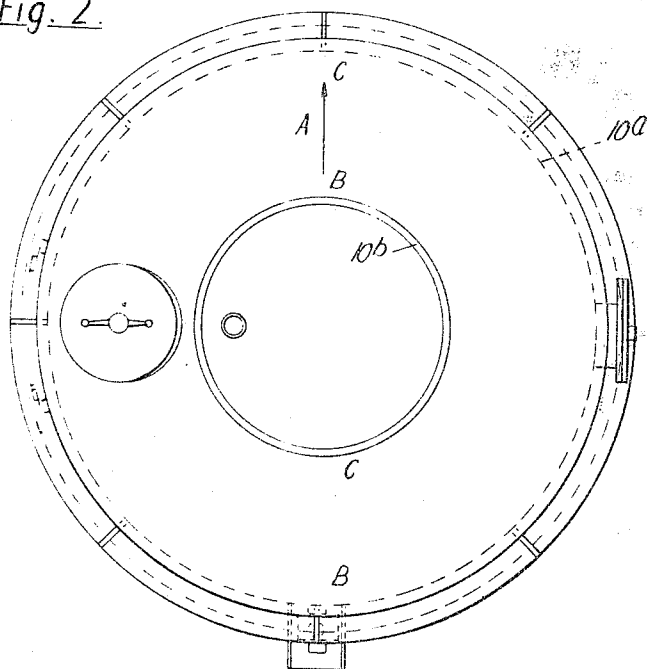


Fig. 2.



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Fig. 3.

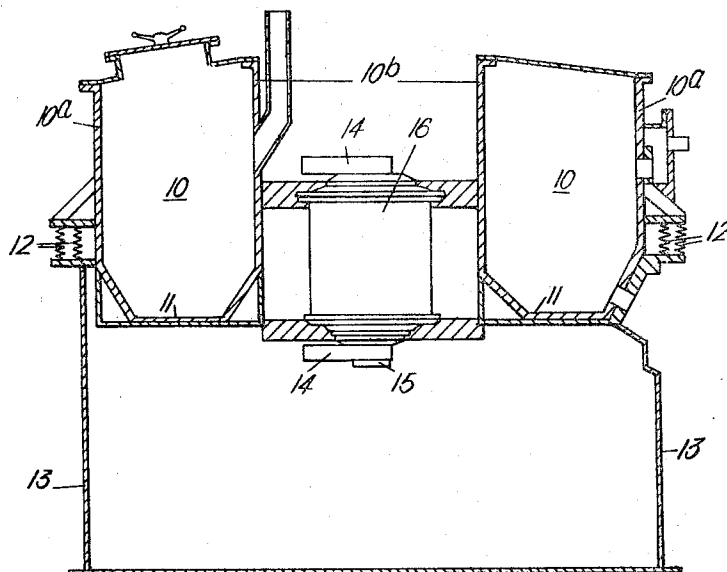
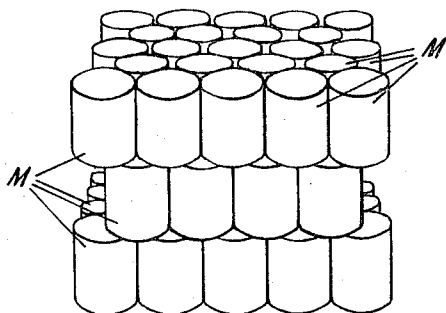


Fig. 4.



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3,356,302

GRINDING OPERATIONS

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3 Claims. (Cl. 241—30)

ABSTRACT OF THE DISCLOSURE

The method of grinding, polishing and/or deburring material to be processed including placing cylindrical pieces of treating media into a chamber along with the material to be treated and subjecting the chamber to compound vibrational movements to cause the media to orient into a generally parallel rolling relationship.

Background of invention

This invention relates to grinding operations in which the material to be processed, which may be either in the form of a suspension in liquid or as dry powder is fed into a chamber containing media of specific shape and subjected to controlled compound vibration. In vibration grinding mills at present in use the media is usually spherical giving a comparatively large volume of voids between the spheres and providing only point contact to effect the grinding operation. It is found in practice that the volume of voids between spherical media approximates to 40% of the total volume of media and charge. As a result of many experiments I have found the grinding efficiency and the rate of grinding to be greatly enhanced if the volume of voids between the media is substantially reduced. Since the use of spheres as media must always leave a large volume of voids experiments have been conducted upon other shapes and in particular upon cylindrical media. Generally cylindrical media were found to be inferior to spheres in that a random arrangement of the cylindrical pieces results in a still higher proportion of voids. Moreover the vibration of the mill subjected the cylindrical media to a succession of point impacts which soon caused the cylinders to wear down at the ends with the result that they became rounded and eventually the media tended to become spherical. The rate of wear on the media should of course be reduced to a minimum to prevent excessive contamination of the product.

