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VITRIFIED ABRASIVE WHEEL

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My invention relates to vitrified abrasive forms that are more usually grinding wheels and that are therefore hereinafter referred to as wheels. And the invention relates to the material of which the wheels are made and to the method of and apparatus for treating that material, the invention being concerned with mixes of abrasive grain and binder, with their treatment for an optional storage in bins prior to molding and with their treatment preparatory to molding, as well as to the method of molding and to apparatus for carrying out the molding operation.

A purpose of the invention is to eliminate the need for clay in an abrasive mix.

A further purpose is to avoid the use of hydrous aluminum silicate in an abrasive mix of grain and felspar.

A further purpose is to eliminate or lessen the dangers of silicosis to the users of wheels, by providing wheels free from or low in uncombined silica.

A further purpose is to bond abrasive grains with Portland cement and felspar.

Felspars which are anhydrous silicates of alumina with soda or/and with potassa or/and with lime are now used with clay in abrasive mixes and with and without a temporary bond in the grain-felspar-and-clay mix, but the use of clay has been objectionable, with or without a temporary bond.

The molded wheels containing clay are prior to firing too fragile for ordinary handling without excessive breakage so that it has been usual to include a temporary bond with the grain-felspar-and-clay mix, a temporary bond that has been different with different manufacturers, silicate of soda, different forms of sulfite pitch, starches, sugars and molasses all having been used.

In general, while the temporary bond may correct the too great fragileness before firing it does not correct faults and difficulties incident to the presence of clay whether or not the wheel mix includes a temporary bond and which are no doubt largely or wholly due to the water of hydration in the hydrous aluminum silicate, the main constituent of clay.

This water, chemically bound at low temperatures, is during firing expelled along a wide range of high temperature. Great shrinkages and great tendencies to crack occur during firing so that only very slowly should the temperature of the firing wheel be raised to full firing temperature and only very slowly should the wheel be allowed to cool from the firing temperature. And as a result, it has been very difficult to predeterminedly control the wheels for density and porosity and very difficult to secure uniformity of structure and of porosity throughout individual wheels.

My wheels, molded from grain-felspar-Portland cement-water mixes, without clay, are strong enough for rough and easy handling before firing, do not materially either shrink or crack in either firing or cooling even when quickly fired or/and very rapidly cooled. They are very easily predeterminedly controlled with respect to density and porosity, have a great uniformity of porosity and structure throughout individual wheels and thus are believed to be much superior to the wheels of the prior art.

A further purpose is optionally to incorporate asbestos in a grain-felspar-Portland cement mix.

A further purpose is optionally to incorporate silica in a grain-felspar-Portland cement mix.

A further purpose is to use reclaimed grain and Portland cement mixes, with or without felspar according to the amount of binder in the reclaimed grain. It will be understood that reclaimed grain comprises crushed and ground-up vitrified wheels, a product usually from wheels discarded as imperfect or worn out.

A further purpose is to provide as an article of manufacture or for use as needed abrasive grains coated with binder material.

A further purpose is to coat abrasive grains with a felspar-Portland cement-water mix, optionally storing the coated grains in bins for use as needed and preparatory to molding treating the coated grains with a temporary bonding material of the prior art or, usually more desirably, with a felspar-Portland cement-water mix.

A further purpose is to provide abrasive grains with plural coatings of felspar-Portland cement-water mixes, letting a first coating set before the application of a second coating and preferably using a mix more rich in felspar and less rich in Portland in the first coating than in the second coating.

A further purpose is to secure more uniform and perfect bonding between the abrasive grains of a firing wheel by surrounding the grains with plural coatings of bond material characterized that the material of an inner coating is vitrifiable at a lower temperature than the material of the coating outside the inner coating.

A further purpose is to predetermine wheel characteristics by selective control of the molding pressure or/and by selective control of characteristics of the abrasive mix, with respect to the grain or/and with respect to the bond material, as with respect to the relative proportions of grain and bond, to the composition of the bond and to how the bond is applied to the grain.

A further purpose is to impregnate snagging wheels and other high speed vitrified wheels with a gelatin solution.

Further purposes will appear in the specification and in the claims.

I have elected to illustrate my invention in a few only of its many forms and modifications thereof, selecting for illustration forms that are practical and efficient in operation and which well illustrate the principles involved.

Portland cement is an anhydrous product from firing closely proportioned finely divided limestone and clay and broadly can be thought of as aluminates and silicates of lime in solid solutions with each other. These are thought to be principally alite, thought to be a solid solution of tri-calcium aluminate in tri-calcium silicate, alite being the main water-reactive constituent of the cement, and celite, thought to be a solid solution of di-calcium aluminate in di-calcium silicate and to have little influence on the setting characteristics of the cement in that it appears to be little affected by water.

