# United States Patent [19]

**Roach et al.**

[11] **4,387,537**

[45] **Jun. 14, 1983**


[54] **DEBURRING AND CLEANING MACHINE AND PROCESS**


[75] Inventors: **Maurice P. Roach; Russell D. Burkhart; James B. Meehan,** all of Waterloo, Iowa

[73] Assignee: **Iowa Engineered Processes Corp.,** Waterloo, Iowa



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[51] **Int. Cl.**[3] ..... **A24B 31/00**

[52] **U.S. Cl.** ..... **51/17;** 51/16; 51/7; 51/417; 51/217 S

[58] **Field of Search** ..... 51/16, 4, 7, 17, 417, 51/217 S, 317; 366/112, 122



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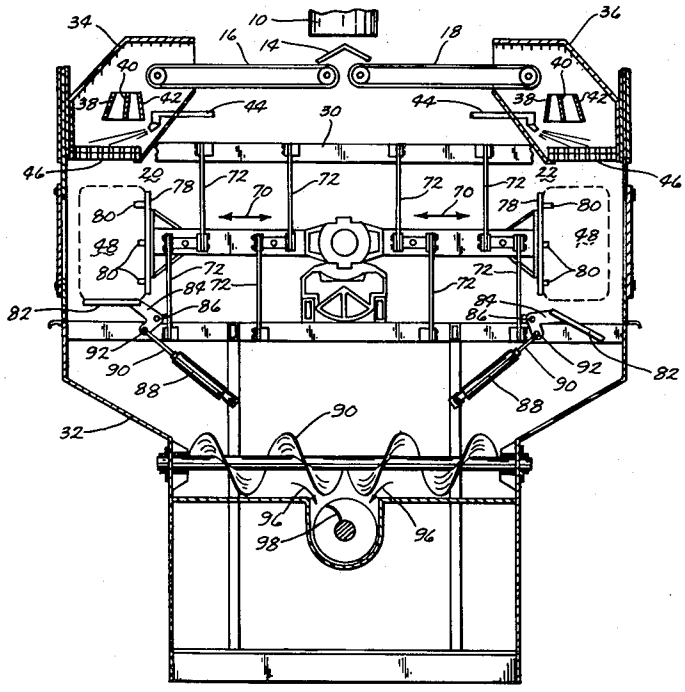
*Primary Examiner*—James G. Smith
*Assistant Examiner*—Willmon Fridie, Jr.
*Attorney, Agent, or Firm*—Zarley, McKee, Thomte, Voorhees & Sease



[57] **ABSTRACT**

A deburring and cleaning machine and process designed to successfully clean work pieces such as castings, machined parts, and the like. The machine is characterized by a freely open work piece mounting plate movable in a predetermined pattern while simultaneously allowing free falling abrasion media to fall over, around and through the work piece. The method involves positioning a work piece in an open treating area, moving the work piece in a predetermined pattern through the treating area, and simultaneously free-falling abrasive media cascading over, around and through the work piece. The open treating area and the free-fall cascading of abrasive media provide improved cleaning and deburring of internal passageways, free falling abrasive media cascading, etc.


