United States Patent

Kobayashi

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[54] **VIBRATION GENERATING DEVICE FOR VIBRATORY MACHINE**

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Related U.S. Application Data

[62] Division of Ser. No. 787,534, Dec. 27, 1968, abandoned.

[30] **Foreign Application Priority Data**

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Apr. 20, 1968	Japan	43/32278
May 10, 1968	Japan	43/38696

[52] **U.S. Cl.** **310/81**

[51] **Int. Cl.** **H02k 7/06**

[58] **Field of Search** ....310/80, 81; 74/26, 61, 87; 759/DIG. 1, DIG. 42, DIG. 43

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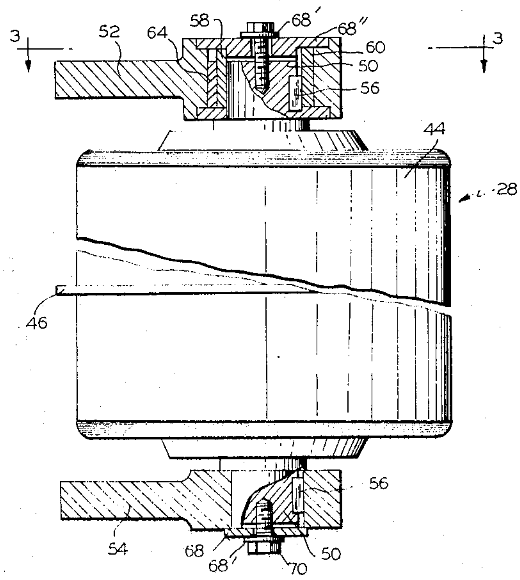
[57] **ABSTRACT**

A vibration generating device for a vibratory machine has a reversible electric motor with at least two eccentric weights on the opposite ends of the shaft thereof, the position of which is automatically changeable upon reversal of the direction of rotation of the motor. The weights act during rotation of the motor to cause the machine to effect different vibratory motion depending on the direction of rotation of the motor.

