Jan. 28, 1969 G. W. BALZ 3,423,884

FINISHING APPARATUS HAVING A PLURALITY OF COMPARTMENTS

Filed Jan. 12, 1966

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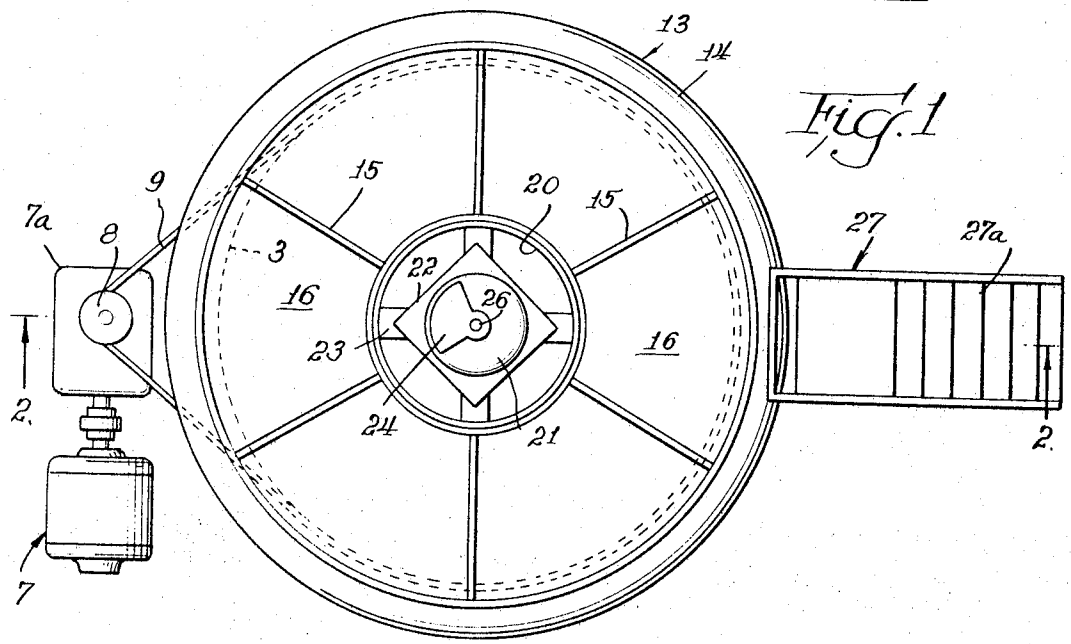