When water is added to the portland it reacts with both components of the alite, by direct addition to the tri-calcium aluminate and with the tri-calcium silicate to form hydrated lime and hydrated di-calcium silicate. The setting action is thought to be from dissolution of more soluble compounds, resulting in supersaturations and interlocking depositions of crystals, for example of different aluminates and silicates of calcium.

I have found that anhydrous Portland cement and felpsar mixed together in almost any proportion, if heated to vitrifying temperatures, go into solid solutions with each other or otherwise combine to produce fluxed materials appearing to be everywhere uniform.

I have found that these fluxed materials have properties that progressively change with progressive change in the relative proportion of the portland and felspar ingredients; that the fluxed materials from mixes containing successively greater proportions of portland are successively softer, less strong and melt at higher temperatures, and vice versa that the fluxed materials from mixes successively lower in portland and higher in felspar are successively harder, more strong and melt at lower temperatures.

I have found that wheels molded from grain-portland-felspar-water mixes, with quite widely varied proportions of the mix ingredients, after setting are amply strong for handling unfired and that when they are fired their water is expelled and they vitrify without material shrinkage or material expansion and with but little tendency to crack in firing.

I have found that wheel characteristics may be selectively varied by selectively varying the relative proportions of the mix ingredients, with and without varying the molding pressures and with and without an inclusion of one or more other materials with the grain-felspar-portland-water ingredients.

I have found that it is sometimes advantageous to incorporate additional materials with the grain, felspar, portland and water,—for example, it is sometimes desirable to include silica sand with the mix and sometimes desirable to include asbestos with the mix.

An addition of silica sand makes a wheel harder and stronger, probably for several reasons; it is itself somewhat harder than felspar and makes a harder stronger set with portland and water than that made by felspar with portland and water, perhaps from a tendency of the silica to react chemically with lime of the portland or/and from a tendency for the alkali of the felspar to affect the setting of the portland, as by increasing the solubility of its aluminates.

In present practice in the manufacture of wheels silica sand is used extensively for the purpose of decreasing plasticity and it is said to be with a resultant danger to users, danger of silicosis. My wheels are either low in or without free silica and much or all of any silica sand incorporated with the portland is probably chemically bound with lime as silicate after the wheels have been fired.

An incorporation of powdered asbestos is often quite desirable, its use being conducive to greater porosity, more easy handling, greater uniformity at molding and therefore greater uniformity and better balance after firing.

When the grain used is "reclaimed grain," the crushed and ground product from discarded wheels, the grain itself is already carrying the binder incorporated for the manufacture of the discarded wheels so that I use reclaimed grain and portland, with or without felspar according to the amount of binder or flux in the reclaimed grain and that desired in the product.

I may use my grain-portland-felspar mix with and without a temporary binder. The term temporary binder as herein used applies to a solution of organic bond material and the use of a temporary binder with my grain-portland-felspar mix permits quick oven drying after molding. When the mix is molded with water without a temporary binder the molded mix should be let set for a day or two before firing.

If a day or two delay between molding and firing is objectionable I use a solution of dextrine or of other temporary bond instead of water. This permits drying in an oven and thereafter immediate firing, the portland giving a body for the felspar to take hold of, being as it were an anhydrous substitute for the clay of usual practice but free from the many objections incident to the use of clay.

I may puddle my grain-felspar-portland mix with water and pour into a mold, or I may coat the grain with portland, felspar and water, with one coat or with as many coats as needed or desired.

It is anticipated that in usual practice there will be not more than two coats, with an adequate setting of a first coat, preferably not less than for one to two days, before applying a second coating, and with the coated grain usually molded under pressure at once after applying the second coating.

In illustration of coating, the well-mixed dry ingredients—grain, portland and felspar—are slowly tumbled while being sprayed with water, the total water thus sprayed upon the slowly tumbling mass corresponding to perhaps from four to seven per cent of the weight of the dry ingredients.

The mass is now one of coated grains or very small nodules and the mass is ready either for molding or for the progressive setting of the grain coatings.

When applying a second or third coating to grain already coated the process is the same except that the well-mixed dry ingredients are now coated grain, portland and felspar, to be sprayed with water while being slowly tumbled.

The coated grains may be marketed to manufacturers of wheels, the coated grains to be made in grades, from different standard mixes of grain, portland and felspar, mixes selected to best suit their selective use by the manufacturer of the many different commercial grades of wheel.