3 Claims, 8 Drawing Figures



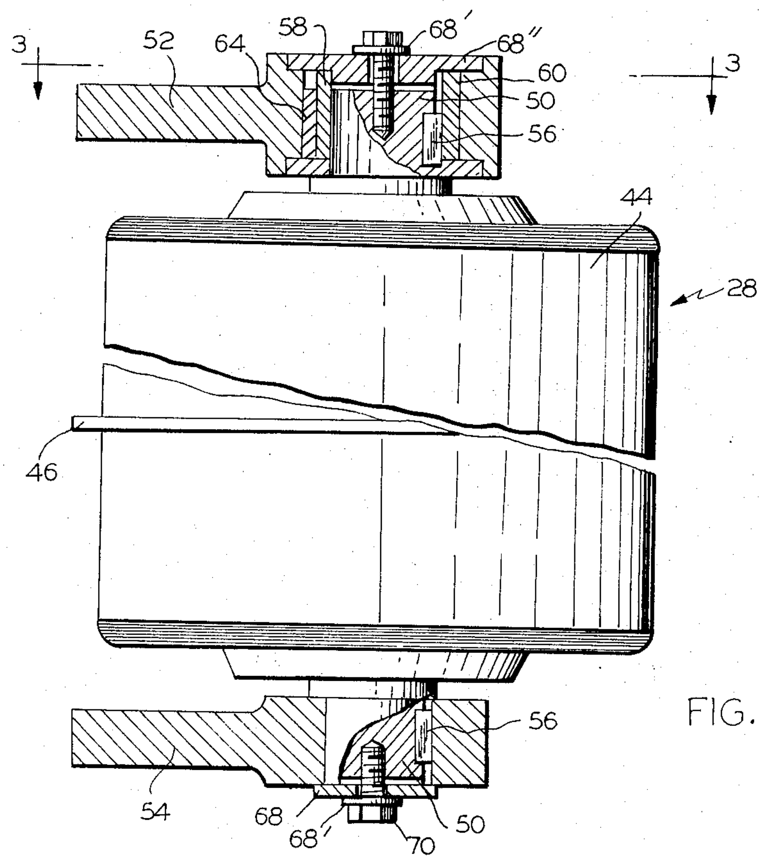


FIG. 1

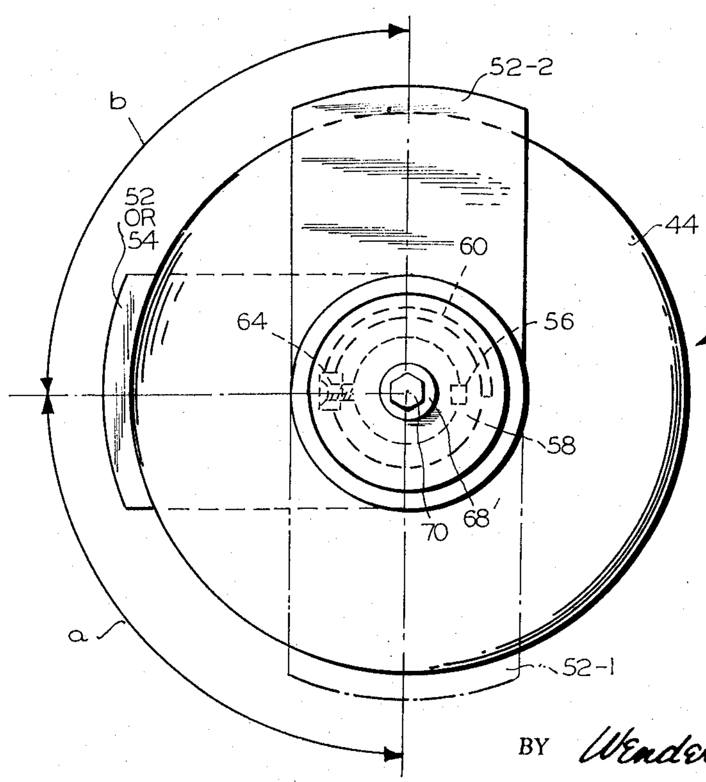


FIG. 2

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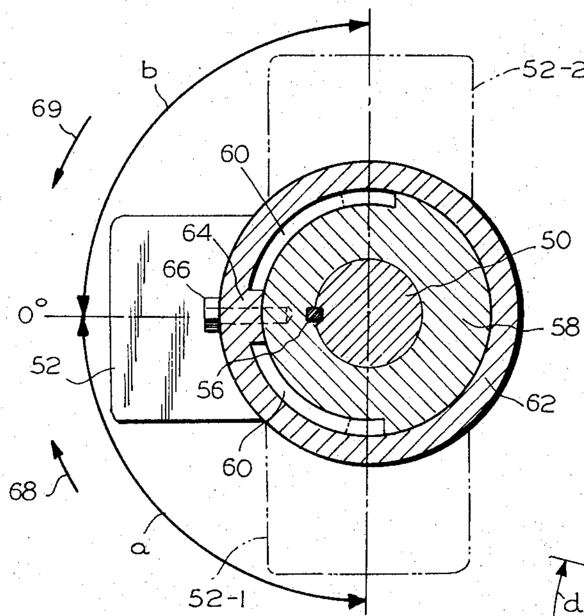

