United States Patent [19]

Kenagy

[11] **3,808,747**

[45] **May 7, 1974**

[54] **MECHANICAL FINISHING AND MEDIA THEREFOR**

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[73] Assignee: **The Wheelabrator Corporation,** Mishawaka, Ind.

[22] Filed: **May 24, 1972**

[21] Appl. No.: **256,598**

Related U.S. Application Data

[63] Continuation of Ser. No. 44,475, June 8, 1970.

[52] **U.S. Cl.** **51/164.5**

[51] **Int. Cl.** **B24b 31/14**

[58] **Field of Search** 51/164.5, 313

[56] **References Cited**

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Primary Examiner—Harold D. Whitehead

[57] **ABSTRACT**

This invention is addressed to mechanical finishing and media therefor wherein the finishing media are formed of geometric shapes of bauxite particles which have been sintered at a temperature within the range of 2,900°–3,100° F.

2 Claims, 8 Drawing Figures

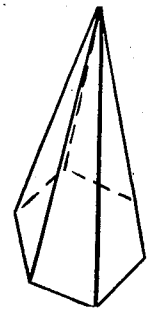


FIG. 1

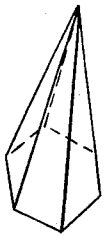


FIG. 2



FIG. 3



FIG. 4

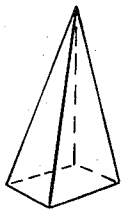


FIG. 6

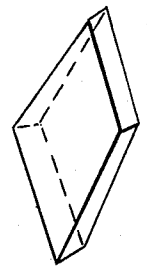


FIG. 7

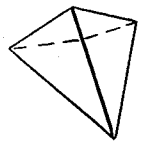


FIG. 5

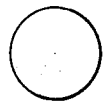
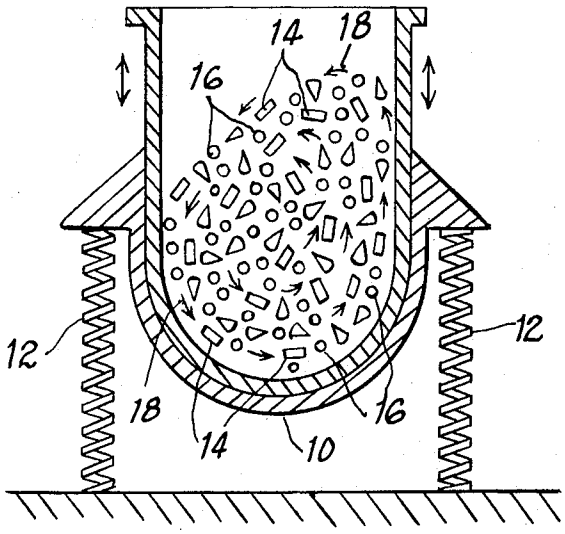


FIG. 8



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MECHANICAL FINISHING AND MEDIA THEREFOR

This is a continuation of application Ser. No. 44,475, filed June 8, 1970.

This invention relates to mechanical finishing of articles formed of metal, plastics, ceramics and the like, and more particularly to media for use in mechanical finishing operations.

The mechanical finishing of articles formed of metal, plastic, ceramic and like materials is frequently effected commercially in mechanical finishing equipment such as rotating barrels or vibratory finishing equipment in which the articles to be finished are subjected to cleaning, descaling, deburring, grinding, radiusing, fine finishing, lustering and burnishing in the presence of finishing media. The articles to be finished are usually placed in the work container with the finishing media, with or without various chemical cleaning additives. Thereafter, the work container is put in motion whereby the media abrade against the articles to thereby provide a finished article.

In order to effect the desired finishing, the finishing media must effect a certain amount of stock removal to provide the desired surface on the finished article, with the extent of stock removal depending upon the original surface condition of the article to be finished and/or upon the desired finish. In any event, an abrasive material must be present as a component of the finishing media and/or as an additive for which the media serve as a carrier whereby the abrasive or cutting action of the media can be controlled within close limits to provide a uniform finish on the articles processed. Control of the abrasive qualities of the finishing media can be achieved by the type and amount of abrasive contained in the finishing media and/or by the type, amount and size distribution of abrasive additives employed in conjunction with the finishing media.

