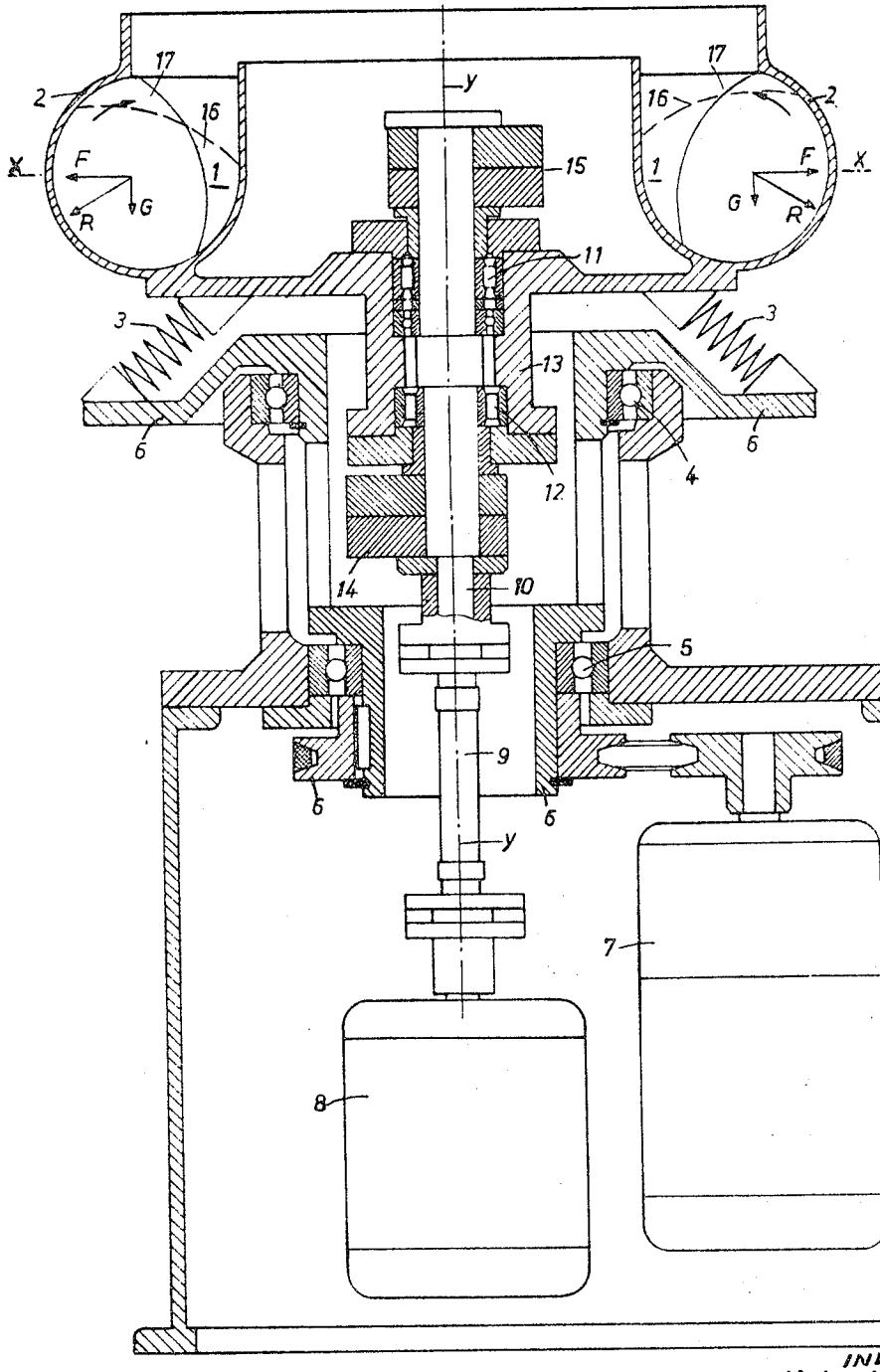
Sept. 2, 1969 H. PICK 3,464,674

VIBRATOR

Filed Jan. 19, 1968



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United States Patent Office 3,464,674 Patented Sept. 2, 1969

3,464,674

VIBRATOR

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Filed Jan. 19, 1968, Ser. No. 699,112
Claims priority, application Germany, Jan. 26, 1967, G 49,095/67
Int. Cl. B01f 13/08, 9/10
U.S. Cl. 259—72 6 Claims

ABSTRACT OF THE DISCLOSURE

A vibrator has an annular material receptacle that is resiliently supported in a substantially horizontal position and rotated about a substantially vertical axis, and an out-of-balance shaft that extends through the receptacle.

