FREE GRAIN POLISHING PROCESS AND APPARATUS

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FIG. 3

FIG. 4

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FREE GRANULAR POLISHING PROCESS AND APPARATUS

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The present invention relates to process and apparatus for surface polishing and has for a principal object the provision of a unique high production process for deburring, polishing and buffing all types and shapes of articles.

A further object is the provision of a high production and low cost machine having the necessary strength and durability for long and hard usage.

Another object is the provision in such a machine of polishing medium having complete flexibility and adaptability to every possible position, portion and contour of a work piece. More particularly, each work piece is located in a polishing aggregate which conforms to the contour of the work piece while pressuring and polishing the same.

In accordance with a preferred embodiment of the present invention, centrifugal force is utilized to apply pressure between the abrasive material and the work being finished.

Preferably a sliding movement is effected between the work piece and the abrasive material which produces a cutting or scratching action with a minimum of impact and a maximum of sustained sliding pressure.

A primary advantage of the invention is that the relative movement between work piece and abrasive is slow and produces a minimum of heat while the absolute movements of both the work piece and the abrasive may be extremely rapid and productive of centrifugal forces therebetween of the order of several to several hundred g's.

The present invention should not be confused with prior art processes and equipment. In one such prior art apparatus, a drum containing abrasive material is rotated at a relatively high rate of speed thereby throwing the abrasive to the outer wall of the barrel and the work piece is plowed through the compacted material.

Another such method involves rapidly moving a work piece through abrasive particles in a barrel.

Still another process involves tumbling work pieces and abrasive material in a barrel.

However, under these three methods there may be excessive impact between the work pieces and the abrasive. Lacking is the sustained high pressure and slow movement between work and abrasive particles characteristic of the present invention which causes the abrasive material to scratch and abrade the surfaces of the work pieces. Thus, the present invention causes the abrasive particles to cut and remove the surface of the work piece rather than pounding the surface or otherwise causing the surface material merely to flow.

According to the present invention, the work pieces are placed within a drum or other suitable vessel which contains small solid particles of abrasive material, such as emery, pumice or rouge, flour, ground corn cob, sawdust, scraps of leather, cloth, or the like, pellets of rubber or plastic, or any of a wide variety of particulated materials found suitable.

The drum is rotated at high speed to compact the particulated material by centrifugal force. This high speed rotation may be affected about the axis of the drum or about an axis displaced therefrom. Because of the large forces required, the apparatus preferably is in or close to dynamic balance. Preferably, a cylindrical drum of circular cross section is employed. However, various polygon cross sections may be selected. Where the centrifugal force is created by rotating a drum about an axis spaced from the axis of the drum, it is desirable to provide an additional drum or other counterbalancing weight on the opposite side of the axis about which the drum is rotated.

It is a feature of the invention that the surface of the work piece, which is to be polished, is moved through the centrifugally compacted abrasive particles at a very slow relative speed.

In accordance with the present invention, the slow relative movement between work piece and abrasive may be effected in a variety of ways.

As examples, the work piece may be mounted on the drum or on a turret plate and rotate with the drum. Where the work piece is mounted on the drum, the mounting may provide for rotary, oscillatory, reciprocating or other movement, or combination thereof between work piece and drum. When a turret is employed, the turret may be rotated at a slightly different speed than the drum to provide the desired small relative movement between the work piece and the abrasive in combination with centrifugally compacting the abrasive through which the work piece is moved.

The invention also contemplates that a turret plate on which a work piece is mounted within the drum may be rotated about an axis coinciding with the axis of rotation of the drum, or spaced therefrom and either parallel or angularly disposed thereto so as to effect various relatively slightly movements of the work piece in the abrasive while both are being moved at the high speed required to compact the abrasive and create the cutting pressure between abrasive and work piece characteristic of the invention.

It will be understood that the mounting arrangements herein described may be employed in various combinations to impart a desired movement of the work piece within the pressurized mass of abrasive particles.

It also will be apparent that a number of work pieces may be finished concurrently within the abrasive.

The invention also contemplates that the necessary movement of the work piece in the abrasive material may be effected with the work piece freely movable therein. In the latter case, it frequently is preferable that only a single article be located within a compartment containing abrasive. It has been found that a plurality of articles free in the same compartment may injure each, particularly if they are large and relatively weak. Moreover, a drum may be divided into a plurality of separate compartments each containing abrasive particles and preferably a single work piece.

