Sept. 28, 1965 L. GAMS ETAL 3,208,731

VIBRATING MACHINE FOR CONTINUOUSLY TREATING WORKPIECES

Filed Sept. 4, 1964

4 Sheets-Sheet 1

Fig. 1

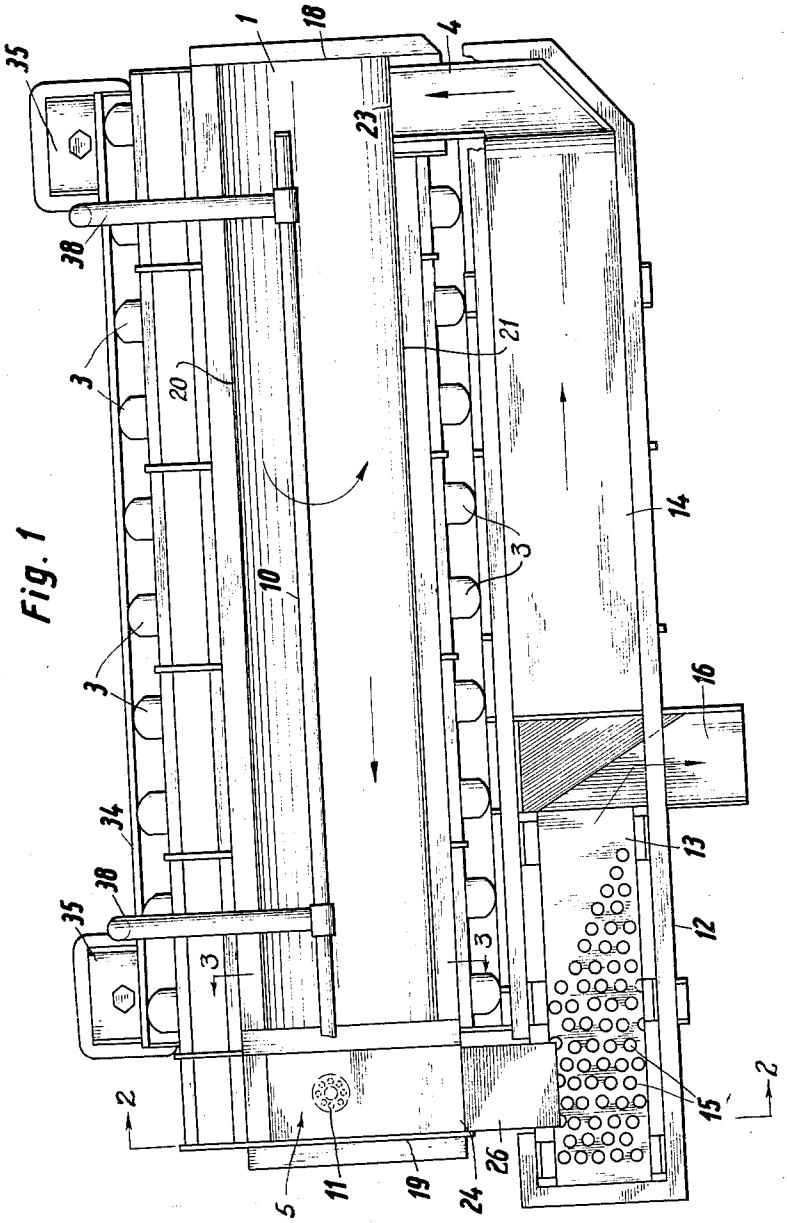

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Fig. 2

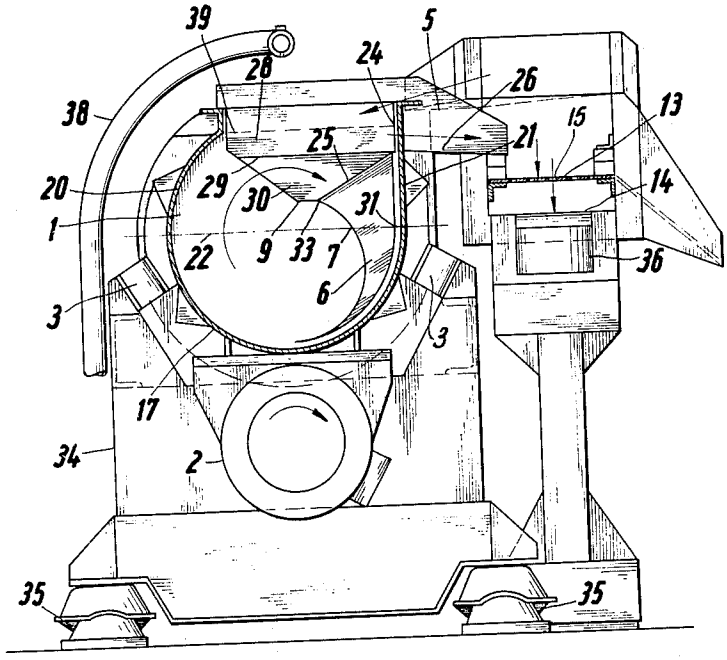

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Fig. 4

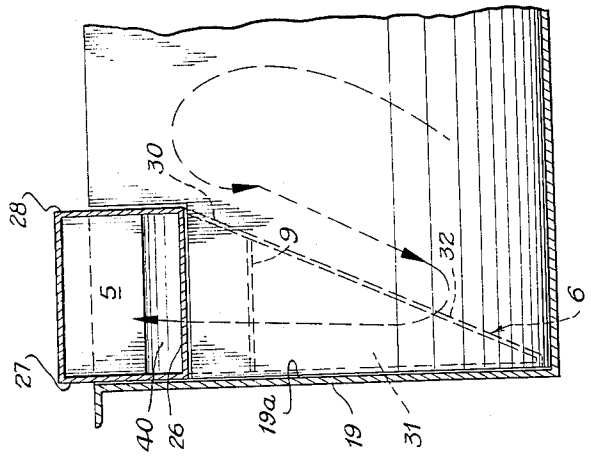

Fig. 3

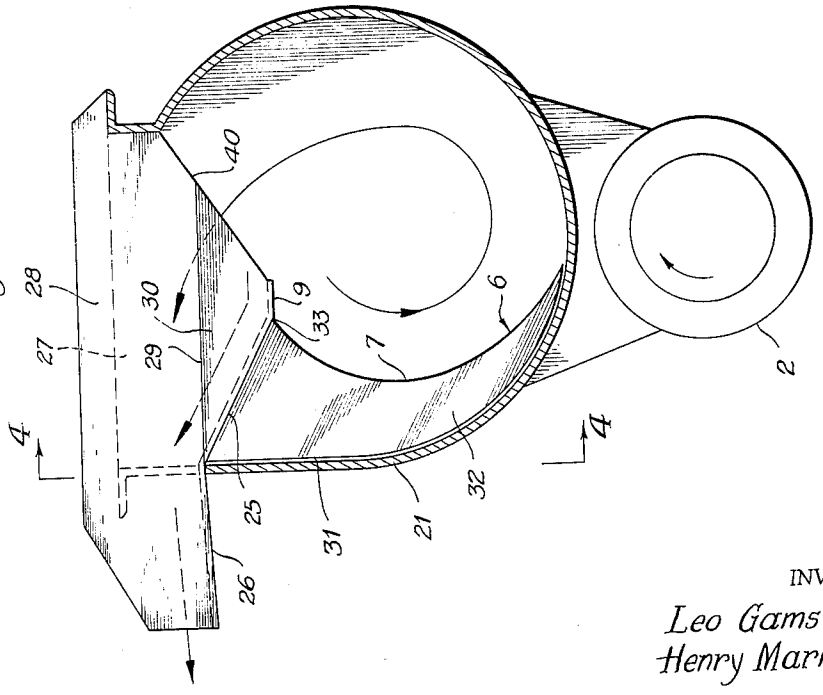

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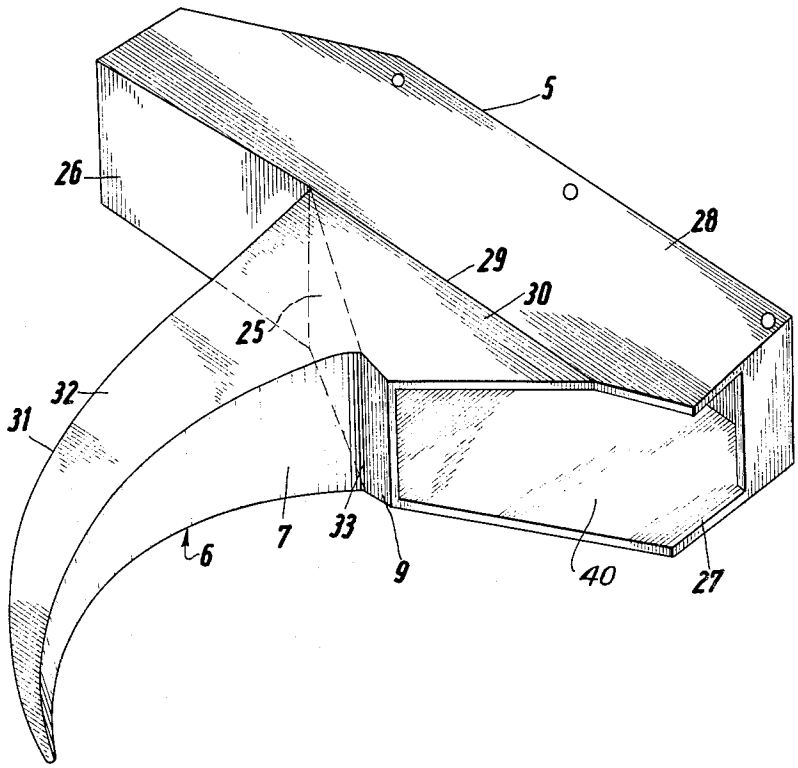
Fig. 5



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3,208,731

VIBRATING MACHINE FOR CONTINUOUSLY TREATING WORKPIECES

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8 Claims. (Cl. 259—2)

This invention relates to a machine for treating workpieces and, in particular, to a machine for continuously treating the surfaces of workpieces by means of vibrations.

Continuously operating machines exist for vibrating workpieces in a tank containing a treating material composed of liquids and/or solids in the form of dust granules or larger particles. Such workpieces are articles mass-produced from metal, synthetic materials, and the like. The main part of the machine is an oblong tank having the form of a trough, tub, basin or tube which is vibrated by an unbalanced shaft attached to the bottom of the tank. A tube is seldom used for the tank. This is because it is