June 29, 1965 J. F. RAMPE 3,191,348

APPARATUS FOR ORBITAL FINISHING

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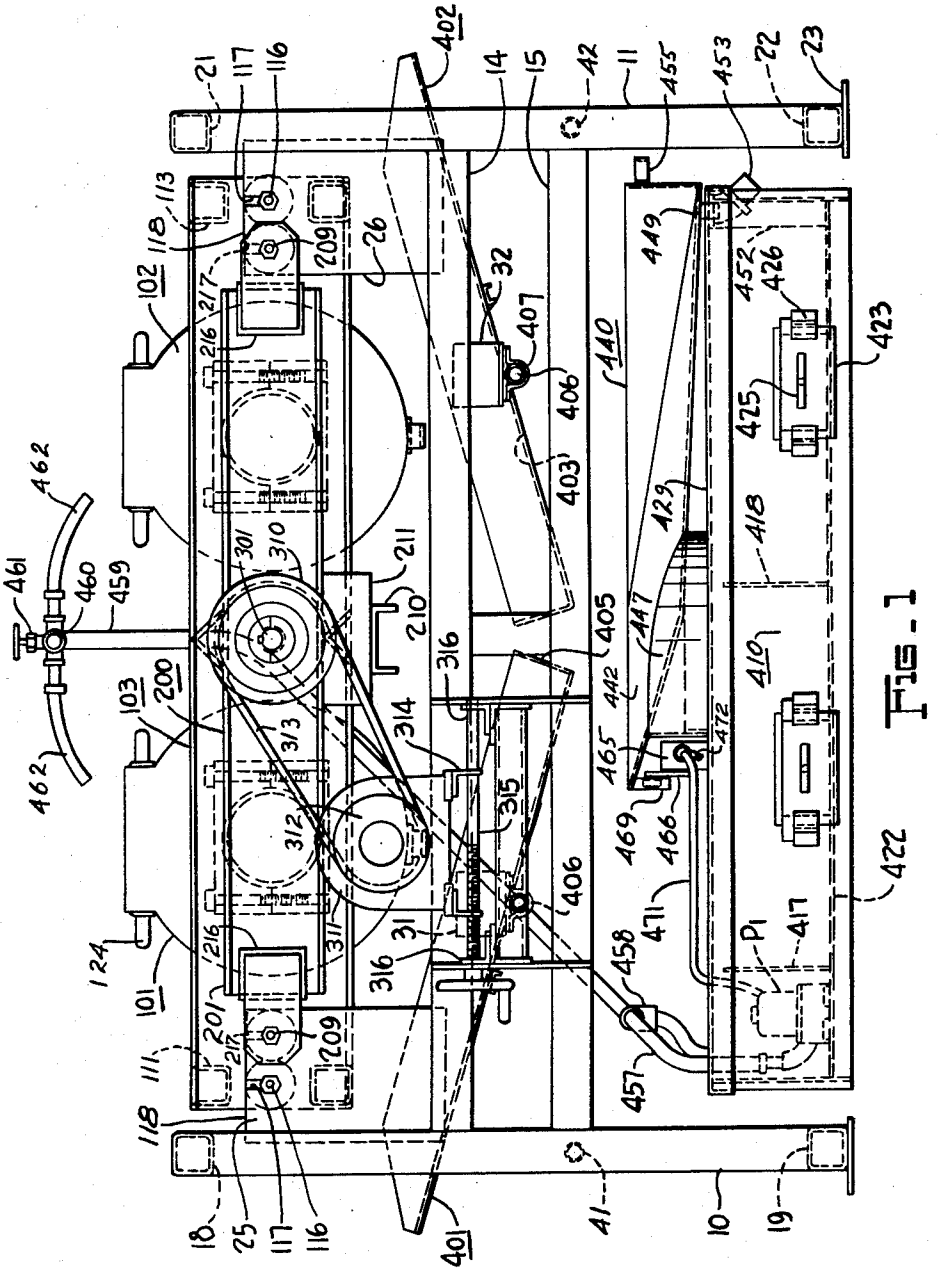


FIG. 1

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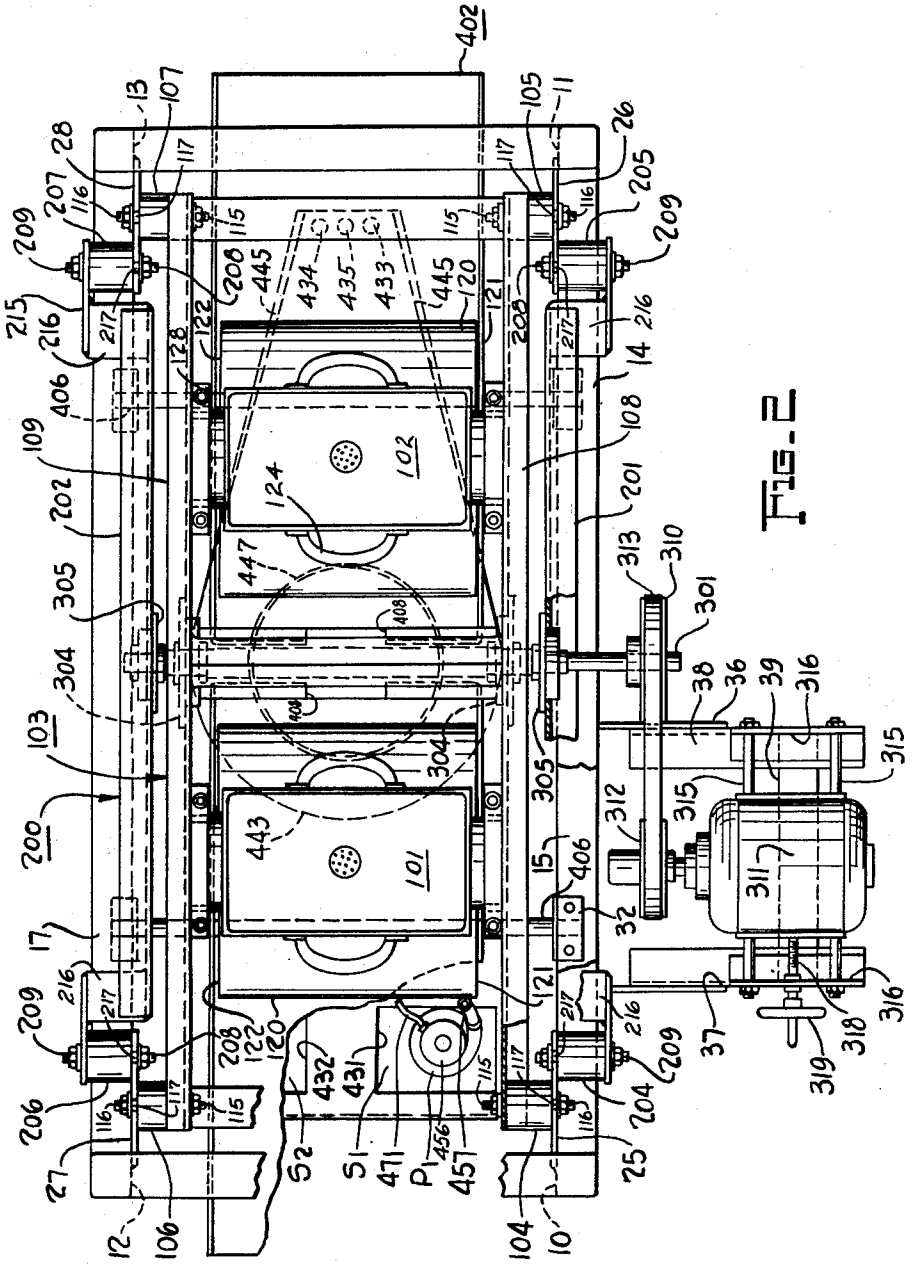