This invention relates generally to material handling devices and more particularly to an improved vibrator of the type known sometimes as a vibratory mill.

Prior art devices in the field to which this invention is directed were comprised of annular work receptacles having semi-circular or rectangular transverse cross sections. The receptacles were vibrated by one or more out of phase, unbalanced masses that were mounted on a drive shaft. The unbalanced masses were secured to the shaft at some distance to the plane of the horizontal center of gravity of the receptacle which was concentric with the axis of the shaft. Examples of this general type of prior art devices are U.S. Patents No. 2,882,024 and 3,100,088.

In this first form of the prior art, the material in the receptacle was driven along a path conforming to the shape of the receptacle and, in addition, was moved transversely to the annular path. Thus the material actually moved along a helical path that resulted from the combined movements described immediately above. The relative movements of the articles in the receptacle, in turn, resulted in the grinding or polishing thereof.

Another form of the prior art is described in German Patent No. 937,055 and French Patents Nos. 1,264,058 and 1,544,181. These structures used a combination of turning and swinging motions to agitate the receptacle grinding or polishing means, and where necessary, a fluid was used in the receptacle together with the work pieces.

One shortcoming of the prior art devices is that the receptacles could be moved at only a very limited rotational speed. The articles only partly filled the receptacle and formed a slanted surface layer. As the receptacle rotated, the articles near the top fell to the bottom and in this manner the material was circulated. Only a segment of the transverse area of the receptacle was utilized, however, and thus required a considerable length of time to complete a work cycle.

Accordingly it is an object of this invention to provide an improved vibrator for vibrating articles therein.

It is another object of this invention to provide an improved article vibrating device having a resiliently supported, rotary driven article receptacle and means to unbalance the receptacle as it rotates.

A further object of this invention is to provide a more compact arrangement of the above mentioned vibrating device.

A particular object of this invention is to provide means for imparting a combination of rotary and swinging motions to the articles contained in a vibrating device while at the same time altering the angular velocity of the articles.

By way of contrast to the prior art, the present invention broadly provides for an annular work piece receptacle that

has a substantially toroidal shape. In particular in one of the embodiments of the instant invention, the two lower quadrants and at least a portion of one of the upper quadrants of the receptacle are curved; the partially curved upper quadrant is provided with an upwardly extending outer wall section; and an inner wall section extends upwardly from the opposite, lower quadrant to define an entrance throat into tne receptacle.

The receptacle is supported from beneath on springs that extend towards the rotational axis of the receptacle. A hollow support member provides the mounting means for the lower ends of the springs, the upper ends of which are secured to the lower surface of the receptacle. Drive means are provided for rotating the support member about the axis of the receptacle. A motor driven shaft, having out-of-balance masses secured thereto, extends through the hollow support means and is rotatably journalled in the receptacle. Thus, when both motors are energized, the receptacle will rotate along an irregular path.

As the receptacle and the support member are driven, the articles in the receptacle are thrown outwardly due to centrifugal force. As the articles have a gravitational force of their own, however, which force is directed downwardly, the resultant force on the articles is directed downwardly and outwardly. The resultant force thus produced is somewhat smaller than the acceleration imparted to the articles due to the swiging motion of the receptacle and the net effect is periodically to alter the magnitude of the resultant force.

The magnitude of the centrifugal force depends on the rotational speed of the articles in the receptacle. The swinging motion of the receptacle which is added to the rotational motion of the receptacle causes a variation in the centrifugal force thus creating a loosening or aerating effect on the articles therein. The swinging motion occurs on a closed, curved path which coincides at times with the rotational movement of the articles and is, at other times, opposite thereto.