FIG. 3

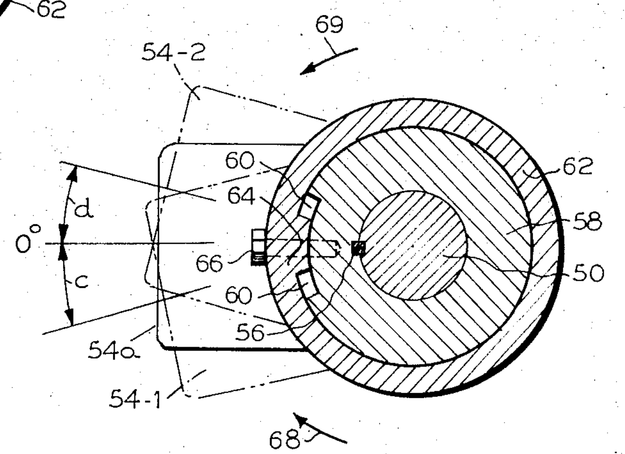

FIG. 4

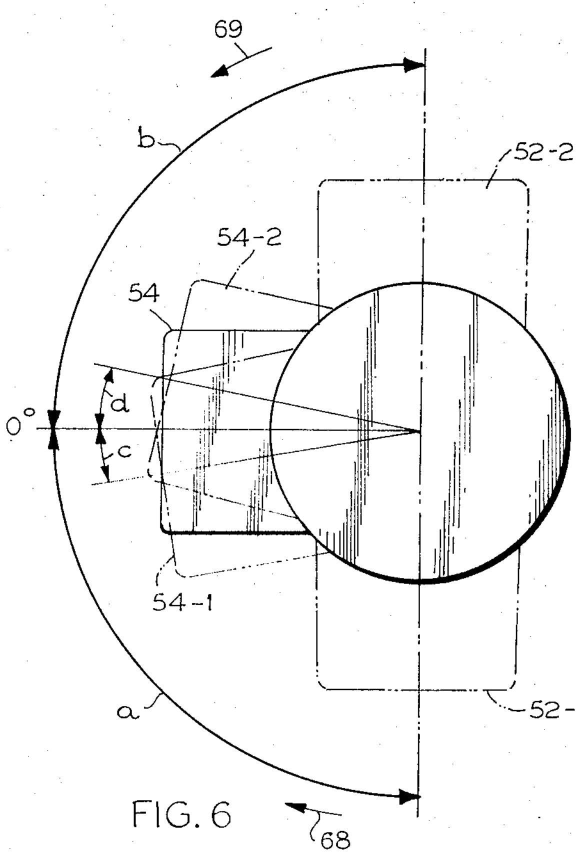

FIG. 6

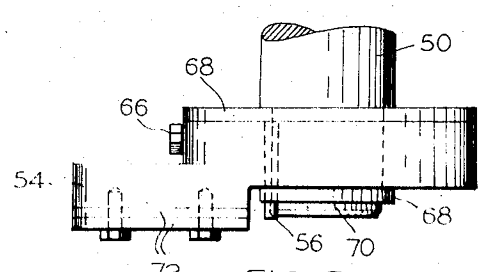

FIG. 5

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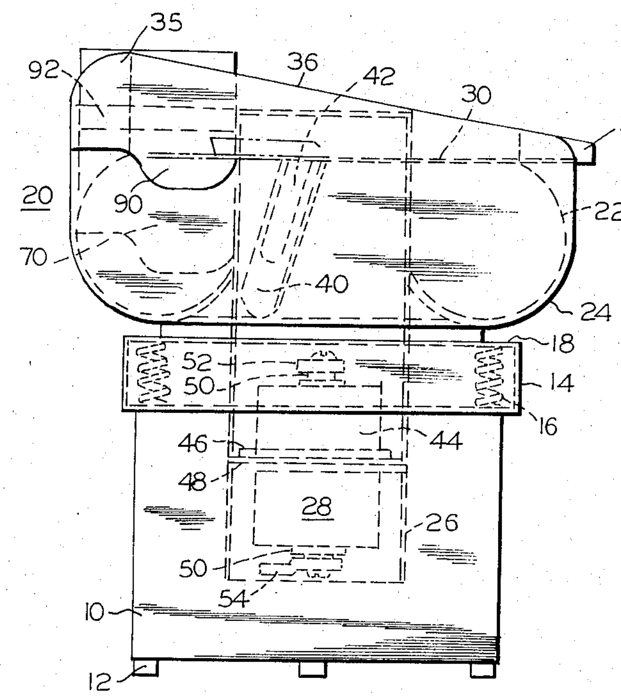