FIG. 2

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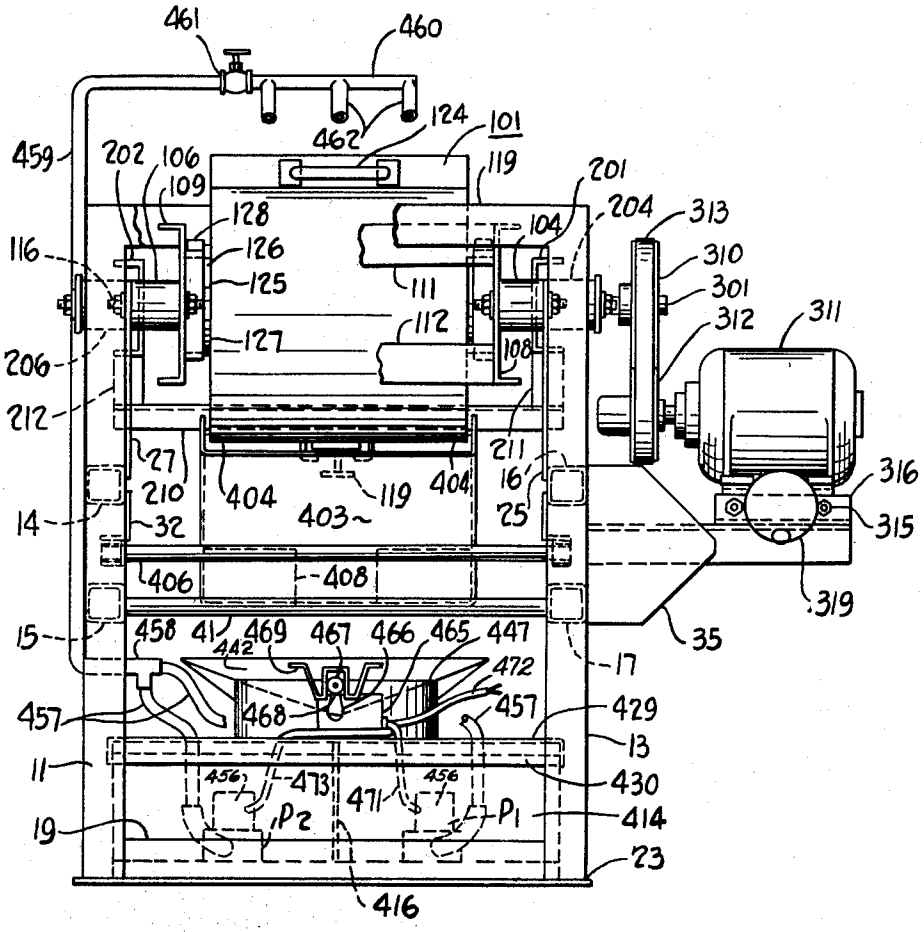


FIG. 3

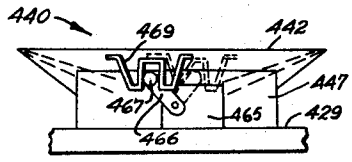


FIG. 3a

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Filed March 1, 1963 7 Sheets-Sheet 4

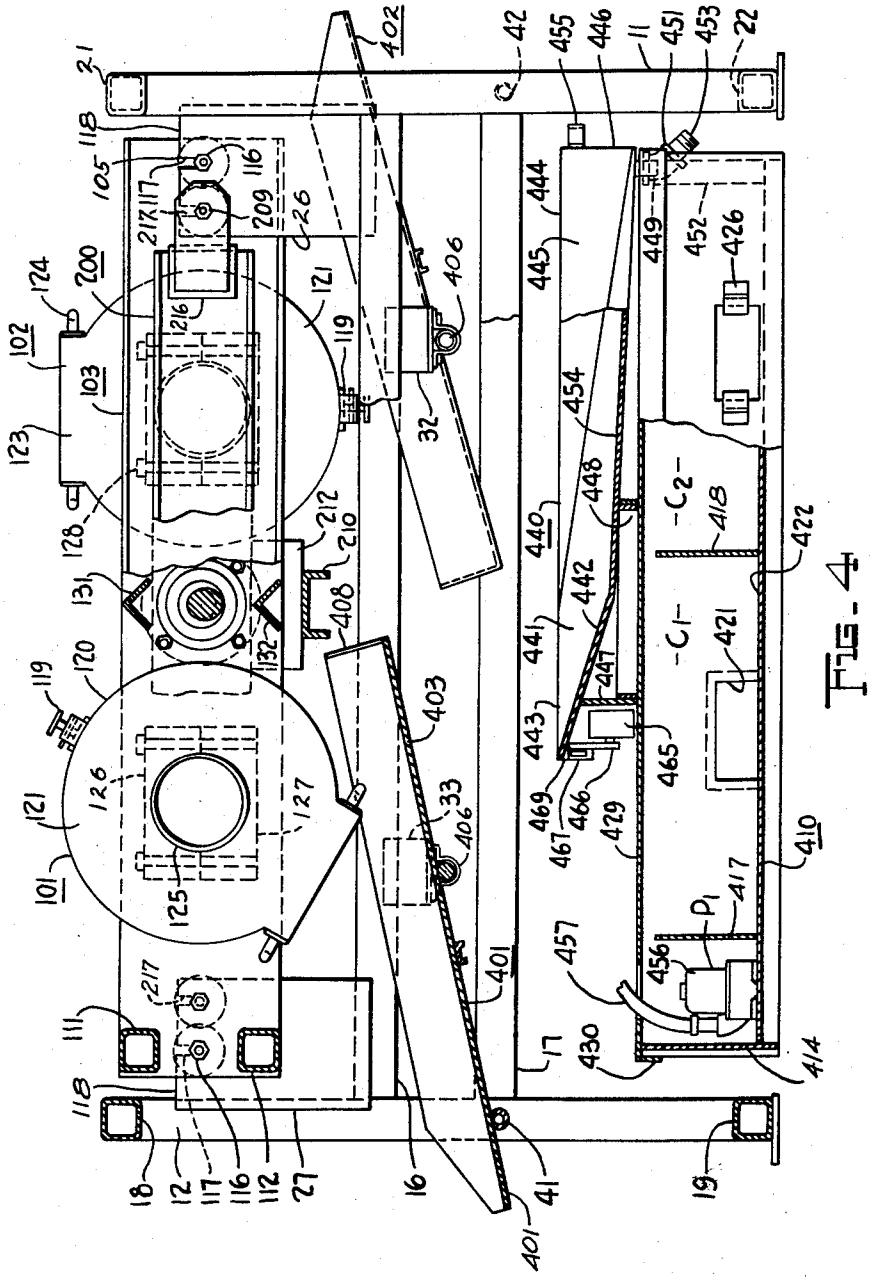


FIG. 4

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APPARATUS FOR ORBITAL FINISHING

Filed March 1, 1963 7 Sheets-Sheet 5

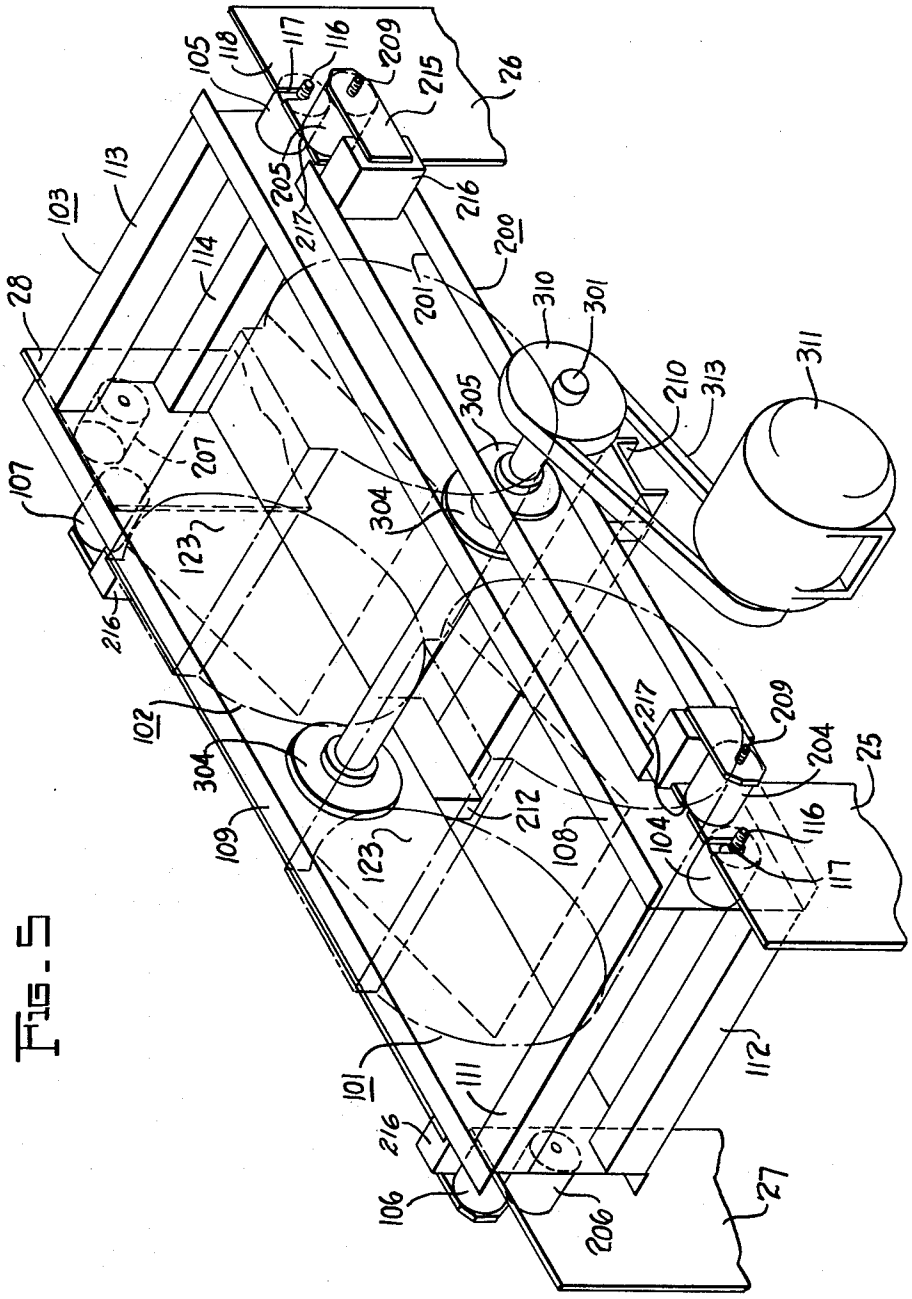


FIG. 5

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Filed March 1, 1963 7 Sheets-Sheet 6