**8 Claims, 3 Drawing Figures**



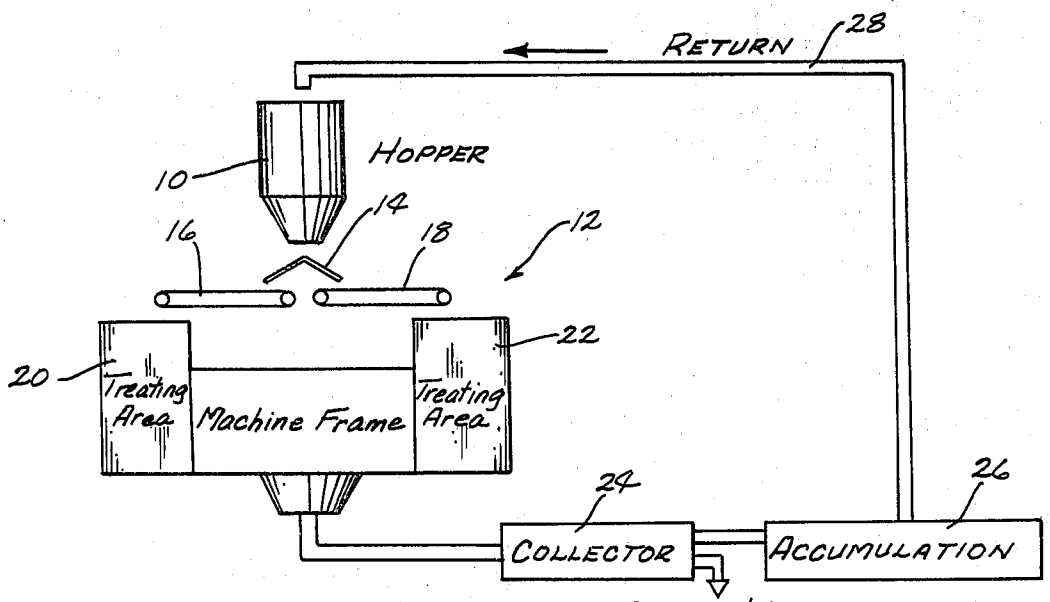

RETURN
28
HOPPER
10
14
16
18
12
22
20
Treating Area
Machine Frame
Treating Area
24
26
COLLECTOR
ACCUMULATION
SWARF & LIQUIDS RESIDUE

