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PROCESS FOR MAKING PREFORMED ABRASIVE ARTICLES

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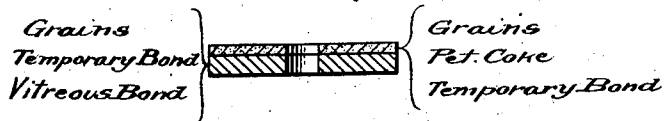
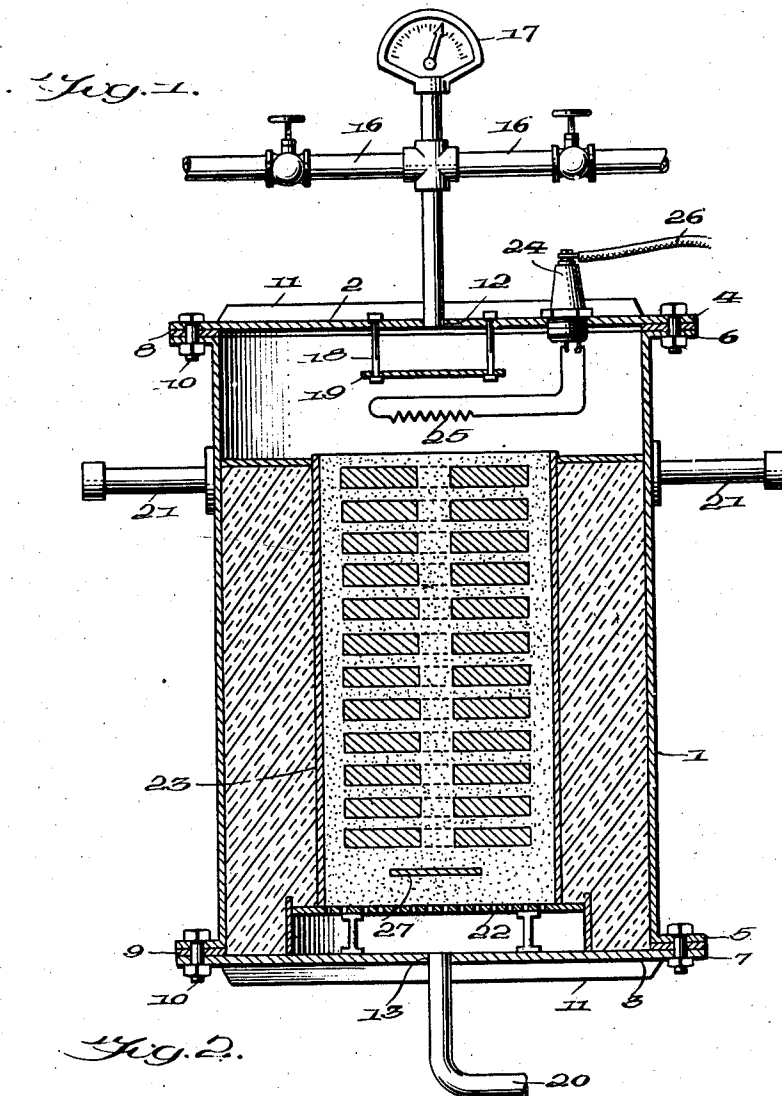


Fig. 3.



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PROCESS FOR MAKING PREFORMED
ABRASIVE ARTICLES

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4 Claims. (Cl. 51-278)

This invention relates to a process and apparatus for making preformed abrasive articles. More particularly the invention contemplates the provision of a novel, efficient, and economic process for producing abrasive wheels of superior quality.

This application is a continuation-in-part of my copending application Serial No. 41,003, filed September 17, 1935.

10 According to current practice, abrasive grinding wheels are composed of grains or grit of hard abrasive material, generally oxide of aluminum or silicon carbide bonded together by a suitable bonding agent. The nature of the bonding material and its quantity determine, to a large extent, the character of the wheel and the uses to which it may be put.

Both organic and inorganic bonding materials are used, the latter, however, being the most common. The usual bonding material comprises a vitrified substance resembling porcelain produced by a controlled process of heating in some form of kiln.

25 In the manufacture of vitrified abrasive articles, the abrasive grains or grits are mixed with clays of the desired qualities together with feldspar, flint, or like materials and water. The mixture is then formed into the desired shape, such as a wheel, by molding or the like. The wheel is then dried and placed in a kiln. The characteristics of the wheel are controlled to some extent by varying the amount and nature of the bond employed as well as by the subsequent heat treatment.

