METHOD OF SURFACE FINISHING ARTICLES

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ATTORNEYS
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This invention pertains to the art of metal finishing. More particularly, it relates to ways and means for surface finishing articles as by deburring, scrubbing, abrading, or the like. In fabricating metallic parts and the like, it frequently happens that burrs and rough surfaces are formed on the articles. One procedure for removing burrs and roughness of the surfaces of the articles is by barrel finishing. This procedure involves a barrel and abrasive particles inside of the barrel. The articles to be surface finished are placed in the barrel and the barrel is rotated on its axis whereby both abrasive particles and articles are tumbled together. This procedure cannot be used, however, on many articles because of their fragile nature. The tumbling action involved is inherently too rough and hard on such articles. In other instances such a procedure is not too effective because of the shape of the article to be finished. The abrasive particles in such instances do not appear to reach or at least to have any effect on burrs on edges somewhat shielded from the abrasive particles under tumbling conditions.

In both cases it has been necessary to manually deburr each individual article. This, of course, is inefficient and expensive. There is a need, therefore, for ways and means for mechanically deburring and surface finishing articles of a fragile nature and of odd shape.

An object of this invention is to provide ways and means for mechanically deburring or surface finishing articles regardless of their fragility and regardless of any irregularity in shape.

A specific object of this invention is to provide a method for surface finishing articles, which involves gentle action. Another specific object of this invention is to provide a method for surface finishing articles which, under barrel finishing procedures, would remain relatively unaffected.

The method is based on the general concept of forming a bed of particles which are abrasive relative to the articles to be finished, placing articles to be finished in said bed and establishing and maintaining said particles in motion relative to the articles to be finished.

In addition to this general concept, this invention involves the further concept of gently turning over articles in said bed so that all edges thereof are exposed to abrasive particles moving relative thereto.

A specific concept relied upon in the method of this invention is that of establishing and maintaining relative motion between abrasive particles and articles to be finished by subjecting said bed and articles therein to vibratory conveying forces. In this concept it is necessary that the average mass of the abrasive particles differ from the average mass of the articles to be finished.

A further concept involved in the method of this invention is that of the vibratory conveying forces being applied to cause particles and articles in said bed to generally travel in one direction and in the path of travel of said particles and articles providing a deflecting surface which causes particles and articles to circulate in said bed and thereby cause articles in said bed to be gently turned over.

Still another method concept involved in this invention is that of removing finished articles and abrasive particles from the bed, separating the finished articles from the abrasive particles and returning the abrasive particles to the bed.

These and other concepts involved in this invention are present in the embodiment illustrated in the drawings which form a material part of the disclosure.

Turning to the drawings, it will be observed that:

FIG. 1 is a general side view of a preferred embodiment of the article-finishing machine of this invention:

FIG. 2 is a plan view of the machine shown in FIG. 1:

FIG. 3 is an enlarged, partially sectioned, side view of the main portion of the apparatus of FIG. 1, which view shows in detail the vibratory conveyor means structure of the machine:

FIG. 4 is an end view of the apparatus taken in the direction of arrow 4 in FIG. 1.

In greater detail, the drawings disclose an article-finishing machine 10. As shown in FIGS. 1 and 2, the machine 10 comprises an article feed section 11, a bin section 12, a screen section 13, and an abrasive particle return section 14.

The article feed section 11 comprises a hopper 16 for receiving and storing articles to be finished. Below the discharge end of the hopper 16 there is provided a vibratory conveyor 17 for delivering articles from the hopper 16 to the front end of the bin section 12. The conveyor 17 includes a trough or the like 17a disposed beneath the discharge end of the hopper 16 in article-receiving relation therewith. The trough is supported on flexible leaves 17b which are mounted in angularly upstanding relation on a support 17c. Means, not shown, coupled to the trough, serve to impart a horizontal reciprocatory component of motion thereto. However, because of the angular disposition of leaves 17b the trough also has a vertical component of motion with the resultant motion being along an inclined plane whose lower end is below the discharge end of hopper 16 and whose upper end is above the bin section 12. The reciprocatory or vibratory motion thus imparted serves to convey articles along the trough from beneath the hopper 16 to the discharge end of trough 17a. This vibratory-conveying principle is well understood in the conveying art and need not be further described.