The dividers may be perforated so that the contents, except for the work piece, may freely migrate among the several compartments. Movement of the free work piece in the compacted abrasive may be effected in various ways. As an example, the centrifugal or other compacting force may be progressively or periodically shifted with respect to the work piece, or the abrasive material, or with respect to both. Thus, in a preferred embodi-
The drum is rotated rapidly about a first axis to compact the contents and rotate about a second axis spaced from the first axis so as to shift the compacted material and the work piece within the drum. Preferably, the mass of the work piece is substantially greater than that of the individual particles of abrasive materials, so that the work piece moves through and over the tightly compacted abrasive and is sharply cut and abraded under high pressure without impact shock.

Characteristics of the invention are that the abrasive closely conforms to and polishes all protruding and non-protruding surfaces of the work piece over which the abrasive flows. Movement of the work piece in the abrasive may be restricted by the compartment, or by guides therein, or both, or by the mounting so that the cutting is concentrated on selected surfaces of the work pieces and in selected directions along the work piece.

It is a primary feature of the invention that the abrasive closely conforms to the surfaces of the work piece without cavity despite the high speeds utilized to compact the confined abrasive material under pressure and despite the relative movement between abrasive and work piece. The abrasive cuts and finishes the work piece surfaces against and over which it flows. The flow of abrasive along the work piece preferably is restricted to a relatively slow speed which produces maximum cut.

The centrifugal forces employed to apply pressure between the abrasive and work piece lock the abrasive medium in position so that there is a minimum of rolling of the particles against the work piece surfaces. If desired, the drum of a turret-type machine may contain a plow to keep the abrasive material thoroughly mixed. The plow preferably rotates only sufficiently out of phase with the drum to effect the mixing. Generally, however, such a plow is unnecessary because of the mixing action which is effected on the abrasive material by movement of the work piece therein and by stopping and starting rotation of the drum. A thorough mixing of the abrasive is continually effected without a plow when the drum is rotated about a first axis for centrifugal force and about a second axis to continually or periodically shift the contents within the drum.

The invention provides unique process and apparatus for surface polishing small and large articles of irregular as well as regular surface contour. The invention also provides for effectively polishing all surface portions, both internal and external, cavities and grooves expeditiously and economically.

Illustrative embodiments of the invention are described with reference to the accompanying drawings, in which:

FIGURE 1 is a plan view of apparatus in which work pieces are freely moved within centrifugally compacted abrasive medium in accordance with the invention;

FIG. 2 is an elevation view partly in cross-section of the apparatus shown in FIG. 1;

FIG. 3 is a cross-sectional view of a second embodiment of the invention in which work pieces are mounted for movement within centrifugally compacted abrasive material; and

FIG. 4 shows a multi-compartment drum having a side opening.

Referring to FIGS. 1 and 2, a main frame structure generally designated 10 provides support for two spaced bearings 11, 11 in which a shaft 12 is journaled for rotation by any suitable drive, the drive pulley 13 being merely illustrative.

Secured to the shaft 12 for rotation therewith is an impeller 14 at the opposite ends of which a pair of drums 15, 15 are journaled for rotation about their individual axes which are equally spaced from and parallel to the shaft 12.

In the embodiment illustrated in FIGS. 1 and 2, each drum is secured to a lower individual stub shaft 16 that is rotatably journaled in a bearing 17 in the impeller 14. Secured to each stub shaft 16 are individual sprockets 18, 18 which are driven by individual chains 19, 19 from a three-step drive sprocket 20 rotatably journaled on the shaft 12.

In accordance with the present invention, the sprocket 20 is driven at a speed selected to rotate the drums 15, 15 about the axis of the shaft stubs 16, 16 while the drums are rotated about the first axis by centrifugal force, and over the abrasive that is rotatably journaled in the ends of a second impeller 21 that is movably secured to the upper end of the shaft 12, as by cap bolt 25, and to the lower impeller 14 by cross ties 26, 26 and cap bolts 27, 27.

The size of the drums may vary depending upon the size of the work pieces that are to be finished. However, it has been found that a wide variety of sizes and shapes of work pieces can be polished in the same drum.