Because of the combined rotating and swinging motions that result from a resilient, rotary drive system, the movement of the articles within the receptacle occurs with a periodically changing angular velocity. During the acceleration and retardation of the articles there also occurs a multiplication of the movement of the articles with respect to each other and particularly a squeezing between, or compaction of, the parts which constantly changes in magnitude. The squeezing movement between the parts causes still additional movement of the articles. It will therefore be apparent that the combination of all of the article movements will greatly shorten the work cycle required to achieve the required finish in the articles.

Another feature of the construction of the receptacle is that the concave outer wall prevents the articles from being hurled out as the receptacle rotates. The curved cross sectional shape also serves to guide the articles into a revolving movement as a result of the swinging movement of the receptacle. Further, since the curved side walls act to retain the articles during rotation, the upper side of the receptacle may be left open, thus preventing the building of excessive internal pressures and facilitating the loading and unloading of the receptacle.

Turning now to the drive means for the receptacle, it will be seen that the resilient support therefor permits the addition or summation of the rotational and swinging movements of the receptacle. The resilient support is provided by a plurality of springs which are set at an angle to the rotational axis of the work support and thereby contributes to both the rotating and swinging action of the receptacle which is vibrated by means independent of the drive means for the support member.

A feature of this invention is that the entire device may be made very compactly by concentrically surrounding

the unbalanced shaft with the annular work piece receptacle. Another constructional feature of the invention is the provision of two out-of-balance masses that are out-of-phase with each other. The lower mass is placed below the horizontal plane of the center of gravity of the work piece receptacle and the upper mass is placed no lower than the horizontal plane of the center of gravity. The axes of the angularly positioned support springs intersect at a point that is no lower than the horizontal plane of the gravity and substantially coincidental with the rotational axis of the annular work piece receptacle.

The aforementioned construction transmits the rotary and swinging movement of the receptacle to the contents therein and the articles themselves move with a rotary movement in the cross section of the annular receptacle and a curvilinear movement along the annular receptacle. These two movements occur concurrently and in combination with the periodic change in the angular velocity of the articles in the receptacle.

The foregoing and other features, objects and advantages of the invention will, in part, be pointed out with particularity and will, in part, become obvious from the following, more detailed description of the invention, taken in conjunction with the accompanying drawing which forms an integral part thereof.

Referring now to the drawing, the single view of which is a sectional view taken along the longitudinal, rotational axis of the device, there is shown an annular work piece receptacle **1** that has a wall **2** which includes a concave outer wall, the largest diameter of which is designated as the horizontal plane *x*—*x*. Straight wall sections extend upwardly from the receptacle wall **2** to define a throat therebetween.

The receptacle **1** is supported by a plurality of springs **3** that are in a slanted position so that the spring axes intersect substantially at or above the horizontal plane *x*—*x* of the center of gravity. The point of intersection is substantially on the axis *y*—*y* of the annular work piece receptacle **1** at a location determined by the quantity of material in the receptacle.

The springs **3** are carried by abutments on a hollow support member **6** that is rotatably journalled about the axis *y*—*y* by means of bearings **4** and **5**. The support member **6** is driven by a motor **7**. Suitable means such as the pulley and belt system illustrated, couple the motor **7** to the support member **6**. Thus the drive torque of the motor **7** is transmitted to the work piece receptacle **1** through the support member **6** and the springs **3**, so that the receptacle **1** may be resiliently rotated.

An out-of-balance shaft **10** is journalled concentrically within the hollow support member **1**. The shaft **10** is driven through a flexible coupling **9** by a motor **8**. The shaft **10** is rotatably journalled in a downwardly extending portion **13** of the receptacle **1** by means of bearings **11** and **12**.

The out-of-balance shaft **10** has out-of-balance masses **14** and **15** secured thereto. The out-of-balance masses are axially spaced from each other on the shaft **10** and angularly out-of-phase with each other. The mass **14** is located at a distance below the horizontal plane of the center of gravity which coincides with the *x*—*x* plane. The mass **14** may also be positioned as high as the *x*—*x* plane. The mass **15**, on the other hand, is located substantially at the *x*—*x* center of gravity plane or may even be positioned higher than that.

