Aug. 29, 1967 J. F. RAMPE 3,337,997

FINISHING APPARATUS

Filed March 24, 1965 7 Sheets-Sheet 1

Fig. 1

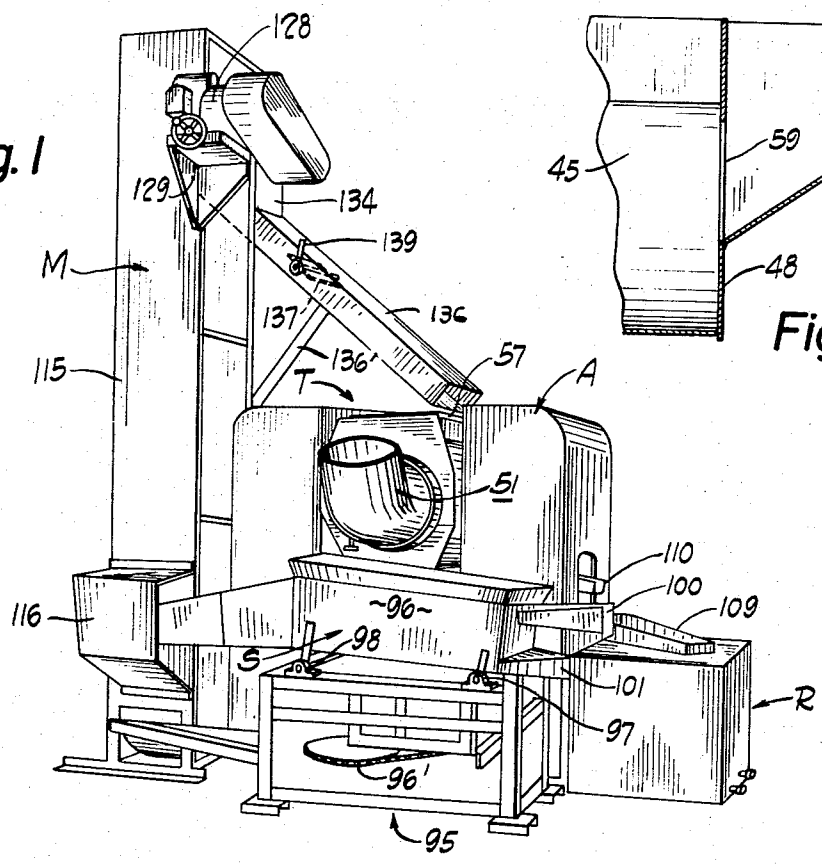


Fig. 9

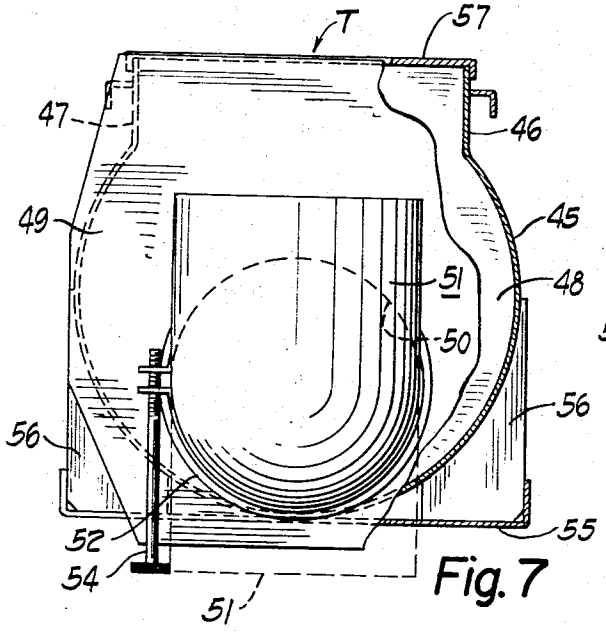


Fig. 7

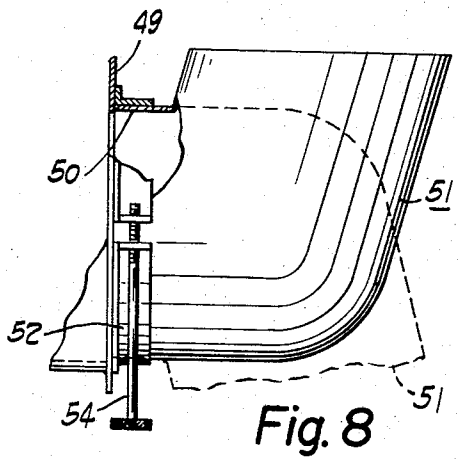


Fig. 8

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FINISHING APPARATUS

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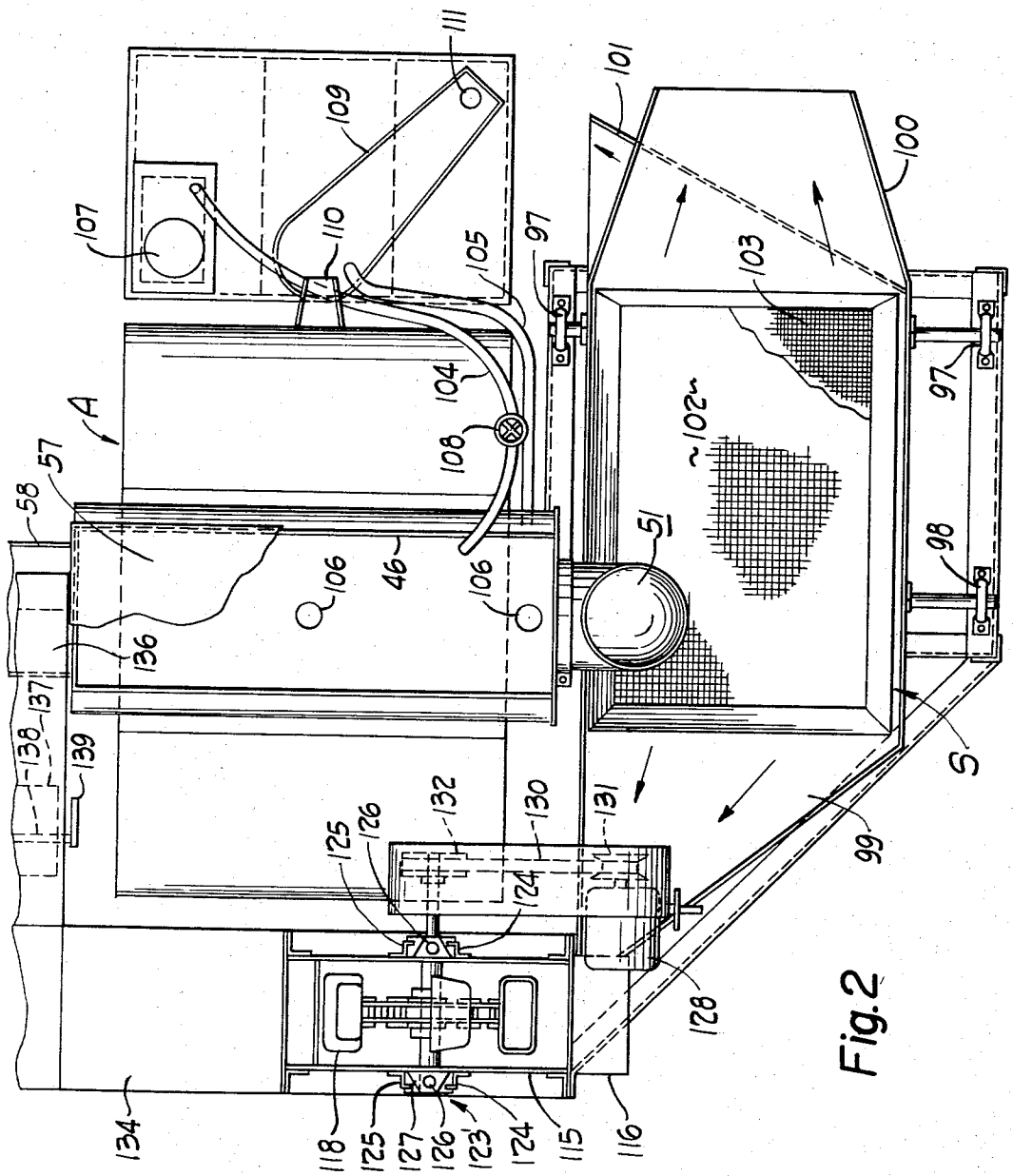