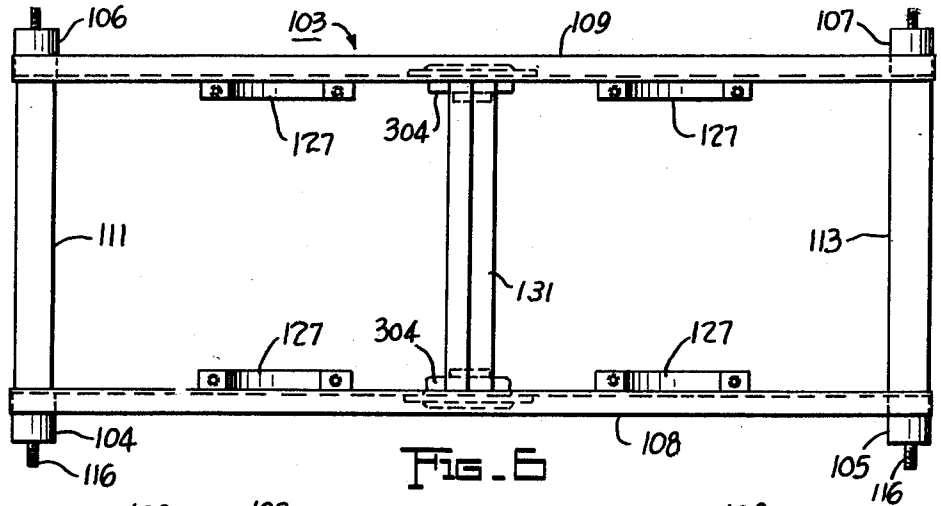


FIG. 6

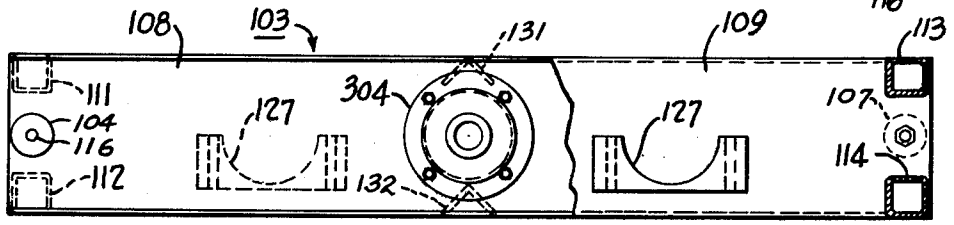


FIG. 7

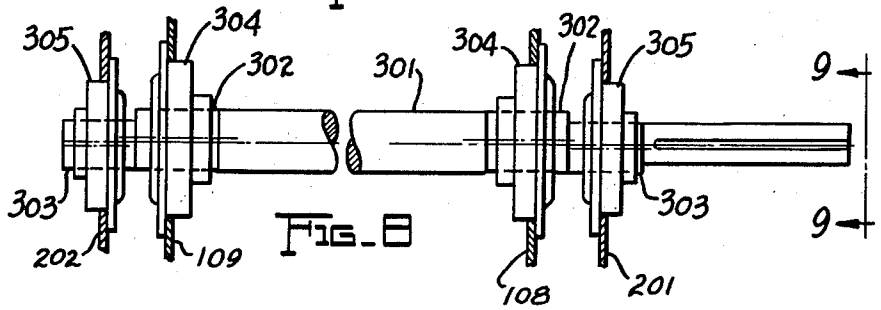


FIG. 8

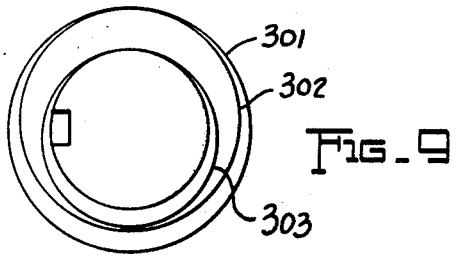


FIG. 9

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Filed March 1, 1963 7 Sheets-Sheet 7

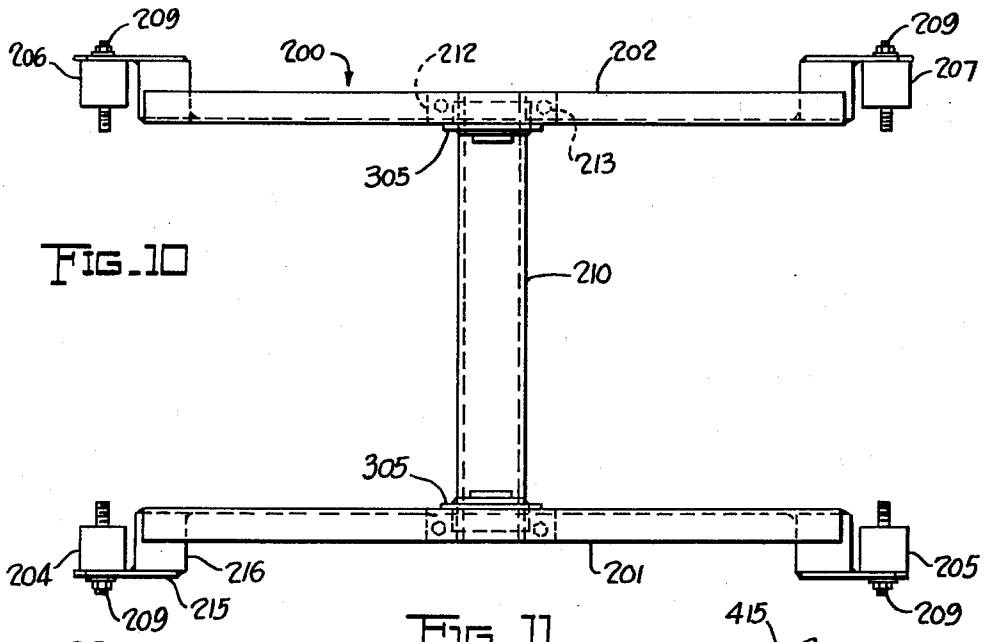
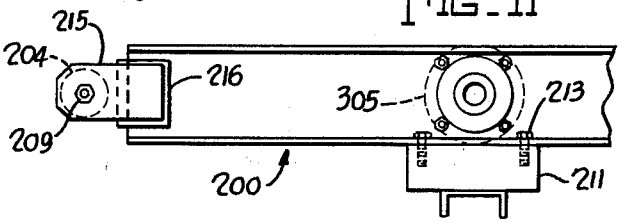


FIG. 10

FIG. 11



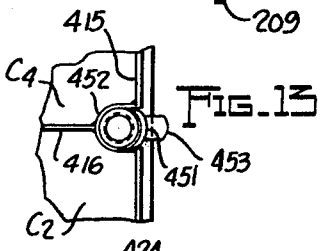


FIG. 13

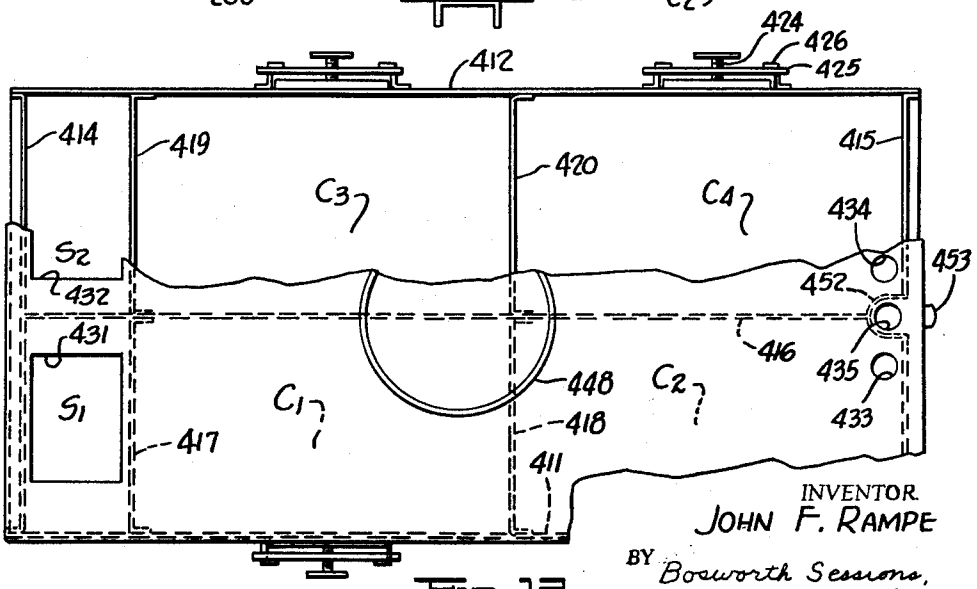


FIG. 12

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3,191,348

APPARATUS FOR ORBITAL FINISHING

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Filed Mar. 1, 1963, Ser. No. 261,981
18 Claims. (Cl. 51—163)

This invention relates to the finishing of commercial parts by vibratory action, more particularly to finishing apparatus of the orbital type.