usually desirable to easily observe the progress of the workpieces through the tank without interrupting the process. Therefore, in practice, it is preferred to use an open-top tank having a semi-circular bottom inasmuch as such a bottom enhances a relatively uniform movement of the workpieces through the tank. The side walls of the tank are straight and rise vertically from the upper part of the semi-circular bottom. In machines which operate non-continuously, it has been proposed that these straight side walls be inclined toward the interior of the tank so that a counter-movement of the workpieces in the tank is either avoided or at least so reduced that the vibrated workpieces move from one side wall to the other. This, in turn, avoids or at least reduces the uneven treatment of the workpieces and the hard wear and tear on the inner coating of the tank touched by the workpieces. However, such a tank construction only achieves these results to a small degree.

Existing treatment tanks are also directly supported on springs. Insulators are used as the only support of the tank upon the base, these insulators directly engaging the tank at an angle between the radial and tangential lines to the semi-circular tank bottom. An unbalanced shaft having a longitudinal axis parallel to the longitudinal axis of the tank is attached to the bottom of the tank to serve as the vibrator. In order to produce a forward movement of the workpiece and treating material fed into one end of the oblong tank and toward the discharge end of the tank, several techniques have been used. In one case, the tank is arranged at a vertical angle to the longitudinal axis of the machine, as disclosed in German Patent 1,047,993. This has the disadvantage in that the tank must be longer than a horizontal tank. Again, if no abutting wall is placed at the discharge end of the tank, then the level of the material in the tank is low so that the space in the tank is not fully utilized and the workpiece and the treating material are discharged too quickly. If, on the other hand, the discharge of the treating material and workpiece is restrained at the discharge end of the tank by lowering the discharge end and/or elevating the dischange opening, then the angular position of the tank at the discharge end produces congestion at that point and a variance in the level of the material in the tank in such a way that the surface of the material is higher at the discharge end than at the inlet end of the tank. In addition to the fact that here again the full capacity of the tank is not utilized completely, the workpieces and solid treatment particles take different paths in the various portions of the tank so that the surfaces of the workpieces

are not ensured a uniform treatment, and the wear and tear on the interior tank coating greatly varies.