Fig. 1

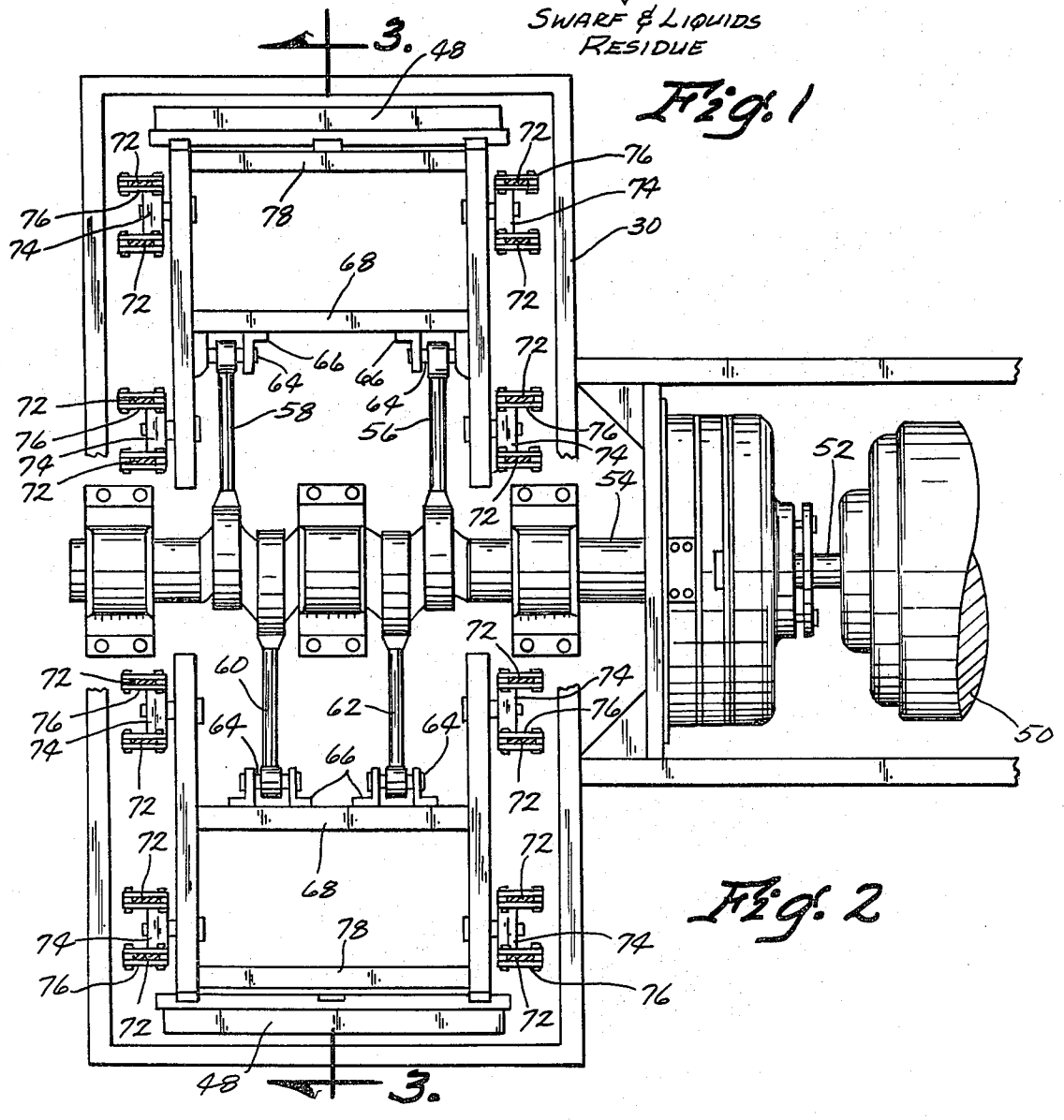

3.
48
72
76
74
78
30
68
66
64
58
56
54
52
60
62
50
3.