While the drums 15, 15 are illustrated as circular in cross section, it has been found that various polygonal cross sections also are suitable and sometimes preferable.

In operation, the impeller 14 is rotated at a selected speed by centrifugal force on the material in the drums in a range of from a few to several hundred g's. Merely as illustrated, a force of approximately fifty g's has successfully polished a multitude of articles of widely different shapes and forms of different metal and plastic materials.

Consequently, the sprocket 20 is driven so as to shift and change the portion of each drum 15, 15 which is outermost and thereby cause the contents to shift and the work piece to move through and against the compacted abrasive material under pressure and thereby be cut and finished.

In one embodiment, the axes of eleven inch diameter drums were located twelve inches from the axis of shaft 12, which were rotated at approximately 400 r.p.m. while the drums were rotated about their own axes at approximately half that speed. Gear ratios of impeller to drum speeds also have proved advantageous. The two centrifugal forces acting on the work piece and the material cooperate to effect a particularly satisfactory finishing action on the work surfaces. Apparently, it is desirable to maintain high centrifugal forces on the work pieces through the highly centrifugally compacted polishing media.

Preferably the drums 15, 15 are lined with layers 28 of rubber or other relatively soft material which has a high friction coefficient that prevents sliding and imparts a smooth, flowing caterpillar tread-like movement to the abrasive media in the drums.

The lining 28 may be suitably anchored against movement relative to the drum wall 15' by integral rubber lagging 28 molded into spaced opening 30 through the wall.

While the drums 15, 15 are illustrated as top-loaded, the invention contemplates, as shown in FIG. 4, that drums 15a may be used having a plurality of compartments 31, 31 which are separated by divider plates 33 that may have holes 32 through which the abrasive material, but not the individual work piece, in each compartment may move. As shown in FIG. 4, access to the several compartments 31, 31 for loading and unloading abrasive and work pieces is through a side door 34.

While in the embodiment shown in FIGS. 1 and 2, the drums are rotated about a vertical shaft, it will be appreciated that the apparatus also may be mounted so as to locate the shaft 12 and the drums 15, 15 for rotation about horizontal or other axes.

It also will be appreciated that a work piece W may be processed in successive passes with abrasive material of
progressively greater fineness until a desired finish is achieved.

Because of the heat generated, it generally has been found preferable to employ dry abrasives. However, damp and wet abrasive mixtures have been successfully used.

Referring to the embodiment shown in FIG. 3, a frame 40 in which a hollow shaft 41 is journaled for rotation by a suitable drive generally is designated 42. Secured to the shaft 41 for rotation therewith is a drum 43 which is additionally supported for rotation by bearings 44 in the frame 40. A removabley secured cover 45 provides access to the interior of the drum.

Extending through and rotatable with the hollow shaft 41 is a hollow shaft 46 which extends into the drum 43. Secured to the end of the shaft 46 within the drum 43 is a turret generally designated 47 on which are mounted a plurality of work piece holders, each of which is generally designated 48.

Each holder 48 is intended to carry and move one or more work pieces 49 through abrasive material in the drum. As shown in FIG. 3, each holder 48 includes a spindle 51 which is journaled for rotation in the turret 47 by means of bearings 52 and may be rotated or oscillated as by a chain and gear drive 53 from a third concentric shaft 54.

In operation, the drum 43 is rotated to thoroughly compact abrasive material therein by centrifugal force. The turret 47 may be rotated at a slightly different speed than the drum 43 so that a work piece on each holder 48 is moved at a sufficiently slow relative speed against the compacted abrasive material so as to cut the surfaces of the work pieces without impact or cavitation. The invention also contemplates that the holder spindles 51 be rotated or oscillated to rotate or rotate the work pieces, which are removably mounted thereon, while the turret 47 moves the work pieces against the compacted abrasive.

The invention also contemplates movement of the work pieces relative to the drum by means of the turret without rotary or oscillatory movement of the spindles. While several embodiments of the invention have been illustrated and described, it will be understood that they are primarily illustrative in character and that numerous modifications may be made within the scope of the invention defined by the foregoing claims.

Figuring of the work is required. Free action of the work against the compacted abrasive material produces a non-directional finish which is particularly desirable. The work moves at all different angles and positions against the abrasive to effect the non-directional finish.