Another technique which has been used to move the contents of the tank from the supply to the discharge end is in keeping the supply inlet opening into the tank higher than the discharge opening. This, however, does not avoid the heretofore described disadvantages because there exists within the tank a difference in the level of the material between the ends of the tank.

It has also been proposed to control the flow of the material in the tank by means of guide baffles. Such did help to avoid the existing disadvantages. However, the initial machine cost is increased by reason of the baffles and the protective coatings for the baffles. Also, the operational costs increase because these protective baffle linings wear off relatively quickly and need constant renewal. Furthermore, the usable space within the tank was decreased by the presence of the baffles.

The object of this invention is to produce a continuously operating machine which avoids the above disadvantages. In this machine, the treatment tank for holding a mixture of workpieces and treating material has a horizontal semi-circular bottom with side and end walls of equal height. The tank is elastically supported and has a vibrator directly attached to its bottom. Means are provided for the supplying and removing of workpieces and treating material. Also means are provided for taking the material discharged from the tank, separating and recycling the treated material with filtering if required, and removing the treated workpieces. The treated workpieces have had their surfaces treated as by scouring, cleaning from rust or scale, rounding edges, rough polishing, smoothing, polishing, burnishing, and the like, of metal, synthetic materials and the like. The tank of this invention has one longitudinal side wall formed as an uninterrupted continuation of the semi-circular bottom. In this tank, the supply opening and the discharging opening are positioned at the same level in the opposite longitudinal wall which is straight and rises vertically from the upper part of the semi-circular bottom. A discharge chute extends through the discharge opening of the tank and has its inlet opening end parallel to the longitudinal axis of the tank and approximately above the center of the semi-circular bottom.

In the machine of this invention, the material is moved from the inlet supply opening to the discharge opening with an easily controlled velocity and without the need of tilting the tank or useing such auxiliary means as guide baffles. The tank is vibrated at the usual frequency of about from 600 to 3,000 vibrations per minute to move a desired volume of material through the tank in a specified time and to discharge the material from the tank at the same rate. This automatically sets the velocity of the material and the discharge of a certain volume of the material per unit of time. A machine according to this invention is therefor especially adapted for use with automatic conveyor belts inasmuch as it can be set to serve the conveyor belts without additional control means.

Another advantage of the machine of this invention is in that the level of the contents in the tank is the same at all points. This means that the workpieces and cleaning or treating material move in a uniform manner along the entire treating path in the tank and the contact between the workpieces and treating material is completely uniform. This results in a precise control of the intensity of the surface treatment on the workpieces which can be determined in advance to obtain uniformly treated surfaces. Also, this improves the evenness of the wear and tear on the interior tank liner and thus increases the life of the same. Finally, this permits the use of substantially

the entire inside of the tank which, in turn, considerably increases the output of the machine.

Another advantage of the machine construction is in that the curved shape of one side wall avoids the well-known phenomenon of the upheaval of a portion of the contents of the tank which runs counter to the rotation of the main portion of the tank contents at a point where the contents move away from one side wall toward the other side wall as occurs in a tank with straight side walls. The curved wall of this invention not only prevents heavy wear and tear on the tank protective interior liner, but also prevents an irregularity of the contents movement through the tank, such as has been observed in continuously operating treating machines which have straight walls. The curved longitudinal side wall of this invention thus considerably contributes to the fact that in the same unit of time the quantity of treated workpieces and material leaving the tank outlet equals the amount of workpieces and treating material introduced through the supply opening and this relationship remains practically the same despite the largest possible amount of workpieces and material introduced into the supply opening.

The discharge chute projecting through the tank outlet opening according to this invention is necessary in order to obtain a smooth passage of the mixture of work pieces and treating material through the tank. In the absence of this chute extending into the tank, the contents of the tank would become congested while moving through the tank which would make a horizontal bottom for the tank unsuitable for a continuous machine operation.