Fig. 2

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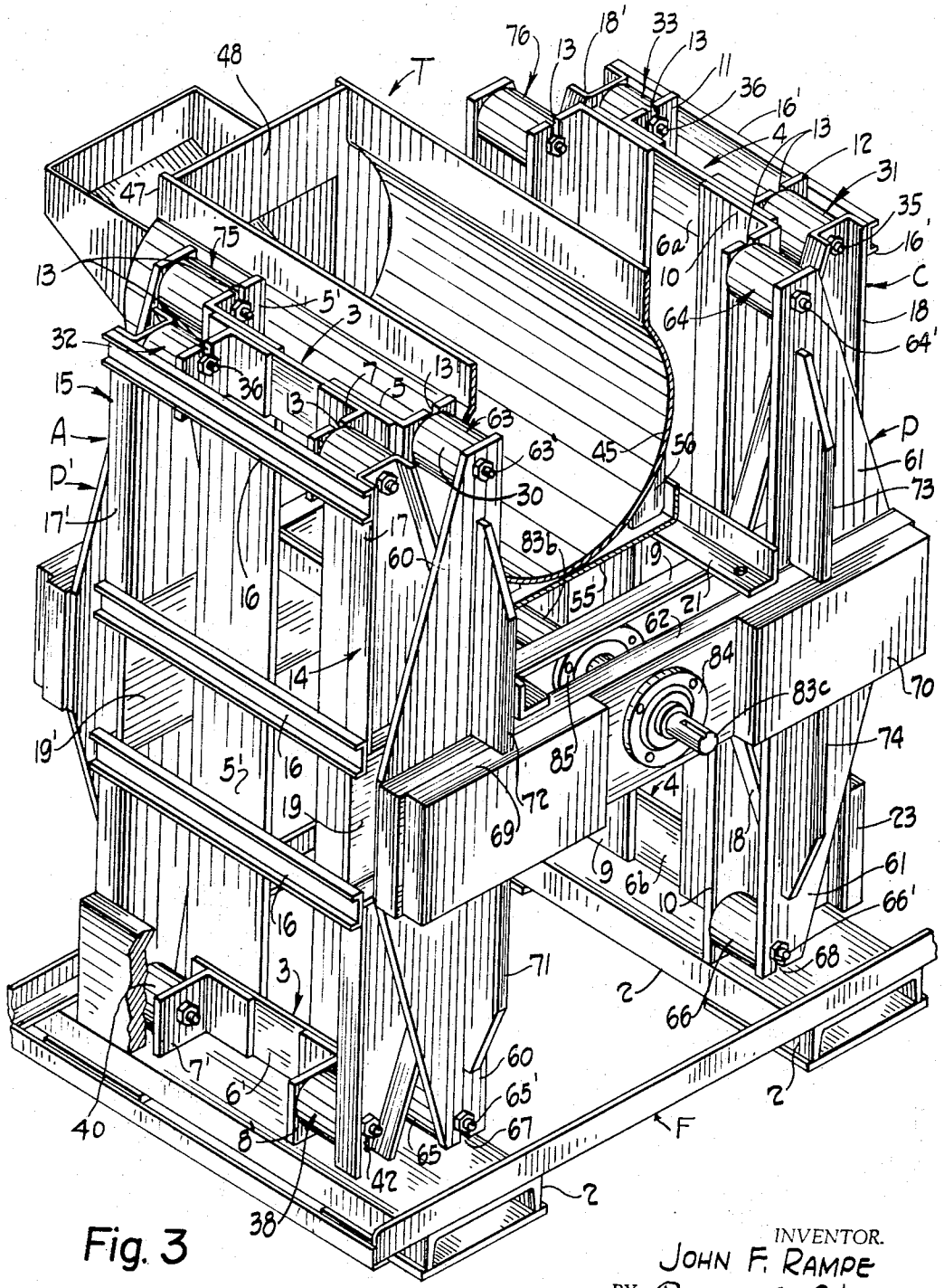