Fig. 2

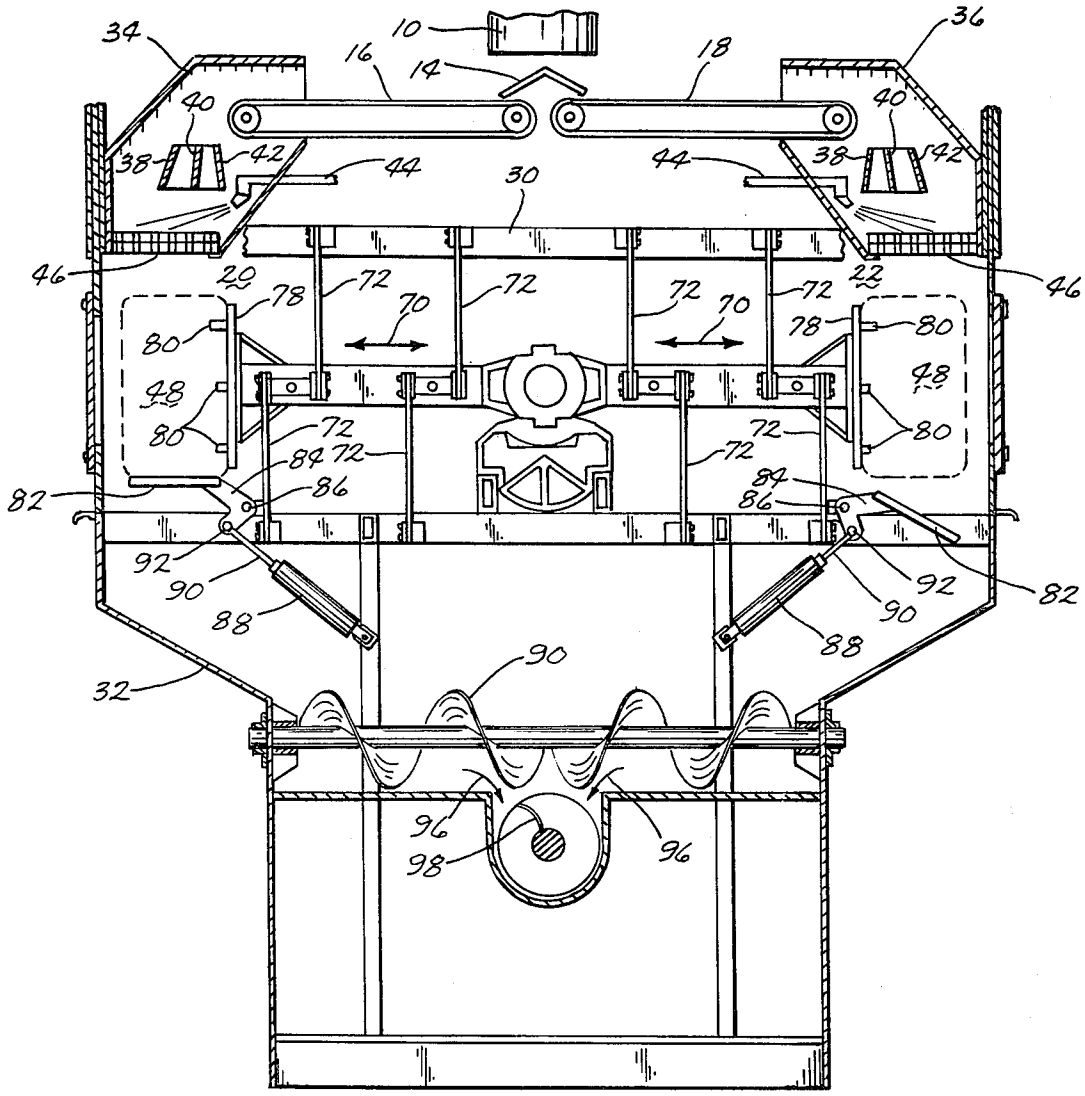

34
10
16
14
18
36
40
40
38
42
44
44
38
42
30
46
20
78
72
70
72
72
70
72
22
46
78
80
80
48
48
80
80
72
72
72
72
84
72
84
82
86
86
82
92
92
90
90
88
88
90
32
96
96
98

Fig. 3

# DEBURRING AND CLEANING MACHINE AND PROCESS

## BACKGROUND OF THE INVENTION

This invention relates to a machine and method useful in cleaning and deburring work pieces such as castings, machined parts and the like. Such work pieces as cast parts after removal from ceramic or permanent molds, typically have rough edges and/or "fins" which exist not only on the exterior surfaces, but also on internal passages and machined components or parts typically have sharp edges or "burrs" remaining from machining operations. These must necessarily be removed before the parts can be utilized as machine components. Prior techniques for cleaning work pieces such as cast parts have included blast cleaning with abrasion media such as steel shot, grit and the like; tumbling barrels filled with grinding media such as crushed stone, aluminum oxide, sand, carbide abrasive materials and the like; vibratory tubs wherein a tub is moved by an eccentric crank shaft with the work piece placed in the tub and filled with abrasive media, etc. Later, in the early 1960's, vibratory bowl techniques were employed wherein the work piece was placed in a container filled with media and cleaning fluid and shaken in a helical pattern within the confines of the bowl.

While all of the above mentioned prior art approaches to cleaning of work pieces have met with some success, they all have notable disadvantages. In particular, a primary disadvantage common to each of the systems mentioned above is that both the work piece and the abrasive cleaning media are contained in a confined space, the boundaries of which are defined by the vibrating container. The net result is that predictable patterns of movement for both the abrasion media and the work piece occur. This in turn results in abrasive media often becoming packed in the internal passageways of the work piece with the result being that the deburring and cleaning process is not effective, since portions of the work piece are insulated from the impacts of the abrasive media by packed abrasive media.

Accordingly, the primary object of the present invention is to overcome the above mentioned deficiencies with respect to prior art work piece deburring and cleaning machines and processes.

In particular, it is a primary object of the present invention in order to provide a deburring and cleaning machine and process which successfully prevents abrasive media compaction during the cleaning process.

Another object of the present invention is to provide a deburring machine and cleaning process for work pieces which allows the work piece to be effectively cleaned, smoothed and treated in a manner which is effective not only for external surfaces of the work piece, but more effectively cleans and deburrs internal passageways.

A still further object of the present invention is to provide a deburring and cleaning machine and process which, rather than packing the machine parts and the abrasive media inside of a container or receptacle, allows the abrasive media to free-fall through a wholly open area within which the work piece to be cleaned is moved.