According to this invention, the design of the discharge chute permits the machine to operate very well and without interruption. The bottom of the chute has a horizontal portion extending parallel to the longitudinal axis of the tank and is continued into a bottom portion inclined upwardly at an angle from about 25 to 35° to the straight longitudinal side wall and then inclined slightly downwardly and outwardly of the tank so that the discharge end edge of the bottom will lie above a part of the machine used for the further treatment of the tank contents, such as the separation of the workpieces from the treated material and the recycling of the latter. The chute has one vertical side wall parallel and preferably in contact with the outlet end wall of the tank in order to eliminate dead angles and spaces. The opposite vertical side wall of the tank has an inclined lower chute inlet edge extending between the horizontal bottom portion and the upper edge of the curved longitudinal side of the tank. Beneath and joined to the bottom of the chute is a spur-shaped member having four walls, one wall of which abuts and conforms in shape to the curve of the straight tank wall and bottom tank wall and extends to a point approximately at the center of the tank bottom, a second wall of which is curved from said point to the horizontal bottom portion of the chute, a third wall of which is flat and abuts the discharge end of the tank, and a fourth wall of which extends from said point to an edge of the inclined bottom portion of the chute and lies at an angle to the third wall. This spur-shaped member is square in horizontal cross-section.

This spur-shaped member has several important features which, in cooperation with the design of the chute, produce an uninterrupted flow of the workpieces and treating material from the supply end of the tank through the tank outlet opening. The fourth wall of the spur-shaped member is inclined to the vertical and makes it possible that the tank contents can flow smoothly up toward the discharge end wall of the tank and up into the range of the inlet opening into the chute. The second curved wall of the spur-shaped member finds a path for the smooth flow of the tank contents without turbulence and in the direction of the uniform movement of the tank contents. Experience has shown that the rate of discharge of the tank contents through the chute decreases as the distance between the horizontal bottom portion

of the chute and the pointed end of the spur-shaped member decreases. An important feature of this invention lies in the use of the horizontal bottom portion of the chute lying within the interior of the tank and that the spur-shaped member extends downwardly from this horizontal bottom portion.

Another feature of this invention lies in the displacement of the tank as produced by the frequency and amplitude of the tank vibrations in order to produce a sufficient forward and smooth movement of the tank contents. This tank displacement is substantially dependent upon the manner by which the vibrating mechanism is attached to the tank. It is a feature of this invention that the tank is supported on elastic elements positioned along the entire length of the tank and directed substantially radially of the tank to bear against the upper part of the semi-cylindrical bottom of the tank. A somewhat similar support has been heretofore used in a longitudinally inclined tank, as disclosed in German Patent 1,047,993. Elastic spring elements were used. However, according to this invention, using a horizontal tank, such spring elements cause the tank to swing in curves which produce the disadvantages of irregular tank vibrations and instability of position. In this invention, elastic rubber shear elements are used and positioned so that the tank is displaced in a uniformly swinging curve and thus produces a smooth uniform flow of the tank contents. This effect is enhanced by the further use of elastic cushion members between the machine framework and the floor. This also provides a protection for the machine and the floor or foundations from the severe effects of the machine vibrations.

In addition to the above features, the machine is combined with means adjacent the longitudinal straight wall of the tank for the further treatment of the contents removed from the tank. Such is composed of an apparatus for separating the treated workpieces from the treating material, and also for a recycling of the treating material to the tank and, if necessary, the workpieces. This additional apparatus results in a very compact machine which is economical, both as to time and the use of treating material, especially when both the supply opening and the tank outlet opening are in the straight longitudinal wall of the tank. This additional apparatus is composed of an upper sieve transporting member which receives the output from the discharge chute of the tank and a lower conveyor beneath the sieve member for receiving the treating material which is recycled to the supply opening of the tank. The treated workpieces are removed through a sieve chute. The upper sieve transporting member and the lower conveyor member are reciprocating conveyors.

Another feature of the invention is the provision of means for rinsing the contents in the tank for removing particles which have been rubbed off the workpieces. This improves the finish of the surfaces of the workpieces to a substantial degree. This rinsing means is composed of a sprinkler system mounted above and extending along the entire length of the tank from which a spray of cleaning liquid is directed downwardly into the tank contents. The dirtied cleaning liquid is removed through one or more screened drains in the bottom of the tank from which it can be passed through a filter and pumped back to the sprinkler system.