Summary of invention

Further experiments have shown, however, that it is possible to create a predetermined orientation of the pieces of cylindrical grinding media with most beneficial results.

The present invention consists in the use of a grinding chamber containing cylindrical pieces of grinding media which are made to orient themselves into a generally parallel relationship so that a rolling or rubbing action in line or face contact is created between the adjacent cylindrical surfaces of the pieces of media under the vibrational movement of the grinding chamber.

This predetermined orientation of the cylindrical pieces of media can best be achieved by subjecting the grinding chamber and its contents to compound rotational vibrations about an approximately vertical axis. The two or more vibratory systems must be capable of phase adjustment and control so as to produce and maintain near optimum packing density for the media and charge of process material.

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Under these conditions cylindricals will pack to give voids approximating to 22% of the total volume. It will be appreciated that while a lower percentage of voids could be obtained by the use of media in certain other shapes such as prisms and even cubes with rounded edges, in practice the use of such media is found detrimental to rapid feeding and discharge of the mills and also gives a low flow rate through the mills when used in continuous grinding processes.

The purpose of the phased compound vibratory system is to provide conditions which will facilitate free rotation of the pieces of media which are not aligned but which will not disturb the alignment of those pieces which are packed to give maximum packing density. Under such conditions and after a sufficient interval of time, all the media will be aligned to give the optimum packing density and will then provide line and face contact but no point contact.

The invention will be further described with reference to the accompanying drawings in which:

FIGURE 1 is a side elevation of a grinding mill.

FIGURE 2 is a plan.

FIGURE 3 is a vertical section.

FIGURE 4 is a perspective view showing the grouping of the grinding media desired, drawn to a larger scale.

It is preferable that the grinding chamber 10 should be of cylindrical shape with its axis approximately vertical. For instance the grinding chamber may include an outer cylindrical wall 10^a and an inner cylindrical wall 10^b both concentric about a vertical axis, so that as viewed in plan the chamber is of annular shape. Parallel alignment of the grinding media is facilitated by having the base 11 of the grinding chamber in the shape of a semi toroid.

If at any time the annular chamber 10 as a whole is rapidly displaced in the direction of the arrow A, FIGURE 2, by a high frequency rotational vibration about the vertical axis then the media at point B will be subjected to a pressure above that of the mean and the media at the point C will be subjected to a pressure below that of the mean. Now if at the same time a second form of vibration is introduced which will impart a small turning movement to the media, then provided the release of pressure at point C is adequate the media will rotate into a new position. It will be appreciated that once the cylindrical media M, FIGURE 4 is packed to give maximum density as shown then the degree of pressure reduction required to facilitate rotation of the cylindrical pieces of media is considerably greater than is necessary to produce parallel alignment and hence if the amplitude is correctly adjusted aligned media will remain so aligned.

The annular grinding chamber, in conjunction with the type of vibratory action referred to, is calculated to promote a circulation of the media around the grinding chamber, but without upsetting the prescribed orientation of the media as a whole.

In the construction illustrated grinding chamber 10 is mounted on an annular series of springs 12 carried by a base 13 and is subjected to the necessary compound vibrations by means of out-of-balance masses 14 carried by a vertical spindle 15 mounted on the vertical axis of the grinding chamber and subjected to rotation by an electric motor 16 giving the high frequency compound vibration having the desired rotational and upward and downward component; the angle of lead between the two weights 14 being capable of adjustment so as to correctly phase the two vibratory systems.

The term "grinding" is used herein broadly to include polishing or de-burring operations.

I claim:

1. Method of grinding and similar operations comprising the steps of placing cylindrical pieces of grinding

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media into a grinding chamber, feeding the material to be treated in the chamber, subjecting the grinding chamber to controled compound vibrational movements, thereby causing the grinding media to orient into a generally parallel relationship, and thus creating rolling and rubbing action in contact between adjacent surfaces of the pieces of media.

2. Method as claimed in claim 1 in which the material fed in is in the form of a suspension in liquid.

3. Method as claimed in claim 1 in which the material fed in is in a dry state.

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