Fig. 3

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FINISHING APPARATUS

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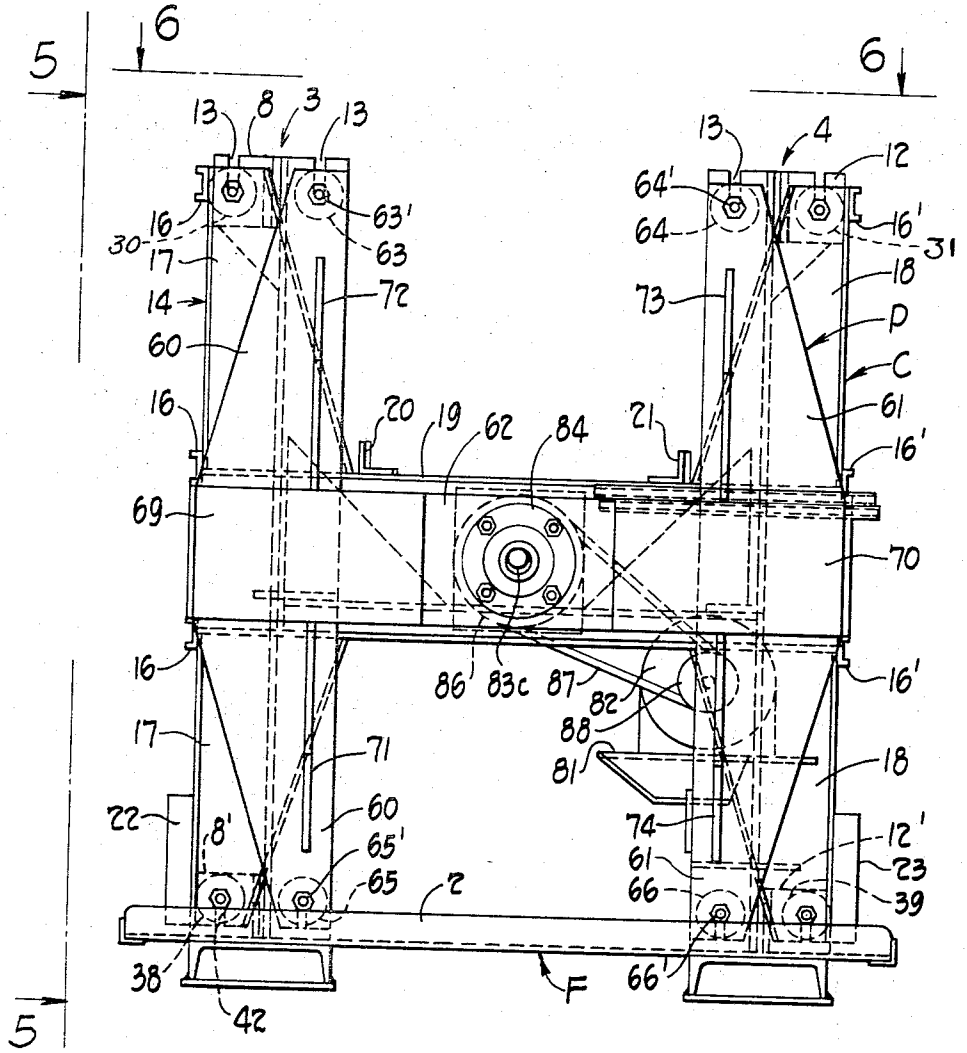


Fig. 4

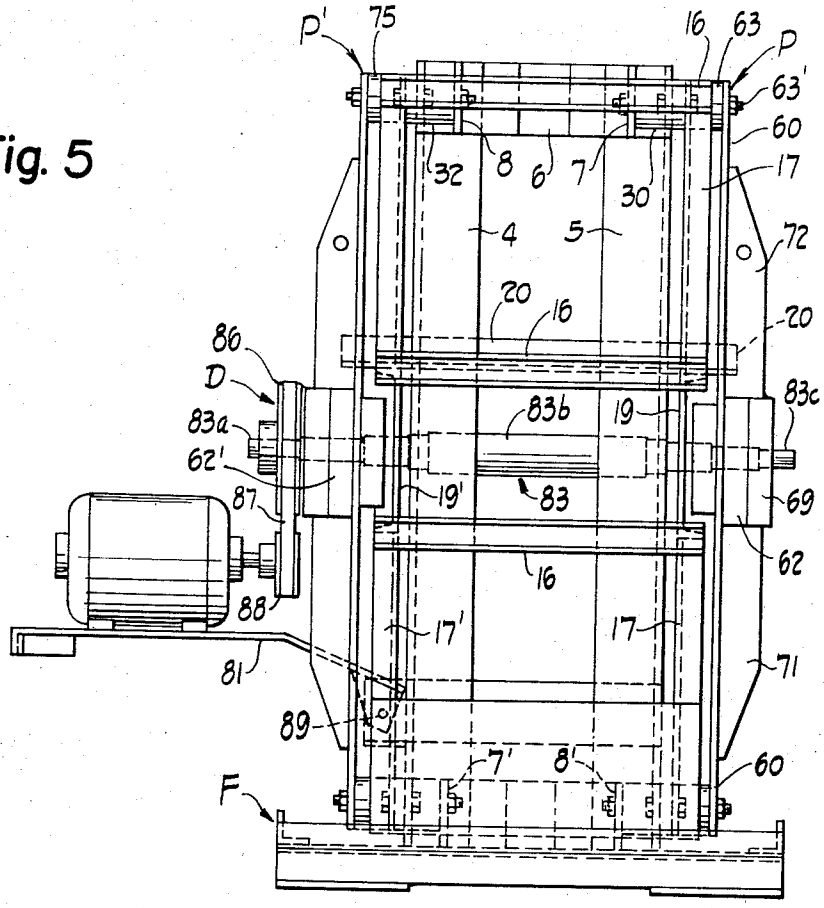
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Fig. 5



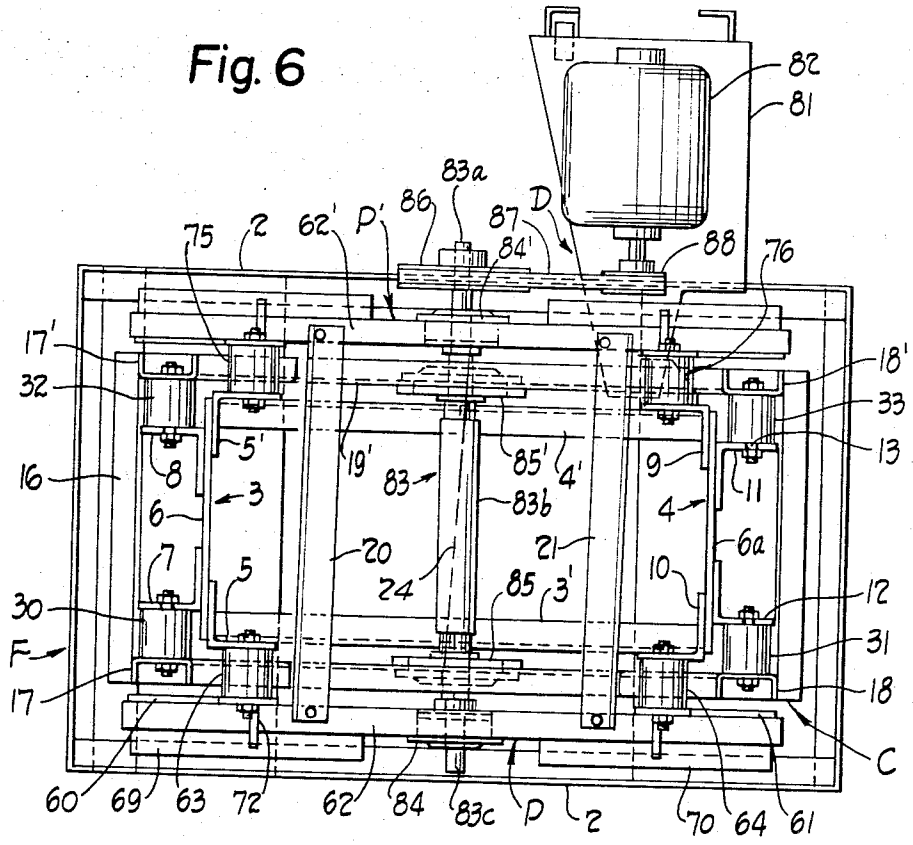
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FINISHING APPARATUS