The bin section 12 comprises a bin 20 supported on a vibratory conveyor assembly 21.

The bin 20 has a generally horizontally disposed bottom 22, a front end wall 23, a pair of side walls 24 and 25 and an end closure member 26 adjacent the back end thereof. The end closure member 26 is an arcuate member 26a preferably semi-circular in side view. It extends across the width of the bin 20 between the side walls 24 and 25 with the concave side thereof facing the front end wall 23. It has a generally horizontal and transverse axis of rotation and is pivotally mounted on said axis to the side walls 24 and 25. Normally, the bottom end of the end closure member 26 bears against the bottom 22 of the bin 20. However, by means of a crank arm assembly 27, the end closure member 26 can be pivoted so as to lift its bottom end out of engagement with the bottom 22 and to a sufficient height to permit finished articles and abrasive particles in the bin to be conveyed to the screen section 13. To each end of arcuate member 26 a lower plate 26a and an upper plate 26c as shown in FIGS. 2 and 3. These end plates overlie the inner wall surfaces of bin side walls 24 and 25. Each ovalar end plate has a stub shaft as at 26d and 26e which extend through holes in the bin side walls 24 and 25 and rotatably support the end closure as aforesaid. Sub shaft 26e is secured as by
welding, exteriorly of bin wall 24 to the crank arm 27a of the crank assembly 27. The crank assembly 27 may be actuated in any suitable fashion, not shown. For example, manually, by gearing and lifting portion 27b to open the end closure, and upon release the weight of portion 27b will cause closure of the member 26a. Or, the assembly may be automatically controlled by a suitable electrically, mechanically, or fluid pressure operated device 27c.

The vibratory conveyor assembly 21 for the bin 20 is shown in FIG. 3. It comprises the vibratory conveyor bed. It involves a pair of leaf-spring supports 29 and 30 secured by brackets 31 to the bottom 22 of the bin 20 and secured to a stationary support frame 32 by similar brackets 31a. Mounted on the support frame 32 is an eccentric 33 having an eccentric rod 34 in the form of a leaf spring secured as by a mounting bracket 34a to the bottom 22 of the bin 20. Also mounted on the support frame 32 is a gear box 35 and a prime mover 36 preferably of the electric motor type. The eccentric 33 has a driven pulley. The gear box 35 has both a drive pulley and a driven pulley. The prime mover 36 has a drive pulley. By means of a drive belt 37 between the drive pulley of the prime mover 36 and the driven pulley of the gear box 35 and a drive belt 38 between the drive pulley of the gear box 35 and the driven pulley of the eccentric 33 movement of the prime mover 36 is transmitted to the eccentric 33.

Under operative conditions the eccentric 33 imparts a motion to the bin 20 which comprises vertical and horizontal components of motion with the resultant motion being in the direction of an inclined plane the lower end of which is at the right-hand side of FIG. 3 and the upper end of which is at the left-hand side of FIG. 3. The bin is supported as aforementioned upon the leaf springs 29 and 30 which allow for this inclined motion. As the bin 20 moves upwardly along the incline, it serves to elevate and to move toward the left-hand end of the bin articles to be finished as well as finishing particles in the bin. The incline is not a true incline but more of an accurate incline. However, the vibratory movement of the bin imparted thereto by the eccentric 33 is such that once the articles and particles are moving upwardly and to the left as viewed in FIG. 3, the sudden retraction of the bin downwardly and to the right allows the articles and the particles to continue their upward and leftward motion. The momentum of the articles and the particles in the bin is sufficient to cause this continued motion thereof during downward retraction of the bin. This completes one cycle of vibratory movement. Successive cycles serve to continue the conveying motion of the articles and the particles in the bin toward the left-hand end thereof. The leaf spring 34 serves to allow the vibratory movement of the supporting bed of the bin relative to the eccentric 33 while connecting the eccentric to the bin for the reciprocatory motion.