Fig. 1

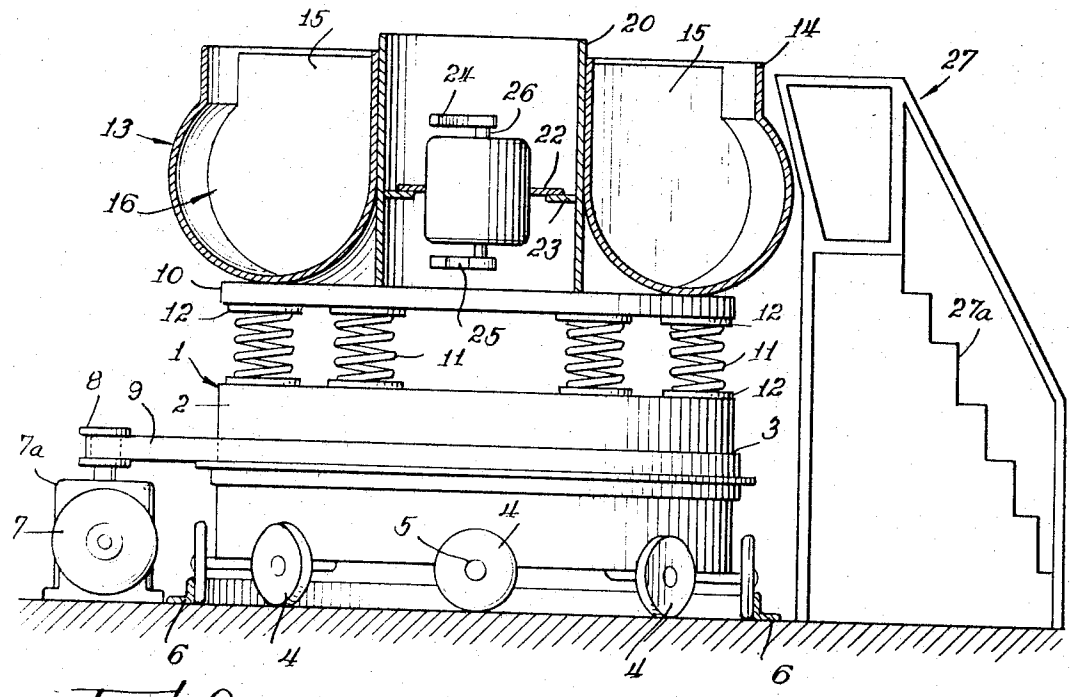


Fig. 2

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Fig. 