Filed March 24, 1965 7 Sheets-Sheet 6

Fig. 6



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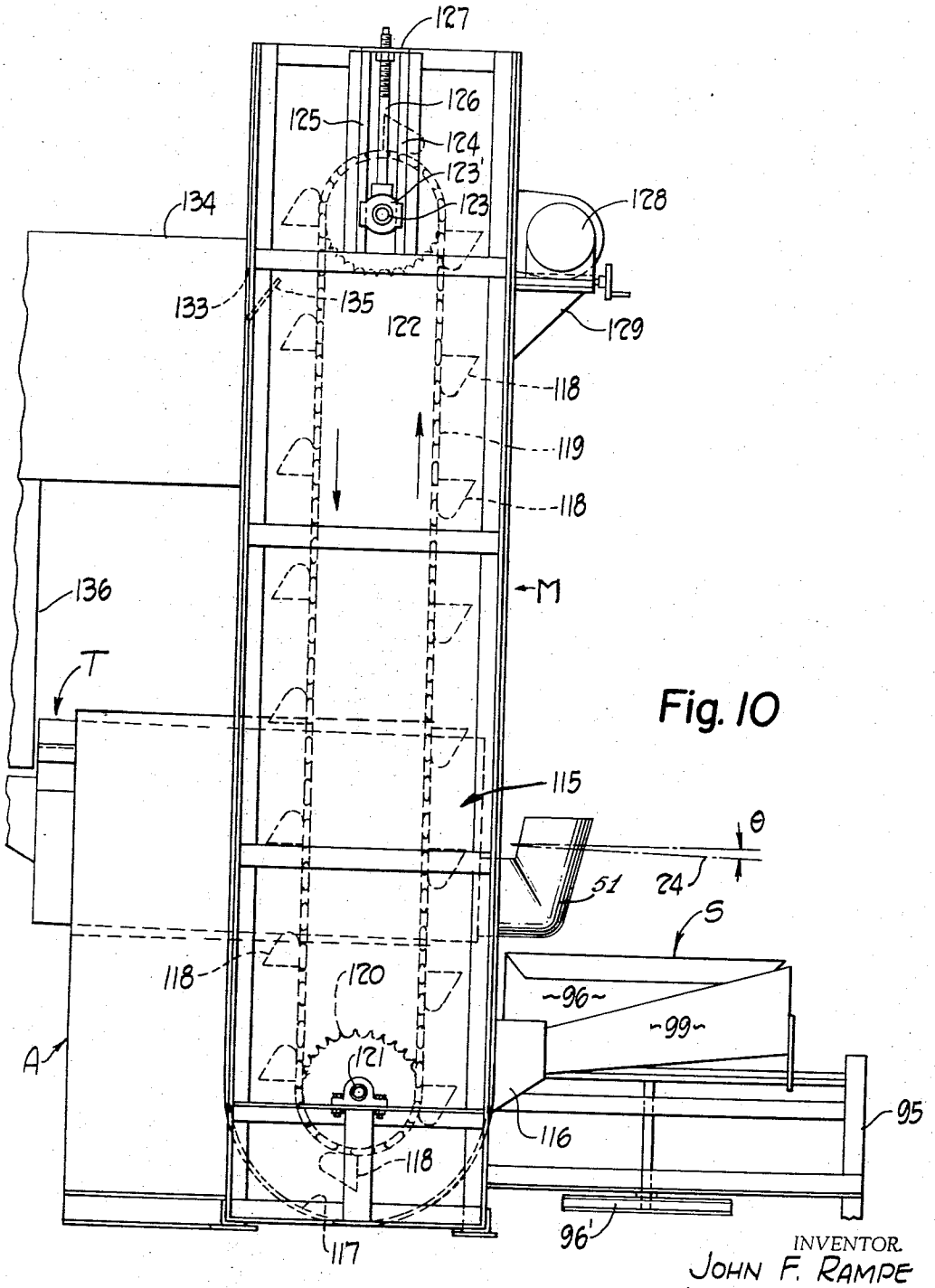


Fig. 10

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3,337,997

FINISHING APPARATUS

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Filed Mar. 24, 1965, Ser. No. 442,457
4 Claims. (Cl. 51—163)

ABSTRACT OF THE DISCLOSURE

Vibratory finishing apparatus characterized among other things by a frame; a prime mover; a shaft driven by the prime mover; a shaft-mounted eccentric; a work-carrying tub vibrated by the eccentric; charging and discharging means in opposite portions of the tub; and an angular relationship between the tub axis and the shaft such that work-pieces proceeding from the charging means to the discharging means travel in a substantially helical path.

This invention relates to vibratory finishing apparatus of the type shown and described in copending U.S. application, Ser. No. 357,212, filed Apr. 3, 1964, now Patent No. 3,318,051.

In that application is disclosed an orbital type vibratory apparatus for the surface finishing of articles such as castings, forgings, stampings, etc., in which an open-topped work holding tub is mounted on a carriage which in turn is supported on a fixed frame by resilient mounts whereby the carriage and the tub may have orbital movement relative to the frame. A counterpoise structure is also supported on the fixed frame adjacent to the tub carriage by resilient mounts and a common eccentric drive shaft imparts orbital movement to both the tub carriage and the counterpoise structure. The forces imposed on the eccentric drive shaft by the orbital movement of the resiliently mounted tub carriage and the tub are oppposed and balanced by the forces imposed on the eccentric drive shaft by the orbital movement of the resiliently mounted counterpoise structure. This arrangement provides a smooth running mechanism which may be operated at high speed without setting up dangerous and harmful vibrations in the apparatus itself or in the building which it is housed.

In the operation of finishing apparatus of this type an abrasive finishing medium such as steel shot, stone particles, or other suitable material, selected according to the results desired, is charged into the tub with the articles to be finished. A liquid, for example water, is usually, but not always, added to facilitate the polishing, de-burring or other finishing action of the finishing medium on the work. In the apparatus of the above-identified copending patent application, and in other finishing apparatus of this general type, the finishing is carried on in batches, the apparatus being completely stopped to empty the tub at the completion of each finishing cycle and the tub then being recharged with articles to be finished, abrasive media and liquid vehicle and the operation repeated.

