Dec. 13, 1966 P. P. RUPPE 3,290,836

METHOD OF SURFACE FINISHING ARTICLES

Original Filed April 6, 1962 2 Sheets-Sheet 1

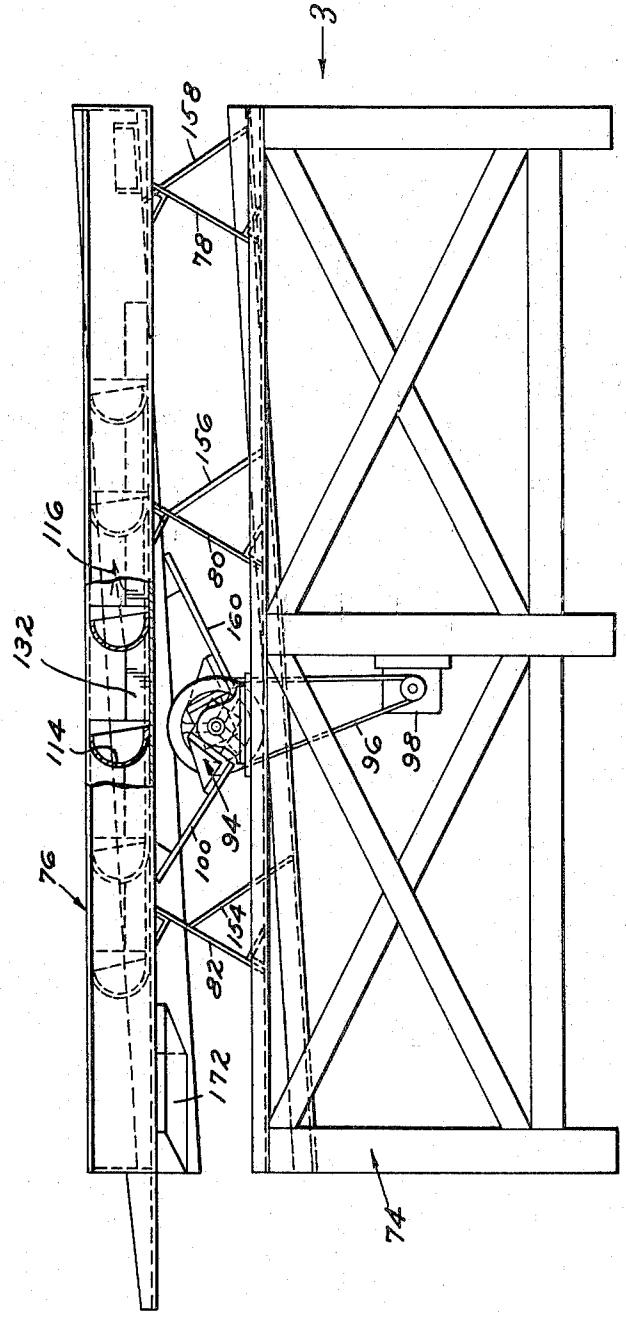


FIG. 1

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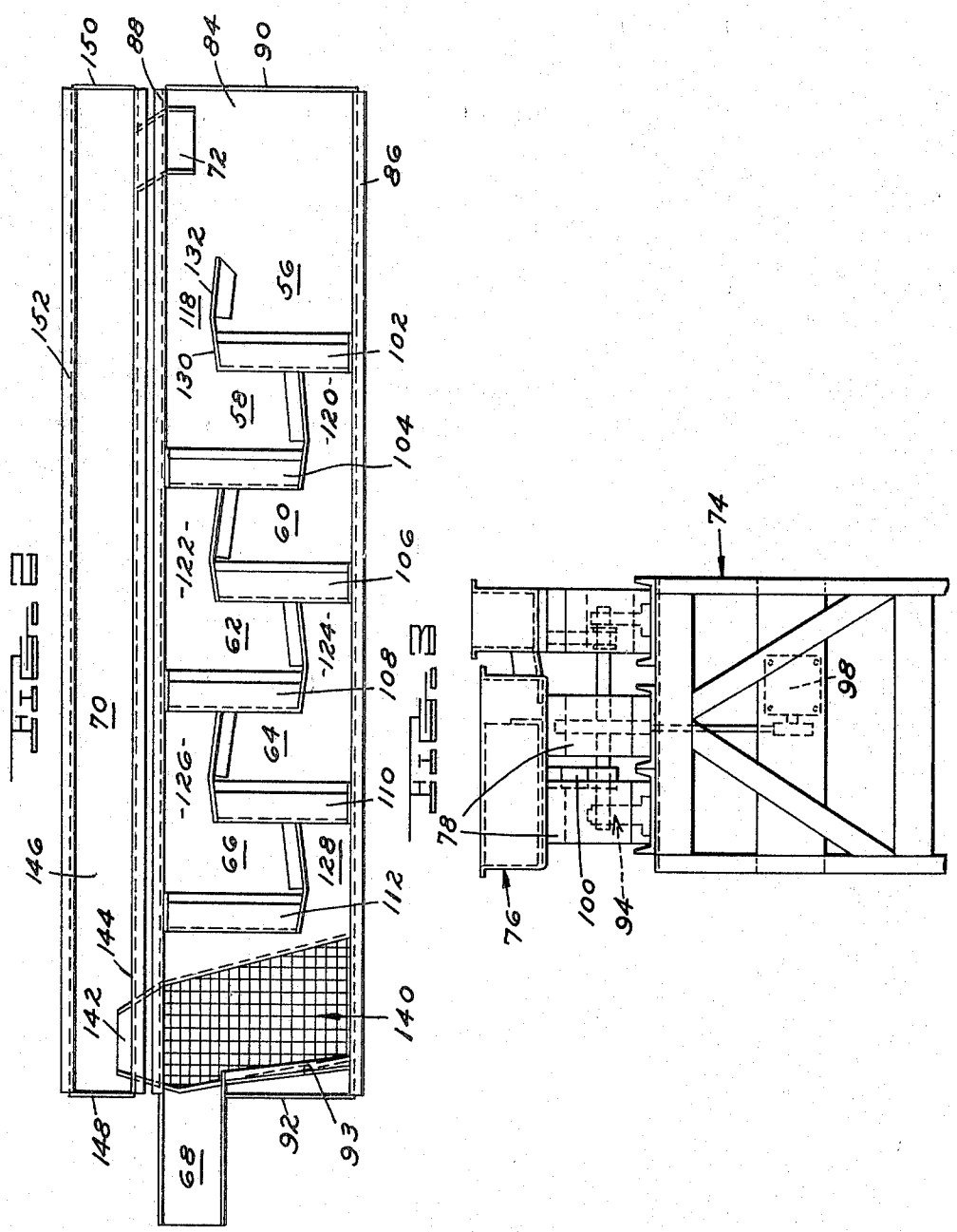


FIG. 2

FIG. 3

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3,290,836

METHOD OF SURFACE FINISHING ARTICLES

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Original application Apr. 6, 1962, Ser. No. 186,302, now Patent No. 3,246,429, dated Apr. 19, 1966. Divided and this application May 27, 1965, Ser. No. 459,302
11 Claims. (Cl. 51—317)

This application is a division of my co-pending application Serial No. 186,302, filed April 6, 1962, now Patent No. 3,246,429, dated April 19, 1966, which is in turn a continuation-in-part of my application Serial No. 853,393, filed November 16, 1959, now Patent No. 3,187,473, dated June 8, 1965.

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.

Another object is to provide a method of continuous deburring or articles, as distinguished from a batch method such as the barrel finishing method. By this continuous method articles are introduced into a vibrating bed of abrasive particles and relative movement between the articles and particles of the bed serves to deburr the articles, the articles moving in a circuitous path through the bed to finally emerge from a discharge point of the bed. The method is such that articles may be continuously fed to the inlet of the bed and deburred articles continuously discharged from the discharge point of the bed, all without any interruption of the deburring process. Such portion of the abrasive particles as are discharged from the bed along with the articles, are collected and returned to the bed adjacent the article inlet to the bed.

The method aspect of the invention is based on the concept of a continuous deburring process wherein the articles to be finished are introduced to the bed of particles at the upstream end of the bed, relative to the direction of travel of the particles in the bed, and the articles move in the bed in the direction of particle movement through a plurality of deburring zones arranged along the general direction of particle movement in the bed, with the articles finally emerging from the bed through the final deburring zone thereof. In each zone the articles are deflected in a circulatory path causing the articles to be gently turned over in the bed repeatedly exposing all faces and edges of the articles to the deburring action of the abrasive particles.