3.

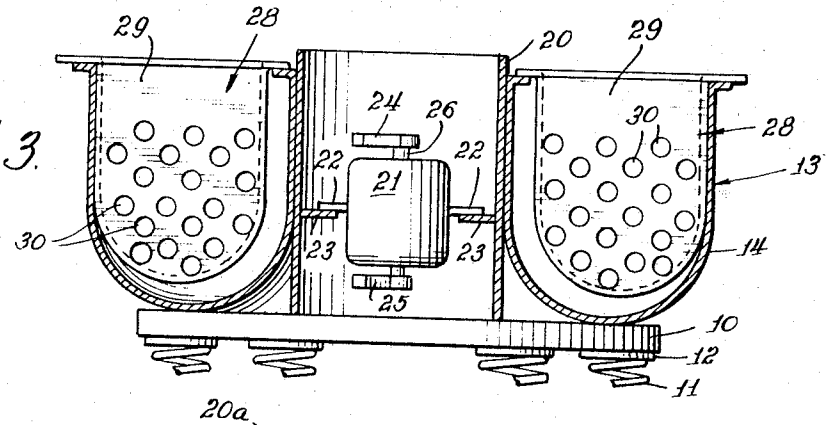
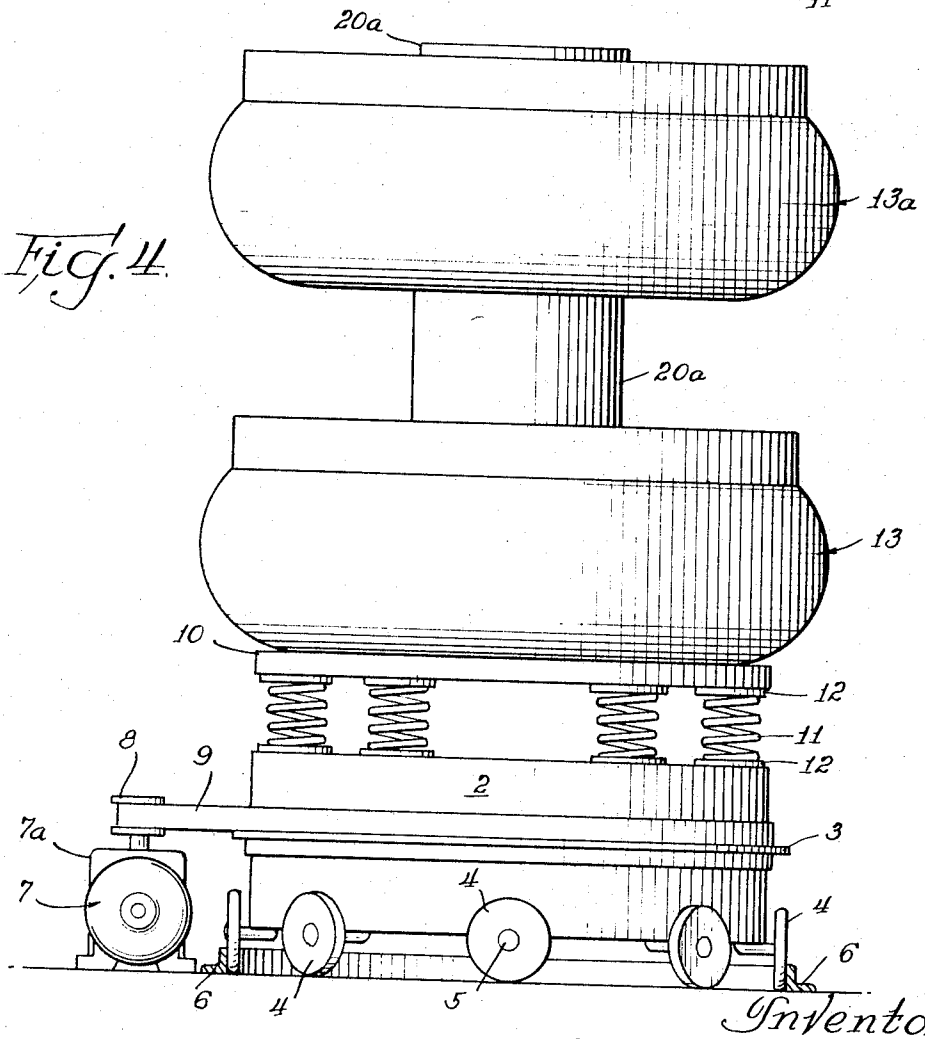