The stopping of the apparatus for emptying the tubs, recharging them and starting up again is a time consuming operation and it is one of the objects of the present invention to provide a vibratory finishing apparatus by which this time is minimized in bath operation and which may also be adapted to operate continuously without stopping or shut down. To this end means are provided whereby articles may be intermittently or continuously deposited in one end of the tub and intermittently or continuously discharged from the other end without stopping the orbital movement thereof. Advantageously, the generally cylindrical tub is mounted on the carriage with the tub axis slightly inclined and defining an acute angle, as viewed

both in elevation and in plan, with the axis of the substantially horizontal vibratory drive shaft. This angular relationship causes the vibratory forces developed by the drive shaft to move the workpieces through a substantially helical path to insure substantially equal finishing of all workpieces and to aid the discharge of finished workpieces from the lower end of the tub.

The tub is provided with a discharge elbow rotatably mounted around the discharge port. The length of the angularly depending portion is sufficient to prevent the discharge of workpieces when the elbow is rotated to a position in which the depending portion is directed upwardly. When the workpieces are to be discharged, the elbow is rotated to direct the angularly depending portion downwardly. With this arrangement, there will be no change in the area of the discharge opening and the parts can be quickly and easily discharged. Further, the discharge of parts can be quickly and easily terminated. The finishing medium may be intermittently or continuously charged into and removed from the tub without stopping same, the undesirable fines which result from the finishing process may be separated out and removed, and the liquid vehicle may be intermittently or continuously withdrawn, separated from an entrained undesirable material, and returned to the tub during operation thereof.

Further objects of my invention include the provision of an improved finishing machine in which the work receiving vessel or tub is disposed for convenient loading and unloading of workpieces and finishing medium therein into and which may be readily discharged without stopping its vibratory movement; the provision of an orbital type finishing machine of compact and rugged design in which the tub may be loaded from one end and unloaded from the other end during operation thereof; the provision of a vibratory finishing machine which will not transmit substantial vibration to the floor or other support on which it is mounted; and the provision of a vibratory type finishing machine which may be operated continuously, which requires a minimum of upkeep, and which may be economically constructed and maintained.

The above and other objects of my invention will appear from the following description and from the accompanying drawings, in which:

FIG. 1 is an illustrative perspective view showing the improved continuous finishing machine including the orbital type vibratory finishing tub, the work and finishing medium separating screen, the medium recirculating mechanism, and the fluid vehicle cleaning and circulating apparatus;

FIG. 2 is a plan on a somewhat larger scale of the apparatus illustrated in FIG 1;

FIG. 3 is an enlarged perspective view, partially broken away for clearness, of the finishing tub and its support and drive means;

FIG. 4 is an end elevational view, taken from the right in FIG. 3, illustrating the vibration damping tub support mechanism, the tub being removed;

FIG. 5 is a side elevational view taken substantially on line 5—5 of FIG. 4;

FIG. 6 is a plan taken substantially on line 6—6 of FIG. 4;

FIG. 7 is a detached end view of the finishing tub, parts being broken away to show the inner contour thereof and the end discharge arrangement;

FIG. 8 is a side view of the front end of the finishing tub and the discharge arrangement, partly in section;

FIG. 9 is a fragmentary view, partly in section, of the rear end of the finishing tub; and

FIG. 10 is an enlarged fragmentary elevational view showing the separator screen unit and the medium recirculating conveyor.

In FIG. 1, which is a general perspective view of my improved apparatus, and in FIG. 2 which is a plan view thereof, the orbital finishing unit is generally indicated at A, the medium and work separator unit at S, the fluid settling and recirculating tank at R, and the medium recirculating conveyor at M. Seen as in FIGS. 1 and 2, the finishing unit A, except for the tub T, is enclosed in a protective sheet metal casing. In FIGS. 3–6 inclusive, the orbital finishing unit is illustrated with the enclosing cover removed. Broadly speaking, the finishing unit A includes a stationary frame generally indicated at F, a tub supporting carriage structure generally indicated at C, a counterpoise structure generally indicated at P, a work carrying tub T, and drive means D for imparting the desired movement to the tub carriage and tub.

The frame structure (see FIGS. 3 and 4) consists of a generally rectangular base **2** on which are mounted upright columns **3** and **4**. The column **3** is made up of angle members **5** and **5'** which extend upward from the base **2** and are connected by suitable top and bottom cross members **6** and **6'**. Top offset angle tub carriage support flanges **7** and **8** are secured at the top of column **3** and project in the opposite direction from the angles **5** and **5'**. Similar bottom offset angle tub carriage support flanges **7'** and **8'** are secured at the bottom of the column **3**.

In like manner, the column **4** has vertical angle members **9** and **10** connected by top and bottom cross members **6a** and **6b**, oppositely extending top offset angle tube carriage supports **11** and **12**, and bottom tub carriage supports one of which is seen at **12'** in FIG. 4. The upper edges of the oppositely extending flanges of the angles **5** and **5'** and the tub carriage supports **7** and **8**, and the corresponding upper edges of the angles **9** and **10** and the tub carriage supports **11** and **12**, are each provided with a downwardly extending slot **13** to receive resilient shear mount members as will be later described. Suitable reinforcing cross members **3'** and **4'**, extending between the columns **3** and **4**, are also provided to impart the desired rigidity to the structure (see FIG. 4).

The tub carriage structure C, as best seen in FIGS. 3–6, includes a pair of upright H-shaped tub carrying members generally indicated at **14** and **15**. The front (as seen in FIG. 3) tub carrying member **14** includes a pair of vertical uprights **17** and **18** connected together by a transverse horizontal center cross member **19**. The rear tub carying member **15**, in like manner, consists of a pair of vertical uprights **17'** and **18'** connected together by a center cross member **19**. The two H-shaped members **14** and **15** are secured together by transverse struts **16** which connect the vertical members **17** and **17'** and similar transverse struts **16'** which connect the vertical members **18** and **18'**. A pair of parallel angle irons **20, 21** are secured in acuate angular relationship to center cross members **19, 19'** and are employed as tub supporting channels to support the tub T with its axis forming an acute angle with the drive shaft axis and with the tub axis slightly inclined in a manner which will be subsequently described.

Heavy transverse bars **22** and **23** are secured to the lower ends of each of the H-shaped end members **14** and **15** and extend across between the vertical uprights **17, 17'** and **18, 18'** thereof. These bars **22** and **23** constitute weights which are designed to balance the weight of the tub T and the work load carried therein.

The tub carriage C is suspended at its upper end in the frame F by four resilient shear mounts **30, 31, 32,** and **33**. Each of these mounts (see FIG. 3) comprises a cylindrical resilient body of rubber or the like having coaxial bolts **35** and **36** embedded therein and extending out from its opposite ends which are flat and parallel. The inner ends f bolts **35** and **36**, which are bonded in the resilient body, are spaced from each other to provide a resilient connection between the stationary frame F and the tub supporting carriage C whereby the carriage may have orbital or other vibratory movement independently of and relative to the frame. Such movement, however, is restricted by the

mounts **30–33** to being substantially in a plane normal to the longitudinal axis of the tub T.

