Oct. 25, 1932. R. C. BENNER ET AL 1,884,529

CONSOLIDATING GRANULAR MATERIALS

Filed Jan. 28, 1929

Fig. 1.

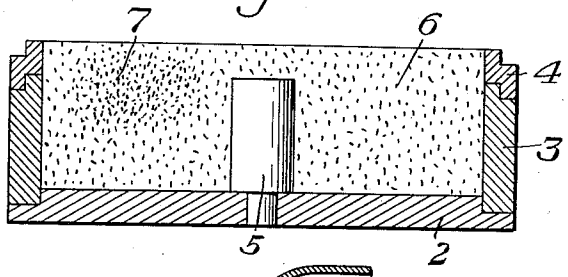


Fig. 2.

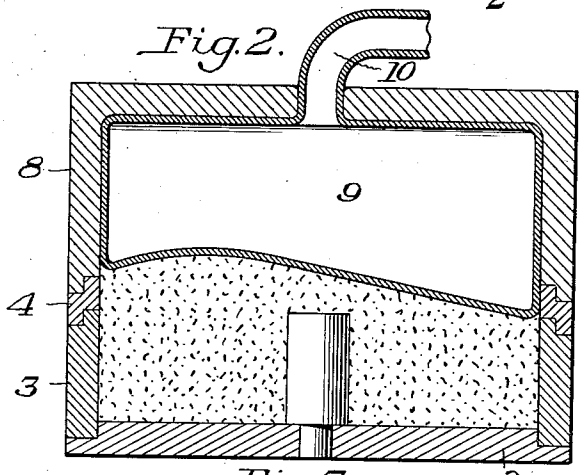


Fig. 3.

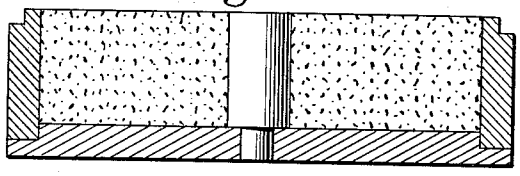
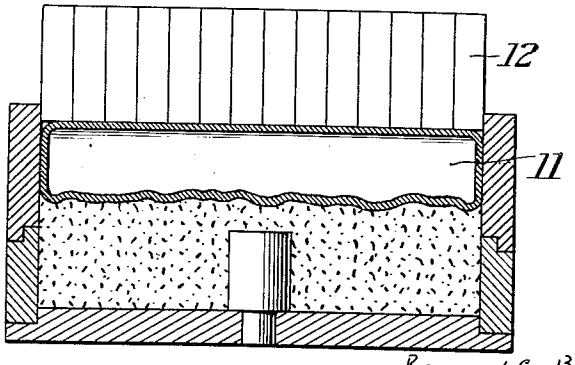


Fig. 4.



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UNITED STATES PATENT OFFICE

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CONSOLIDATING GRANULAR MATERIALS

Application filed January 28, 1929. Serial No. 335,520.

This application is a continuation in part of our copending application, Serial No. 298,215, filed August 8, 1928.

Our invention relates to consolidating granular materials, and more particularly to consolidating mixes of granular material and bond so as to secure a substantially uniformly distributed volume density, and to the consolidated masses so produced. The invention is particularly applicable to the manufacture of abrasive and ceramic articles formed of mixes of granular materials and bond, so as to produce superior articles of such character having substantially uniform density throughout.

Abrasive articles have, in most cases, a relatively high porosity and should be as uniform in physical character as possible. Non-uniformity tends to produce uneven grinding action, and also introduces an element of danger by unbalancing the grinding wheels, which are usually operated at high speeds.

Uniformity is desirable from two different points of view. From one point of view the uniformity of large sections, for example, cross-sectional halves of a wheel, is important. Differences in the weight of such large sections, due to greater density in one than in another, causes unbalancing. Such a condition should be compensated for or the wheel will not grind evenly and may be dangerous to operate.

Under present methods the most satisfactory way of overcoming this, for commercial use of the wheels, is to use a counter-balancing insertion at the arbor. For certain classes of work, such, for example, as precision grinding, the wheel must have as nearly static balance as possible. This fixes a limit in the difference in weight between two large portions of the wheel of less than that required at the circumference to overcome the rolling friction of the wheel shaft on the testing ways, and is usually of the order of magnitude of less than 1/2500 of the weight of the wheel.