Finishing media containing an abrasive as a component in the media heretofore known exhibit a wear down or attrition rate which is proportional to the cutting or abrasive action they provide. The finish obtainable with such media depends upon the type of abrasive and its grain size as well as upon the amount of abrasive material contained in the media. For example, a vitrified preformed abrasive body containing only coarse abrasive granules wears away quite rapidly and yields a relatively coarse finish. On the other hand, a similar body containing a wide distribution of abrasive particle sizes does not cut as rapidly and provides a finer finish, but will last much longer.

Similarly, finishing media containing only abrasive material, such as random-shape fused aluminum oxide chips which have a large or coarse crystal structure is worn away by attrition quite rapidly and is susceptible to fractures in processing, but yield a coarser finish than similar media containing a very fine, uniform crystal structure.

Finishing media formed of a major portion of a calcined or raw bauxite which has been sintered at high temperatures are known to the art. However, such media have suffered from the disadvantage that none have provided an optimum balance between cutting ability and rate of attrition. Thus, those media which are characterized by a low rate of attrition have insufficient cutting ability, and those having an acceptable

cutting ability are characterized by a high rate of attrition.

Attempts have been made in an effort to overcome the foregoing disadvantage, but without success. For example, it has been proposed to form finishing media to include abrasive fines, such as fused aluminum oxide, to improve the cutting ability. However, such media exhibit an attrition rate which varies in direct proportion to the amount of abrasive fines present, with the result that a high cutting ability is accompanied by a high attrition rate.

It is accordingly an object of the present invention to provide finishing media having improved cutting ability and increased resistance to attrition which are capable of providing a fine finish.

It is another object of the invention to provide new and improved finishing media having a dense, uniformly fine crystal structure having a long usuable life which maintains its original configuration over extended periods of use.

It is a further object of the present invention to provide new and improved finishing media and a method for their preparation wherein the finishing media are characterized by a long life, improved shape retention characteristics and increased resistance to fracture in processing and use.

It is yet another object of the present invention to provide new and improved finishing media and a new and improved mechanical finishing process for using same wherein the finishing media are susceptible to use, with or without chemical and processing additives, in high energy processing equipment.

These and other objects and advantages of the invention will appear hereinafter, and, for purposes of illustration, but not of limitation, embodiments of the invention are shown in the accompanying drawings.

FIG. 1 is a view of the configuration of one embodiment of finishing media embodying the features of the present invention;

FIG. 2 is a view of an alternative shape of finishing media of the invention;

FIG. 3 is a view of another shape for media of the invention;

FIG. 4 is a view of yet another shape for media of the invention;

FIG. 5 is a view of spherical media embodying the features of the invention;

FIG. 6 is a view of yet another configuration of media of the invention;

FIG. 7 is a view of another configuration for media of the invention; and,

FIG. 8 is a schematic diagram of a finishing process according to the invention.

The concepts of the present invention reside in preformed all-abrasive finishing media formed of geometric shapes of bauxite which have been sintered at a temperature within the range of 2,900° to 3,100° F. It has been found that finishing media prepared in this manner exhibit a high resistance to wear by attrition and yet provide exceptional cutting ability as compared to finishing media heretofore formed of mixtures of bauxite and aluminum oxide. The media according to present invention will also yield finer finishes than obtainable with ano other all-abrasive preform. In addition, finishing media embodying the concepts of this invention have significantly improved mechanical properties, such as increased tensile strength, which enables use to

be made of the finishing media of the invention in high energy finishing equipment without significant fracture of the media. Since media according to this invention are equally suitable for fast cut, fine finish and good metal coloring and burnishing, and still look equally well on all metals and alloys, they are truly all-purpose media.

In accordance with the practice of the invention, the media are prepared by first reducing bauxite, which can be in the form of raw bauxite, but is preferably bauxite which has been calcined in accordance with conventional procedures, to a particle size within the range of 3–20 microns. The reduction in the grain size is preferably achieved by ball milling, but it will be appreciated by those skilled in the art that other methods of reducing the particle size may similarly be employed.

Thereafter, the pulverized bauxite particles are formed into the desired geometric shape, sintered by heating to a top temperature between 2,900° F and 3,100° F., holding such temperature for 0.1 to 5 hours. This sintering temperature and time are dependent on the properties of the bauxite and may vary as the physical and chemical properties of bauxite vary.