It is intended that a manufacturer of a specific grade of wheel need only go to a proper bin of coated grain (of which the coatings may or may not include silica sand or/and asbestos or/and reclaimed grain), mix the coated grain with a temporary binder (for example with dextrine solution), mold, dry and fire; or he may mix the coated grain with felspar and portland, spray the tumbling mass with water, mold, set for one or two days and fire.

I have found that with plural coatings it is preferable to have the inner coat vitrifiable at a lower temperature than the outer coat, this appearing to secure better bonding and somewhat greater uniformity with respect to porosity and structure than when the reverse is true.

Thus, suppose it be desired to have 40% total bond in the wheel, 15% as a first coating and 25% as a second coating, desirably the first coating should be relatively high in felspar, for example, three times as much felspar as portland, and the second coating should be relatively high in portland, suitably three times as much portland as felspar.

In the preceding example, the mixture obviously may vary pro and con to a fifty-fifty of portland and felspar.

The porosity of the fired wheels is intrinsically high in that during firing the wheels dimensionally do not materially shrink. The porosity can be selectively varied by varying the percentage of bond and the quantity of water in the bond, the porosity increasing when the bond percentage is raised or/and when the quantity of water in the bond is raised.

Molding pressures may be suitably from two hundred to two thousand pounds per square inch and the wheel porosity appears to be but little affected by even fairly wide change of molding pressure.

In practice wheels are differentiated into high speed and low speed wheels, the high speed wheels operating at about ten thousand surface feet per minute and temperatures seldom higher than three hundred degrees Fahrenheit, and the low speed wheels operating at from five to six thousand surface feet per minute.

I find that my wheels are cooler and faster cutting, both as high speed and as low speed wheels and with both operate perhaps best at speeds somewhat lower than the customary high and low speeds. This characteristic may be due to the high porosity of the wheels.

I anticipate that one of the very big fiields for my wheels is as snagging wheels for snagging castings and billets. Snagging service needs very hard, tough, heavy duty and safe wheels. These are large high speed wheels, today made with Bakelite or other condensation bond.

I find that the high porosity and great hardness of my wheels makes them particularly well adapted to this heavy duty high speed service and that I can moreover greatly increase the strength and toughness of the wheels by impregnating the vitrified wheels with a molten bond.

I have found that gelatin is a material particularly suited to this impregnating service, the strength and toughness of my high porous wheels being greatly increased when the wheels are additionally bonded by impregnating them with gelatin.

As an illustration, I had two of my wheels, six inch wheels, intended to be exactly alike except that one was with and the other without gelatin impregnation, subjected to speed-of-failure tests. The wheel without gelatin impregnation failed at a surface speed of fourteen thousand feet per minute while the gelatin impregnated wheel did not fail at all, even under the highest available speed, twenty thousand surface feet per minute.

To impregnate with gelatin,—flake gelatin may be covered with water, let soak for about fifteen minutes, the excess water poured off and the soaked gelatin melted over a water bath; the wheel is submerged in the molten gelatin and after a suitable period (ten or fifteen minutes may be long enough with my highly porous wheels) the heat is removed and the mass let cool with the wheel still submerged.

The wheel is then removed and after scraping away the adhering gelatin is thoroughly dried in a drying oven at not over 212 Fahrenheit.

Because of the water expelled in drying the wheel interstices are no longer completely filled but the gelatin additional bonding is in all of the original interstices of the wheel and greatly increases the strength and toughness of the wheel.

Having thus described my invention what I claim as new and desire to secure by Letters Patent is:

1. A mix for a vitrified abrasive form and comprising grain, felspar and Portland cement.

2. A mix for a vitrified abrasive form and comprising grain, felspar, Portland cement and asbestos.

3. A mix for a vitrified abrasive form and comprising abrasive grain, felspar, Portland cement and silica sand.

4. An article of manufacture or commerce comprising abrasive grains coated with a set mixture of Portland cement, felspar and water.

5. A mix for a vitrified abrasive form and comprising abrasive grains and plural coatings thereon of which the first coating is set before the application of the second, the first coating comprising Portland cement, felspar and water and in which the second coating includes material vitrifiable with the first.

6. A mix for an abrasive vitrified form and comprising abrasive grains having a plurality of coatings, each coating including Portland cement, felspar and water and with an inner coating having a higher felspar to portland ratio than an outer coating.

7. A vitrified abrasive wheel comprising a vitrified molded mix of abrasive grain, felspar and Portland cement.

8. A vitrified abrasive wheel comprising a vitrified molded mix of abrasive grain, felspar, Portland cement and asbestos.

9. A vitrified abrasive wheel comprising a vitrified molded mix of abrasive grain, felspar, Portland cement and silica.

10. A vitrified abrasive wheel comprising a vitrified molded mix of abrasive grain, felspar, Portland cement, asbestos and silica.

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