Fig. 4.



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Fig. 5.

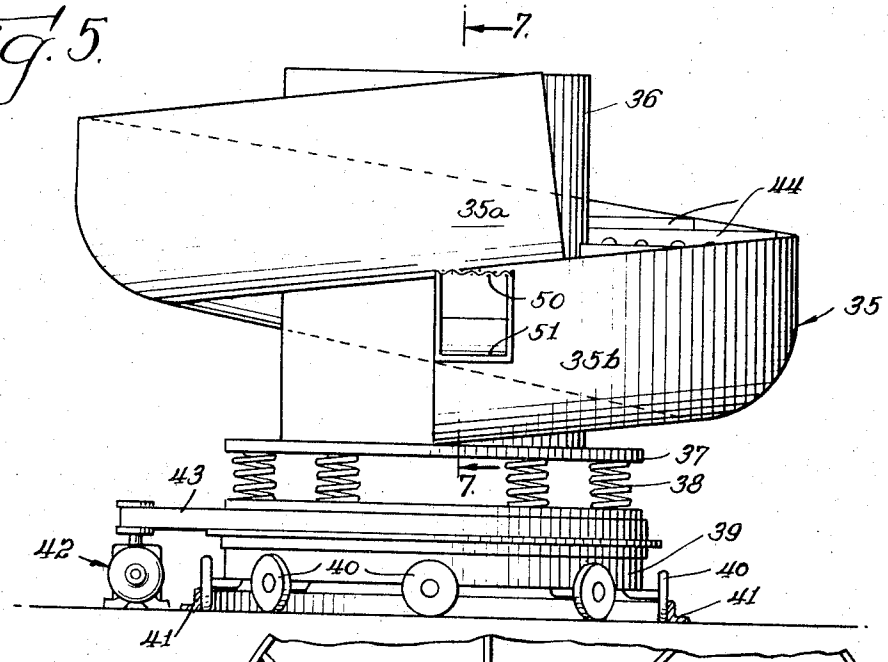


Fig. 6

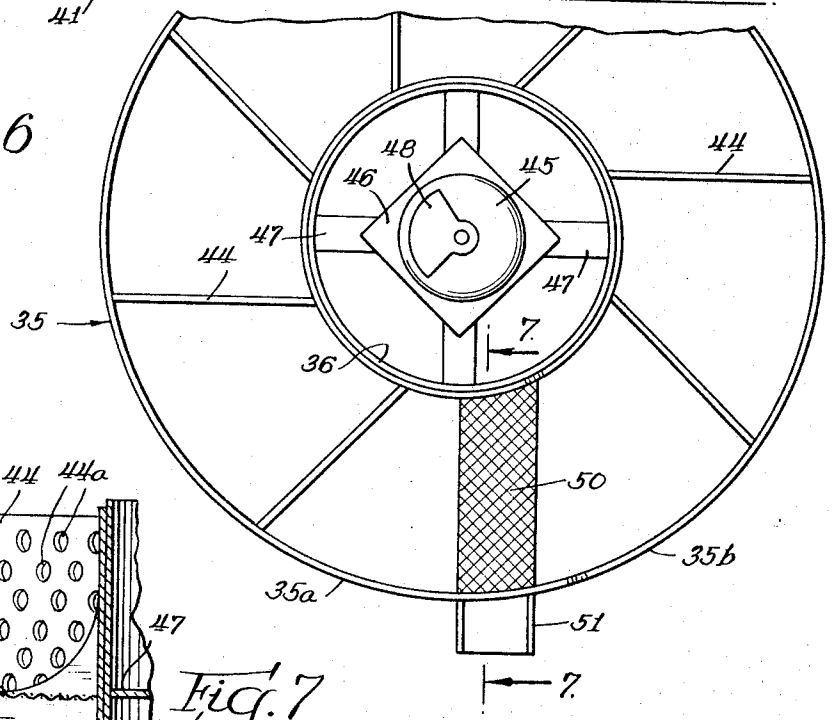
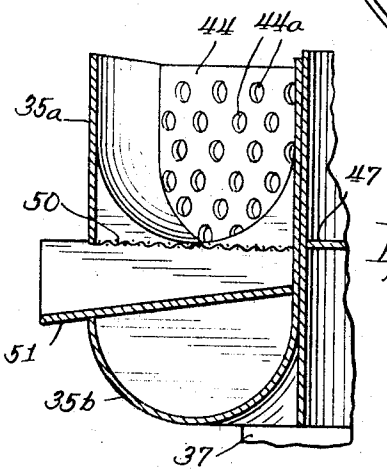


Fig. 7



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3,423,884

FINISHING APPARATUS HAVING A PLURALITY OF COMPARTMENTS

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U.S. Cl. 51—163 20 Claims
Int. Cl. B24b 31/00; B02c 17/08

ABSTRACT OF THE DISCLOSURE

A finishing machine for finishing the surface of parts comprising a substantially curvilinear chamber, as for example in the form of an annular trough, having means dividing the chamber into a plurality of compartments adapted to retain the parts during operation of the machine, vibratory means provided for subjecting a mixture comprising parts and finishing material to vibration to cause the mixture to undergo orbital motion and the parts to be finished, and in an improved embodiment, having means for rotating the chamber.

The present invention relates to finishing machines and is more particularly concerned with a finishing machine having a curvilinear and preferably annular or helical construction and divided into a plurality of separate compartments, and whereby means is provided to enable an operator to load and remove parts without the necessity for shifting his position.

Finishing machines may be of several different types. With regard to the mode of operation, there are tumbling type machines and vibratory type machines, the latter being a finishing machine in which a vibration generating means, e.g., a rotary motor provided with eccentric members, is employed for imparting alternating waves of energy to a finishing, e.g., abrading, chamber for moving a mass of finishing media and unfinished parts therein. In addition, self-separating vibratory finishing machines are now available which employ integral foraminous members for automatically separating finishing media from finished parts upon rotation of a housing from a finishing position to a transfer position. When so rotated, the finishing media flows through openings in the foraminous member and is deposited in a storage chamber whereas the finished parts are discharged from the housing or transferred to a succeeding stage, depending upon whether the device is of single or multistage construction. Additionally, finishing machines are now known which comprise an annular or helical finishing chamber in the form of a trough which is caused to vibrate about a vertical axis, imparting both orbital and linear motion to the parts and finishing material contained therein.

In prior art machines, all the parts to be finished are inserted into a single finishing chamber in which the parts are all finished together. No provision has been made for finishing parts individually. Individual finishing of parts is frequently highly desirable, particularly in the case of large parts, where the parts may strike and damage each other during the finishing operation, or where a plurality of different parts are to be finished without intermingling.