It is known that finishing operations such as deburring and burnishing can be performed efficiently by high speed vibratory motion in which the individual articles gyrate in orbital paths of small magnitude. Machines heretofore available for such orbital finishing operations have not been completely satisfactory in that they are heavy, complex and therefore costly. Moreover, excessive shaking of the foundations of the machines and even the buildings in which they are housed has occurred. Conventional machines employ rotating masses to obtain the orbital shaking motion desired; machines which employ eccentrics for the motion customarily provide a mass on and rotatable with the eccentric shaft for flywheel effect. Such rotating masses are undesirable, not only because of higher costs resulting from the necessity for larger shafts and bearings, but because of the objectionable shaking of the foundation and the building; moreover, there is an element of danger because of the stored energy in a rotating mass which might be set free should the supporting shaft break or come loose.

It is therefore the principal object of the invention to provide a vibratory or orbital finisher which eliminates the objections referred to, more particularly to provide an orbital finisher which is relatively light in weight, is without flywheels or other large rotating masses, which has minimum reaction or shaking effect on its frame and and on the foundation on which it is mounted; an aim of the invention is to provide such a machine in which counterpoise means and tub means are mounted one within the other in a common supporting frame, in which the counterpoise means and the tub means, both resiliently mounted in the supporting frame, are coupled by eccentric means and dynamically balanced, one against the other.

Another object is to provide a finisher of the character referred to which comprises in combination a generally rectangular tub carriage and a counterpoise which is in the form of a symmetrical open ended or generally H-shaped structure. More particularly, it is sought to provide an interfitting arrangement in which the tub means is nested within the counterpoise, the counterpoise including connected members physically located outside the tub means.

Another object is to provide a vibratory finisher of the orbital type having tub means supported by resilient shear mounts, more particularly by a plurality of widely distributed rubber mounts oriented relative to one another so that they resist in shear all motions in vertical planes which parallel the orbital plane and resist in tension or compression all components of motion normal to such plane.

Another object is to provide a vibratory finisher in which the frame includes vertical plates in confronting pairs with the same plates supporting both the tub means and the counterpoise by means of shear mounts of the character referred to. As a refinement of this aspect of the invention the tub means is supported by a first set of resilient mounts abutted against and secured to the plates and the counterpoise is supported by a second set of mounts also abutted against and secured to the plates but on the opposite sides of the plates from the mounts which carry the tub means. In a still more specialized arrangement, the mounting plates are disposed in spaced parallel planes in pairs with confronting inside surfaces and oppositely directed outside surfaces; the set of mounts for the tub means are located on the confronting inside surfaces and the mounts for the counterpoise are located on the outside surfaces of the plates.

Another object is to provide a vibratory finisher having a pair of tubs of substantial identity adapted to receive substantially equal portions of a load of articles ad finishing media for which the finisher is designed, more specifically to provide such a finisher arrangement in which the tubs are driven by eccentric shaft means located between the tubs with the center of inertia of the loaded tubs and those components which are fast to the tubs being in close juxtaposition to the axis of the eccentric shaft.

Another object is concerned with the unloading of vibratory finisher tubs and the provision of a tub mounting arrangement which permits tilting of the tubs for unloading and locking of the tubs in upright positions for the finishing operation. More particularly it is sought to provide a finisher machine with a tilting tub in combination with a chute supported in the frame of the machine below the tub and adapted to tilt in one direction for unloading and in another direction for catching and collecting finishing liquid draining from the tub during operation; this object is concerned with a tilting chute which, in the unloading position, carries articles discharged from the tub to a point outside the frame and, in the operating position, carries liquid released from the tub to a collection point in the center of the machine.

Another object is to provide an improved settling tank for use in the liquid circulating system of a vibratory finisher. More particularly, this object is concerned with a settling tank adapted to be located within the area of the horizontal projection of the finisher so as to be supported on the same floor area as the finisher but independently of the latter.

Another object is to provide a settling tank in combination with a collecting trough adapted to catch liquid discharged from the tub of the finisher during operation and to carry the collected liquid into a predetermined portion of the tank or to waste. More particularly, it is sought to provide a collecting trough-settling tank combination in which the tank includes a plurality of chambers and the trough feeds the collected liquid selectively into one of the chambers. As a further refinement of this aspect of the invention it is sought to provide pump means and control means arranged automatically to circulate the finishing liquid through the chamber into which the trough feeds the returning liquid.

Other objects and adavntages relate to certain novel features of construction and combinations and arrangements of parts which provide economy in manufacture and operation. The invention is described in connection with the accompanying drawings forming a part of the specification and illustrating a preferred embodiment which represents the best known mode of practicing the invention.

In the drawings:

FIG. 1 is a front elevational view of the finishing machine of the present invention;

FIG. 2 is a top view of the machine of FIG. 1, with parts broken away and with parts removed for clarity and simplicity;

FIG. 3 is a view of the finisher taken from the left-hand end of FIG. 1, also with parts broken away and with parts removed;

FIG. 3*a* is a fragmentary elevational view, with parts removed, showing different relative positions of the switch through which the liquid circulating pumps are energized;

FIG. 4 is a front elevational view, similar to FIG. 1,

various parts and components being broken away, shown in section or removed to reveal the structural details and internal parts;

FIG. 5 is an isometric view, diagrammatic in character, showing the relationships between the tub means or carriage, the counterpoise, the supporting frame structure and the drive;

FIG. 6 is a plan view of the carriage;

FIG. 7 is a side view of the carriage, partly in section and with parts broken away and removed;

FIG. 8 is an elevational view of the drive shaft, foreshortened and enlarged with respect to the preceding figures;

FIG. 9 is an end view of the drive shaft, taken substantially in the plane represented by the lines 9—9 of FIG. 8 and enlarged relative thereto;

FIG. 10 is a plan view of the counterpoise;

FIG. 11 is a fragmentary side view of the counterpoise;

FIG. 12 is a plan view of the storage and settling tank of the liquid circulating system, with parts broken away and removed to show the compartments; and

FIG. 13 is a fragmentary plan view of the receiving end of the settling tank with part of the cover broken away to show the drain fitting.

The finisher of the present invention, briefly described, comprises a stationary supporting framework on which are resiliently mounted suitable work receiving tub or receptacle means and a counterpoise. The tub means and the counterpoise are drivingly connected through an eccentric shaft powered by an electric motor also carried by the frame structure and connected to the shaft by a variable speed drive. The parts of the frame structure are designated by numerals in the tens; the parts and components of the tub means are designated by numerals in the one hundreds; the parts of the counterpoise are designated by numerals in the two hundreds and the parts of the drive means are designated by numerals in the three hundreds.

An unloading and triple recirculating liquid system is provided for the liquids used in deburring, burnishing, and other types of finishing; the parts of the unloading and recirculating system are designated by numerals in the four hundreds.

Supporting frame

The frame structure includes a pair of horizontally spaced front uprights or legs 10, 11 and a companion pair of similarly spaced rear uprights or legs 12, 13. Across the front of the machine midway of its height 11, 12 are connected by a pair of side rails 14, 15 disposed one above the other in spaced parallel relation. A similar pair of rear side rails 16, 17, similarly located, connect the rear uprights 12, 13. At the left end of the machine the front and rear uprights are connected by horizontal top and bottom end members 18, 19 and at the right end by horizontal top and bottom end members 21, 22. The frame members are conveniently formed of steel tubes of uniform square or rectangular section suitably secured together as by welding. Foot members 23 in the form of flat steel plates are welded to the bottoms of the uprights 10–13. Steel plates are provided for mounting the tub means and the counterpoise in the frame structure, one coplanar pair of such plates, indicated at 25, 26 are welded in the angles between the front uprights 10, 11 and the top front rail 14, another coplanar pair, indicated at 27, 28 are located in the angles between the rear uprights 12, 13 and the rear top side rail 16. The mounting plates are flat and made fast to the uprights and side rails as by welding; they are arranged in pairs with the plates of each pair in spaced parallel relation to one another and to the other pair. Brackets 31, 32, 33 and 34 are provided on the top side rails 14, 15 for supporting the unloading chutes, as will appear. These brackets may take the form of sections of steel angle bars, the brackets 31, 32 being welded to the inside faces of the top front rail 14, the rear brackets 33, 34 being welded to the inside face of the top rear rail 16.