The second standpoint as to uniformity is that of local uniformity or uniformity of small sections or portions of the wheel; for example, areas occupied by 50 to 100 grains. Differences in bond and grain distributions and the pore spaces from one section to another affect the cutting quality of the wheel, that is, the ability of the wheel to remain cool and to grind without leaving chatter marks. Differences in the distribution of grain, bond and pore spaces also affect the dynamic balance of the wheel.

Again, refractory articles, while generally of much lower porosity than grinding wheels, should have a uniform structure or packing of the component articles. Non-uniformity of physical structure will result in uneven strains and possible rupture under varying temperature conditions. It is therefore desirable that the structure of such refractory articles be as nearly uniform as possible.

Two main methods have heretofore been used in the forming of such abrasive and refractory articles. One of them, called the "puddle process" employs a very wet mixture or slip containing usually about 20% of water. The other process, known by various names according to the pressure-applying means, consists in molding under pressure a damp mix containing usually only about 2.5% of water.

Each of these methods has advantages and disadvantages. The puddle process produces articles of fairly uniform porosity, but requires a long time for drying because of the large percentage of contained water. This is objectionable from the standpoint of quantity production, and moreover, articles so made must be cut or trimmed down to the desired shape and size after drying. On the other hand, articles made from damp mixes require only a short time for drying and need less cutting down or dressing to bring them to the desired shape and size, since they can be moulded to the desired form by tamping and pressing. The disadvantage with the damp mix process, whether the molded article be tamped or pressed, is that it has low and uneven porosity.

We have discovered a method of applying preliminary pressure to such mixes which will greatly improve the uniformity or distribution of the particles throughout the article prior to its final forming pressure. This

preliminary yielding pressure is preferably applied by a fluid-pressure cushion which will conform to the charge of mixture and will subject different portions of the charge to pressures which will substantially equalize the distribution of the particles.

In the drawing,—

Figure 1 is a diagrammatic sectional side elevation showing an abrasive mix in the forming mold;

Figure 2 is a similar view showing the application of fluid pressure with the exposed surface;

Figure 3 is a similar view with the pressure device and strike-off ring and excess material removed; and

Figure 4 is a view similar to Figure 2, showing a modified form,

Referring to Figure 1, 2 indicates a mold bottom, 3 a mold, and 4 a strike-off ring interfitting with the mold body. 5 is a central post for forming the opening at the center of the wheel to be manufactured. 6 indicates a damp mix which is charged into the mold and which may have irregular porosity or distribution. For example, we have indicated at 7 a more closely assembled group of particles than in the rest of the mix.

When the mix has been fed in, we may supply the metal container 8, shown in Figure 2, interfitting with the strike-off ring and containing a pneumatic cushion 9 of material such as rubber, this pneumatic cushion having a supply tube 10 leading to a source of air under pressure which can be regulated in accordance with the particular mix employed. After the air bag has been carefully placed on top of the mix and covered with the container, which may be clamped by any suitable means, the air pressure is then gradually applied until the maximum pressure is reached, for example, 15 pounds per square inch in a typical case, after which the pressure apparatus and the strike-off ring are removed and the excess mix struck off with a straight edge.

During the preliminary pressing in the case of the mix shown in Figure 1, the pneumatic cushion would take somewhat the form shown in Figure 2, due to the greater density of the portion 7, and the remaining portions would be brought up to this density by the yielding pressure of the cushion. Hence, the irregular strength and cutting conditions which would otherwise occur in the wheel are reduced or eliminated by this preliminary yielding pressure. The greatest downward displacement will, of course, occur where the greater porosity is present, and thus the porosity distribution will be better equalized.

This condition is intended to be illustrated in Figure 3, which shows the condition after the removal of the cushion, container and strike-off ring, and the striking off of the extra material. After this preliminary pressing, the damp mix may be subjected to the final forming pressure in the usual manner, and by any preferred means. The final forming pressure is a relatively much greater pressure than the preliminary compacting pressure, and in the making of abrasive wheels may be about 5,000 pounds per square inch.