It is accordingly an object of the present invention to provide a novel and improved finishing machine which overcomes the disadvantages of existing machines. It is another object of the invention to provide an improved finishing machine which provides individual finishing of parts without danger of their being damaged by contact with other parts being finished. It is a further object to provide a finishing apparatus which may be loaded and unloaded by an operator without the necessity of shifting

his position. It is an additional object to provide a machine having means provided therein for automatically removing finishing material "fines" during the finishing process. The accomplishment of the foregoing and additional objects will become more fully apparent hereinafter.

Accordingly, the present invention in its broadest concept comprises a curvilinear finishing chamber which is stationary with regard to rotative movement. The finishing chamber is divided into a plurality of separate compartments. The operator accomplishes loading and unloading of the compartments by walking around the device at a rate of speed which may correspond to the rate of the finishing cycle. Although this embodiment does not permit the operator to load and unload the machine from a stationary position, it has the considerable advantage of providing a plurality of separate finishing compartments within a relatively small space, in contrast to an apparatus comprising a series of compartments linearly arranged along a long straight line or a long finishing tub which is linearly arranged and divided into a series of separate chambers, which apparatus is extremely difficult to vibrate efficiently.

According to a preferred embodiment of the present invention, an apparatus is provided having a curvilinear finishing chamber which may be substantially horizontal or, alternatively, helical, about a vertical axis. The chamber is radially partitioned into a plurality of compartments each of which may be filled with one or more parts to be finished and finishing material. Additionally, the apparatus is mounted for rotation about a vertical axis. Power means is provided for rotating the apparatus slowly as the finishing chamber is vibrated. As a result, the individual chambers may be loaded and unloaded by a stationary operator. In a modification of the invention, the partitions are provided with a plurality of orifices, permitting the finishing material to pass therethrough while retaining the parts to be finished within the individual compartments. The chamber may be made discontinuous at one portion and provided with a screen having a mesh or gauge suitable for passing "fines" or worn out finishing material but sufficiently fine to prevent the finishing material of operative size from passing therethrough. Consequently, the screen returns the finishing material to the finishing chamber while separating and removing the "fines."

The invention in several of its preferred embodiments is illustrated by the accompanying drawings in which:

FIG. 1 is a top view of a finishing machine according to the invention.

FIG. 2 is a cross-section of the machine taken at the line 2—2 of FIG. 1.

FIG. 3 is a cross-section of a modified embodiment.

FIG. 4 is a side elevation of still another embodiment of the invention.

FIG. 5 is a side elevation of a further embodiment of the invention.

FIG. 6 is a fragmentary top view of the apparatus of FIG. 5; and

FIG. 7 is a fragmentary cross-section taken at the lines 7—7 of FIGS. 5 and 6.

Reference is now made to the accompanying drawings for a better understanding of the invention, wherein all the parts are numbered and wherein the same numbers are used to refer to corresponding parts throughout.

Referring to FIGS. 1 and 2, a finishing machine is shown having a frame 1 comprising a base plate 2 having a single flange pulley 3 affixed thereto. The base is provided with a plurality of wheels 4 mounted on axles 5 to permit the base to be rotated. A circular rail 6 is provided to restrict translational movement of the base 2. A motor 7 and transmission 7a having a pulley 8 ro-

tates the base by means of an endless belt **9** mounted over the pulley **8** and the pulley **3**. The base may be rotated continuously or, alternatively, may be intermittently rotated to place the apparatus in any one of a plurality of indexed positions by employment of suitable indexing means.

A base plate **10** is spring-mounted on the base **2** by means of helical springs **11** which are affixed to the base **2** and to the base plate **10** by means of small plates or cups **12** which are suitably affixed to the plates.

A curvilinear finishing chamber **13** is mounted on the plate **10** in a substantially horizontal position. If desired, the plate **10** may have its central portion cut out. The finishing chamber **13** is shown in FIGS. 1 and 2 in the form of an annular trough **14** having an arcuate, e.g. semicylindrical, bottom. Although the finishing chamber **13** is shown in the drawings in the form of a trough, it may be provided in other forms, as for example in the form of a tube, tray, etc. However, the form shown in the drawings is preferred. A plurality of transverse or diagonal partitions or diaphragms **15** are positioned at intervals within the trough dividing the trough into a plurality of finishing compartments **16**.