An outrigger or supplemental frame is provided to carry the drive motor, this frame comprising flat gusset plates 35, 36 disposed in spaced parallel relation with their rear edges abutted against the front faces of and spanning between the front rail members 14, 15 to which they are welded. Shelf pieces 37, 38 are welded to the inside faces of the gusset plates in spaced parallel confronting relation. These shelf pieces may be sections of steel angle bars and adjacent their near ends are connected by a horizontal tie piece 39.

To serve as stops for unloading chutes 401, 402, later described, horizontal bars or tubes 41, 42 are secured between the end uprights, the bar 41 extending between the left uprights 10, 12 and the bar 42 extending between the right uprights 11, 13. A vertical center brace 44 extends between the midpoints of the front side rails 14, 15 and is welded in place.

Tub and carriage assembly

Articles to be deburred, burnished or otherwise treated are loaded into tub means which comprises a pair of tubs 101, 102 supported in a rectangular open carriage 103. This carriage is suspended by a plurality of rubber shear mounts 104, 105, 106 and 107 located at or adjacent the four corners of the carriage and fast to the mounting plates 25, 26, 27 and 28, respectively. The carriage 103 comprises front and rear bolsters or side members 108, 109 which may take the form of steel channels disposed in spaced parallel relation with their flanges directed outwardly. Tubular steel cross members 111, 112, one above the other, extend horizontally and in parallel relation between the carriage side bolsters at the left end of the machine; a corresponding pair of cross members 113, 114 extend between the bolsters at the right end. The shear mounts each comprises a cylindrical rubber body having embedded therein coaxial bolts which project from the centers of its opposite ends. The inner or embedded ends of the bolts are spaced from one another and, desirably, are strongly bonded to the rubber in order to withstand the severe alternations of forces to which the mounts are subjected in operation. The bolts 115 on the inner ends of the shear mounts are received through drill holes in the bolsters 108, 109 of the carriage, adjacent the ends of the latter; the oppositely directed bolts 116 on the outer ends of the rubber shear mounts are received in open ended notches 117 of the mounting plates 25–28. This arrangement permits the carriage to be built separately from the stationary framework and hoisted into place as a unit with the bolts 116 of the shear mounts sliding into the open tops of the notches 117 when the carriage is lowered into place.

Each of the tubs 101, 102 is of substantially cylindrical shape, having an arcuately curved wall 120 extending between and connecting the arcuate peripheries of a pair of spaced parallel planar walls 121, 122. The arcuate wall 120 of each of the tubs is about 300 degrees in circumferential extent, being discontinuous across a minor portion, approximately 60 degrees of the circumferential extent, in the provision of a charging opening 123. Integral angularly disposed extensions of the arcuate wall 120 and extensions of the circular planar side walls 121, 122 are joined at the four corners of the rectangular tub opening 123 in the provision of flanged necks adapted to receive covers, if desired. Handles 124 are made fast to the tub necks and each tub is provided with a bottom opening and quick detachable closure assembly 119. An abrasion resistant lining such as plastic or rubber desirably is provided in each tub.

Although the tubs may be permanently mounted in the carriage 103 as by welding, it is preferable that they be mounted, as shown, for facile removal and replacement and for tilting for unloading. Trunnions 125 (FIG. 4) each of which may take the form of a cylindrically shaped steel ring are abutted axially against the outside surfaces

of the tub sidewalls **121**, **122** and made fast as by welding, the cylindrical rings being concentric to the arcuate wall **120**. The trunnion rings **125** on the opposite sides of the tub are axially aligned and are rotatably received between trunnion block pairs carried by the side members or bolsters **108**, **109** of the carriage. Bottom trunnion block **127** (see FIGS. 6 and 7) of each pair is fast to the web of the carriage side member, top trunnion block **126** being secured to the bottom block by bolts **128** which draw the blocks snugly together so as to clamp them about the trunnions **125** and lock the tubs **101**, **102** against rotation. Each of the tubs is tiltable or rotatable on its trunnions **125** upon loosening the bolts **128** so as to release the grip of the trunnion blocks. This tilting or rotating of the tubs is utilized in unloading, as will appear.

Extending across the center of the carriage and tying the bolsters **108**, **109** together are a pair of angle iron cross members **131**, **132** located, respectively, above and below the eccentric drive shaft **301** to be later described. The stiffeners **131** and **132** are abutted against the webs of the bolsters and welded in place.

Counterpoise

In order to balance the radial forces imposed on drive shaft **301** in gyrating the carriage **103**, suitable counterpoise means **200** is provided to react on the shaft and provide forces in opposition to those of the carriage. Such counterpoise means takes the form of a floating frame comprising a pair of elongated steel channel side members **201**, **202**. These channels parallel the bolsters **108**, **109**, respectively of the carriage **103** and at their ends are resiliently supported by rubber shear mounts **204**, **205**, **206** and **207** located adjacent the shear mounts **104**, **105**, **106** and **107**, respectively, which support the carriage **103**. The rubber mounts for the counterpoise **200** are attached to vertically disposed flat steel plates **215** which parallel the webs of the channels **201**, **202**. The plates **215** are made fast to the webs of the channels **201**, **202** in parallel offset relation as by intervening combination spacer blocks and weights **216**. Each of the rubber shear mounts for the counterpoise includes a pair of axially aligned studs **208**, **209** which have their heads embedded in and bonded to the rubber body of the mount and which project from the opposite ends of the body. These studs correspond, respectively, to the studs **115** and **116** referred to in connection with the rubber mounts for the carriage **103**.

Vertical slots **217** are provided in the mounting plates **25–28** to receive the studs **209** of the rubber shear mounts which carry the counterpoise **200**. The slots **217** open through top edges **118** of the mounting plates so that the counterpoise as well as the carriage, each as a complete unit including the respective shear mounts, can be easily mounted in and demounted from the frame structure in original assembly and, if desired, in disassembly for servicing the machine. The studs **209** are fitted with threaded nuts by means of which the rubber cushioned bodies of the mounts are drawn snugly against the flat outside surfaces of the mounting plates. This is the same arrangement as that used for attaching the shear mounts for the tub carriage to the opposite, inwardly directed surfaces of the plates.

At points spaced toward their centers from their ends, preferably at their centers, the counterpoise channels **201**, **202**, are connected by a cross member or tie piece **210** in the form of a rolled steel channel which, as shown to advantage in FIG. 4, is located below and in parallel relation to the stiffeners **131**, **132** of the carriage **103**. The tie piece **210**, at its ends, is bonded to spacing blocks **211**, **212** which, in turn, are secured as by bolts **213** to the bottom flanges of the channels **201**, **202**.

The counterpoise frame is thus substantially H-shaped in plan form (FIG. 11), the extremities of the channel members extending outwardly, cantilever fashion, from the central portion of the counterpoise constituted by the cross tie piece **210**.

Eccentric drive

Extending in transverse relation to both the carriage **103** and the counterpoise **200** is drive shaft **301** previously mentioned. It is provided with a first pair of axially-spaced eccentric portions **302** for the carriage and, outside the carriage eccentrics and in 180 degree relation to the latter, a second pair of axially-spaced eccentrics **303** for the counterpoise **200**. Suitable ball or roller bearing assemblies **304** are provided in the carriage side channels **108**, **109** to receive the cylindrically shaped inner eccentrics **302**. A similar pair of bearing assemblies **305** are mounted in openings in the web portions of the channels **201**, **202** of the counterpoise to receive the cylindrically shaped outer eccentrics **303**.

On the front side of the machine the shaft **301** projects beyond the profile of the front side rails **14**, **15** and has a pulley **310** fast thereon. An electric motor **311** is arranged to drive the shaft **301**, the motor having a variable diameter pulley **312** secured on its shaft and a V-belt **313** being trained around the pulleys **310** and **312**. The motor base is secured to spaced parallel angle members **314** apertured to receive in transverse relation a pair of spaced parallel guide rods **315** which, in turn, are supported at their ends in angle members **316** carried by the shelf members **37**, **38**. The motor **311** is traversed on the rods **315** by a threaded rod **318** rotatable in a guide hole in the angle member **316** and provided on its outboard end with a hand wheel **319**. The rod is held against endwise movement in the angle member **316** and is threaded through a nut carried by one of the angle members **314** to which the motor base is secured. By rotation of the hand wheel **319**, the motor **311** and its shaft are shifted laterally relative to the eccentric shaft **301** with the result that the drive ratio between the motor and the eccentric shaft **301** is varied. This is accomplished by change in the effective diameter of the drive pulley **312**.