FIG. 7

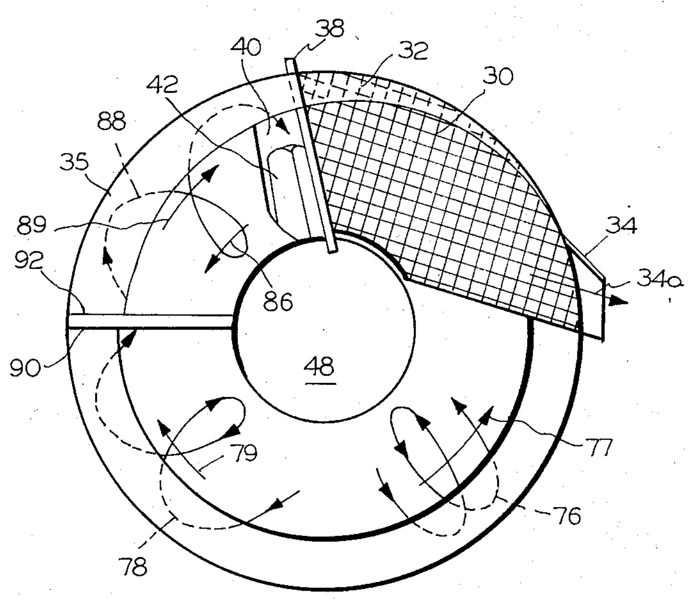

FIG. 8

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VIBRATION GENERATING DEVICE FOR VIBRATORY MACHINE

This application is a division of application Ser. No. 787,534, filed Dec. 27, 1968, now abandoned.

BACKGROUND OF THE INVENTION AND PRIOR ART

The present invention relates to a vibration generating device for a finishing machine or the like having automatically adjustable eccentric weights.

Vibratory machines of several different types having vertically or horizontally oriented motors are known in the art. In prior art finishing machines, the vibration generating device for said machines has a motor means with eccentric weights clamped on the shaft thereof. Any adjustment of the position of the eccentric weights is usually performed by hand and is a difficult and time-consuming process.

As is well known in the art, the production of linear motion and orbital motion in a mass confined in an annular chamber is dependent chiefly upon the relative positioning of eccentric weights on the shaft of the motor for producing such motion. It is sometimes desirable for the machine to have two kinds of vibration. For instance, different kinds of vibration are preferred in finishing and separation. Orbital motion of the mass is preferred for the finishing operation and progression of the mass linearly along the finishing chamber is preferred for the separating operation. Another instance in which different kinds of vibration are preferred is in grinding and polishing. In ordinary processing, workpieces are at first roughly finished and then polished. In prior art finishing machines, not only are two sets of machines necessary for the two kinds of work, but also auxiliary machines are necessary, that is a screening machine and transportation apparatus.

OBJECT AND BRIEF DESCRIPTION OF THE INVENTION

It is accordingly a primary object of the present invention to provide a vibration generating device wherein two kinds of vibration are provided automatically by reversal of the direction of motor rotation.

This object is achieved by the provision of a vibration generating device comprising a motor having at least one and preferably two automatically adjustable eccentric weights, preferably one on each end of the motor shaft. The position of at least one of said eccentric weights is changed automatically to predetermined phase angle depending on the direction of the rotation of said motor means.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be further described, by way of example only, with reference to the accompanying drawings in which:

FIG. **1** is a side elevational view of vibration generating device according to the invention, with parts illustrated in section and parts broken away;

FIG. **2** is a plan view of the device shown in FIG. **1**;

FIG. **3** is a fragmental sectional view taken on line **3—3** of FIG. **1**;

FIG. **4** is a view similar to FIG. **3**, illustrating an automatically changeable eccentric weight preferably to be mounted on the lower end of the motor shaft;

FIG. **5** is a fragmental side elevational view of the device shown in FIG. **4**;

FIG. **6** is a diagrammatic view for explaining the operation of the device shown in FIGS. **3** to **5**;

FIG. **7** is a side elevational view of a vibratory finishing apparatus having a vibration generating device according to the invention mounted therein; and

FIG. **8** is a plan view of the apparatus shown in FIG. **7** indicating the movement of the mass.