Such vibratory motion of the bin bottom 22 is rapid and the distance of travel thereof is small. In this regard, it has been found that an eccentric speed of 800 revolutions per minute is satisfactory for the purposes of this invention.

As shown in the figures of the drawings, the screen structure is supported by a generally horizontally disposed screen 40 mounted between the side rails of a generally horizontally disposed particle-receiving chute 41. The chute is mounted upon the support 32 similar to the mounting of the bin 20, i.e., upon a pair of leaf springs 41a and 41b as shown in FIG. 4. A leaf spring 41c connected to the chute and to an eccentric 41d serves to impart vibratory motion to the chute. The eccentric 41d is driven through a belt drive or the like 41e by an electric motor 41f. Beneath the screen 40 the chute is provided with a bottom wall 40a upon which deburring particles rest upon falling through the screen. The finished articles remain on top of the screen 40. The vibratory conveying motion of the chute conveys the articles and the particles that are falling from right to left as viewed in FIG. 4. The bottom wall 40a terminates as at 40b to define a particle-discharge opening 43 through which finishing particles may discharge from the chute into an elevator 14. The screen terminates at point 40c over the bottom wall of a discharge chute 42 leading to a storage or collecting station.

The abrasive particle return section 14 comprises an elevator 44 for receiving abrasive particles from the discharge opening 43 and for elevating the same to a height above the bin 20. Below the end of the elevator 44 at this height there is provided a downwardly inclined particle return chute 45, the bottom end of which is over the bin 20. The elevator 44 illustrated in FIGS. 1 and 2 of the drawings comprises an endless belt 46 mounted at the upper end thereof on a drive roll 47 and at the bottom end thereof on an idler roll 48. The outside of the belt is provided with a plurality of flights 49 which intercept the abrasive particles. The discharge opening 43, convey the particles upwardly to the top end thereof and dump the same into the return chute 45.

**Operation**

To prepare the machine 10 for use, the end closure member 26 of the bin 20 is closed so that the bottom end thereof is in engagement with the bottom 22 of the bin 20. Abrasive particles are introduced into the bin 20 in sufficient quantity to provide a bed on the bottom 22. The hopper 16 is then charged with articles to be finished. The machine 10 is now ready for operation.

The vibratory conveyor 17 is then activated whereupon articles to be finished are conveyed from the hopper discharge to the end of the conveyor 17 and into the bin 20. The prime mover 36 is then turned on whereby vibratory conveying forces are created by the vibratory conveyor assembly 21 and applied to the bin bottom 22. This causes abrasive particles and articles to be subjected to the vibratory conveying forces. Articles on top of the bed sink into the bed and become surrounded by the relatively abrasive particles.

Because of the difference in mass between the articles to be finished and the relative abrasive particles, the vibratory conveyor 17 continues to impart a vibratory motion between the abrasive particles and the articles to be finished whereby abrasive action on burrs or rough surfaces, or dirty surfaces to be cleaned on the articles takes place and the surfaces are finished.

In addition, the particles and articles in the bed move towards the end closure member 26. As particles and articles reach the end closure member 26, they are deflected upwardly and backewardly because of the semi-circular shape of the end closure member 26. Such upward deflection causes a gentle circular movement of articles in the bed with the result that all portions of articles to be finished are contacted by the abrasive particles regardless of the shape of the article.