Mounted on the plate **10** and within the annular trough is a cylindrical supporting frame **20**. A vibratory motor **21** is mounted on the frame **20** by means of a mounting plate **22** affixed to the motor housing and brackets **23** affixed to the frame **20** at one end and to the plate **22** at the other. A pair of eccentric weights **24** and **25** are mounted one at each end of the motor shaft **26**. If desired, only one eccentric weight need be used. However, greater efficiency is achieved with two or even more weights. The eccentric weights should preferably be out of phase with each other to provide the desired vibratory motion.

A platform **27** is shown for permitting an operator to be positioned at a height sufficient to enable him to load and unload the parts without difficulty. The platform **27** as shown is provided with a stairway access **27***a*.

The apparatus shown in FIGS. 1 and 2 is placed into operation by first loading each compartment with parts and finishing material. Where the parts are large, and particularly of such nature that they may be damaged by being knocked against one another, only a single part is advantageously placed in each compartment. Since the walls of the trough and the partitions are generally coated with an elastic material such as rubber or an elastomeric plastic such as polyvinyl chloride, the part is not damaged by collision with the walls of the trough or partitions. If desired, the apparatus may be rotated continuously during the finishing process at such a rate that the period of rotation coincides with the period required for finishing the parts. Thus the operator may load and remove the parts continuously. Alternatively, the apparatus may be left stationary during operation, but merely rotated to indexed positions when it is desired to remove or load the parts.

Although the apparatus has been shown in FIGS. 1 and 2 as being designed to rotate about a vertical axis, the apparatus may be made stationary, in which case the operator walks around the apparatus from one compartment to the other to load and unload the parts. Although this embodiment does not have the advantage that the operator may remain stationary, it does have the advantage that a series of compartments for finishing parts is provided which, because they are oriented circularly, may be readily vibrated and require little space, as opposed to an elongated series of compartments.

FIG. 3 illustrates an embodiment of the invention wherein individual removeable compartments **28** are inserted within the trough. In one form of this embodiment the end walls of the compartments are continuous, and the compartments **28** are loaded and unloaded with both parts and finishing material while they are out of the trough. Alternatively, as shown in FIG. 3, the end walls **29** of the compartments may be foraminous, the apertures **30** provided being of a size sufficiently large to permit the finishing material to pass therethrough, but of a size sufficiently small to restrain the parts. Consequently, the finishing material itself may be loaded into the trough **14** while the parts are loaded into the compartment containers **28**. During the finishing process the finishing material is free to enter and leave the individual compartments. After the parts have been sufficiently finished, the compartments are lifted from the trough and the finishing material permitted to leave through the apertures **30** and return to the tray. Alternatively, the compartments may be removed while still retaining the finishing material. Suitable linear motion is imparted to the finishing material when the eccentric weights are properly out of phase. The vibrations, by setting of the unbalance weights, preferably impart an orbital motion to the finishing material and the parts in each separate compartment.

FIG. 4 illustrates an embodiment somewhat modified from that of FIGS. 1 and 2. In this embodiment, an additional finishing chamber **13***a* is provided which is mounted upon an extended supporting frame **20***a* above a similar lower chamber **13**. This embodiment provides twice the finishing capacity of the machine shown in FIGS. 1 and 2. However, the individual finishing chambers operate independently of each other. The remainder of the structure is similar to that of FIGS. 1 and 2.

The embodiment illustrated in FIGS. 5–7 constitutes still a further modification over that shown in FIGS. 1 and 2. Here, instead of utilizing a substantially annular finishing chamber, the apparatus comprises a helical finishing chamber **35** mounted on a cylindrical supporting frame **36** which is affixed at its bottom to a base plate **37** spring-mounted on helical springs **38** to a motor-driven rotating base **39** similar to that illustrated in FIGS. 1 and 2. The base is mounted on wheels **40** retained in position by a rail **41** affixed to the floor. The base **39** is driven by a motor and trunnion assembly **42** connected to the base by means of an endless belt **43**.