A yet more specific object of the invention is to provide a deburring and cleaning machine and process which allows the abrasive media material to penetrate



even the smallest and most difficult areas of the work piece, without compacting therein, and then falling to a catch pan for recycle and reuse.

An even more precise object of the present invention is to provide a deburring machine and process which allows simultaneous subjection of a work piece to a free-falling and cascading curtain of abrasive media while continually moving the work piece in an open area.

The method and means of accomplishing each of the above objectives, as well as others, will become apparent from the detailed description of the invention which follows hereinafter.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a flow chart showing in schematic block diagram fashion the complete movement of abrasive media through the machine and process of the invention, as well as recycle for subsequent treatment.

FIG. 2 is a plan view of the essential components of the deburring and cleaning machine.

FIG. 3 is an elevated side view taken along line 3—3 of FIG. 2.

## SUMMARY OF THE INVENTION

The apparatus comprises a substantially open frame work, with a vibratory means mounted in the frame work and a work piece mounting plate associated with the vibratory means for responsive movement of the mounting plate in a prescribed planar or spatial motion. The work piece is attached to the mounting plate which itself is positioned in the freely open portion of the frame work and means is provided to free fall cascading media over, around and through the work piece to be cleaned.

The process comprises positioning of a work piece in an open treating area, moving the work piece in a predetermined planar or spatial motion and simultaneously free-fall cascading abrasive media, around and through the moving work piece.

## DETAILED DESCRIPTION OF THE INVENTION

As familiar to those of ordinary skill in the art of the designing of apparati for cleaning castings and other work pieces, a variety of differing "abrasive media" may be employed. The abrasive media itself does not form a part of the present invention, and it is understood that any of the conventional abrasive media may be used in both the machine and process of the invention. For example, conventional abrasive media may consist of alumina oxide, silicon carbide, hardened steel forms such as steel shot, ceramic forms such as silicon dioxide, granite chips and the like. Further, as is also well known, the abrasive media typically comprises the abrasive material mixed with a small amount of a water soluble bio-degradable cleaning compound, such as conventional synthetic detergents. Typically the amount of detergent solution may be from ½% to 2% by weight of the liquid employed. Emperically the amount is just enough to make the media wet or slightly dampened.

Before describing the apparatus and the process in considerable detail with reference to FIGS. 2 and 3, attention is first directed to FIG. 1 showing a block diagram schematic. Abrasive media as previously described along with a bio-degradable detergent composi-

tion are contained in hopper **10**. The abrasive media falls from hopper **10**, positioned above the apparatus of the present invention, generally depicted at **12**. The abrasive media falls onto divider **14** where it is split into two portions, one conveyed to each side of the machine, as will be hereinafter described, by endless conveyor belts **16** and **18**. The abrasive media then free-falls through an open area of the machine **12** labeled in the block diagram as "fixture", or in other words, machine framework. The abrasive media falls through the respective two treating areas **20** and **22**, to a collector **24**. Collector **24** separates "swarf", that is, dirty detergent and other residue from cleaned abrasive media accumulated at **26** which is recycled via return line **28** to hopper **10** for reuse. Having now described the flow of abrasive media through the machine in general detail, reference will be made to the specific embodiment of the invention illustrated in FIGS. **2** and **3**.

A device according to the invention is comprised of a substantially open supporting framework depicted generally at **30**. Surrounding the framework **30** is a cover sheet **32**. The precise position and configuration of the frame members forming framework **30** is not critical and may be determined as needed for on-site construction of the device. The only important factor is that the framework be substantially open so as to be non-confining to abrasive media and that the framework provide support for hereinafter described vibratory means structural components, the work piece mounting plate structural components, and the structural components necessary for movement of abrasive media through the work piece treating area.