30 Both continuous tunnel type and intermittent pottery type kilns are currently employed for the heat treatment of the wheels. In the tunnel type kilns, usually about four days are required to mature and cool the wheels. In the pottery type kilns, it may require as long as three weeks to produce the finished wheel. The use of any kiln is expensive and requires a large investment. The consumption of large amounts of fuel and the time factor in kiln firing are important items in the production costs because of the necessity of retaining for long periods the arches, saggars, walls, and entire kiln at the requisite temperature.

35 It is one purpose of the present invention to completely obviate the necessity for kiln firing in the production of vitrified abrasive wheels. By the present invention, the great fuel costs incident to the manufacture of vitrified abrasive wheels are reduced to a minimum as are the labor costs and capital investment. Furthermore the production of my improved abrasive wheel is reduced to a one-day operation.

40 In accordance with the present invention, the heat necessary to produce the vitrified bond in the wheel is generated in immediate juxtaposition

to the wheel itself without the application of heat in the manner required in kiln firing.

While the invention in its broader aspect comprehends any of many modes of generating the necessary heat to form the vitrified bond in situ in immediate juxtaposition to the wheel, my preferred method will be first described. In this method the abrasive grains or grits are mixed with the necessary known ingredients to form the required bond in the finished wheel.

10 In its more specific aspects, the invention contemplates the molding of green abrasive articles, more particularly abrasive wheels, from a mixture comprising suitable abrasive grains, a previously fused vitreous bonding material, and a temporary binder without including in this mixture a combustible material, which latter procedure constitutes the subject matter of the invention claimed in my copending application Serial No. 41,003, filed September 17, 1935.

20 The present invention contemplates placing the green molded abrasive articles in a closed retort wherein each article is completely surrounded by a granular material, for example, abrasive grains similar to those included in the abrasive articles being formed. This material is inert at the temperature necessary to form a vitreous bond between the abrasive grains in the articles being formed. There is included in said surrounding granular material a combustible material in sufficient amount to generate, when burned in the retort, adequate heat to form a vitreous bond between the abrasive grains in the articles being produced.

30 In one contemplated procedure, the green abrasive wheels are prepared in the form of two juxtaposed layers, one of which is adapted to constitute, when the process is completed, the abrasive wheel and the other one of which carries therein combustible material to be burned out during the process for the purpose of generating heat to form a vitreous bond between the abrasive grains in the wheel being produced.

35 In carrying out my process, it is preferable to employ a combustible material to be burned in the retort which will not react so vigorously as to cause violent escape of volatile products, and it is further preferable to employ a combustible material that will not leave any objectionable non-volatile residue in the granular material after the combustible material has been burned therefrom. I have found petroleum coke or coke produced from coal tar to be very satisfactory for use as the combustible material in the process of the present invention since such combustible material produces substantially no ash. Other combustible materials possessing the above defined characteristics are, of course, suitable for use.

40 I have found it preferable to employ, for form-

ing the vitreous bond between the abrasive grains in the articles produced, a pre-fused or fritted material since, through the employment of such a bonding agent, only a relatively simple fusion is required to be effected in the article. It will be appreciated that clays, feldspar, and flint form a heterogeneous system in which the reaction may be slow although, of course, a suitable bond can be formed from such material. It is also within the province of my invention to employ a flux in the form of a more readily fusible material, such as borax, cryolite, or the like.

It is necessary, in carrying out the process, that a temperature of from 1000 to 1500° C. be produced within the abrasive articles being formed. This temperature can be produced in the articles, however, when carrying out my process by employing only a comparatively small amount of carbon or its equivalent in the granular material surrounding the green molded articles in the retort. By employing, in carrying out the process, an atmosphere of oxygen, it is possible to even further reduce the amount of combustible material necessary to generate the requisite heat in the abrasive articles being manufactured. It is to be understood, however, that an atmosphere of oxygen is not essential since the burning may be effected solely through the use of air.

It is to be understood that in the molding of the green wheel before heat treatment, any conventional temporary bonding agent may be employed, such, for example, as dextrine and Bakelite which burn off completely during the heat treating step.

Where the green wheel is formed in two layers, one of which contains the vitreous bonding material and the other of which contains the combustible material, it will be observed that, after the burning out of the combustible material from the layer containing the same, the granular material of that layer becomes wholly free and represents loose unbonded grains since the temporary bonding material simply acts to hold the wheel together in its preformed shape during the drying and handling operations preparatory to placing it in the retort.