A plurality of foraminous diaphragms **44** are provided which divide the trough into a plurality of separate compartments. The apertures **44***a* of the diaphragm are of sufficient size to pass the finishing material but sufficiently small to retain the parts within each compartment. A motor **45** affixed to a mounting plate **46** is mounted within the supporting frame **36** by means of brackets **47**. Unbalance weights **48** are affixed to the shaft of the motor.

A screen **50** is provided at the bottom of the upper end **35***a* of the chamber **35**, having a chute **51** positioned immediately below. The screen is chosen of such mesh that the finishing material of operative size is retained thereon and continues past the screen and is returned to the lower end **35***b* of the chamber. However, the "fines," i.e., finishing material which has been subject to attrition to the extent that it is worn below an operative size, falls through the screen and is guided out of the apparatus by means of the chute **51**. Consequently, an automatically operating means is provided for continuously removing the worn out finishing material or "fines." Such means may also be provided in non-helical embodiments of the invention. Moreover, the foraminous diaphragms may also be provided in non-helical embodiments of the invention.

In setting the embodiment of FIGS. 5–7 into operation, the finishing material is placed into the bottom of the trough either in one chamber or, preferably, distributeded uniformly among the various chambers. The parts are loaded into the various chambers.

When the motor **45** is set in motion, the unbalance weights **48** impart vibration to the housing. When the eccentric weights **48** are arranged out of phase, a compound motion is imparted to the finishing material and parts. A first component of the vibratory motion causes the parts and finishing material to travel in an orbital path in a plane substantially perpendicular to the trough. Addi-

tionally, a linear force is imparted causing the parts and finishing material to travel linearly upwardly along the helical trough. The parts are of sufficient size so that they are restrained by the partitions or diaphragms **44** and remain in their original compartments. However, the finishing material is sufficiently small so that it passes through the foramina of the diaphragms and continues linearly along the trough in an upward direction. The finishing material passes from one compartment to another until eventually it reaches the uppermost compartment **35***a* at one end of the helix. The finishing material then passes over the screen **50** where the fines are separated and removed from the chamber by means of the chute **51**. The finishing material which does not pass through the screen continues and is returned to the compartment **35***b* at the lower end of the helix where the finishing material is again free to travel through the successive compartments. If desired, additional finishing material may be periodically added to replace that removed as fines.

The finishing machine of the present invention has numerous advantages over prior art machines. In its broadest concept it provides a machine having a curvilinear finishing chamber divided into a plurality of separate compartments. This enables parts to be individually processed within the separate compartments where there is danger of damaging the parts as a result of their jostling against each other. Moreover, a linear series of separate compartments is thus provided within a relatively small space. The form of the apparatus permits the linear arrangement of separate compartments to be readily vibrated to carry out the finishing process.

In its preferred embodiment the present apparatus provides means for rotating the entire finishing chamber, permitting the operator to load and unload the various compartments without leaving his stationary post. Further, in one embodiment means is provided for automatically removing "fines" during the finishing process.

It is to be understood that the invention is not limited to the exact details of construction, operation, or exact materials or embodimens shown and described, as obvious modifications and equivalents will be apparent to one skilled in the art, and the invention is therefore to be limited only by the scope of the appended claims.

I claim:

1. A finishing machine for finishing the surface of parts with relatively small pieces of finishing material compared to the size of said parts comprising a housing mounted for vibration defining a substantially curvilinear finishing chamber, foraminous means dividing said chamber into a plurality of curvilinearly arranged compartments adapted to retain said parts and allow said finishing material to pass through, and vibratory means operatively associated with said housing comprising a motor positioned with its shaft oriented generally vertically and carrying eccentric weights in out-of-phase relationship for subjecting a mixture comprising said parts and a finishing material to vibration causing said mixture to undergo orbital motion and said parts to be finished and said finishing material to travel linearly along said trough, a limited area of the bottom of said chamber being provided with screen means for separating and removing fines from said finishing material.