The preformed geometric shapes which are to sintered under the foregoing conditions can be formed by any of a variety of provedures known to those skilled in the art including, but not limited to extrusion, molding, die pressing or casting. In accordance with the preferred procedure, the pulverized bauxite particles are admixed with a small amount of a fugitive binder component which burns out during the sintering process to leave bauxite as the only component in the body. Binders which will burn out during the sintering process are well known to the art, and are represented by polyvinyl alcohol. However, other binders such as bentonite and-/or a variety of other clays mixed with water can also be used in accordance with the practice of the present invention, but do not burn out during the sintering process.

The binder component may be used in the form of a liquid or a powder, and in an amount sufficient to maintain the preformed geometric shape as a coherent mass prior to the sintering operation. For this purpose, the amount of the binder can be varied within wide ranges, although best results can be achieved when the binder component is present in the mass in an amount up to 10 percent by weight binder, and preferably up to 3 percent by weight. If desired, pressures up to about 100 psi may be used to compact the bauxite particles in the preformed bodies prior to sintering, although pressure is not required.

It will be understood by those skilled in the art that the new and improved finishing media of the invention can also be preformed without the aid of a binder component by a variety of techniques, such as by dry pressing the bauxite particles in die forms or the like at pressure up to about 100 psi. After the shapes are formed by die pressing, they are then sintered at the temperature described. However, it is generally preferred to form the shape with the aid of one or more of the binders described since sintered bauxite bodies preformed with the aid of a binder have superior porosities and crystal structures, thereby providing finishing media having increased tensile strength and wear life.

After the preformed bodies have been sintered, they are allowed to slowly cool in a conventional manner to avoid fracture from sudden cooling. Thereafter, it is frequently desirable to condition in a vibrator, tumbling barrel or the like to remove sharp edges and/or any extraneous matter adhering to the shapes as a result of the forming process.

The finishing media can be formed of any of a variety of geometric shapes. For example, the media can be in the form of spheres, cubes, cones, polygonal pyramids including pyramids having triangular, square, pentagonal, hexagonal, heptagonal, octagonal, etc. shaped bases. In accordance with the most preferred embodiment of this invention, the novel finishing media are formed with a hexagonal pyramid configuration.

Finishing media having a hexagonal pyramid configuration are particularly preferred in the present invention since this configuration provides a series of flat surfaces which offer more contact points with the stock to be processed to thereby increase the rate of cutting, and yet minimize the attrition caused by the wear of media on other media. In addition, the hexagonal pyramid configuration provides a maximum anti-wedging effect whereby media having this configuration can enter a hole, crevice or other opening in the stock to be finished by more than half of the distance in height of the media without becoming wedged in the opening. As the stock is turned in processing or in being discharged from the work container, the configuration of the media cause them to simply fall out of the opening in the stock since the center of gravity of the pyramid is near the bottom thereof. Furthermore, the tapered sides of the hexagon offer less wedging surface as compared to other geometric shapes. Because of the anti-wedging effect exhibited by the hexagonal configuration, it is necessary to provide only a few sizes of media for a wide range of applications.

A hexagonal pyramid finishing body embodying the concepts of the present invention is illustrated in FIG. 1 of the drawings. In accordance with the most preferred embodiment of the invention, the ratio between the height of the pyramid and the length of the longest diagonal or the base, as represented by a diagonal line from point 1 to point 2 on the base, is within the range of 0.1 to 4, and preferably 0.8 to about 1.2. Pyramids having a base diagonal of 0.5 to 2 inches are preferred, but it will be understood that the invention is not limited to such sizes.

Other suitable configurations are shown in FIGS. 2 to 6. For example, the media can have a cone configuration as illustrated in FIG. 2, a triangular pyramid as illustrated in FIG. 3, a rectangular pyramid as in FIG. 4, a sphere as in FIG. 5 and a diamond as in FIG. 6. The same size considerations described above with reference to the hexagonal pyramid are similarly applicable to the configuration of FIGS. 2 to 4. Use can also be made of a triangular pyramid of the type shown in FIG. 7 wherein all sides *a*, *b*, *c*, *d* and *e* are equal. It will be understood that a variety of other geometric configurations as well as random configurations may similarly be used instead of those specifically described.