In the invention there is employed the concept of a plurality of deburring zones containing abrasive particles and articles to be finished with the bin being connected with vibratory conveyor means structure. Furthermore, the downstream end of each zone toward which particles and articles are conveyed is provided with a deflector means comprising a curved path in the deburring zone. The deflector means is so constructed and arranged so that articles and particles may spill around an end of the curved wall for discharge from the deburring zone; and in a staggered arrangement of the zones the articles spill around the ends of the walls from one deburring zone to the next.

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 an article-finishing machine for carrying out the method invention;

FIG. 2 is a top view of the machine of FIG. 1; and

FIG. 3 is an end view of the apparatus of FIG. 1 looking in the direction of arrow **3** therein.

The apparatus shown in the drawing is adapted to carry out what may be thought of as a continuous article-finishing method as distinguished from a batch or semi-batch type method. The continuous method apparatus comprises, as showin FIG. 2, a succession of article-finishing zones **56**, **58**, **60**, **62**, **64** and **66** which provide for successive beds of abrasive articles and particles. During operation of the apparatus the beds are subjected to vibratory conveying forces, and articles and particles overflow or spill from one bed to the next along the succession of beds from the upstream end **56** to the downstream end **66**. Overflow or spillage from the downstream bed is collected and the articles and particles separated from each other, the articles discharging through chute **68** while the particles are returned by the transfer means **70** to be introduced to the upstream end of the apparatus through re-entry chute **72**. The spillage results from having such a quantity of abrasive particles in the beds together with the articles to be surface finished, that upon subjecting the beds to the vibratory forces, the particles and articles overflow or spill from the beds as they move in their circulatory path through the beds.

More particularly the apparatus comprises a frame **74** upon which an elongate trough-like bin **76** is supported by angularly disposed pairs **78**, **80** and **82** of leaf springs. The bin **76** has a bottom wall **84**, parallel side walls **86** and **88** and end walls **90** and **92**.

Connected to the bin for subjecting it to vibratory forces is vibratory mechanism including an eccentric drive **94** in driven engagement through a drive belt or the like **96** with motor **98** mounted on frame **74**. A leaf spring **100** connects the eccentric to bin **76**. Upon operation of the motor **98** the bin is subjected to a vibratory motion tending to move abrasive particles and articles to be surface finished disposed within the bin from the upstream end thereof (the right-hand end as viewed in FIG. 2) toward the downstream end (the left-hand end). The springs **78**, **80** and **82** are preferably at an angle of 60 degrees. The amplitude of vibrating motion is preferably $\frac{5}{16}$ of an

inch and the frequency in a range of 600 to 2400 cycles per minute.

Within the bin are a succession of baffle means cooperating with the bottom and side walls of the bin to define finishing zones or beds of abrasive particles and articles to be surface finished. Such baffle means comprises a series of recirculating baffles **102, 104, 106, 108, 110** and **112** each of which has a concave face **114** as shown in FIG. 1. The baffles are generally semi-cylindrical in section. Each return baffle is secured along its lower edge to the floor **84** of the bin and cocked in a slight angle such that its concave face tends to open slightly upwardly as along arrow **116** in FIG. 1. The recirculating baffles are disposed in successive laterally staggered relation along the bin as shown in FIG. 2 to provide passageways as at **118, 120, 122, 124** and **126** around opposite sides of successive finishing zones. Such passageways allow overflow or spillage of articles and particles from one finishing zone or bed to be transferred to the next zone or bed in the succession. One end of each recirculating baffle juxtaposes a side wall of the bin while the opposite end is spaced from the other side wall by the width of the aforementioned passageways. Such opposite end of each recirculating baffle is closed by a secondary baffle comprising a first portion **130** juxtaposing such end of the recirculating baffle and a second portion **132** disposed at an angle to the first portion and extending upstream of the recirculating baffle to define with the recirculating baffle and the opposed side wall of the bin each of the finishing zones, such as zone **56**.