2. A finishing machine according to claim **1** wherein said means dividing said chamber into a plurality of compartments comprises a plurality of removable containers, the walls of said removable containers being foraminous.

3. A finishing machine according to claim **1** wherein said housing comprises a trough helically arranged about a vertical axis and wherein said means dividing said chamber into a plurality of compartments comprises transverse foraminous vertical walls, said vibratory means being so arranged that said finishing material is caused to travel linearly upwardly along said trough, and means provided in said chamber for separating fines from said finishing material and removing said fines from said chamber.

4. A finishing machine for finishing the surface of parts comprising a base mounted for rotation about a vertical axis and means for rotating said base, a housing mounted on said base for vibration defining a substantially curvilinear finishing chamber, and vibratory means operatively associated with said housing comprising a motor positioned with its shaft oriented generally vertically and carrying eccentric weights in out-of-phase relationship for subjecting a mixture comprising said parts and a refinishing material to vibration causing said mixture to undergo orbital motion and said parts to be finished.

5. A finishing machine for finishing the surface of parts comprising a base mounted for rotation about a vertical axis and means for rotating said base, a housing mounted on said base for vibration defining a substantially curvilinear finishing chamber, means dividing said chamber into a plurality of compartments, and vibratory means operatively associated with said housing comprising a motor positioned with its shaft oriented generally vertically and carrying eccentric weights in out-of-phase relationship for subjecting a mixture comprising said parts and a finishing material to vibration causing said mixture to undergo orbital motion and said parts to be finished.

6. A finishing machine according to claim **5** wherein said housing comprises a trough the bottom of which has an arcuate cross-section.

7. A finishing machine according to claim **5** wherein said housing is annular and substantially horizontally oriented.

8. A finishing machine according to claim **5** wherein said means dividing said chamber into a plurality of compartments comprises a plurality of removable containers.

9. A finishing machine acording to claim **8** wherein the walls of said removable containers are foraminous for permitting said finishing material to pass therethrough while retaining said parts.

10. A finishing machine according to claim **5** wherein said means dividing said chamber into a plurality of compartments comprises a plurality of transversely oriented vertical partitions.

11. A finishing machine according to claim **9** wherein said partitions are foraminous for permitting said finishing materal to pass therethrough while retaining said parts.

12. A finishing machine according to claim **5** wherein a limited area of the bottom of said chamber is provided with screen means for separating and removing fines from said finishing material.

13. A finishing machine according to claim **5** wherein said housing comprises a trough helically arranged about a vertical axis.

14. A finishing machine according to claim **5** wherein said vibratory means comprises a motor positioned with its shaft oriented generally vertically and carrying eccentric weights.

15. A finishing machine according to claim **13** wherein said eccentric weights are out of phase with each other.

16. A finishing machine according to claim **5** wherein said means for rotating said base is adapted to place said housing into any one of a plurality of indexed stationary positions.

17. A finishing machine according to claim **5** wherein said base is adapted to be rotated continuously at a rate wherein the period of rotation is approximately equal to the period of time necessary to finish said parts, whereby a stationary operator may load and remove parts from said compartments as said housing rotates.

18. A finishing machine according to claim **5** having a plurality of vertically spaced annular chambers each being divided into compartments.

19. A finishing machine according to claim **5** wherein said housing comprises a trough helically arranged about a vertical axis and wherein said means dividing said chamber into a plurality of compartments comprises transverse foraminous vertical walls adapted to pass said finishing

material but to retain said parts, said vibratory means being so arranged that said finishing material is caused to travel linearly upwardly along said trough, and means provided in said trough for separating fines from said finishing material and removing said fines from said chamber.

20. A finishing machine according to claim **5** wherein said housing comprises a trough helically arranged about a vertical axis and wherein said means dividing said chamber into a plurality of compartments comprises a plurality of containers having foraminous walls adapted to pass said finishing material but to retain said parts, said vibratory means being so arranged that said finishing material is caused to travel linearly upwardly along said trough, and means provided in said trough for separating fines from said finishing material and removing said fines from said chamber.

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