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METHOD OF MAKING ABRASIVE STRUCTURES.

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To all whom it may concern:

Be it known that I, CHARLES W. THOMAS, a citizen of the United States, and a resident of Glenloch, Chester county, Pennsylvania, have invented Methods of Making Abrasive Structures, of which the following is a specification.

One object of my invention is to provide an abrasive structure such as a wheel, which shall possess a longer life and higher efficiency of action than similar structures now known to the art;—the invention contemplating a novel method of making such abrasive structure and at the same time definitely predetermining its hardness and degree of friability.

Another object of the invention is to provide a method of making abrasive structures whereby it shall be possible to materially reduce the time of their manufacture.

A large part of the time which has heretofore been required for the manufacture of abrasive structures such as abrasive wheels has been consumed in the slow drying and long extended firing and annealing necessitated because of the resistant and non-fluid condition of the bonding material employed, as well as because of the widely different coefficients of expansion of this material and the abrasive grains and also because of the relatively large and unequal change in the volumes during drying, firing and cooling not only of the bond employed but also of the structure as a whole. Moreover the changes in the volume of the materials from which the structures are made do not coincide with each other nor with the changes in temperature to which they are exposed. If any of the various steps of the process of manufacture are carried out in less than a certain time, the structure under treatment will either crack or be subject to such strains as will result in its early destruction or unsatisfactory action under operating conditions. Moreover, as a result of the long continued firing hitherto necessary, the abrasive grains and in some cases the bond, contained in the wheel or other structure, are caused to a greater or less extent to lose their cutting power, especially when they include carbon in their composition and are fired under oxidizing conditions.

Abrasive structures such as those mentioned, fail to give the most satisfactory results under conditions of use because the voids between their grains of abrasive material are irregular in their distribution and are not definitely predetermined as to their sizes, so that the cutting or abrasive power is diminished or made irregular and uncertain and it is difficult to obtain wheels of a uniform hardness and efficiency.

Further, abrasive structures are of lower tensile strength and have a lower range of hardness than is desirable because of the nature of the bonds, such as clay and feldspar, which are employed and which are not best suited to hold together the particles constituting the abrasive structure consistent with maintaining the best abrasive quality in the finished product. On the other hand, if the abrasive structures are so treated with clay or claylike substances above mentioned as to possess the desired tensile strength, they will "glaze", fill and heat under operating conditions, causing friction rather than cutting.

I have therefore devised a method whereby the first of the above noted objections can be overcome and the times required for the different processes of manufacture of abrasive structures can be very materially reduced, for which purpose I make such structures of materials which do not appreciably change their volumes during manufacture. To attain this end I employ substances which have already been exposed to heat conditions similar to or greater than those existing during the manufacture of the abrasive structures, so that practically little or no further shrinkage or change of volume can occur. With this idea in view, the principal raw materials comprising the bond for the abrasive grains are first given a heat treatment such as will cause them to shrink to the fullest extent before they are used in making the abrasive structure.

In attaining the second of the above objects I employ a bonding material which, in addition to undergoing practically no shrinkage during the manufacture of the abrasive structure, is employed in the form of particles of predetermined size or sizes and which during said manufacture, will become fluid and so dispose itself as to cause the voids throughout the finished product to be likewise of predetermined size, disposition, form and number.

In carrying out my invention I prepare a mixture of abrasive grains, such for example as aloxite, and glass in the proportion of 100 pounds of the first of these materials

to 8½ pounds of the second, using as a temporary binder 75 ounces of molasses or silicate of soda. These ingredients are thoroughly mixed so that the resulting mass is of definite, preferably uniform composition throughout and it is then molded in any desired manner as by a pressure of from 1400 to 1500 pounds per square inch;—higher pressures being employed if less friable finished products are desired. It may be molded by other means than pressure if advisable.

The wheel or other structure so formed is then dried for a period which may vary from one to eight or ten hours, depending on its form and size, until it is bone dry, and it is thereafter fired in a suitable kiln or furnace at a temperture of approximately 2000° F. (for above example) for a period which may vary from one minute to five hours, depending among other things on its dimensions. For example, a structure (of the above composition) four inches in diameter and one inch thick, in the form of a disk having a three-quarter inch centrally placed shaft hole, was fired for one-half an hour at a temperature of 2100°, after which it was allowed to cool in the air until its temperature was 1500° F. It was then placed in an annealing oven at a temperature of 1300° F., and in three hours was cooled to the temperature of the atmosphere.