One of the principal features of the finishing apparatus of the present invention is the symmetrical arrangement and disposition of the parts of the tub means about the axis of the eccentrics **302** and also the symmetrical arrangement and disposition of the parts of the counterpoise about the axis of the eccentrics **303**. This symmetrical arrangement locates the axes of the eccentrics at or closely adjacent the centers of inertia of the masses that are driven by the eccentrics when the shaft is rotated.

Rotation of the shaft **301** drives the tub means comprising the carriage **103** and the tubs **101** and **102** together with the contents of the latter, in a substantially circular orbital path of small magnitude and in opposition to the counterpoise **200** which also is driven in an orbital path of small magnitude.

The two eccentrics **302** which constitute a pair and which drive the tub means have the same throw and the same orientation relative to the shaft axis. As mentioned above, the throw of the tub driving eccentrics **302** is 180 degrees out of phase with respect to the throw of the counterpoise driving eccentrics **303** in order that the mass of the counterpoise will be driven in balancing opposition to the mass of the tub means. The throw of the eccentrics **302** is relatively small, being of the order of from about $\frac{1}{32}$ inch to about $\frac{1}{8}$ inch, preferably about $\frac{1}{16}$ inch. A similar throw is used for the eccentrics **303** when the mass of the counterpoise **200** is substantially equal to the mass of the tub means including any load being finished. In order to equate the mass of the counterpoise to that of the tub means, suitable weights may be attached to the side channels **201**, **202**, the weights being distributed so as to locate the center of inertia of the counterpoise closely adjacent the axis of the eccentrics **303**. For example, the spacing blocks **216** may be of steel of suitable size to provide the desired weight. Since there are two pairs of the spacer weights **216**, one pair for each of the side channels **201**, **202**, and since each pair is symmetrically

disposed relative to the axis of the eccentrics 303, the desired weight distribution is maintained.

As shown to advantage in FIG. 2, the rubber shear mounts 104–107 for the tub means are disposed inside and abutted against the flat vertical inwardly directed surfaces of the mounting plates 25–28. The shear mounts 204–207 for the counterpoise are located outside and abutted against the flat vertical outwardly directed surfaces of the same mounting plates. By this arrangement the frame structure is simplified with resultant weight reduction and economy in manufacture. Another advantage stemming from locating the shear mounts for the counterpoise on the opposite sides of the mounting plates from the shear mounts for the tub means is that the rubber mounts may be identical, simplifying procurement of parts and assembly. The side channels 201, 202 of the counterpoise are located in close juxtaposition to the side channels 108, 109 of the carriage. The point at which each of the eccentrics 302 is loaded by one of the carriage bearing assemblies 304 is closely spaced axially of the shaft from the point at which a corresponding one of the eccentrics 303 is loaded by one of the bearing assemblies 305 of the counterpoise. Whipping and distortion of the shaft in operation is minimized with resultant reduction in fatigue, longer life, reduced bearing wear and smoother operation. Moreover, a more compact machine design is feasible.

Another advantageous feature of the present invention is the arrangement of the shear mounts with the axes of their attaching studs 115, 116, 208 and 209 paralleling the rotational axis of the eccentric drive shaft 301. Each mount thus yields in shear to accommodate the weight of the tub means and of the counterpoise, as the case may be, and also to absorb the displacement of the tub means and of the counterpoise relative to one another and to the frame structure when gyrated by the eccentric shaft. The system is thus characterized by minimum resistance to deflection in directions lying in planes normal to such shaft axis. In directions paralleling the drive shaft axis the shear mounts all exhibit relatively high resistance to displacement, the rubber bodies of the mounts being in either tension or compression when resisting force components parallel to the drive shaft.

By employing the principle of positive eccentric drive, with the mass of the counterpoise opposing and therefore balancing the mass of the tub means, there is eliminated any need for a heavy rotating mass such as a flywheel or eccentric weight in the driving system. Thus the present machine is safer than those which use heavy rotating masses or flywheels since the danger of injury or damage resulting from a rotating weight getting loose is eliminated.

Unloading system

Located beneath the tubs 101, 102 and in end to end relation are a pair of tilting chutes 401, 402; they are conveniently fabricated of sheet steel and are substantially identical. Each chute has a substantially flat bottom 403, spaced parallel vertical sides 404 and an upstanding rear end 405 which is connected to the chute bottom and to the sides 404. The chutes are tiltingly mounted on spaced, parallel, horizontal fulcrum rods; the ends of such rods are received in pillow blocks 407 secured against the bottom surfaces of the frame brackets 32.

The chutes are oppositely directed and mounted on the rods 406 with each rod being spaced from the ends of the chute which it supports. The rear end walls 405 of the chutes are adjacent one another and the open ends of the chutes project through the ends of the frame structure between the uprights. The end wall 405 of each chute is formed with a central full height opening or slot 408 to serve as an outlet when the chute is up tilted, as will appear. Suitable releasable means, not shown, is provided for retaining each chute in either the up tilted position of FIG. 1 or the down tilted position in which the chute 401 is shown in FIG. 4.

The stop bars 41, 42, previously mentioned, engage and support the forward ends of the chutes when the latter are in the down turned position.

Liquid circulating system

A sheet metal tank 410 is provided for water or other liquids used in the finishing process. This tank is desirably of substantially rectangular plan form and somewhat smaller than the frame structure of the machine so as to fit completely within the vertical profile of the latter. The tank is adapted to rest on the same floor or base as that which supports the machine, the tank being separate from the machine to permit easy withdrawal of the tank from under the machine for cleaning and servicing.

The tank 410 has upstanding side walls 411, 412 and end walls 414, 415. A longitudinally extending central partition 416 and cross partitions 417, 418, 419 and 420 (FIG. 12) divide the interior of the tank into four settling chambers C1, C2, C3 and C4 and a pair of sump chambers S1, S2. The settling chambers C1–C4 are approximately equal in size and of rectangular plan form; the sump chambers S1, S2 are relatively small and are adapted to receive pumps P1, P2. The cross partitions 417—420 are each formed with a central cut-out portion or, as shown, are of slightly less height than the longitudinal partition 416 and the outside walls of the tank so that when the liquid level in the chamber C2, fed from the trough 440, exceeds a predetermined height it overflows the partition 418 and enters the chamber C1. When the liquid level in the chamber C1 exceeds a predetermined height it overflows the partition 417 and enters the sump chamber S1 containing the pump P1. Similarly, liquid discharged from the trough into the chamber C4, upon reaching a predetermined height, overflows the partition 420 and enters the chamber C3; liquid in the chamber C3 reaching a predetermined height overflows the partition 419 and enters the sump chamber S2 containing the pump P2.

Clean-out openings 421 are formed in the front and rear side walls 411, 412 of the tank 410 to provide access into the settling chambers C1–C4. The tank has a raised flat horizontal bottom 422 and the openings 421, rectangular in shape, are continuous to the bottom, permitting easy clean out of sediment which settles in the chambers. Closures for the openings 421 comprise rectangular plates 423 slightly larger than the openings; the closure plates are each held against the outside surface of the tank wall by endwise pressure of a threaded rod 424 threadedly engaged in the center of a T-shaped member 425 supported at its ends by Z-brackets 426. A pair of these brackets are welded to the side walls of the tank at each of the openings 421 just beyond the sides of the latter. Gasket material is provided between the marginal portions of the closure plates 423 and the portions of the tank walls which surround the openings.

A flat metal sheet or plate cover 429 having downturned marginal flanges 430 is disposed across the top of the tank 410; the cover is formed at its left-hand end, as viewed in FIG. 12, with rectangular openings 431, 432 which register with the sump chambers S1, S2, respectively. At its other or right-hand end the cover 429 is formed with circular openings 433, 434 and 435, later referred to.

Surmounting the storage tank 410 and supported on the cover 429 is a trough 440 which is disposed with its dished receiving end 441 beneath the notched out openings 408 in the rear ends of the tilting chutes 401, 402. At the receiving end of the trough its side wall 442 is concave and sloping, is formed with an arcuate periphery 443 the width or diameter of which is greater than the axial length of the tubs 101 and 102. Toward the right hand or discharge end 444 of the trough and along the sides of the latter, the side portions of the sloping wall

442, blend into converging upright side wall portions 445, the latter being connected at the discharge end to an upright wall 446. An upright cylindrically shaped supporting wall 447 is fast to the underside of the trough at the receiving end 441 of the latter, is concentric to the periphery 443 and is received over an upstanding cylindrical ring 448 fast to the central portion of the tank top 429. The supporting wall 447 has an upper periphery of varying height to accommodate the changing contour of the sloping trough side wall 442; it also has a free sliding fit about the upstanding ring 448 which constitutes pivot means centering and permitting swinging of the trough in selectively positioning discharge spout 449 at the discharge end 444 in any one of the tank cover openings 433, 435 or 434. These openings are equidistant from the pivot center of the trough. When located in the opening 433, the spout 449 discharges into the settling chamber C2; when located in the opening 434, the spout discharges into the settling chamber C4 of the tank. When inserted into the middle opening 435, the spout 449 projects into the upper end of a 45 degree elbow fitting 451 located upright in the plane of the central partition 416 and suitably supported in an upright U-shaped metal column member 452 the edges of which abut and are sealed with the tank walls and bottom. The upper or receiving end of the elbow 451 is disposed so as to abut against the underside of the tank top 429, the lower end of the elbow projecting partially through the end wall 415 of the tank and having a tubular extension 453.