Turning now to FIG. **3**, it can be seen that media falling from hopper or container **10** hits divider **14** wherein it is divided into two equal portions, one portion which falls on endless conveyor **16**, and one portion which falls on endless conveyor **18**. Conveyors **16** and **18** convey the media in opposite directions, to abrasive media flow regulating containers or vessels **34** and **36**, which are mounted to supporting framework **30**. Vessels **34** and **36** have media distribution plates **38**, **40** and **42** mounted therein along the inside walls of vessel **34**, the purposes of which are to catch falling media as it falls from endless conveyors **16** and **18** in order to assure effective distribution of the media prior to its gravity falling through the work piece. Thus, the media is divided into substantially equal portions falling to the area defined by dividers **38** and **40**, and to the area defined by dividers **40** and **42**. After falling through the dividers in vessels **34** and **36**, the hereinbefore mentioned detergent composition is introduced by a sprayer **44** onto the free falling media. As will be apparent, for purposes of clarity, since the apparatus comprises two like portions on each side of the framework **30**, like numbers will be utilized for both sides and a description given for only one with the understanding being that identical structure and processes are performed simultaneously on both sides of the machine **12**. Sprayer **44** is, of course, connected to a convenient and conventional source for a liquid detergent and extends from that source into containers **34** and **36** positioned to spray detergent onto the abrasive media after the media falls through distribution plates **38**, **40** and **42**. After the detergent spray hits the abrasive media, it falls through aperture distribution plates **46** positioned at the bottom of vessels **34** and **36**. The purpose of distribution plates **46**, like the hereinbefore referred to dividers, is to direct the flow of the abrasive media to assure uniform distribution of the abrasive media as it cascades over and through the work piece. It can be seen that the flow of the abrasive media from conveyors **16** and **18** through the open framework **30** of the machine **12** is a free fall cascading movement through a substantially open area without the abrasive media being confined. This feature is an essential feature of the machine and the process.

After falling through aperture distribution plates **46**, the media enters the previously described open treating areas **20** and **22**. The work pieces **48** are positioned in the open treating areas **20** and **22** to allow them to be continually subjected to the free falling, non-confined abrasive media. The work pieces **48** are themselves supported in the treating area **20** and moved in a predetermined planar or spatial motion by means now described. The motive power means **50** drives shaft **52** which in turn, through appropriate connecting means not specifically numbered, drives crank shaft **54**. Associatively connected to crank shaft **54** by conventional means are connecting rods **56** and **58**, **60** and **62**. Thus, it can be seen that rotary movement of crank shaft **54**, caused by movement of driven motor shaft **52**, will in turn cause reciprocal motion of connector rods **56** and **58** and **60** and **62**. The outer ends of connector rods **56**, **58**, **60** and **62** are connected via pins **64** and brackets **66** to the work piece mounting support frames **68**. Thus, frames **68** responsively move, looking at FIG. **2**, when connector rods **60** and **62**, **56** and **58** move reciprocally. Their movement, as depicted in the present device, is a reciprocal movement as illustrated by arrows **70** (see FIG. **3**). In order to provide stabilization to the individual work piece mounting support frames **68**, those are connected themselves to the overall device framework **30** via leaf springs **72** or other mechanisms which are yieldably resilient such that they stabilize the reciprocal movement of work piece mounting support frame **68**. The leaf springs **72** are mounted in conventional fashion via linkage connectors of conventional construction **74–76**. Thus, it can be seen that the work piece mounting support frame **68**, hereinafter referred to as the driven frame, moves responsively to the power driven motor **50**.

Motor **50** may be any conventional motive power means, but typically success can be achieved with a five horsepower to 15 horsepower motor rotating the crank shaft **54** at from 500 rpm to 10,000 rpm; however, it is understood that the precise motor, its horsepower and the revolutions per minute are not critical, those being readily determined and controlled for the individual work to be accomplished. Positioned at the outer end extremity of driven frame **68** is a work piece mounting plate **78**. Work piece mounting plate **78** has fasteners **80**, likewise of conventional construction, to allow the work piece **48** to be fastened to mounting plate **78**. Positioned below the work piece **48** is a movable bottom support **82**. Movable bottom **82** is connected to link **84** which is pivotally connected to frame **30** at **86**. Also connected to frame **86** at a point remote from pivot **86**, in pivotal fashion, is hydraulic cylinder **88**. The cylinder rod **90** is pivotally connected to link **86** at **92**. Thus, it can be seen that movable bottom **82** is movable from a supporting position shown in the left side of FIG. **3**, with the cylinder **90** extended to a non-support position shown in the right side of FIG. **3**, with the cylinder rod **90** retracted. The purpose of this supporting mechanism is to allow the work piece **48** to be supported in an at-rest position while it is attached via fasteners **80** to the work piece mounting plate **78**. Thereafter, movable

bottom **82** is retracted, as depicted in the right side of FIG. **3**, so that it will not interfere with the free-fall of abrasive media through the open treating area **20**.

Thus, it can be seen that the work piece **48** is mounted freely in a non-confined manner within the treating area **20**, and **22**, and it is reciprocated at a predetermined rate and pattern within the area. Simultaneously with this reciprocal movement through the treating area **20** free-falling and cascading abrasive media drops onto, around, over and through the work piece **48**, and when the bottom **82** is moved away from the work piece **48**, the abrasive media after falling through the work piece **48** falls to the bottom of the apparatus **12**. In the bottom of the apparatus **12** is conveying auger or other mechanisms **94** which picks up the spent or used abrasive media and conveys it inwardly as depicted in FIG. **3** where it drops as indicated via arrows **96** to another auger **98** which conveys the abrasive media out from the bottom of the apparatus **12** towards the viewer in FIG. **3**.

The precise motive power means and connecting means for augers **94**, **98** are well known, and will not be specifically described herein. Spent media, or swarf, conveyed via augers **94** and **98** from the bottom of the apparatus **12** is then moved to a conventional collector **24** (see FIG. **1**) wherein detergent, undesirable residue and other contaminants are removed and then the recycle process commenced.

It can be seen that in accordance with the present invention, the cleaning abrasive media free falls through an open treating area and onto the end around and through the work piece **48**. Moreover, the work piece within the open treating area **20** and **22** is itself moved in a predetermined pattern via conventional vibrating means. The work piece supporting structure is designed so that it does not interfere with the free fall of abrasive media. Thus, unlike prior deburring and cleaning machines, with the present machine, it has been found that little or no compaction of abrasive media within the work piece occurs. This is so because the work piece itself is not confined and the abrasive media allowed to move in a free falling pattern. Thus, if there is a tendency for abrasive media to become compacted, the movement of the work piece will resist this compaction because of the free, open nature of the treating area. Moreover, because the abrasive media is free falling itself in an unconfined manner, it can successfully enter small, internal passages of the work piece **48** and effectively clean those. It therefore can be seen that the device of the present invention accomplishes all of its stated objectives.

What is claimed is:

**1**. A cascading deburring machine, comprising a substantially open framework;

vibratory means comprising a power means driving a shaft connected to a crankshaft which causes reciprocal movement mounted in said framework;

a workpiece mounting plate responsively connected to said vibratory means for responsive movement and reciprocal movement of said mounting plate within said open framework in a predetermined pattern; said workpiece mounting plate being positioned within said framework but in a freely open portion of said framework and cascading means positioned on said framework above said mounting plate to cascade free falling abrasive media within said framework and over, around and through interior portions of any article to be cleaned which might be mounted to said mounting plate.

**2**. The device of claim **1** wherein said cascading means is a hopper having an associated abrasive media distribution plate.

**3**. The device of claim **2** wherein an abrasive media collector is positioned on said framework below said workpiece mounting plate.

**4**. The device of claim **3** wherein said machine also includes means to clean said abrasive media and return cleaned media to said hopper.

**5**. The device of claim **1** wherein said vibratory means is one which provides reciprocal motion to said workpiece mounting plate.

**6**. The device of claim **1** wherein said vibratory means is a motor of variant horsepower which rotates from 5 h.p. to 15 h.p. rotating a crank shaft at from 500 rpm to about 10,000 rpm.

**7**. The device of claim **2** wherein said distribution plate has associated means for introducing small amounts of cleaning and wetting agent into said abrasive media.

**8**. The device of claim **7** wherein said distribution plate includes a sizing device and control means to control the rate of flow of cascading media.

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