I have found that abrasive structures made as above described have voids which are practically of predetermined size, since while the temporary binder (molasses) is burned out of the structure, the particles of glass become fluid at the temperatures employed, and each of them flows to the corners as well as glazes the sides, of the spaces they occupy, leaving a definite number of cavities of practically determined volumes. If the grains of bonding material are of uniform size, and are distributed with substantial uniformity throughout the entire mass of the finished structure, the voids will be uniform;—it being thus possible to positively control the sizes and numbers of said voids as well as their forms by employing granules of the necessary size, material and shape.

Moreover, since the glass does not appreciably change its volume at the firing temperatures employed, there is practically no shrinkage or variation in the size of the article under manufacture from the time it leaves the press or other molding device until the time it is taken from the annealing oven, and there are therefore no serious strains set up throughout its mass nor any necessity for the more gradual heating and cooling which would otherwise be necessary to avoid its destruction or injury.

The annealing time is also reduced not only because the bonding material and abrasive grains shrink at an approximately uniform rate, but also because in one case the voids are of a substantially uniform size and are distributed with comparative uniformity throughout the mass of the structure.

Again I have found that the best results are obtained when the bonding material not only flows or becomes liquid during the firing but when it chemically combines with the material of the abrasive grains to an extent sufficient to increase the strength, hardness and toughness of said bond material, though obviously without injuring or materially affecting the identity of said grains. While in some cases I employ glass as my bonding material, I may advantageously employ any substance, such as a suitable metal, for example lead, which will liquefy at the temperatures employed and chemically combine with the material of the abrasive grains at a temperature less than that at which they would lose their identity.

Abrasive structures made in accordance with the above process are stronger and more durable than those hitherto made, since during their manufacture they are not subject to the strains resulting from the wedging action due to shrinkage at different times of the clay and feldspar ordinarily constituting the bond, and of the abrasive grains.

Moreover, since on heating the structure after it has been formed according to my invention, the bond softens and liquefies as the temperature rises, and since it remains liquid or plastic through a wide range of temperatures on cooling, there are none of the injurious strains in the finished article which would otherwise require extremely slow heating and cooling to avoid cracking and breakage.

The use of the temporary bond formed by the molasses or silicate of soda constitutes another important feature of my invention, for it not only serves to hold together the mass of raw materials after this has been formed or pressed into the desired shape, permitting it to be handled, dried and fired and maintaining it in such form until the melting of the glass or other material constituting the permanent bond, is complete. Obviously the molasses is carbonized at the firing temperatures and when the glass has melted sufficiently to act as a permanent bond, it may be burned out by causing the kiln to exercise an oxidizing action.

Since for the most part I use bonding materials of such a nature that they chemically combine with the abrasive grains at a temperature below that at which said grains would fuse but which is considerably above that at which said bond fuses, I find that there is a greater or less volatilization of the ingredients of the bonding substance

which leaves it with an increased strength and toughness. Thus in the case of a glass bond, more or less of its ingredients such as calcium and sodium, combine with the abrasive material and with the temporary bond to form compounds which are volatilized at the temperature employed, leaving behind compounds which impart the increased strength and hardness desired.

Obviously if metal such as lead be employed as a bonding material, it may be used in particles of uniform size, number and shape, and when the molded article is fired the lead not only melts and leaves voids of uniform size but it combines chemically with the abrasive grains forming a lead-glass bond. Obviously various sizes of lead particles may be used to predetermine corresponding various sized voids.

I claim:—

1. The method which consists in mixing abrasive grains with a temporary binder, and a permanent binder consisting exclusively of preshrunk vitreous material; forming an object from said mixture; firing said object at a temperature sufficient to cause said permanent binder to flow; and cooling said object.

2. The method which consists in making a mixture consisting exclusively of artificial aluminous abrasive grains, a temporary binder, and a preshrunk vitreous binder; molding said mixture to form an article of definite shape; firing said article to a temperature and for a time sufficient to cause said permanent binder to become fluid and flow to the corners and coat the walls of the cavities between adjacent abrasive grains; and cooling the article.

3. The method which consists in mixing grains of artificial aluminous abrasive with grains of glass of predetermined dimensions and with a temporary binder; molding an article from said mixture; firing the article at a temperature of about 2100° F. until the glass flows to the corners and coats the walls of the cavities between adjacent abrasive grains while leaving complete voids; and cooling the article.

4. The method which consists in mixing grains of an abrasive with a temporary binder and with a preshrunk permanent granular binder; molding said mixture under pressure to thereby form an article of definite hardness; firing the article at a temperature and for a time sufficient to render the permanent binder fluid; and thereafter cooling the article.

5. The method which consists in mixing grains of an artificial aluminous abrasive with a temporary binder and glass particles; molding said mixture under pressure to form an article of definite hardness; firing said article at a temperature and for a time sufficient to melt the glass and cause limited chemical combination of the latter and said abrasive grains; and thereafter cooling the article.

CHARLES W. THOMAS.