The invention will be further described in connection with the accompanying drawing, wherein: Figure 1 is a vertical cross-sectional view of the retort employed in connection with the invention and illustrating one manner of placing the abrasive wheels therein;

Figure 2 is a cross-sectional view of a temporarily bonded green wheel formed in layers; and

Figure 3 is still another view of a special type of green molded wheel as prepared to be placed in the retort.

Referring to the drawing and more particularly to Figure 1, the retort embraces the outer cylinder 1 of thin metal and the somewhat heavier top 2 and bottom 3. The cylinder 1 carries annular flanges 4 and 5 at the top and bottom, respectively, adapted to cooperate with the peripheral flanges 6 and 7 at the top 2 and bottom 3. A suitable deformable metal washer 8 is clamped between the flanges 4 and 6 at the top, and a similar washer 9 is clamped between the flanges 5 and 7 at the bottom. The bottom 3 may, of course, be permanently united to the cylinder 1. As illustrated, however, both the top 2 and bottom 3 are removable by simply taking out the clamping bolts 10.

The top 2 and bottom 3 are reinforced by angle

iron struts 11 welded thereto. The top is provided with a central opening 12 and the bottom with an opening 13. An inlet pipe 14 has a gas-tight fit with the opening 12 and is provided with valve controlled branch lines 15 and 16 for air and oxygen. There is also mounted on the line 14 a suitable pressure gauge 17 for observing the pressure conditions prevailing in the retort. Immediately below the opening 12 in cover 2, there is suspended by rods 18 a baffle member 19 to prevent channeling of the incoming air or oxygen. An outlet pipe 20 for combustion gases and cooling air has a gas-tight fit in the opening 13 in the bottom of the retort. The retort carries trunnions 21 that permit it to be inverted for removal of its charge of treated wheels.

A free circular space having a diameter somewhat greater than that of the wheels to be treated is provided at the bottom immediately above the outlet line 20. This space is between the bottom 3 and the perforated plate or screen 22 suitably supported a few inches above the bottom. An open-ended cylinder 23 having a diameter somewhat greater than that of the wheels to be treated is disposed in concentric relation to the outer cylinder 1. The annular space between the cylinders 1 and 23 is packed with suitable insulating material. A spark plug 24 is fitted into the cover 2, and a coil of readily ignitable thin iron wire 25 is attached to its terminals. The lead 26 extends to any suitable source of electric current such as a 110-volt service line.

In packing a bath of wheels in the retort, a bed of abrasive grains such, for example, as used in the wheels and containing combustible material is filled in at the bottom of the cylinder 23 and supported on the perforated plate 22. A baffle plate 27 may advantageously be set in the bed. The first green wheel is next laid on the bed and, if the wheel is of the type shown in Figure 1, has free abrasive grains filled in around its circumference and in its axial opening. There is then placed over the first wheel a layer of abrasive grains having mixed therewith coke or other combustible material but no binding agents of any kind. This layer transmits heat directly to the wheel above and to the wheel below, but since it contains no bonding material, the grains remain free after the burning operation and the layer acts to keep the wheels separated as individual units. The next wheel is then laid in and the operation repeated until the retort is filled. As illustrated, the retort has a capacity of twelve wheels. The top wheel is covered with a layer of grains and admixed coke, and there is also advantageously provided a layer of a suitable readily ignitable substance in immediate proximity to said iron wire coil 25.

When the green wheels are formed in layers, I preferably provide two mixtures for that purpose. The first mixture comprises suitable abrasive grains, a prefused vitreous bonding material in finely divided form and in an amount sufficient to effectively bond, when refused, the abrasive grains in the wheel, and a temporary binder. The second mixture comprises grains that are inert at the temperature necessary to re-fuse the vitreous bonding material in the wheel. Such grains may be advantageously be additional abrasive grains of the character employed in the wheel. The second mixture also comprises combustible material, such, for example, as petroleum coke, in suitably weighed proportions to give a controlled degree of heat, and a temporary binder.

Such a green molded wheel is shown in Figure

2 wherein the top layer contains the combustible material and the bottom layer contains the vitreous bonding material. In Figure 3 I have shown still another form of pre-molded green wheel wherein the abrasive wheel containing the vitreous bonding material is surrounded by a molded rim made up of the same mixture as the top layer and, therefore, free from any bonding material.

When pre-molded green wheels of the character shown in Figures 2 and 3 are used in carrying out the process, it will be apparent that they are laid in the retort one directly on top of the other. This facilitates the carrying out of the process in that it avoids the necessity for the detailed attention necessary in filling in and leveling off the individual layers of free grains intermediate the respective individual wheels.