Baffle portion **132** of each of the secondary baffles rises upwardly from the bottom wall or floor **84** of the bin a distance not quite but approaching one-half the rise of the recirculating baffles as clearly shown in FIG. 1. The overflow or spillage of abrasive particles and articles being finished occurs principally over this baffle portion **132** of each secondary baffle. The height and length of this portion therefore determines to a great extent the quantity of articles and particles that may be contained within each finishing zone.

As articles and particles spill over baffle portion **132** they fall to the floor **84** of the bin in the passageways **118, 120**, etc., which areas of the floor provide a means for transferring particles and articles to the next successive finishing zone or bed.

At the downstream end of the succession of beds or finishing zones is the article and particle separator means comprising a screen **140** spanning an opening in the floor **84** of the bin and having a mesh sized such that abrasive particles will fall therethrough while articles will pass thereover and out article chute **68**. A deflector wall **93** is provided along the downstream side of screen **140** to guide articles into chute **68**. Below the screen is a particle transfer chute **142** disposed on a downwardly sloping incline and adapted to catch particles from separator **140** and convey them to the return transfer device or conveyor **70** for re-introducion to the opposite end of bin **76**. The chute **142** may be secured to the bottom of bin **76** and empty through an opening in side wall **144** of conveyor **70**.

Conveyor **70** includes a bottom wall **146**, end walls **148** and **150**, and another side wall **152**. It slopes upwardy as shown so that its high end is disposed above the bottom wall **84** of bin **76**. The particle re-entry chute **72** connected to conveyor **70** empties particles travelling up the conveyor back into the upstream end of the bin **76**. Conveyor **70** is supported on framework **74** by leaf springs **154, 156** and **158** which are angled reverse of springs **78, 80** and **82** because the conveying motion to be imparted is the reverse of that in bin **76**. Eccentric mechanism **94** is provided with an eccentric element and follower (not shown in detail) which are operatively connected to drive leaf **160** which is in turn connected to the conveyor **70**. Consequently upon operation of motor **98**, conveyor **70** is operated to convey abrasive particles from the lower end to the higher end for discharge through chute **72** back into the bin. The amplitude and frequency of conveyor **70** is such that it will return particles to the upstream end of the bin as rapidly as they pass through the collector.

For any given frequency and amplitude of vibratory movement imparted to a bin **76**, the rate at which articles to be finished will pass through the finishing operation is principally a function of the quantity or volume of articles and particles in the successive beds or finishing zones. This is so because the rate at which articles and particles spill out of the successive beds is a direct function of the quantity of particles and articles in the beds. If the particle level is high, the spillage is more rapid, and vice versa. Therefore if abrasive particles are added to the system in such quantity that taken together with a rate at which articles are fed to the system there is a high overflow rate between successive beds, the average length of time any of the articles will be subject to the surface finishing will be less than if the quantity of particles added or rate of article infeed are reduced. As a consequence the length of time that articles are subjected to the finishing operation becomes, for any given frequency and amplitude of vibratory conveying motion of the bin, a function of the rate at which articles and particles are fed into the upstream end of the succession of beds or finishing zones.

It has been found that if the proportion by volume of abrasive particles to articles to be finished is 1:1 that a very satisfactory finishing is obtained.

As heretofore mentioned the general direction of article and particle movement through the bin is from the upstream toward the downstream end thereof. During this general motion within each of the successive beds, the movement of articles and particles is deflected by the concave surface **114** of each of the recirculating baffles to cause the articles and particles to recirculate in each of the beds, such recirculation being counter the general direction of article and particle movement in the bed. As the articles recirculate in each of the beds they are gently turned over. During this circulatory travel of articles and particles in each of the beds some of the articles and particles spill out of the beds and are caught by the next successive bed in the succession of beds and the action repeats. In this fashion the articles and particles move through the system from the upstream end of the bin to the downstream end thereof. To give some idea of dimensions of a bin actually constructed and tested, and the rate at which articles were finished, a bin was constructed having a length of approximately 8½ feet and a width of 1½ feet and a depth of 6 inches. Articles of a suitable size for surface finishing in such size bin travelled from one end to the other thereof in about 30 minutes, and were thoroughly and properly surface finished.

A feature of advantage of this invention is that while the machines are 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 this invention is that the vibratory conveyor action 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 abrading, 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 drawing, 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.