The mounts **30, 31, 32** and **33** are respectively secured at the upper ends of the tub carriage vertical uprights **17, 18, 17'** and **18'**, the bolts **35** of the mounts extending through holes in the uprights and being secured thereto by nuts **35'** as indicated in the drawings. The opposite bolts **36** of the mounts **30, 31, 32** and **33** are lowered into the slots **13** in the upper edges of the offset angle tub carrying supports **7, 8, 11** and **12** of the frame F when the carriage C is lowered into position in the frame F. When the bolts **36** are disposed at the bottom ends of slots **13** they are secured therein by nuts **36'** (see FIG. 6).

Resilient shear mounts **38, 39** and **40**, similar in all respects to the shear mounts **30–33**, are bolted to the bottom offset angle tub carrying support flanges **8', 12'** and **7'** respectively (see FIGS. 3 and 4) and another similar mount, not seen in the drawings, is secured to the tub supporting flange on column **4** which corresponds to flange **7'** on column **3**. Upwardly evtending slots such as shown at **42** (FIG. 3) are formed in the bottom ends the vertical uprights **17, 18, 17'** and **18'** of the tub carriage C, and the open bottom ends of these slots receive the bolts at the outer ends of the bottom shear mounts when the carriage C is lowered into position in the frame F.

The workpiece carrying tub T, as best seen in FIGS. 3, 7, 8 and 9, is mounted on the carriage C above the cross members **19** and **19'** of the H-shaped tub carrying members **14** and **15**; is generally cylindrical in shape; and has its longitudinal axis **24** inclined at an angle less than 5° and preferably of the order of 1°, as indicated in FIG. 10, and extending at an acute angle relative to the drive shaft, as shown in FIG. 6. With this orientation of tub axis, the workpieces enter the charging opening, which will be subsequently described, and travel through a substantially helical path to the discharge opening, thus assuring uniform finishing of all workpieces. A curved wall **45** defines the bottom and part of the sides of the tub and vertical side panels **46** and **47**, an apertured rear wall **48**, formed with a charging opening **49**, and an apertured front end wall **50**, formed within a discharge opening **50a**, complete the tub. The upper edges of the side panels **46** and **47** and end walls **48** and **49** provide support for a tub lid or cover **57**.

The tub T includes a base plate **55** secured to the curved wall **45** by gussets **56**. When the tub T is mounted on the tub supporting carriage C this base plate **55** rests upon and is removably secured (as by screws or bolts, not shown) to the tub supporting channels **20, 21**. The length of the tub T is preferably such that the ends thereof project somewhat outside of or beyond the front and rear H-shaped tub carrying members **14** and **15**. The tub T is provided with a charging hopper, or funnel, **58** (FIG. 9) joined to the rear wall **48** and tapering toward an inlet or charging opening **59**. With this arrangement the hopper **58** and the charge opening **50** are unobstructed by other parts of the structure.

The discharge opening **50** is provided with a tubular discharge elbow **51** (FIGS. 7 and 8). Elbow **51** is rotatably supported in alignment with the discharge opening **50** by means of a clamping sleeve **52** held on to end **49** of the tub T by means of a ring **53**. The clamping sleeve **52** can be loosened or tightened relative to elbow **51** by means of a contra-threaded bolt **54**. To discharge workpieces from the tub, bolt **54** is rotated to loosen the engagement of the elbow **51** and the elbow **51** is rotated until the angularly depending portion projects downwardly, as indicated in dotted outline. After discharge is completed, the elbow **51** is rotated to its solid line position and locked in position by bolt **54**. This type of discharge arrangement exhibits advantages over a sliding door arrangement because the elbow does not employ a change in the discharge area. Further, discharge can be quickly and easily controlled, even while parts are being discharged. Still further, the elbow **51** may be rotated to any posi-

tion intermediate the upward and downward positions to permit continuous metered discharge of finished workpieces, the metering rate being determined by the angle of projection of elbow **51** relative to the horizontal. Thus, the elbow contributes to the successful continuous cycling of the finishing apparatus.

By means of the double H-frame tub carriage C, a rigid support is provided for the work receiving tub T, the length of which is limited only by the distance between the front and rear H-shaped members **14** and **15**. It will also be understood that in some cases, one or more additional intermediate H-shaped tub carrying members may be supported from the frame F between the end pair **14** and **15** of such members.

Because of the vertical H-shaped tub support, with the tub mounted in the upper portion thereof and above the transverse cross members **19** and **19'**, there is no structure overlying the charging hopper **58** of the tub or disposed at the other, or discharge end of the tub. As previously noted, this permits unobstructed loading of the tub at one end and unobstructed discharge from the other end thereof. As will be later described, this arrangement will permit continuous charging of articles to be finished into the hopper **58** of the tub at the end thereof opposite to the discharge opening **50** and continuous discharge of finished articles and finishing medium from the end discharge opening **50**.

In order to balance the forces that are imposed upon the drive shaft (to be later described) and to minimize the vibration transmitted to the frame F during gyration of the tub supporting carriage C, a pair of counterpoise structures P and P' are provided. As these structures are substantially identical in form and arrangement, only counterpoise P at the front of the finishing unit A will be described in detail.

The counterpoise P, like the tub supporting carriage C is generally an H-shaped structure having a pair of vertical side members **60, 61** connected by a center transverse member **62**. At the upper ends of members **60** and **61**, resilient shear mounts **63** and **64**, similar to mounts **30–33**, are secured by bolts **63'** and **64'** which extend through holes in the upper ends of members **60** and **61**. The bolts which project from the opposite ends of shear mounts **63** and **64** are carried in those of the slots **13** and other than the ones having the tub frame shear mounts in the upper ends of the vertical frame members **4** and **5**. Bottom shear mounts **65** and **66** are bolted to the lower ends of the vertical frame members **5** and **10**, respectively, and the lower ends of the members **60** and **61** of the counterpoise P are slotted at **67** and **68** (see FIG. 3) to receive bolts **65'** and **66'** which project from the outer ends of the shear mounts **65** and **66**.

From the above, it will be observed that when it is desired to support the counterpoise P on the frame F, the bolts which project from the inner ends of the shear mounts **63** and **64** (which are bolted to the upper ends of members **60** and **61** of the counterpoise) are inserted into the slots **13** in the upper ends of the uprights **5** and **10** on the frame structure and at the same time the slots **67** and **68** at the lower ends of members **60** and **61** of the counterpoise P receive the bolts **65'** and **66'** of the bottom shear supports **65** and **66**.