When a desired number of articles to be finished have been introduced into the bin 20 from the hopper 16, the vibratory conveyor 17 is then stopped. After a sufficient period of time for finishing of all articles in the bed has elapsed, the back end closure member 26 is automatically actuating the crank arm assembly 27 and the elevator 44 turned on. Because of the vibratory conveying action of the bottom 22 of the bin 20, particles and articles are conveyed to the back end thereof and onto the screen 40. The motor 41f may be started simultaneously with the opening of the end of the bin 20, as well as the driving means (not shown) for the elevator 14. Abrasive particles and burrs fall through the screen 40 into the particle chute 41. Finished articles move downwardly on the screen 40 and into the particle-receiving chute 42.
whereby they are conveyed, for example, to an article-collecting station. Abrasive particles on the particle chute 41 move to the discharge opening 43 whereat they fall onto the top surface of the belt 46 of the elevator 44. Once on the endless belt 46 and with the aid of the flights 49, the abrasive particles are elevated up to the upper end thereof and dumped into the return chute 45 and thereby into the bin 20.

When all of the finished articles have been discharged from the bin 20, the back end closure member 26 is closed as by actuating the crank arm assembly 27. When the articles and particles have cleared the chute 40, motor 41 is de-energized, and the elevator 14 stopped once the particles therein have been discharged back into bin 20. The starting and stopping of the various conveyors, the elevator, and the opening and closing of end closure 27, may all be automatically controlled, if desired, in any suitable fashion. The procedure is then repeated.

The length of time which the articles to be deburred reside in the bin 20 under normal operative conditions is dependent upon the nature of the surface to be finished, the nature of the abrasive particles, the frequency of vibration imposed upon the bin 20 and the amplitude of the vibration. These factors, obviously, are determined by local conditions and can best be ascertained by the machine operator upon confronting the local conditions.

The number of articles to be finished in the bin 20 during each finishing cycle of the machine 10 is dependent upon the volume of each article, the volume of abrasive particles in the bed and the volume of the bed. These factors are again determined by local conditions. In general, optimum conditions are obtained when using abrasive particles of smaller particle size than the articles to be deburred and when using a dense bed of abrasive particles.

Thus there is provided a machine for finishing articles. Structure of the machine is readily comprehended and simple in nature. Moreover, its operation is quite simple and it does not require a highly skilled operator.

A feature of advantage of this invention is that while the machine is in operation, the operator can tell by visual inspection the extent of finishing which has occurred and when substantially all of the articles have been surface finished. Another feature of advantage of the machine is that the vibratory conveyor action thereof can be controlled so that agitation and movement of the articles to be finished are gentle. Yet, because of the relative motion between the abrasive particles and articles to be finished, the abrad ing, scrubbing, or deburring action is most effective.

Still another feature of advantage of this invention is that regardless of the shapes of the articles to be finished, all surfaces of the articles are contacted by the abrasive particles in following the teachings of this invention.

The method of this invention can be readily performed not only in the preferred embodiment of the finishing machine illustrated in the drawings, but in other machines of different construction.

The method of this invention is applicable not only with a bed of abrasive particles in the dry state, but also to a bed of abrasive particles suspended in a liquid to form a slurry. Generally speaking, any of the conventional deburring or surface finishing solids such as sand, silicon carbides, and the like may be used in practicing the teachings of this invention.

I claim:

1. A method of surface finishing articles, which comprises: suspending articles to be finished in a bed of relatively abrasive particles having an average mass different from the average mass of said articles; subjecting said bed to vibratory conveying forces directed toward one end of the bed to establish relative motion between said articles and particles and move both articles and particles generally toward said one end; directing said articles and particles generally upwardly in a curvilinear path at said one end of the bed and thence downwardly away from said one end completing a closed loop path; and continuing said conveying forces to recirculate said articles and particles through the bed in said closed loop path.

2. A method of surface finishing articles, which comprises: suspending articles to be finished in a bed of relatively abrasive particles having an average mass different from the average mass of said articles; subjecting said bed to vibratory conveying forces directed toward one end of the bed to establish relative motion between said articles and particles and move both articles and particles generally toward said one end; directing said articles and particles generally upwardly in a curvilinear path at said one end of the bed and thence downwardly away from said one end completing a closed loop path; continuing said conveying forces to recirculate said articles and particles through the bed in said closed loop path; and thereafter utilizing said vibratory conveying forces to vibrato rily convey said articles and said particles out of said bed.

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