When the out-of-balance shaft **10** is driven by the motor **8**, the work piece receptacle **1** is given a sawtooth oscillation in a well known manner. The rotation of the axis of the out-of-balance shaft **10** forces all points lying thereon to generate a cylindrical path obliquely about the surface of a theoretical hyperboloid. The surfaces follow a circular path in a region free from surfaces bordering the annular space and terminate along the broken line **16**.

The contents of the work piece receptacle **1** thereby carry out a rotary movement in the annular cross section in the direction of the arrow shown in the drawing. The contents of the receptacle also carry out a forward movement in the annular space. By a combination of these two movements, the contents of the receptacle **1** traverse a screw thread course.

Due to the varying movements of the articles in the work piece receptacle, in combination with the sawtooth oscillation of the receptacle, the parts in the receptacle move relative to each other. The accelerating and decelerating forces of the swinging motion also cause an intermixing of the articles in the receptacle **1**.

When the receptacle **1** is rotated by the motor **7** about the axis *y*—*y*, simultaneously with the rotation of the shaft **10** and the unbalanced masses **14** and **15**, then a centrifugal force F is produced on the articles in the receptacle. A gravitational force also acts on the articles which, in combination with the centrifugal force produces a resultant force R. The revolutions per minute of the work piece receptacle are proportional to the diameter of the annular receptacle **1** so that the resultant force R is smaller than the accelerating force produced by the swinging motion of the receptacle that periodically falls in a direction opposite to the direction of the resultant force R.

The centrifugal force F effects an increased compression of the articles in the receptacle **1** and therefore an increased mutual influence of the articles on each other. A loosening effect is also maintained by the respective relative movements of the articles, however, due to the limitation of the extent of the resulting force R.

The material in the receptacle acquires a volumetric form which proceeds in the area free from the receptacle wall along the line **17**. This results from the simultaneous swinging and rotary movements of the receptacle **1** and the maintenance of the screw thread course in the circular direction of the direction of the annular receptacle **1**.

A portion of the curved swinging motion is in the direction of the rotation of the receptacle, while the remaining portion of each cycle of curved swinging motion is opposite to the direction of receptacle rotation. As the swinging motion of the receptacle **1** occurs on closed, curved paths, there results from these opposed motions a receptacle rotation with periodically varying angular velocity. This change of angular direction of the receptacle further increases the intensive relative movements of the articles in the receptacle.

Due to the intensive relative movements and the periodic varying of the compression of the articles reresulting from increased centrifugal forces, the articles are subjected to an interaction among each other. Thus the work processes of grinding, mixing, kneading or surface working of the articles is possible in short work periods.

I wish it to be understood that I do not desire to be lmited to the exact details of construction shown and described, for obvious modifications will occur to a person skilled in the art.

Having thus described the invention, what I claim as new and desire to be secured by Letters Patent is as follows:

1. A vibrator, for use in vibrating material, comprising:

(a) an annular receptacle adapted to receive and to hold material to be vibrated;

(b) support means rotatably and resiliently driving and supporting said receptacle substantially horizontially; and

(c) a rotatable upright shaft having means applying an unbalanced force to said receptacle during the rotation thereof in such a manner that the resultant force applied to the material by the combined centrifugal and gravitational forces due to the rotation of the receptacle is smaller than the accelerating force of the swinging movement which periodically

falls in the direction opposite to that of said resultant force.

2. A vibrator in accordance with claim 1, wherein said receptacle has, in cross section, an arcuate outer wall, the largest diameter of which is substantially in the horizontal plane of the center of gravity of said receptacle.

3. A vibrator in accordance with claim 1, wherein said support means is a hollow, rotatable member having a plurality of springs extending upwardly therefrom and into engagement with the underside of said receptacle, the axes of said springs intersecting substantially coincidentally with the rotational axis of said receptacle and at a point at least as high as the horizontal plane of the center of gravity.

4. A vibrator in accordance with claim 1, wherein said means applying an unbalanced force is comprised of at least two masses secured to said upright shaft, said masses being axially spaced on said shaft and angularly off-set from each other.

5. A vibrator in accordance with claim 1, wherein said shaft is concentrically disposed within said support means and rotatably journalled within said receptacle.

6. A vibrator in accordance with claim 1, including a motor and means flexibly coupling said motor to said shaft.

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U.S. Cl. X.R.

51—163; 241—175; 259—1