If necessary, larger neutral particles may be included in the abrasive material to impart non-directional orientation and movement of the work pieces relative to the abrasive. This disoriented movement may be further augmented by bumpers or the like within the drum.

The invention further provides that the work may be fixtured and given a directional or oriented finish where desired. In a preferred form, the drum is rotated at high speeds about a plurality of axes in a manner such that the g's created by the centrifugal forces of rotation about one axis preponderate the g's created by the centrifugal forces of rotation about another axis and effect a catarpillar tread-like movement of the abrasive material relative to the drum against the work while both centrifugal forces are continually exerted on the contents of the drum.

Valve venting of the drum may be provided to dissipate the internal pressures arising from expansion of gases by the heat generated in the polishing action. The individual compartments of the drum and the work piece may be secured to, or mounted for rotary, oscillatory or other movement on the drum. Thus, the relative movement between work piece and abrasive may be effectuated solely by shifting of the abrasive in the drum without movement of the work piece relative to the drum, or in combination with the limited movement provided by the selected mounting of the work piece on the drum.

While movement of a work piece against the compacted material necessarily displaces the material, the displacement is only momentary and without appreciable cavitation inasmuch as centrifugal action forces the abrasive immediately into incipient voids created by movement of the work piece within the abrasive. The outward pressing of the abrasive on the work assures strong finishing action as the work piece is moved angularly to the lines of pressure.

I claim:

1. Apparatus for finishing the surfaces of articles, said apparatus comprising a cylindrical rotary drum, a resilient surface on the inner peripheral wall of said cylindrical drum having a high coefficient of friction and non-slipably engageable with particulated abrasive material in said cylindrical drum, means for rotating said drum about a first axis to compact the particulated abrasive material and an article against the said peripheral wall by a first centrifugal force, and means for rotating said drum about a second axis spaced from said first axis the rotation of the drum about the second axis being not greater than approximately one-half the speed of rotation about the first axis to exert a second centrifugal force on the contents of said drum, said second force being sufficient to modify said first force and shift the contents of the drum along the peripheral wall thereof with a catarpillar tread-like motion substantially free of sliding movement on said peripheral wall and while retaining the shape of the mass of compacted material within the drum.

2. Apparatus as recited in claim 1 and including drum divider means for segregating the articles from each other in the drum and said articles having substantially greater mass than the individual parts of abrasive material and the surfaces thereof being cut and finished by movement of the compacted abrasive against said surfaces.

3. The method of finishing the surface of articles which comprises rotating the articles together with a mass of loose particulated abrasive material in and with a drum about a first axis to compact said material by centrifugal force against the peripheral wall of the drum and the articles in and against the compacted material counterclockwise rotating the drum about a second axis spaced from the first axis and at a speed not greater than approximately one-half the speed of rotation about the first axis, so that the compacted material moves about the inner peripheral surface of the drum at substantially free of sliding movement therewithwhile retaining the shape of the compacted mass and moving the articles to be finished against said compacted materials substantially free from impact and cavitation, the absolute movement of the articles being with and substantially the same as the movement of the abrasive material and said material and articles being subjected to substantially the same centrifugal forces.

4. The method recited in claim 3 and wherein the articles are freely movable with the abrasive material within the drum.

5. The method recited in claim 3 and wherein the articles are securely mounted for movement with the drum and move therewith.

6. The method recited in claim 5 and wherein the articles also are moved relative to said drum.

7. Apparatus for finishing the surface of articles, said apparatus including a rotary drum, the inner peripheral wall of said drum having a high coefficient of friction and non-slipably engageable with particulated abrasive material in said drum, partitions dividing said drum into individual compartments for the substantially free of sliding movement, means for revolving said drum about a first axis to compact particulated abrasive material and an article in each
compartment against the peripheral wall, and means for effecting relative movement between the abrasive material and article in each compartment while said material and articles are compacted under pressure.

8. Apparatus as recited in claim 7 and wherein said partitions separate said articles from each other while the compacted articles and materials are moved relative to each other.

9. Apparatus as recited in claim 7 and wherein said partitions restrict the article in each compartment to a selected pattern of movement.

10. Apparatus as recited in claim 7 and wherein the interior of the drum has a resilient coating.

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