When the retort is packed, the cover 2 is affixed in sealed relation thereto, and oxygen is supplied through the line 15. Suitable means such as a flow meter (not shown) may be provided in the lines 14 and 20 for accurately controlling the rate of flow of air or oxygen through the retort. A switch (not shown) in the spark plug circuit is next closed, which effects ignition in the retort. After ignition has been effected, excess air may be supplied through line 16 in substitution for all or a part of the oxygen being supplied through line 15. The burning takes place very rapidly and can be controlled by the pressure at which the air or oxygen is supplied and the rate of flow thereof through the retort. Ordinarily burning is complete in from twenty to thirty minutes. During this time no heat leaves the retort, and the outgoing gas remains cool and is largely CO₂. Heat does not begin to escape through the retort wall until nearly an hour later. If time is not a factor, cooling is allowed to occur without acceleration and requires from twenty-four to thirty-six hours. By passing a slow stream of air through the retort, the cooling time can be reduced to around eight hours without deleterious effects.

The current difficulty of non-uniformity of wheels from one run to the next is completely overcome in my process. I need employ no temperature measuring instruments of any kind since, by precise measurement of the fuel introduced to the mix and control of the flow of the gas, a consistently uniform product necessarily results.

A further modification of the process contemplates adding to the wheel mixture a substance capable of combining with various metallic oxides forming a bonding substance and then burning the suitable metal. An illustrative example comprises mixing with the abrasive grains both borax and metallic zinc and then burning the metallic zinc with a completely volatile oxidizing agent such as ammonium perchlorate or with gaseous oxygen or air. The resulting zinc oxide forms with borax a vitreous bond for the abrasive grains. This modification is not limited to this particular combination since other metals and other reactive materials, such as sodium silicate, various other silicates, meta and pyrophosphates, and substances of like nature including oxides of non-metals such as silica, may be used.

Having thus described my invention, what I claim is:

1. A process for producing preformed abrasive articles comprising mixing suitable abrasive grains, a previously fused vitreous bonding ma-

terial in finely divided form capable upon being re-fused to effectively bond said abrasive grains, and a temporary binder, molding said mixture into the desired form, placing the resultant green article in a suitable retort and embedding the same therein in a mass of granular material inert at the temperature required to re-fuse said vitreous bonding material, with which granular material there has been mixed a substantially non-residue producing combustible material sufficient in amount to generate, when burned in the retort, adequate heat to fuse said vitreous bonding material in the article, and igniting and burning said combustible material and controlling the cooling of the articles by circulating a current of a gaseous cooling medium through the retort.

2. A process for producing abrasive wheels comprising preparing two mixtures, a first mixture embracing suitable abrasive grains, a vitrifiable bond, and a temporary binder, and a second mixture embracing granular material inert at the temperature required to form a vitreous bond, a combustible material, and a temporary binder, molding a green wheel composed of two layers, one of said layers formed from said first mixture and the other layer from said second mixture whereby one of said layers contains a vitrifiable bond but is free from combustible material and the other of said layers contains combustible material but is free from a vitrifiable bond, stacking a plurality of said molded wheels one upon the other in a retort, and igniting and burning the combustible material in the layers containing the same to generate heat for forming a vitreous bond between the abrasive grains in the juxtaposed layers.

3. In a process for producing preformed abrasive wheels, the steps which comprise preparing a first mixture embracing suitable abrasive grains, a previously fused vitreous bonding material in finely divided form capable of being re-fused to effectively bond said abrasive grains, and a temporary binder, preparing a second mixture comprising granular material inert at the temperature required to fuse said vitreous bonding material, a combustible material, and a temporary binder, and then molding a green wheel in a plurality of layers in such manner that juxtaposed layers are formed from said first and second mixtures, respectively.

4. A process for producing preformed abrasive articles comprising molding a mixture comprising suitable abrasive grains, a vitrifiable bond, and a temporary binder, placing the molded articles in a closed retort wherein the articles are separated one from the other by a granular material substantially inert at the temperature required to form a vitreous bond between the abrasive grains in the articles, providing a dispersed comminuted combustible material in such close juxtaposition to the abrasive grains of the articles that it will, when burned in the retort, generate adequate heat in situ to form a vitreous bond between the abrasive grains of the articles, igniting and burning the combustible material in the closed retort, and, after the combustible material has been burned and a vitreous bond produced between the abrasive grains of the articles, circulating a slow current of a gaseous cooling medium through the retort to control the cooling of the bonded abrasive articles.

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