In use, finishing media embodying the features of the present invention are placed into a work container with raw stock to be finished, and the work container is set in motion, as by vibration and/or rotation. Refering more specifically to FIG. 8, there is shown a schematic illustration of the method of the invention using apparatus of the vibratory type. The work container or tub 10 is fixed for vibration on mounting means 12. Thus,

after the media or raw stock have been placed into container **10**, the container is subjected to controlled vibration whereby the contents of the container are continually agitated. The constant agitation of the parts and media produces a scrubbing action that operates on all portions of the raw stock simultaneously. The motion of the vibrator contents are generally indicated by arrows **18**.

It will be understood by those skilled in the art that various other mechanical finishing apparatus may be used in lieu of the vibratory apparatus described above. For example, use can be made of tumbling and rotating barrels, centifugal equipment and the like. Apparatus of this type all produce agitation of the contents of the work container to thereby provide the desired abrasion for finishing the stock material.

The finishing operation may be carried out by agitating the raw sotck and the media alone, although it is generally preferred to include a liquid or powdered suitable compound (combination of chemical additives) to provide the desired control of the finish and to insure thorough flushing of abrading material from the stock being finished. Water is usually present for this purpose.

To further enhance the cutting ability of the media and to facilitate control of the finishing operation, it is frequently desirable to include in the work container an auxiliary abrasive. Varions abrasive or polish preparations are available for this purpose, and include Lorco abrasives, such as Lorco HS-9-3, Lorco 3X-2 and Lorco Lustre All. Lorco HS-9-3 and Lorco 3X-2 are compositions containing varying amounts of aluminum oxide abrasive, silica flour, borax, soda ash, wetting agent, white soap, sodium and combinations of phosphate salt, viscosity builders and rust preventatives. Lorco Lustre All is a burnishing compoistion and generally contains soap and wood flour. Various other commercially available preparations and burnishing compositions in powdered or liquid form which are well known to those skilled in the art may be used in lieu of those specifically described. The agitation of the owrk container is carried out over varying periods of time, generally within the range of 1 minute to 5 hours, depending upon the extent of stock removal desired, the condition of the raw stock prior to finishing and the surface desired on the finished stock.

Having disclosed the basic concepts of the invention, reference is now made to the examples which are provided by way of illustration, and not by way of limitation, of the invention.

EXAMPLE 1

Calcinated bauxite is ball milled to provide bauxite particles having a maximum cross section within the range of 3–20 microns. Thereafter, 100 parts by weight of the bauxite particles are thoroughly mixed with 1 part by weight of polyvinyl alcohol and 2 parts by weight water. The resulting mixture is then slip cast in the form of a hexagonal pyramid in plaster of paris mold to facilitate rapid absorption of the water.

Thereafter, the bauxite body is removed from the mold, and sintered at a temperature of 3,000° F. for a period of 1 hour. The preformed finishing media are then allowed to cool slowly, and are conditioned in a vibratory finishing apparatus for 15 minutes. Substantially no polyvinyl alcohol is found in the resulting body.

EXAMPLE 2

The procedure of Example 1 is repeated except that the polyvinyl alcohol binder is replaced by bentonite which is present in the mixture prior to sintering in a ratio of 2.5 parts by weight of bentonite per 100 parts by weight of bauxite.

EXAMPLE 3

The procedure of Example 1 is again repeated except that the binding component is polyvinyl alcohol which is employed without the use of water. In this example, the polyvinyl alcohol is employed in an amount corresponding to two parts by weight of polyvinyl alcohol per 100 parts by weight of bauxite particles.

EXAMPLE 4

Raw bauxite is ball milled to provide fine bauxite particles having a size distribution within the range of 3 to 20 microns. The resulting particles are placed in a die form having a hexagonal pyramid configuration, and dry pressed at 85 psi.

Thereafter, the preformed bauxite body is removed from the die form and sintered at 3,050° F. for 3 hours. It is found that media formed in this manner have a somewhat greater porosity than those prepared with the aid of a fugitive binder in Examples 1 and 2. Such porosity can be significantly reduced by wet extrusion followed by die pressing.

EXAMPLE 5

The procedure of Example 1 is again repeated except that the plaster of paris mold has a rectangular pyramid configuration.

EXAMPLE 6

This example illustrates the use of finishing media prepared in accordance with the procedure set forth in Example 1.