What is claimed is:

1. A method of surface finishing articles, which comprises: subjecting to vibratory conveying forces a bed of articles to be surface finished and abrasive particles whose average mass is different than the average mass of articles such that the particles and articles tend to move in a general direction toward one end of the bed, deflecting the articles and particles in their movement into a circulatory path counter the general direction of movement toward said one end of the bed causing the articles to be gently turned over in the bed, feeding additional abrasive particles and articles to be finished to the bed to cause spillage of articles and particles therefrom, collecting such spillage from the first bed in another bed of abrasive particles and articles, subjecting the second bed to similar forces and deflecting articles and particles into a circulatory path as in the first bed, spilling articles and particles from the second bed upon accumulation of an overflow volume therein, collecting spillage from the second bed, separating the articles from the particles of the spillage from the second bed, and returning the separate particles to the first bed.

2. A method of surface finishing articles comprising: providing a succession of beds of abrasive particles and articles to be finished, subjecting each bed to vibratory conveying forces to set up relative motion between the particles and articles and to cause the particles and articles to move generally along said succession of beds, defecting the articles and particles into a path counter said general movement along the succession of beds, feeding particles and articles to be finished to a first bed of said succession, transferring particles and articles by spilling them from bed to bed along said succession from the first bed, transferring particles and articles out of the last bed of said succession, and separating the particles from the articles transferred from the last bed.

3. The invention as defined in claim 2 characterized by varying the rate of transfer of articles and particles from bed to bed along said succession as a function of the rate of feed of articles and particles to said first bed.

4. The invention as defined in claim 2 characterized by returning to said first bed the particles separated from the articles transferred from the last bed.

5. The invention as defined in claim 2 characterized by varying the rate of article and particle transfer from bed to bed as a function of the rate of feed of articles to said first bed, and varying the rate of article feed to the first bed to vary the length of time articles are subjected to surface finishing.

6. The invention as defined in claim 2 characterized by varying the rate of particle and article transfer from bed to bed as a function of the volume of particles and articles in the beds, and varying the volume of particles and articles in the beds to vary the rate of transfer thereof and consequent time that articles are subjected to surface finishing.

7. A method of surface finishing articles comprising: subjecting a succession of beds of abrasive particles and articles to be surface finished to vibratory conveying forces causing a general movement of particles and articles to one end of each bed, deflecting such movement in each bed into a circulatory path counter said general movement to said one end of the bed, spilling overflow particles and articles from each bed, catching such overflow in the next bed of the succession whereby articles and particles move from bed to bed along the succession from the upstream end thereof toward the downstream end of the succession, introducing articles and particles to said succession of beds at the upstream end thereof to cause an overflow condition in the successive beds, and catching and separating articles from particles spilling from a bed at the downstream end of the succession.

8. The invention as defined in claim 7 characterized by re-introducing at the upstream end of said succession the particles separated from the articles spilling from said bed at the downstream end of the succession.

9. The invention as defined in claim 7 characterized by varying the rate at which articles are introduced to said succession of beds to vary the rate of overflow spillage and the consequent time articles are subjected to surface finishing.

10. The invention as defined in claim 7 characterized by directing said vibratory conveying forces in a direction causing said movement of articles and particles from the upstream end of each bed toward the downstream end, directing said deflection of articles and particles such that the counter movement thereof in each bed is in a direction upstream of said succession of beds.

11. A method of surface finishing articles comprising: subjecting a succession of beds of articles to be finished and abrasive particles of an average mass different from the average mass of the articles to vibratory conveying forces extending in the direction of said succession to cause a general movement of articles and particles in the direction of said succession and from one end of each bed toward the opposite end thereof, gently turning over in each bed the articles to be finished while recirculating the articles and particles in each bed in a direction counter said general movement, transferring spilling overflow articles and particles from each bed, catching such overflow in the next bed of the succession whereby articles and particles move from bed to bed along the succession from an upstream end of the succession toward the downstream end thereof, introducing articles at the upstream end of the succession of beds, separating articles from particles spilling from a bed at the downstream end of the succession, and introducing separated particles to the upstream end of the succession along with new articles to be surface finished to maintain an overflow condition in the beds.

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