The means by which the objects of the invention are obtained are described more fully with reference to the accompanying drawings in which:

FIGURE 1 is a plan view of the workpiece cleaning machine;

FIGURE 2 is a vertical cross-sectional view taken on the line 2—2 of FIGURE 1;

FIGURE 3 is a cros-sectional view taken on the line 3—3 of FIGURE 1;

FIGURE 4 is a partial side view taken on the line 4—4 of FIGURE 3; and

FIGURE 5 is a perspective view of the tank discharge chute connected to the spur-shaped member.

As shown in the drawings, the material treating tank **1** is vibrated by a vibrating mechanism **2** attached to the bottom of the tank. Tank **1** is mounted on a supporting framework through the medium of rubber shear blocks **3**. Tank **1** is supplied with workpieces and treating material, which may be composed of solid particles, through supply chute **4**. The contents are removed from the tank through the discharge chute **5**. Joined to the bottom of the chute is the spur-shaped member **6** which has a curved surface **7** facing toward the interior of the tank and joined to a horizontal portion **9** of the chute bottom.

A perforated longitudinal pipe **10** extends longitudinally above the pipe for spraying cleaning fluid into the tank contents. This fluid can be removed through screened drains **11** in the bottom of the tank.

Mounted adjacent to and extending parallel to the longitudinal axis of the tank is a conveying apparatus **12** which is composed of an upper reciprocating sieve member **13** and a lower reciprocating conveyor means **14** for receiving the tank contents discharged from the tank. Workpieces which cannot fall through the perforations **15** in the sieve **13** are removed through the sieve chute **16**.

Tank **1** has a semi-circular bottom **17**, and walls **18** and **19**, which are of the same type as side walls **20** and **21**. The horizontally positioned semi-circular bottom portion is curved up to the line **22**, FIGURE 2. From that line, side wall **20** is continued uninterruptedly from the curved bottom up to an angle of about 240°. On the other hand, the opposite side wall **21** rises vertically straight from line **22** and thus forms the longitudinal straight wall portion of the tank. A supply opening **23** is positioned in the straight side wall **21** at the supply end of the tank, and the discharge opening **24** is positioned against the discharge end wall **19** of the tank. The lower edges of openings **23** and **24** are at the same horizontal level. Supply chute **4** communicates with the conveyor **14** of the apparatus **12** and extends through supply opening **23**. Discharge chute **5** extends from the interior of the tank through the outlet opening **24**. In addition to the horizontal portion **9**, the bottom of the chute is continued into an upwardly inclined portion **25** and then into a slightly downwardly inclined portion **26** which passes through the outlet opening **24**. The chute has vertical side walls **27** and **28**. Attached to the bottom edge **29** of wall **28** is a panel **30** which is inclined toward the lowest point of the end wall **19**. A four-cornered spur-shaped member **6** is attached to the inclined bottom portion **25** and has its lower pointed end bearing against tank end wall **19** at the lowest point in the bottom. Thus the spur-shaped member is composed of four walls, the first wall **31** of which abuts and conforms in shape to the curve of the straight tank wall **21** and the bottom **17** and terminates in a point approximately at the center of the tank bottom, a second wall **7** is curved upwardly from that point to the horizontal bottom portion **9** of the chute, a third wall **19***a*, FIGURE 4, which is flat and abuts the discharge end **19** of the tank, and a fourth wall **32** which extends from the bottom point of the spur-shaped member to the edge **33** joining the horizontal tank bottom portion **9** and the inclined bottom portion **25**, this fourth wall **32** being vertically inclined in alignment with the panel **30**.

Tank **1** is carried on its supporting frame **34** through the medium of the rubber shear elements **3**. These elements are symmetrically distributed along the length of the tank and radially bear against the semi-circular bottom **17** directly beneath the line **22** so that the tank is elastically held on frame **34**. In turn, frame **34** is supported on the floor through the medium of elastic cushion members **35**.

The tank vibrating mechanism **2** is directly joined to the bottom **17** of tank **1**. This mechanism can be positioned either coaxially with or diagonally to the longitudinal axis of the tank either within or outside of the

center of gravity of the machine. The conveying apparatus **12** can have the sieve member **13** and the conveyor **14** inclined at different angles with respect to each other. This transport means is driven by a reciprocating motor **36**, FIGURE 2.

The pipe **10** is supplied with fluid by means of pipes **38**.