Counter balancing weights **69** and **70** are secured to the transverse center member **62** of the counterpoise P for purposes which will be later described. To add rigidity to the counterpoise structure stiffening webs **71, 72, 73** and **74** are secured to the members **60** and **61** and the transverse member **62** as by welding. The resilient shear mounts **63, 64, 65** and **66** are so disposed, and the counterpoise structure P is so designated, that when supported on the frame F, the counterpoise is entirely out of contact therewith and also entirely out of contact with the tub supporting carriage C. The resilient shear mounts permit the counterpoise P to oscillate relative to the frame F and independently of the tub carriage C.

The rear counterpoise structure P' is substantially identical with the structure P but is mounted adjacent to and outside of tub carrying member **15**, at the opposite end of the finishing unit A from tub carrying member **14**, on resilient shear mounts similar to those which support the counterpoise P, the upper two mounts being seen at **75** and **76** in FIG. 3. As the counterpoise P' is mounted in the same manner as counterpoise P it also is supported for limited orbital movement independently of the frame F and the tub carriage C. As seen in FIG. 3, one of the pairs of H-shaped counterpoise structures P and P' is supported adjacent each of the pair of H-shaped tub carrying members **14** and **15** with the transverse members **62** of the counterpoise structures horizontally disposed and aligned with the cross members **19** and **19'** of the tub carrying members.

The drive mechanism for imparting orbital movement to the tub supporting carriage C and the tub T is generally indicated at D on FIG. 6 of the drawings. As best seen in FIGS. 4, 5, 6, and 8, this drive means includes a drive motor **82** mounted on a supporting bracket **81** which is pivotally mounted on the frame F at **89** (see FIG. 5). A floating drive shaft **83** has end and center portions **83***a*, **83***b* and **83***c* (see FIG. 5) and its axis extends normally to the transverse cross members **19** and **19'** of the tub carriage C. The drive shaft axis **24** lies in a horizontal plane and the tub axis **24** is positioned in a slightly inclined plane. Preferably, the angle of inclination is less than 5° and an angle of 1° is sufficient to produce the proper movement of workpieces toward the discharge opening **50**. Also, preferably, the channels **20, 21** support the tub T in a position such that the tub axis **24** lies in a vertical plane defining an acute angle with the vertical plane containing the axis of drive shaft **83**. This angle is less than 30° and preferably is of the order of 5°. This angular relationship contributes to the continuous operation of the machine by translating a component of force from drive shaft **83** to the workpieces in the tub T in direction tending to move the workpieces through the tub discharge opening **50**.

An eccentric counterpoise engaging portion **83***d* of shaft **83** (FIG. 6) is rotatably mounted in a bearing **84** carried by the center transverse member **62** of the front counterpoise structure P. Adjacent to eccentric counterpoise engaging shaft portion **83***d* is a tub carriage engaging eccentric shaft portion **83***e* which is supported in a suitable bearing **85** in the cross member **19** of the front H-shaped tub carrying member **14** of the tub supporting carriage C.

In like manner, at the rear end of drive shaft **83**, a counterpoise engaging eccentric portion **83***f* (coaxial with eccentric portion **83***d*) extends through a suitable bearing **84'** in the transverse member **62'** of the rear counterpoise P' and a tub carriage engaging eccentric portion **83***g* (offset 180° from eccentric portion **83***f* and coaxial with eccentric portion **83***e*) extends through a bearing **85'** in the cross member **19'** of the rear H-shaped tub carrying member **15** of the tub support carriage C.

The rear end **83***a* of shaft **83** has a pulley **86** secured thereto and the driving belt **87** extends between the pulley **86** and the drive motor pulley **88**. As the motor support bracket **81** is pivotally secured at its inner end **89** at (see FIG. 5) to the frame F, the weight of the motor **82** and the bracket **81** maintains the belt **87** under substantially constant tension regardless of any minor variations in the position of the center line of shaft **83** which may occur during starting, stopping or operation of the apparatus.

If it is desired that the tub carriage C and the tub T have an orbital movement of approximately ⅛" amplitude, the common center line of the portions **83***e* and **83***g* of shaft **83**, which extend through the bearings **85** and **85'** and activate the carriage C, will be offset approxi-

mately 1/16" from the main shaft center line of the coaxial portions **83***a*, **83***b* and **83***c*.

In order that the forces that are imposed on the tub carriage C and the tub T during rotation of shaft **83** will be properly counterbalanced and opposed by the counterpoise members P and P', the common center line of the shaft portions **83***d* and **83***f*, which extend through and are supported in bearings **84** and **84'** in counterpoise members P and P', is offset the same distance (approximately 1/16") on the opposite side of the main shaft center line and 180° from the common center line of portions **83***e* and **83***g*.

The counterpoise members P and P' are so designed that their centers of inertia or mass lie in close juxtaposition to the main axis of the shaft **83** and the tub carriage C and the tub T are so designed that the center of mass or inertia thereof, with the designed load of parts and finishing materials in the tub, is also in close juxtaposition to the main axis of the shaft **83** and forms an acute angle therewith, as previously mentioned.

Now, when the motor **82** is operated and the shaft **83** is rotated, orbital movement will be imparted to the tub carriage C and to the tub T and its contents. A corresponding but opposed orbital movement will also be imparted to the counterpoise members P and P', these orbital movements being permitted by the resilient shear mounts which support these structures relative to the frame F. Due to the balancing of the orbit imparting forces applied to the tub carriage and tub as one unit and to the counterpoise structures as another unit during the above described operation of this apparatus, the main shaft center line or axis of the portions **83***a*, **83***b* and **83***c* of the shaft **83** and hence the center of drive pulley **86**, will remain substantially stationary and a minimum of vibratory forces will be transmitted to the frame structure F and the foundation upon which it is supported.

The orbital finishing unit A has been described above. Referring particularly to FIGS. 1, 2 and 9, the finishing medium and work separator unit S, the fluid settling and recirculating tank R, and the finishing medium recirculating conveyor M will now be described.

The separator unit S includes a frame structure **95** on which a screen box or housing **96** is rockably supported on pivotal supports **97** and **98**. As seen in FIG. 1, the screen box **96** is inclined downwardly to the right and suitable drive means **96'** is provided for imparting oscillating rocking motion to the box **96** on its supports **97** and **98**. A finishing medium discharge chute **99** extends from one end of the screen box **96** and an upper work discharge chute **100** and a lower waste fines discharge chute **101** extend from the opposite end.

As best seen in FIG. 2, the upper course screen **102** receives material discharged from the tub T by the elbow **51**. This screen is of large enough mesh to permit the finishing medium to pass therethrough but will retain thereon the workpieces that have been discharged from the tub T. Due to the inclination of this screen **102** downwardly to the right as seen in FIG. 1, and to the oscillating vibratory movement thereof, the articles that have been finished move thereover and are discharged by the upper chute **100**. The finishing medium and any discharged liquid vehicle pass through the upper screen **102** and the finishing medium is stopped by the lower relatively fine mesh screen **103**. This screen is inclined in a direction opposite to upper screen **102** so that the finishing medium particles thereon will travel to the left (FIGS. 1 and 2) into the finishing medium discharge chute **99** which, as seen in FIG. 1, is inclined downwardly and extends to the medium recirculating conveyor M.

The fluid vehicle and fine particles of abrasive material removed from the parts being finished pass through the lower screen **103** to the inclined bottom of the screen box **96** and then travel to the right (FIG. 1) to the waste fines outlet chute **101** which discharges them into a suitable receptacle (not shown). From the preceding description it will be observed that the separator unit S will separate and convey to different locations the parts that have been finished in the tub, the finishing medium and the waste fines and liquid that result from the finishing operation.

In order to maintain the desired quantity and quality of liquid (such as water) in the tub T, a recirculating and cleaning system is provided which includes the settling and recirculating tank R, an inlet hose **104** which extends from tank R and discharges into the open top of the tub T, and an outlet hose **105** which connects to drain openings **106** in the bottom of the tub T and conducts the liquid from the tub T to the tank R. The tank R provides means whereby sludge from the finishing operation which is entrained in the liquid vehicle withdrawn from the tub T may be permitted to settle out from the liquid, thus providing a source of clean liquid which may be recirculated by means of a pump **107** through the hose **104** back to the tub T. A valve **108** in hose **104** is adapted to shut off or throttle the flow of clean liquid back to the tub T and valve means, not shown, are provided to control the discharge of liquid from the tub T through hose **105**.

By means of this liquid vehicle settling and recirculating apparatus the sludge which results from the abrasive cleaning operation may be continuously removed from the circulating liquid vehicle, thus maintaining most efficient cutting action at all times and resulting in cleaner and brighter finished parts. A trough **109** on top of tank R is adapted to receive liquid from the tub T which is discharged from the spout **110** when the tub is emptied of liquid at the end of a batch finishing operation. Suitable connections and valves (not shown) control the flow of liquid from the tub T to the spout **110** and trough **109** discharges into tank R through an outlet **111** (FIG. 2).

The medium recirculating conveyor M, which receives the finishing medium from the separator unit S and returns it to the tub T, is best seen in FIGS. 1, 2 and 10. A vertical housing or tower **115** has a medium receiving hopper **116** at its lower end. The medium discharge chute **99** of the separator unit S has its outlet within the hopper **116** and discharges the particles of finishing medium thereinto.

As best seen in FIG. 10, the inner bottom wall **117** of the tower **115** is curved to facilitate picking up of the medium which enters the bottom of the tower **115** from the hopper **116** by the conveyor buckets **118** which are mounted on a conveyor chain **119**. The conveyor chain **119** is endless and extends around a bottom sprocket **120** rotatably mounted on a shaft **121** and an upper sprocket **122** mounted on drive shaft **123**. The top shaft bearings **123'** are mounted for vertical adjustment in guideways **124** and **125** and tension on the chain **119** may be maintained at the proper value by the adjusting screws **126** which extend through suitable threaded apertures in plate **127** mounted on the tower **115**.

The chain and bucket conveyor just described is driven by a motor **128**, mounted on a bracket **129** on the tower **115**, through a belt **130** (FIG. 2) which extend from the motor pulley **131** to the pulley **132** which is mounted on the end of the shaft **123**. An outlet opening **133** in the upper part of tower **115** opens into the medium receiving box **134** which is mounted on the side of the tower **115** and a guideplate or baffle **135**, which extends inwardly into the tower **115** adjacent the bottom of outlet opening **133**, is adapted to direct the finishing medium into the receiving box **134** as it is dumped from the buckets **118** when they pass over the top sprocket **122**.

As seen in FIG. 10 and indicated by arrows, the conveyor chain **119** travels in counterclockwise direction so that the open ends of the buckets **118** are on top as the buckets move upwardly, and are on the bottom as the buckets move downwardly. An inclined chute **136**,

supported by a bracket **136'**, extends from the bottom of the receiving box **134** to a point above the charging hopper **58** of the tub T as seen in FIG. 2. In order to shut off or regulate the flow of medium through the chute **136** to the tub T, a movable baffle or damper **137** is supported on a shaft **138** extending across the chute **136** near its upper end. As seen in FIGS. 1 and 2, this damper **137** is open to permit the free flow of finishing medium through the chute **136**. A handle **139** on the outer end of shaft **138** will facilitate adjustment of the position of the damper **137** and permit same to be moved transversely of the chute **136** to block the flow of finishing medium therethrough, when desired. When the baffle **137** is closed, the finishing medium which is elevated by the conveyor buckets **118** will be collected in the receiving box **134**.

From the above explanation of the improved finishing apparatus, it will be understood that it is adapted for operation cyclically or continuously, that the tub support and balancing mechanism is such that the open top of the tub is fully exposed and accessible while the ends of the tub are also fully exposed to permit free, and if desired, continuous discharge therefrom. Furthermore, although one illustrative embodiment of this invention has been described in considerable detail, it will be understood that variations and modifications may be made in the particular form and arrangement of the several elements thereof without departing from the spirit of this invention. It is not, therefore, limited to the exact apparatus herein shown and described.

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

What is claimed is:

1. Vibratory finishing apparatus including a frame structure, a tub carrying member having a pair of uprights and a cross member extending between said uprights, resilient shear mount means on said frame structure for supporting said tub carrying member on said uprights, a work carrying tub mounted on said tub carrying member between said uprights and above said cross member thereof, said tub having its longitudinal axis extending at an acute angle relative to said cross member and having a charging opening in one end thereof and

a discharge opening in the other end thereof, a drive shaft having its axis extending substantially normally to said cross member of said tube carrying member, said shaft having an eccentric portion having bearing in said cross member, means for rotating said shaft, a counterpoise structure having a pair of side members connected by a transverse member, resilient mount means on said frame structure for supporting said counterpoise structure on said side members thereof, said drive shaft having a second eccentric portion offset substantially 180° from said first eccentric portion and having bearing in said transverse member of said counterpoise structure, the center of mass of said tub carrying member and tub with designed load therein and the center of mass of said counterpoise structure being disposed in close juxtaposition to said axis of said drive shaft.

2. Vibratory finishing apparatus according to claim **1** which includes a plurality of said counterpoise structures, one supported on said frame structure by said resilient shear mount means adjacent to each of said tub carrying members and wherein said longitudinal tub axis lies in a vertical plane defining an acute angle of less than 30° with a vertical plane containing said drive shaft axis and wherein said tub axis lies in an inclined plane having an angle of inclination of less than 5°.

3. Vibratory finishing apparatus according to claim **2** wherein said shaft axis is substantially horizontal and wherein said acute angle is substantially 5°.

4. Vibratory finishing apparatus according to claim **2** wherein said angle of inclination is of the order of 1 degree.

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