Uniformity of product obtained by this method is due to the substantially uniform density of the mix resulting from the application of the yielding pressure over the surface of the mix, the positions of the different parts of the cushion being in accordance with the resistance of the different parts of the mix. The depth of each portion of the mix will decrease in proportion to its original depth to an extent depending on the original density. The density having thus been made substantially uniform, the upper irregular parts are struck off or removed, leaving a mix of substantially uniform density throughout.

The wall of the bag which comes in contact with the exposed upper surface on the mass of mix 6 in the mold forms a flexible diaphragm to which is applied a pressure which, because of its fluid character, is uniformly distributed over the area of the diaphragm. This diaphragm, because of its flexible character, conforms not only to the major irregularities, but also to the small surface irregularities, and therefore applies a pressure which is distributed substantially uniformly over the entire area of such surface, that is to say, each minute or infinitesimal portion of the area of such surface has applied to it the same pressure. This is made possible because of the flexibility of the diaphragm which allows it to conform to the small, as well as large, surface irregularities.

Instead of applying a pneumatic or fluid pressure inside the bag, a closed fluid pressure cushion, such as shown in Figure 4, may be used, and a weight or a series of weights, indicated at 12, may impart the desired pressure to the fluid, such, for example, as the gaseous fluid (air) within the closed cushion. The weights, of course, may be made smaller or larger, and the pressure varied under different conditions. The interposition of the flexible walled cushion between the series of weights 12 and the mix, causes the pressure to be distributed substantially uniformly over each minute or infinitesimal portion of the exposed area of the mix, as contrasted with the case in which the series of weights 12 is applied directly to the mix, in which case the weight of each weight 12 will be distributed over an area which is relatively large compared with the granules of the mix.

The use of the flexible cushion or pressure

diaphragm therefore permits a much more uniform distribution of the pressure than would be the case where a series of relatively movable weights or rods 12 were applied directly to the exposed surface of the mix.

It will be seen that the fluid through which the pressure is applied to the surface of the mix in the mold is effective through a thin membrane which is sufficiently flexible to adjust itself to the fine irregularities in the surface of the mix so that the pressure is always applied in a direction normal to the surface of the exposed grains. The result obtained, therefore, is very similar to the result which would obtain if the fluid could press against the surface of the mix without the use of a diaphragm at all. Since the diaphragm must necessarily be elastic there is a slight difference between the pressure which obtains where a diaphragm is used and the pressure which would obtain theoretically if it were possible to bring the fluid directly into contact with the surface grains. Because of the substantial similarity to the use of a fluid, I have described the pressure as a "substantially fluid pressure", and the term "substantially fluid pressure" as hereinafter used shall be understood to mean a pressure exerted by a body of fluid under pressure and separated from the surface being pressed by a flexible diaphragm.

The device herein described may be employed as one of the devices for applying the preliminary consolidating pressure in the process of securing uniformity of distribution of a mix of granular material and bond by jolting, which is described and claimed in our application, Serial No. 335,519, filed of even date herewith.

The mass of mix may be placed in the mold in any suitable way, such as throwing it in and levelling it off by hand, as now usually practiced.

A more uniform distribution of the granular material and bond may, however, be effected by sifting the mix into the mold. This is preferably done by sifting the mix through a vibrating or gyratory riddle or screen suspended above the mold and which has an area of at least 25 per cent larger than that of the mold. The riddle or screen is vibrated as uniformly as possible and at the correct speed to cover the surface of the riddle with the mix, while the mold which is being slowly revolved on a turntable at uniform speed is being filled by the mix sifted through the riddle. The method of securing such improved preliminary distribution of the mix in the mold before applying the consolidating pressure is disclosed in our copending application, Serial No. 245,659, filed January 10, 1928.

After the preliminary pressure produces a mass of granular material in the mold having a substantially uniformly distributed internal density, the strike-off ring is removed and the excess mix removed or struck off with a straight edge prior to the application of the plunger which applies the final forming pressure to the article.

The advantages of our invention result from the greater uniformity of distribution, pore space, etc., in the final article, resulting from the correcting of uneven distribution by means of the preliminary pressure. In the use of the invention on bonded abrasives, the articles are more evenly balanced and the physical condition of local portions of the wheel is more uniform, thus keeping the wheel cool and avoiding chatter marks during its operation. Both the static and dynamic balance of the wheel are improved

Changes may be made in the material employed, the amount of bond, the wetness of the mix, etc., without departing from our invention as defined in the following claims.