In operation, the tank **1** is first filled to the level of the dashed line **39**, FIGURE 2, with solid treating material, such as shot or chips. The vibrating mechanism **2** is then started so that its unbalanced shaft rotates clockwise as shown by the arrow in FIGURE 2. The speed of the vibrator motor is such as to create the vibration frequency of from about 2,000 to 3,000 vibrations per minute. The loose solid bodies of treating material in tank **1** are thus caused to rotate because of the chosen direction of rotation of the unbalanced shaft and because of the shape of the tank **1**. This rotation is such that the treating material particles move downwardly adjacent the straight wall **21** and upwardly along the curved side wall **20** as indicated by the arrow in FIGURE 2. Raw workpieces are now introduced adjacent the inlet end wall **18** and, if desired, by means of chute **4** extending through inlet opening **23**. The volume of workpieces supplied in a given unit of time depends upon the treatment time and holding capacity of the tank **1** as previously ascertained. Also, the reciprocating motor **36** is started and thus the transport means **12** is placed into operation and pipe **10** turned on to spray cleaning fluid into the tank contents. The workpieces move in a somewhat spiral-like path through tank **1** and are discharged from the tank through chute **5** at about the same volume per unit of time as they are introduced in the supply end and then are received on the transport means **12**.

The effect of the chute **4** and the spur-shaped member **6** is indicated in FIGURES 3 and 4. The tank contents have a spiral movement through the tank **1** as indicated by the arrow A, FIGURE 3, and toward the chute **5**. The tank contents are then directed by the spur-shaped member **6** in an upward direction and into the chute inlet opening **40** which extends between chute side wall **27**, wall **28**, panel **30** and horizontal bottom **9**. The spur-shaped member **6** has the effect in that such tank contents which are not immediately moved into inlet opening **40** are recycled toward the opening until they have entered the chute without obstructing the movement of the tank contents in the tank.

The workpieces are retained by sieve member **13** and removed through screen chute **16** while the treating material particles are transferred by conveyor **14** back to inlet supply chute **4**.

Having now described the means by which the objects of the invention are obtained.

We claim:

1. In a workpiece treating machine having a horizontal tank with a semi-cylindrical bottom and vertically extending side walls of equal height, elastic means for supporting said tank, vibrator means secured to said tank for agitating the contents in the tank, transporting means for supplying workpieces and treating material to one end of said tank, means for removing treated workpieces from the other end of the tank, and means for receiving the removed treating material and treated workpieces and for separating the workpieces and recycling the material to the tank, the improvement in which one side wall of said tank is curved as an uninterrupted continuation of said bottom, the opposite wall being straight and having a tank outlet opening positioned at the same level as said supply means, and said means for removing the material and treated workpieces comprising a discharge chute extending from the interior of said tank through the tank outlet opening.

2. In a machine as in claim **1**, said discharge chute having a horizontal bottom entrance portion below the tank outlet opening and connected to an inclined bottom

portion extending to the lower edge of the tank outlet portion.

3. In a machine as in claim 2, further comprising a spur-shaped member beneath the inclined bottom portion of said chute, said member having four walls, one wall of which abuts and conforms in shape to the curve of the straight tank wall and bottom tank wall and extends to a point approximately at the center of the tank bottom, a second wall of which is curved from said point to said horizontal bottom portion of said chute, a third wall of which is flat and abuts the discharge end of said tank, and a fourth wall of which extends from said point to an edge of the inclined bottom portion of said chute and lies at an angle to the third wall.

4. In a machine as in claim 3, said elastic means for supporting said tank comprising a frame, a plurality of rubber shear elements positioned along the length of said tank and directed substantially radially of the tank and bearing against the upper part of the semi-cylindrical bottom of the tank and said frame.

5. In a machine as in claim 4, further comprising elastic cushion members between said frame and the floor.

6. In a machine as in claim 5, said means for receiving the removed material and treated workpieces comprising transport means adjacent the outside of said opposite straight tank wall and at the same level as said supply means.

7. In a machine as in claim 6, said transport means further comprising an upper sieve member joined to a discharge chute for the removal of treated workpieces, and a lower conveyor for moving said material.

8. In a machine as in claim 7, further comprising pipe means mounted above said tank for supplying liquid to the entire longitudinal length of said tank, and drainage means for removing liquid from said tank and recycling filtered liquid to said pipe means.

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