As shown in FIG. 4, the bottom of the trough 440 slopes downwardly from its receiving end 441 to its discharge end 444 so that liquids or fluent materials received in the trough flow by gravity out the discharge spout 449 and into either one of the settling chambers C2 or C4, depending upon whether the spout is in the opening 433 or 434, or are discharged through the fitting 451 into a suitable floor drain (not shown) and to waste if the spout 449 is in the middle opening 435 which registers with the elbow fittting 451. To facilitate manual movement of the discharge spout 449 from one of the openings to another, accomplished by lifting the trough discharge end and shifting it laterally, a handle 455 is secured to the end wall 446. The loose fit of the supporting wall 447 on the centering wall 448 permits tilting of the trough on the centering wall sufficient to allow withdrawal and reinsertion of the spout 449 from and into the several openings in the tank top.

Located in the sump chambers S1, S2 are the previously mentioned pumps P1, P2 each comprising a pedestal type main housing having and supported on the tank bottom 410 by stubby legs so as to allow flow of liquid into a center inlet opening in the underside of the housing. Each pump housing is surmounted by an electric driving motor 456; the outlet from the impeller chamber is connected by a flexible hose or conduit 457 to a T-fitting 458 (FIG. 3) in turn connected by series conduits 459 to a distributing manifold 460 disposed horizontally above and parallel to the top center brace 131 of the carriage. A suitable valve 461 is interposed in the connection between the feed conduit 459 and the manifold 460 to control the flow and the release from the manifold and from branch lines 462 connected into the latter of the liquid supplied by one or the other of the pumps P1, P2. Each of the pumps or the outlet conduit from it is provided with an internal one way or check valve or is so designed as to prevent reverse flow of liquid so that when one pump is functioning and the other is idle, reverse flow through the outlet hose 457 of the idle pump is prevented.

Mounted on the tank top 429 adjacent the supporting wall 447 of the trough 440 and so as to be protected by the overhand of the sloping trough wall 442, is a double throw or three-position electrical switch 465. This switch has a live movable center contactor connected to a swinging arm actuator 466 spring biased to a center upright position (FIG. 3) in which the switch is open. On the upper end of the actuating arm 466 is a roller 467 received in center slot 468 of a W-shaped bracket 469 fast to the underside of the overhanging trough wall 442. When the trough 440 is shifted to place the discharge spout 449 in the tank top opening 433, the trough and the W-bracket 469 are shifted relative to the switch 456 to the positions shown by the full lines of FIG. 3*a*. In this position of the switch a suitable circuit through the live center contactor connects the motor 456 of the pump P1 to an electrical power source through suitable cable conductors 471, 472. When the trough is swung on the circular centering wall 448 to position the spout 449 in the tank top opening 434, the W-bracket 469 and the switch arm 466 are shifted to the relative positions shown by the broken lines of FIG. 3*a*; in these relative positions the live center contactor of the switch is closed with a contact that is connected in a suitable electric circuit through the conductor 472 and a cable 473 for energizing the motor 456 of the pump P2.

Electrical energy for the main drive motor 311 and for the pump motors 456 is supplied by a conventional control system (not shown) provided with the usual safety interlocks and overload releases.

In operation of the finishing machine of the present invention, the tubs 101 and 102 are loaded approximately equally but not completely full with the customary mass of finishing medium such as stones or other suitable abrasive particles and with the articles such as castings to be finished. The loading is accomplished by pouring the media and articles into the open tops of the tubs, the latter being upright as in FIG. 1. If the articles are to be finished dry, the machine is then started by energizing the motor 311 and adjusting the speed of gyration by the handwheel 319 so that the eccentric shaft 301 rotates at a speed of from about 900 to about 1800 revolutions per minute. For wet processing operations water or other suitable liquid may be added to the mass in the tubs through the open tops of the latter either before starting or while the machine is in operation. If it is desired to circulate the liquid through the tubs, the stoppers or plugs 119 in the bottom discharge openings of the tubs are removed, as in FIG. 1, so that the liquid runs out the discharge openings into the up tilted chutes 401, 402.

Liquids discharged from the open drain outlets in the bottoms of the tubs 101, 102 flow by gravity toward the rear end walls 405 and over the notches 408 of the latter so as to fall into the receiving end 441 of the trough 440. The trough carries the liquid to the receiving end of the tank 410, discharging to waste through the fitting 451 or into either the chamber C2 or the chamber C4 depending upon whether the discharge spout 449 is located in the opening 433 or the opening 434. Assuming the discharge is into the tank chamber C2, the liquid will first fill such chamber, overflow the weir or partition 418 and then fill the chamber C1. From the latter the liquid overflows the weir or partition 417 and runs into the sump chamber S1. As previously mentioned, location of the trough 441 in that position which places the discharge spout 449 in the tank top opening 433, conditions the switch 465 so that the motor 456 of the pump P1 is energized. Thus liquid overflowing the weir 417 is drawn in by the pump P1 and forced through the conduits connected thereto into the manifold 460 and thus returned to and recycled through the tubs.

In traveling through a series of the chambers of the settling tank seriatim, the suspended solid materials settle out of the liquid so that relatively clear liquid is recirculated by the pump system. As necessary, the sediment deposited in the tank chambers is removed through the clean-out openings 421, the closures 423 being removed for the purpose and, of course, the liquid being drained from the particular chamber at the same time.

If desired, the tank 410 is supplied with two kinds of finishing liquids as, for example, a deburring liquid in the chambers C1 and C2 and a burnishing liquid in the chambers C3 and C4. After a suitable period of opera-

tion with the deburring liquid circulating through the tubs and the tanks C1, C2, the trough is shifted on the pivot wall 448 by removing the spout 449 from the tank top opening 433 and placing such spout in the opening 434. This shifting of the trough shifts the arm 466 of the switch 465, stopping the pump P1 and starting the pump P2. Thus the circulation of the finishing liquid is automatically stopped and the burnishing liquid is placed in circulation automatically.

To flush clear liquid or water through the tubs 101, 102, such liquid is introduced into the top openings of the tubs as through a hose, not shown, released through the open discharge outlets in the bottoms of the tubs, carried by the up titled chutes 401 and 402 into the trough 440 which, in this instance, is in center position with the discharge 449 in the receiving end of the elbow fitting 451. The pump motors are both deenergized and the liquid is released to waste from the fitting 451.

After the finishing of the articles is completed the tubs 101, 102 are emptied by tilting them on their trunnions as shown in FIG. 4 with respect to the tub 101. In the emptying procedure the chutes 401, 402 are each placed in the down tilted position as shown in FIG. 4 with respect to the chute 401. In such down position the discharge end of the chute which projects beyond and from between the uprights of the machine frame discharges outside the frame and into any suitable receptacle such articles and finishing media as are released from the overturned tub.

In accordance with the patent statutes the principles of the present invention may be utilized in various ways, numerous modifications and alterations being contemplated, substitution of parts and changes in construction being resorted to as desired, it being understood that the embodiment shown in the drawings and described above is given merely for purposes of explanation and illustration without intending to limit the scope of the claims to the specific details disclosed.

What I claim is:

1. A vibratory device for finishing articles, said device comprising:
- tub means for containing a load of such articles and finishing media,
- counterpoise means having a mass substantially equivalent to the mass of the tub means including the design load,
- eccentric means journaled in both the tub means and the counterpoise means for rotation about an axis in close juxtaposition to the centers of inertia of the tub means and of the counterpoise means,
- the tub means and the counterpoise means being coupled through the eccentric means in centrifugal force compensating opposition to one another,
- frame means,
- resilient means connected between the frame means and both the tub means and the counterpoise means at points spaced from said axis, said resilient connecting means constituting the sole support for the tub means, the counterpoise means and the eccentric means and supporting the tub means and the counterpoise means in non-rotative relation to one another and to the frame means,
- drive means operatively associated with the eccentric means for rotating it, and
- said tub means having a concave bottom shaped about an axis substantially parallel to the eccentric axis whereby rotation of the eccentric means produces orbital motion of the tub means and the counterpoise means in balance with one another and in a plane normal to the eccentric axis and the load is induced to progress by mass movement across the concave tub bottom in planes generally normal to said axes and over closed paths about the tub axis.

2. A vibratory device as in claim 1 in which the tub means includes wall means which with said bottom define a load confining chamber having an effective vertical height at least as great as its horizontal width measured transverse to the tub axis.

3. A vibratory device as in claim 1 in which the eccentric means and all parts rotating with it constitute an insubstantial fractional portion of the total mass carried by the resilient means.

4. A vibratory finishing device as in claim 1 in which the resilient means comprises a plurality of rubber shear mounts each fast at one end to the frame means,
- other ends of the rubber mounts being fast to the tub means and to the counterpoise means.

5. A vibratory finishing device as in claim 1 in which said drive means comprises:
- a driven element fast on the eccentric means,
- a motor supported on the frame means independently of both the tub means and the counterpoise means, and
- flexible drive means connecting the motor to the driven element.

6. A vibratory finisher comprising a frame,
- a generally rectangular carriage,
- an H-shaped counterpoise comprising spaced parallel side members and a central cross member connecting the side members,
- resilient means mounting the carriage and the counterpoise on the frame with the side members of the counterpoise located outside of the carriage,
- tub means carried by the carriage and adapted to receive a load of articles to be finished and an abrasive medium,
- rotary drive means coupling the carriage and the counterpoise for relative gyratory motion in force balancing opposition to one another,
- and said drive means having its rotational axis in close juxaposition to the centers of inertia of both the carriage and the counterpoise.

7. A vibratory finisher comprising
- a frame having a plurality of flat vertically disposed plates each formed with an open ended slot,
- a carriage,
- means mounting the carriage in the frame,
  - said mounting means comprising a plurality of resilient members fast to the carriage,
  - horizontal stud means anchoring the resilient members to the plates and extending through the slots to permit disassembly of the carriage from and reassembly of the carriage with the frame by sliding the stud means vertically from and replacing the stud means in the slots of the plates,
- tub means supported by the carriage, and
- means having driving connection with the carriage to impart vibratory motion thereto and to the tub means.

8. A vibratory finisher comprising
- a frame having a plurality of flat vertical plates,
- a first set of resilient mounts abutted against and secured to the plates,
- tub means supported by said mounts,
- a second set of resilient mounts abutted against and secured to the plates on the opposite sides of the plates from the mounts of the first set,
- counterpoise means supported by said second set of mounts,
- eccentric shaft means journaled in both the tub means and the counterpoise means and coupling them for relative gyratory movements, and,
- supported by the frame,
- drive means connected to the shaft means to actuate the latter.

9. A finisher as defined in claim 8 in which
- the plates are disposed in spaced parallel planes in pairs with confronting inside surfaces and oppositely directed outside surfaces,
  - the first set of mounts being on the confronting

inside surfaces and the second set of mounts being on the outside surfaces,

the counterpoise means including members extending from the space between the planes of the plates to the second set of mounts and attached to the the latter outside the space between said planes.

10. In a vibratory finisher of the type comprising

a supporting frame,

a tub adapted to receive a load of articles to be finished and an abrasive medium,

said tub having a top opening through which articles are received and discharged and a bottom outlet through which liquid used in the finishing is discharged,

means mounting the tub on the frame for tilting motion between a working position in which the top opening is uppermost and an unloading position in which the top opening is directed downwardly to release articles from the tub interior by gravity,

a liquid storage tank located within the horizontal limits of the frame,

a trough on and supported by the tank,

a chute and means supporting it in the frame for tilting movement about a horizontal axis,

said chute being disposed beneath the tub and being adapted to receive liquid discharged from the outlet,

and the chute being tiltable between a working position in which received liquid flows toward the center of the frame and is released to drop by gravity into the trough and an unloading position in which articles released from the tub in the unloading position are intercepted by the chute and carried by the latter beyond the horizontal limits of the frame.

11. In a vibratory finisher of the type comprising a supporting frame,

a pair of tubs each adapted to receive a load of articles to be finished and an abrasive medium,

said tubs each having a top opening through which articles are received and discharged and a bottom outlet through which liquid used in the finishing is discharged,

means mounting the tubs on the frame for tilting motion of each tub between a working position in which the top opening is uppermost and an unloading position in which the top opening is directed downwardly to release articles from the tub interior by gravity,

a liquid storage tank located within the horizontal limits of the frame,

a trough on and supported by the tank,

a pair of chutes,

means supporting the chutes in the frame with one chute beneath one of the tubs and the other chute beneath the other of the tubs,

and the chutes each being tiltable between a working position in which liquid discharged from the corresponding tub is received by the chute, conducted toward the center of the finisher and released to drop by gravity into the trough and an unloading position in which articles released from the tub in the unloading position are intercepted by the chute and carried by the latter beyond the horizontal limits of the frame.

12. A liquid circulating system for use in association with abrasive finishing apparatus of the type comprising tub means adapted to receive articles to be finished,

the tub means having an outlet through which liquid used in the finishing is discharged,

said system including a tank,

a waste fitting on and supported by the tank,

said fitting having a discharge outside the tank,

a trough having receiving and discharging ends,

a spout on the discharge end of the trough,

means mounting the trough on the tank for shifting between a waste position in which the spout is disposed to discharge into said fitting and a return position in which the spout is disposed to discharge into the tank,

an electric pump connected to receive liquid from the tank and to discharge received liquid for recirculation through the tub means,

and control means governing energization of the pump, said control means including electric switch means having an operative connection with the trough, the trough being adapted through said operative connection to condition the switch means for energizing the pump upon shifting of the trough from the waste position to the return position and to condition the switch means for deenergizing the pump upon shifting of the trough from the return position to the waste position.

13. A liquid circulating system for use in association with abrasive finishing apparatus of the type comprising tub means adapted to receive articles to be finished,

the tub means having an outlet through which liquid used in the finishing is discharged,

said system including a tank,

partition means dividing the tank into separate chambers,

a trough having receiving and discharging ends,

a spout on the discharging end of the trough,

means mounting the trough on the tank for shifting between a first position in which the spout is disposed to discharge into one of said chambers and a second position in which the spout is disposed to discharge into another of said chambers,

electric pump means connected to receive liquid selectively from the chambers and to discharge received liquid for recirculation through the tub means,

and control means including electric switch means governing energization of the pump means,

said switch means having an operative connection with the trough and the trough being adapted through said operative connection to condition the switch means for energizing the pump means to withdraw liquid from the one chamber when the trough is in said first position and to withdraw liquid from the other chamber when the trough is in said second position.

14. A liquid circulating system for use in association with abrasive finishing apparatus of the type comprising tub means adapted to receive articles to be finished,

the tub means having an outlet through which liquid used in the finishing is discharged,

said system including a tank,

partition means dividing the tank into separate chambers,

a waste fitting on and supported by the tank,

said fitting having a discharge outside the tank,

a trough having receiving and discharging ends,

a spout on the discharging end of the trough,

means mounting the trough on the tank for shifting between a first position in which the spout is disposed to discharge into one of said chambers, a second position in which the spout is disposed to discharge into another of said chambers and a third position in which the spout is disposed to discharge into said fitting,

electric pump means connected to receive liquid selectively from the chambers and to discharge received liquid for recirculation through the tub means,

and control means including electric switch means governing energization of the pump means,

said switch means having an operative connection with the trough and the trough being adapted through said operative connection to condtion the switch means for energizing the pump means to withdraw liquid from the one chamber when the trough is in said first position, to withdraw liquid from the other chamber when the trough is in said second position

and for deenergizing the pump means when the trough is in said third position.

15. A liquid circulating system as defined in claim 13 in which the pump means comprises a pair of independently driven electric pumps one of which receives liquid from said one chamber and the other of which receives liquid from said other chamber,

said switch means being conditioned to energize said one pump when the trough is in said first position and to energize said other pump when the trough is in said second position.

16. In a vibratory finisher of the type comprising a supporting frame,

tub means adapted to receive a load of articles to be finished and an abrasive medium,

eccentric drive means having an operative connective with the tub means and adapted to induce orbital gyratory movement in the tub means,

a plurality of shear mounts connected between the supporting frame and the tub means,

said mounts each being disposed to yield in shear to the weight of the tub means and also to force components of all directions lying in planes paralleling the orbital movement;

a counterpoise having a mass approximating that of the tub means,

the drive means having an operative connection with the counterpoise and being adapted to drive it in opposition to the tub means,

and a plurality of shear mounts connected between the supporting frame and the counterpoise,

said counterpoise mounts each being disposed to yield in shear to the weight of the counterpoise

and also to force components of all directions lying in planes paralleling the orbital movement.

17. In a vibratory finisher of the type defined in claim 16 the shear mounts which support the tub means each being in close juxtaposition to a shear mount which supports the counterpoise.

18. In a vibratory finisher of the type defined in claim 16,

the frame structure including upright flat plates,

the shear mounts each having opposite end faces,

means connecting one such end face of each mount to one of the flat plates with each plate having a mount for the tub means extending horizontally therefrom in one direction and a mount for the counterpoise extending horizontally therefrom in another direction, and

the other such end face of each tub mount being connected to the tub means and of each counterpoise mount to the counterpoise.

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