22 runs were made using hexagonal pyramid media having a diagonal length of 1.5 inches and a height of 1.5 inches in a heavy duty vibrating finishing machine having a net load capacity of 18 cu. ft. The runs were carried out on "raw" bicycle crank forgings formed of hardened steel and requiring an average of 0.016 to 0.020 inches of stock removal for polishing prior to chrome plating to provide an acceptable plating surface. Of the 22 runs, 13 were made using 240 pieces of large bicycle crank forgings in each run, and in the remaining 9 loads, 300 pieces of smaller bicycle pedal cranks were used. Thus, a total of 3,120 large crank forgings and a total of 2,700 smaller forgings or a sum total of 5,820 crank forgings were used.

The runs were carried out by first agitating the media and stock containing 8 lbs. of Lorco HS-9-3 in 5 gallons of water for 2 hours. Thereafter, the stock and media are recycled for 5–10 minutes to facilitate flushing of abrading material from the parts and media. Thereafter, the stock is fine finished for 30 minutes in the presence of 5 lbs. of Lorco 3X-2 in 5 gallons of water in the presence of the same media, followed by recycling for 5–10 minutes.

The stock material is then burnished for 15 minutes in the presence of the media and 2 lbs. of Lorco Lustre All in 5 gallons of water. Thereafter, the resulting stock material is recycled and unloaded from the work container.

The media attrition rate for these 22 runs using media embodying the concepts of the present invention is 568 lbs., or 25.82 lbs. per load. When precisely the same procedure is carried out using the best available microcrystalline fused aluminum oxide chip, the attrition rate is found to be 67.5 lbs. per load. It is therefore apparent, that the attrition rate of media of the present invention is less than half the attrition rate for media heretofore known. It is estimated that, because of the efficacy of the media of the present invention, the time required for the initial cutdown can be reduced by at least ½ hour. In addition, the resulting finished products are found to have a substantially better finish which is also reflected in the superior plated surface formed thereon.

EXAMPLE 7

The procedures utilized in Example 6 are repeated in this example except that of the 22 runs made, 15 runs were made using 240 pieces of the large pedal cranks in each run, and the remaining 7 runs were made with 300 pieces of the smaller pedal cranks. Thus, a total of 3,600 large forgings and 2,100 smaller forgings were finished, to provide a sum total of 5,700 forgings processed.

The amount of media initially used in the work container is 1,535 lbs., which amount was maintained at a fairly constant rate throughout the 22 runs. The media attrition for these runs is found to be 450 lbs., or 20.45 lbs. per run.

After the runs are completed, the media are examined and not one fractured piece is discovered.

EXAMPLE 8

This example illustrates the use of the media remaining after the completion of the 22 runs in Example 1.

Approximately 1,545 lbs. of the media returned from the runs described in Example 3 are employed in processing aluminum and zinc die casts in the form of gasoline pump hose nozzles wherein the finishing involved is deburring, radiusing, and burnishing, which is carried out in a vibratory container having a net capacity of 6 cu. ft.

Excellent results are obtained in that the cutting action of the media is much faster than is obtainable with media heretofore available. When the supply of media is exhausted, it is established that the media retain their original configuration over a long wear life. When the individual media had become too small for use, they nevertheless existed in their hexagonal pyramid form.

It will be apparent that I have provided new and improved finishing media and a method for their preparation wherein the media are characterized by superior cutting ability and high resistivity to attrition. In addition, the media of the present invention are resistant to wedging in openings in the stock material being processed, and retain their desired configuration throughout their wear life.

It will be understood that various changes and modifications can be made in the details of formulation, procedure and use, without departing from the spirit of the invention, especially as defined in the following claims.

I claim:

1. Finishing media formed of a body having a hexagonal pyramid configuration in which the ratio of the height of the pyramid to the length of the longest diagonal of the base is within the range of 0.1 to 4, with the body consisting essentially of calcined bauxite particles having diameters within the range of 3 to 20 microns which have been sintered at a temperature within the range of 2,900° to 3,100° F.

2. A method as defined in claim **1** wherein the ratio of the height of the pyramid to the length of the longest diagonal of the base is within the range of 0.8 to 1.2.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,808,747 Dated May 7, 1974

Inventor(s) WILLIAM L. KENAGY (S.N. 256,598)

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Colume 5, line 28, change "Varions" to -- Various --.

Signed and sealed this 22nd day of October 1974.

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents