United States Patent

Rampe

[15] **3,685,213**

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[54] **ORBITAL FINISHING SYSTEM**

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[52] **U.S. Cl.** **51/163**

[51] **Int. Cl.** **B24b 31/06**

[58] **Field of Search** 51/163, 7; 259/72

[56] **References Cited**

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[57] **ABSTRACT**

A vibratory finishing machine including a supporting frame, a processing tub, and vibratory means interposed between the frame and the tub to vibrate the tub. Spaced charging and discharging means deliver workpieces and media into one end of the tub and discharge it through an opening in the opposite end of the tub so as to provide a continuous feed finishing operation. The discharging means includes a weir which extends to an adjustable height to control the height at which workpieces and media discharge from the tub. The discharging means also includes a closure means for closing the discharge opening to retain or discharge workpieces and media. A timing control serves to cyclically actuate the closure operator at adjustable predetermined intervals of time during operation of the machine. Together these adjustable controls permit the retention time of workpieces in the tub to be controllably varied.

10 Claims, 6 Drawing Figures

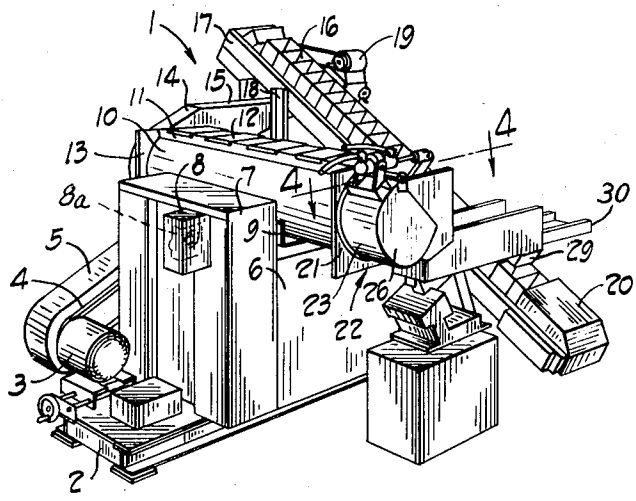


Fig. 1

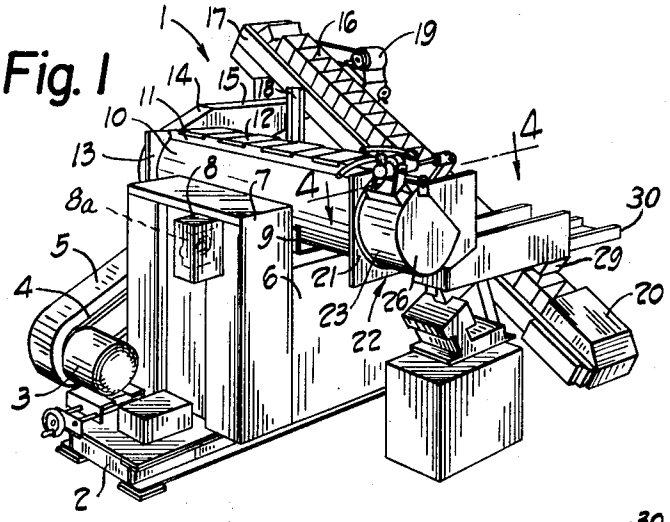
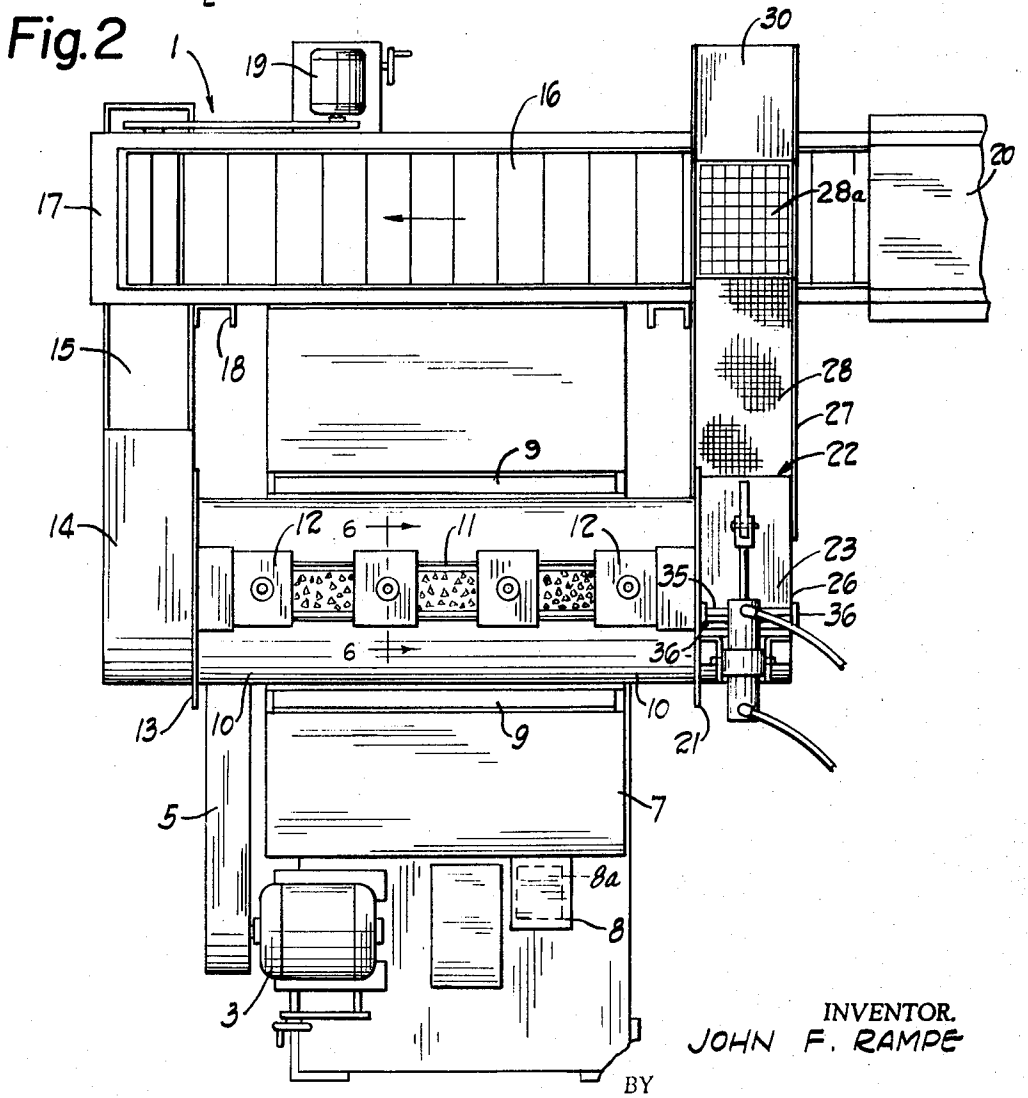


Fig. 2



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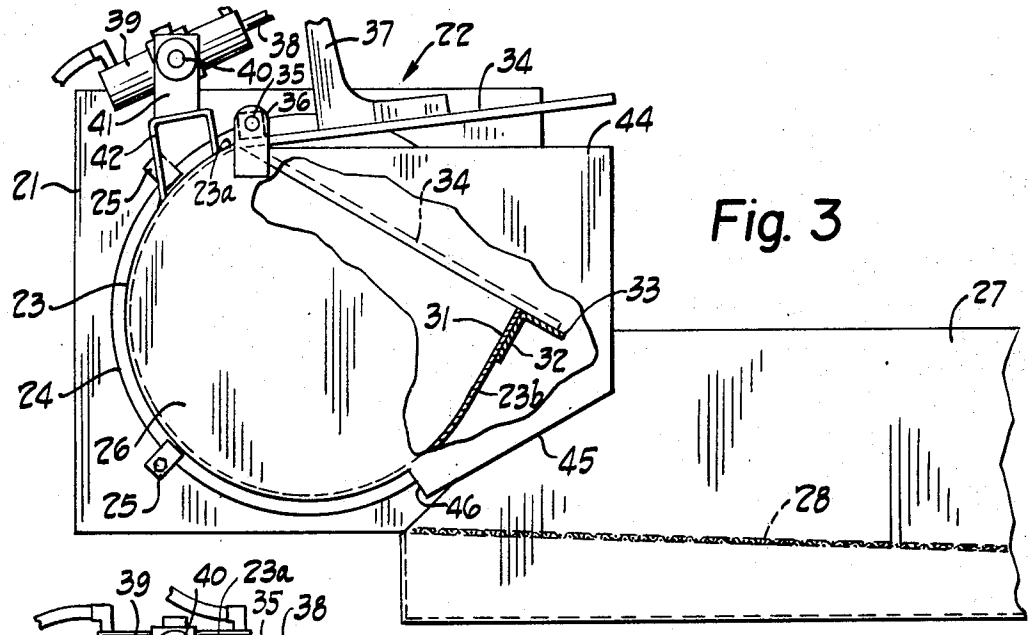

Fig. 3

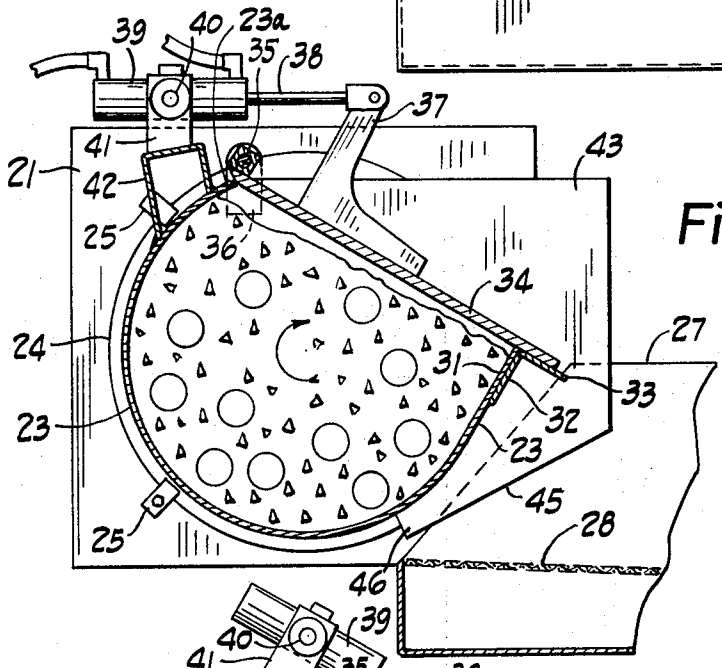

Fig. 4

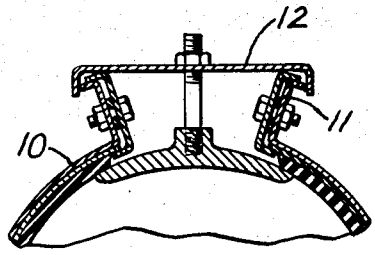

Fig. 6

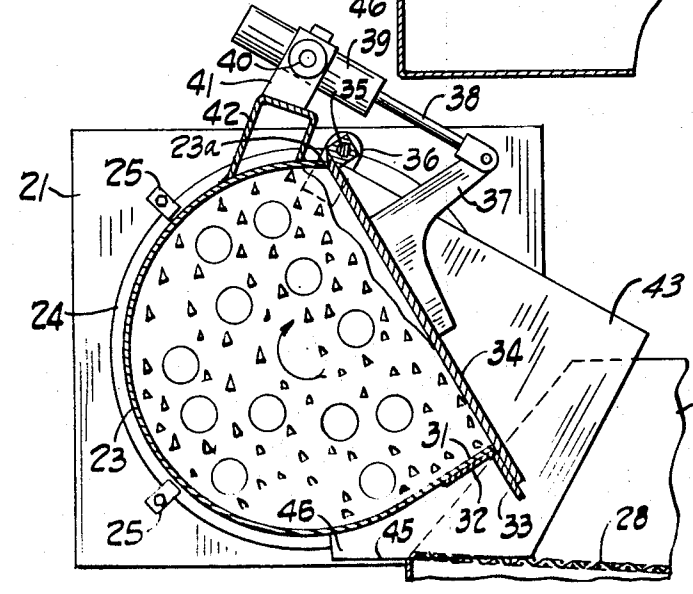

Fig. 5

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CROSS-REFERENCE TO RELATED PATENTS

FINISHING APPARATUS, U.S. Pat. No. 3,318,051 issued May 9, 1967 to John F. Rampe.

FINISHING APPARATUS, U.S. Pat. No. 3,337,997 issued Aug. 29, 1967 to John F. Rampe.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to abrasive finishing machines and more particularly to a vibratory finishing machine of the continuous feed type having a variable discharge system for controlling the retention time of workpieces within the tub of the machine.

2. Prior Art

Vibratory finishing machines adapted to smooth and finish the surfaces of workpieces by such operations as deburring, burnishing, descaling and cleaning are well known. Such machines commonly employ a processing tub adapted to receive a quantity of workpieces and abrasive finishing media. The tub is then vibrated so as to impart a finishing action to the workpieces.

As brought out in the referenced patents, particularly in the latter, the abrasive media can conveniently be separated from the workpieces after the media and workpieces are discharged from the tub. After separation, the workpieces may then be returned to the tub of the finishing machine for re-use. The finishing liquid is usually drained off during separation of the media and workpieces. The finished workpieces are subsequently collected and conveyed to a separate unit or group of units for washing, drying, inspection and packaging.

Various proposed continuous feed vibratory finishing machines are also known. Such proposed machines provide the processing tub with spaced charging and discharging means whereby media and workpieces enter one end of the tub and are subjected to a finishing action as they progress through the tub for discharge at the opposite end.

One problem with known prior art continuous feed vibratory finishing machines is that the retention time that workpieces remain in the tub is not readily controllable. Workpieces of a relatively soft metal, or workpieces needing only minimal deburring, etc., require only a short retention in the tub. Workpieces of harder metal which have many large burrs to be removed, will require longer retention times. Hence, where the retention time requirements differ from that provided by prior art continuous feed finishing machines, it has previously been necessary to operate the finishing machine on a batch process basis where the retention time can be carefully controlled.

SUMMARY OF THE INVENTION

The present invention overcomes the foregoing drawbacks of prior art finishing machines and provides a finishing machines with a variable discharge system for controlling the retention time of workpieces in the tub of the machine.

The finishing machine of the present invention may be operated on a batch basis if so desired but is designed primarily for continuous operation according to a pre-arranged time schedule. Pursuant thereto, a discharge system is provided including an adjustable

weir for varying the height at which workpieces and media are discharged from the tub, and a closure-controlled discharge opening which alternately releases and retains the tub contents. The operation of the discharge assembly is controlled by mechanism adapted to repeat the cycle at short intervals. One of the advantages of the invention resides in the flexibility characterizing the processing cycle, which may be adjusted by the operator from time to time to lengthen or shorten the retention period relative to the release period.

In a representative case, once the cycle has been decided upon, the operator adjusts the controls, more particularly a timing mechanism, to provide a predetermined retention period—typically 10 seconds—for processing the workpieces constituting part of the contents of the tub. This is normally followed by a predetermined release period—typically 5 seconds—for partial discharge of the tub contents. This initial cycle is immediately followed by a second such cycle. The second cycle is commonly followed by a third such cycle, the third by a fourth, the fourth by a fifth and so on as long as desired. In some cases, the nature of the workpieces may call for longer or shorter processing times than those mentioned above; in such instances, the operator can readily re-set the timing mechanism to provide correspondingly longer or shorter retention periods preceding the release periods.

In the operation of the machine, the charging apparatus supplies the tub as required with an abrasive processing medium of any one of kinds commonly used in orbital finishing machines. Concurrently—usually but not necessarily intermittently—an aqueous finishing liquid is introduced therewith to facilitate finishing of the workpieces. The workpieces themselves are added by the operator. For all practical purposes, the operation of the charging apparatus is, in effect, keyed to that of the discharge assembly, supplying abrasive media whenever the discharge assembly releases enough of the tub contents to permit of their introduction.

The discharge system ordinarily comprises a housing projecting from the tub the major axis of which constitutes a continuation of the longitudinal axis of the tub. A discharge opening is formed through the housing. An adjustable weir forms the lower lip of the discharge opening. The weir may be adjusted in height to control the height at which workpieces and media discharge from the tub of the finishing machine. Movable closure is provided to preclude or permit retention of the tub contents, depending on the manner in which the controls are programed. A timing mechanism serves to cyclically actuate the closure operator at adjustable predetermined intervals of time. Together these adjustable controls permit the retention time of workpieces in the tub to be controllably varied.

Accordingly, it is the principal object of the present invention to provide a vibratory finishing machine having an improved apparatus for controlling the retention time of workpieces in the processing tub, and a method of performing finishing operations.

Other objects and a fuller understanding of the invention may be had by referring to the following description and claims taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings,

FIG. **1** is an isometric representation of an orbital finishing machine within the purview of the present invention;

FIG. **2** is a top plan of the machine on a somewhat larger scale;

FIG. **3** is an elevation showing on a still larger scale the discharge assembly at the end of the tub seen at the right in FIGS. **1** and **2**;

FIG. **4** is a corresponding vertical section as seen from the plane indicated by the line **4—4** of FIG. **1** with the discharge assembly closure in closed position;

FIG. **5** is a vertical section similar to that of FIG. **4** showing the discharge assembly as it appears after it has been rotated clockwise through an angle of approximately 45°; and,

FIG. **6** is a fragmentary vertical section as seen from the plane indicated by the line **6—6** of FIG. **2**.

PREFERRED EMBODIMENT OF THE INVENTION

In the form which it takes in the accompanying drawings, the finishing machine **1** of the present invention includes a platform **2**, the near end of which appears in FIG. **1**; other supporting structure such as horizontally and vertically extending channels, beams and reinforcements; a prime mover such as, motor **3**; a chain belt drive **4** leading to shafting and vibration inducing means of the kind shown in the above-mentioned U.S. Pat. No. 3,337,997; a guard **5**; and a shroud **6** enclosing much of the supporting structure, the shafting and the vibration-inducing means. Adjoining shroud **6** is a console **7** on which is a control box **8** incorporating a convention timing mechanism **8a** that can be programed by the operator to accomplish the objectives of the invention.

As will be explained in greater detail, the timing mechanism **8*a*** comprises a conventional timer which can be programed by an operator to cyclically open and close one or more sets of electrical contacts at predetermined intervals of time during operation of the machine **1**. In the present invention such a timing mechanism is used to cyclically open and close a discharge door so as to control the rate of discharge of materials from the tub **10**.

Tub **10**, which is generally cylindrical in shape, is supported from beneath by a cradle consisting in part of structural members **9** one of which may be seen in FIG. **1**. Details of the system for vibrating the tub are shown and described in U.S. Pat. No. 3,337,997. In its top portion, tub **10** has a wide longitudinally extending opening that is flanked by mutually diverging wings **11**. Bridging the space that separates wings **11** is a plurality of cross heads **12** held in place as shown in FIG. **6** by nuts screwed onto studs projecting from the clamping members used to hold the tub lining in place.

Aligned with tub **10** at the charging end of the tub; i.e., the end shown at the left in FIG. **2**, is a generally square end plate **13** with a central circular opening of substantially the same diameter as the tub. Attached to end plate **13** is a hopper **14** for feeding plastic or stone media to the tub. The media are supplied to hopper **14** through an elongated top opening **15**. They may be added from time to time by the operator or caused to drop into opening **15** from the upper end of the bucket conveyor **16** seen in FIG. **1**

Conveyor **16** is mounted in a framework **17** supported by suitable uprights **18** one of which appears in FIG. **1**. Motor **19** supplies power to the upper end of the conveyor. The lower end of the conveyor, which is contained within housing **20**, is not powered. Media such as those to be delivered to hopper **14** are normally re-used, being delivered to conveyor **16** at the right-hand end of the machine, seen as in FIG. **2**.

Mounted on tub **10** at its right-hand end, seen as in FIG. **2**, is a square end plate **21** with a central circular opening (not shown) of substantially the same diameter as tub **10**. Supported on it is a discharge assembly **22** comprising a flat-sided drum **23** that is cylindrical in shape over most of its surface, particularly over the 220° stretch between zones **23*a*** and **23*b*** (FIG. **3**). That end of drum **23** which bears against end plate **21** is provided with a radially directed generally circular flange **24** attached to end plate **21** by four equally spaced subassemblies each of which consists of a threaded stud, a nut and an attaching clip **25**. Clips **25** are normally in contact with flange **24** but may be loosened to permit the drum to be rotated as desired, clockwise or counterclockwise.

Drum **23** has a closed outer face **26**, best seen in FIG. **1**. Face **26** corresponds in outline to the shape of drum **23**, which, as already indicated, takes the form of an incomplete cylinder. Each has a lateral flat or cut-away portion extending over an included angle of about 140°. This portion can be regarded as theoretically delineating the maximum discharge opening of discharge assembly **22**. In practice, however, the extent of such opening is diminished by the presence and manner of operation of the hereinafter described closure, which is designed to alternately preclude and permit the release, through the lateral opening in discharge assembly **22**, of the contents of tub **10**.

Projecting laterally from the drum; i.e., transversely of the machine as a whole, is the discharge trough **27** seen in FIGS. **1** and **2**. Trough **27** is rectangular in cross section, substantially horizontally disposed, and provided just above its bottom with an inclined fine-mesh screen **28**. The openings in the screen are small enough to prevent the workpieces and media from passing through it while allowing the entrained finishing liquid to fall off and drop to the bottom of the trough. It may be recirculated if desired or, if preferred, allowed to drain from trough **27** into a collecting vessel or sewer. In the meanwhile, the workpieces and media are urged toward the far end of screen **28** by gravity and/or forces imposed on them by subsequently discharging tub contents.

At the remote end of the trough, screen **28** is equipped with a wide-mesh insert **28*a*** that allows the media, but not the workpieces, to drop through the screen into an underlying funnel **29** (FIG. **1**). The latter directs the media to the lower end of conveyor **16**, which receives them and carries them toward its upper end for return to tub **10** through hopper **14**. The workpieces are precluded by the wide-mesh insert **28*a*** from dropping through this portion of the screen; instead, they move onto an inclined run-off tray **30**, where they fall by gravity into a waiting tote box or other receptacle.

The above-described construction of the discharge assembly is, in effect, such as to incorporate in drum **23**, in the neighborhood of zone **23*b***, a laterally

oriented, adjustably positioned weir. If desired, the drum wall may terminate just short of zone 23*b*, in which case the resulting laterally presented terminal edge defines the upper limit of the weir. Optionally, the drum wall may be extended or continued tangentially to the body portion of drum **23** by means of upwardly extending flat portion **31**, whereupon its upper edge becomes the upper limit of the weir. In either case, the edge of the weir is preferably reinforced, as by the angular bracket **32**. The outwardly projecting portion **33** of the bracket or other reinforcement can advantageously serve as a seat for the outer edge of closure **34**: see FIG. **4**.

In the neighborhood of zone 23*a* (FIG. **3**), the opposite edge of closure **34** is pivotally supported by a horizontally extending pivot pin **35** carried by a pair of lugs **36** rigidly mounted on drum **23**. An L-shaped actuator **37** is welded as shown to the top face of closure **34**. At its upper end, actuator **37** is connected to a piston rod **38** that projects from the near end of a power cylinder **39**. As can be seen from FIG. **3**, power cylinder **39** is pivotally supported at **40** on upwardly projecting ears **41** that are themselves rigidly mounted on an inverted channel **42**. The latter is preferably welded to the cylindrical portion of drum **23**.

Attached to drum **23** inwardly of the sides of trough **27** are shields **43** and **44**. These shields are a desirable but not a necessary feature of discharge assembly **22**. The presence of shields **43** and **44** confines the discharging tub contents to a path that takes them into trough **27** and onto screen **28**. Preferably, the lower edges **45** of shields **43** and **44** are slanted as shown to enable corner **46** to clear the underlying portion of trough **27** when the height of the weir is to be adjusted as, for example, by rotating the drum from the position shown in FIG. **4** to that shown in FIG. **5**.

To accomplish this result, clips **25** are temporarily loosened, after which drum **23** may be adjusted clockwise (or, if desired, counterclockwise) on end plate **21**. A comparison of FIGS. **4** and **5** will reveal the effect of clockwise rotation on the height of the top edge of the weir. This possibility of selectively adjusting the height of the weir is an advantageous feature. In general, a high weir is desirable when the machine is programed for a long retention time. A low weir is desirable when a short retention time is desired. In either case, tub **10** can be operated at or close to full capacity, as indicated in FIGS. **4** and **5** by the showing of the load line. Provided the longitudinal opening between lateral flanges **11** is completely closed off, tub **10** may be filled completely. In that case, a modicum of pressure is imposed on the tub contents by the static head in hopper **14**.

In normal operation, the workpieces, together with the desired type or types of media, are vibrated in tub **10**, with closure **34** in the closed position, for as long or short a period as desired. Assuming that the shafting is caused to turn in the appropriate direction, the contents of tub **10** will tend to move in a clockwise direction as indicated by the arrows in FIGS. **4** and **5**. This has the effect of producing a load line that substantially parallels the angle assumed by closure **34**. After an interval of perhaps 10 seconds, the timing mechanism **82** will automatically come into operation, causing the piston in power cylinder **39** to move piston rod **38** from right to left. When transmitted to closure **34** through adapter **37**, this movement causes closure **34** to move counterclockwise into the solid line position shown in FIG. **3**.

At this stage, drum **23** is completely open for discharge of the tub contents over the weir. The tub contents, consisting of the workpieces, media and fluid, spill out into trough **27** and onto screen **28**. The pressure of the remaining tub contents tends to force the discharged workpieces and media from left to right over the surface of screen **28**, seen as in FIG. **3**. After a suitable interval, say 5 seconds, the timing mechanism **8a** will operate a second time to restore closure **34** to its closed position.

To the degree that the timing mechanism **8a** itself may be adjusted, the retention time of the tub contents in tub **10** may be increased or decreased. In a given case, the retention time may be reduced from 10 seconds to 5 seconds with the discharge time remaining constant at five seconds. Similarly, the retention time may be increased from 10 seconds to 15 seconds with the discharge time remaining constant at 5 seconds. Thus variations in the retention time, sometimes dictated by the nature of the workpieces, may be achieved, as a result whereof the desired degree of finishing may be accomplished to better advantage. The length of the release time may be varied in like fashion, depending on the wishes of the operator.

In the above-described machine, changes may be made without departing from the spirit of the invention; for example, by using twin shafts at approximately the level of the center of mass of the tub and its load rather than underlying shafting of the type shown in U.S. Pat. No. 3,337,997. Similarly, the details of the charging and discharging apparatus may depart from what is shown in the accompanying drawings. For example, the discharge assembly need not take the form of a flanged hood shaped more or less like a flat-sided drum but, if desired, may take some quite different form so long as it consists or a tub-associated housing into which the tub contents can move as a result of the operation of the tub and from which they can be discharged from time to time, preferably on a programed basis. The closure for the discharge assembly need not be arranged and operated in the manner shown and described but may be differently organized and operated. Other changes may be expected of those skilled in the art to which the invention relates.

It is intended that the patent shall cover, by summarization in appended claims, all features of patentable novelty residing in the invention.

I claim:

1. A vibratory finishing machine comprising:
   a. a supporting frame structure;
   b. a tub structure carried on said frame structure but free to vibrate relative to said frame structure;
   c. vibratory means interposed between said structures to vibrate said tub structure relative to said frame structure;
   d. charging means for feeding into said tub structure a plurality of workpieces to be finished and media to be used in finishing the workpieces;
   e. discharging means for controllably discharging workpieces and media from said tub structure;

f. said charging means and said discharging means being arranged to introduce and discharge workpieces and abrasive media into and from spaced regions of said tub structure whereby the machine is operable in a continuous feed mode;

g. said discharging means comprising:

i. means defining a discharge opening in communication with said tub structure and forming weir means extending to a predetermined height to control the height at which workpieces and media discharge from said tub structure;

ii. closure means selectively closing said discharge opening whereby said closure means may be opened to permit workpieces and media to pass over said weir means and to discharge through said discharge opening, and may be closed to retain workpieces and media within said tub structure;

iii. closure operator means connected to said closure means for opening and closing the closure means; and,

iv. automatic flow control means for periodically actuating said closure operator means to open and close the closure means at selected intervals during the operation of said machine thereby to control automatically the discharge rate of workpieces and media from said tub structure.

2. The vibratory finishing machine of claim **1** wherein said weir means is movable relative to said tub structure to adjustably control the height at which workpieces and media are discharged from said tub structure.

3. The vibratory finishing machine of claim **1** wherein said weir means comprises the lower edge of said discharge opening and said closure means is engageable with the upper edge of said weir means so as to prevent the passage of workpieces and media over said weir means when said closure means is closed.

4. The vibratory finishing machine of claim **1** wherein:

a. said means defining a discharge opening comprises housing means adjustably connected to said tub structure; and,

b. said weir means comprises the lower edge of said discharge opening defined by said housing means;

c. whereby the position of said housing means may be adjusted relative to said tub structure to adjustably control the height at which workpieces and media are discharged from said tub structure.

5. The vibratory finishing machine of claim **4** wherein:

a. said housing extends substantially horizontally such that its central axis in effect continues the central axis of said tub structure;

b. said discharge opening is formed in the periphery of said housing with a region spaced radially from said central axis; and,

c. said housing is adjustably rotatably mounted on said tub structure whereby said housing may be rotated relative to said tub to adjustably position said weir means.

6. The vibratory finishing machine of claim **5** wherein said weir means comprises the lower edge of said discharge opening, and said closure means is engageable with the upper edge of said weir means so as to prevent the passage of workpieces and media over said weir means when said closure is closed.

7. A vibratory finishing machine comprising:

a. a supporting frame structure;

b. a tub structure carried on said frame structure but free to vibrate relative to said frame structure;

c. vibratory means interposed between said structures to vibrate said tub structure relative to said frame structure;

d. charging means for feeding into said tub structure a plurality of workpieces to be finished and media to be used in finishing the workpieces;

e. discharging means for controllably discharging workpieces and media from said tub structure;

f. said charging means and said discharging means being arranged to introduce and discharge workpieces and abrasive media into and from spaced regions of said tub structure whereby the machine is operable in a continuous feed mode;

g. said discharging means comprising:

i. means defining a discharge opening in communication with said tub structure;

ii. closure means for selectively opening and closing said discharge opening so as to permit or prohibit the discharge of workpieces and media from said tub structure;

iii. closure operator means connected to said closure means for opening and closing said closure means; and,

iv. timing control means for cyclically actuating said closure operator means to open and close said closure means at predetermined intervals of time during the operation of said machine, whereby the discharge rate of workpieces and media is automatically controlled.

8. The vibratory finishing machine of claim **7** wherein said means defining a discharge opening also serves to form a weir extending to a predetermined height to control the height at which workpieces and media discharge from said tub structure.

9. The vibratory finishing machine of claim **8** wherein said weir is movable relative to said tub structure to adjustably control the height at which workpieces and media are discharged from said tub structure.

10. The vibratory finishing machine of claim **7** wherein:

a. said closure operator means comprises a fluid operated cylinder which is extensible and contractable to move said closure means; and,

b. said timing means comprises a timer mechanism the intervals of operation of which are adjustable such that the discharge rate of workpieces and media from said tub structure may be adjustably controlled.

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