We claim:

1. The method of consolidating a loose mix of granular material and bond preparatory to finally pressing the same to shape, which comprises applying to a surface of such mix a pressure distributed substantially uniformly over the entire area of such surface.

2. The method of consolidating a loose mix of granular material and bond preparatory to finally pressing the same to shape, which comprises applying to a surface of such mix a pressure distributed substantially uniformly over each minute portion of the area of such surface.

3. The method of consolidating a loose mix of granular material and bond preparatory to finally pressing the same to shape, which comprises applying to a surface of such mix a flexible diaphragm having a substantially uniformly distributed fluid pressure applied thereto, and thereafter pressing the consolidated mass under a plunger.

4. Those steps in the method of forming an abrasive or refractory article from a loose mix of granular material and bond preparatory to pressing the same under a plunger, which consist in placing a mass of the mix in a mold and then applying to a surface of the mass a consolidating pressure substantially uniformly distributed throughout the entire area of such surface.

5. Those steps in the method of forming an abrasive or refractory article from a loose mix of granular material and a bond, which consist in placing a mass of the mix in a mold in excess of the amount required, then applying to a surface of such mass simultaneously over its entire area a compressing cushion capable of conforming to both large and small surface irregularities of the mass, striking off any excess, and further subjecting the mass to compacting pressure.

6. Those steps in the method of forming an abrasive or refractory article from a loose

damp mix of granular material and a bond, which consist in placing a mass of the mix in a mold and then applying to a surface of such mass a compressing cushion consisting of a flexible diaphragm having a substantially uniformly distributed fluid pressure applied thereto, whereby the mass is compacted to a substantially uniform density and thereafter pressing the mass under a plunger.

7. Those steps in the method of forming an abrasive or refractory article from a mix of granular material and a bond, which consist in placing a mass of the loose mix in a mold and then applying to the surface of the mass exposed in the mold a consolidating pressure distributed substantially uniformly over each minute portion of the area of such surface, and thereafter striking off the excess mix and pressing the remainder in the mold to mold the finished article.

8. The method of forming an abrasive or refractory article of substantially uniform density, which comprises mixing a granular material and a bond and sifting the loose mix into a mold, whereby the mix is uniformly deposited in the mold, and then applying to the mix in the mold a consolidating pressure distributed substantially uniformly over the entire surface of the mix exposed in the mold, and thereafter striking off the excess mix and pressing the remainder in the mold to mold the finished article.

9. Those steps in the method of forming an abrasive or refractory article from a loose mix of granular material and bond preparatory to pressing the same under a plunger, which consist in placing a mass of the mix in a mold and then applying to a surface of the mass a substantially fluid consolidating pressure substantially uniformly distributed throughout the entire area of such surface.

10. Those steps in the method of forming an abrasive or refractory article from a loose damp mix of granular material and a bond, which consist in placing a mass of the mix in a mold and then applying to a surface of such mass a compressing cushion consisting of a flexible diaphragm having a substantially uniformly distributed fluid pressure applied thereto, whereby the mix is compacted to a substantially uniform density, and thereafter pressing the mass under a plunger press.

11. Those steps in the method of forming an abrasive or refractory article from a loose mix of granular material and a bond, which consist in placing a mass of the mix in a mold and then applying to the surface of the mass exposed in the mold and simultaneously over the entire area thereof a consolidating pressure distributed substantially uniformly over each minute portion of the area of such surface, and thereafter striking off the excess mix and pressing the remainder in the mold to mold the finished article.

12. The method of forming an abrasive or refractory article of substantially uniform density, which comprises mixing a granular material and a bond and sifting the mix into a mold, whereby the mix is uniformly deposited in the mold, and then applying to the mix in the mold a consolidating pressure distributed substantially uniformly over the entire surface of the mix exposed in the mold, this pressure being applied simultaneously over the entire surface thereof, and thereafter striking off the excess mix and pressing the remainder in the mold to mold the finished article.

In testimony whereof we have hereunto set our hands.

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WILLIAM G. SOLEY.