DETAILED DESCRIPTION OF THE DRAWINGS

Reference is now made to the accompanying drawings for a better understanding of the invention. The vibration generating device **28** will be described with reference to FIGS. **1** to **6**. The unit **28** comprises a reversible electric motor **44** having a mounting flange **46** rigidly secured to a vibratory machine. The motor **44** has an output shaft **50** projecting beyond each end of the motor housing. Each of the projecting end portions of the shaft **50** is stepped and is provided with at least one eccentric weight **52** or **54*a***. The eccentric weight **52** or **54*a*** is disposed on the motor shaft **50** so as to be rotatable about the axis thereof. To this end, an exchangeable sleeve **58** is keyed to the shaft end by a key **56** and said sleeve is provided with a circumferential groove **60** extending a predetermined distance around the periphery of the sleeve so as to subtend a predetermined angle, as shown in FIGS. **3** and **4**. The grooves can have a circumferential length equal to or different from each other. The eccentric weight **52** or **54*a*** is mounted on the associated sleeve **58** by having the hub **62** thereon rotatably fitted onto the sleeve and a control pawl **64** on the hub extending into the associated groove **60**.

Because the eccentric weights are rotatable with respect to the sleeve, when the motor is rotated in the direction of the arrow **68**, i.e., clockwise as viewed in FIGS. **3** and **4**, the inertia of the weights causes them to remain still while the shaft **50** and sleeve **58** turn within the hubs **62** until the ends of the grooves on the sleeves **58** engage the control pawls **64** to drive the weights. The respective weights take positions **52.1** and **54.1** respectively. This means that the weights lag by angles of "a" or "c" respectively with respect to the reference positions as shown in FIGS. **3** and **4**. In the same way, when the motor is rotated in the direction of the arrow **69** i.e. counterclockwise as viewed in FIGS. **3** and **4**, the weights lag by angles "b" or "d" respectively with respect to the reference positions. If desired, both the weights can be mounted on the shaft **50** for displacement about the axis thereof. That is, weight **52** can be mounted on the upper end of the shaft and weight **54*a*** can be mounted on the lower end of the shaft, in which case the difference between the angles of the two weights, i.e., angle (a–c), will be the relative displacement of the weights. Alternatively the upper weight can be movable and the lower weight can be fixed, as weights **52** and **54** shown in FIG. **1**. Either of the weights **52** or **54** can be fixed on the shaft **50**. In order to fix either one of the upper or lower eccentric weights **52** and **54** on the shaft **50**, the weight can be stepped and a set screw **66** extend through the upright portion thereof between the steps, as shown in FIG. **5**.

In order to prevent the weight from falling from the shaft, the same is preferably sandwiched between two washers **68** and **68'** and then secured on the shaft **50** by a set screw **70** as shown in FIG. **5**. Also as shown in FIG. **5** one or more additional weights **72** can be secured to the eccentric weight by screws in order to adjust its mass.

When the lower weight is rotatably disposed on the associated sleeve **60** as shown in FIG. **4**, while the upper weight is fixedly disposed, rotation of the motor **44** in direction of the arrow **68**, i.e., clockwise as viewed in FIGS. 3 and 4, will cause the upper weight **52** to remain at its position **52** as shown in FIG. **3** fixed with respect to the rotating motor shaft, while the lower weight **54a** will move to the position **54–1**, with the result that the upper weight **52** leads the lower weight **54** by an angle "c" as shown in FIG. **6**. When the motor is rotated in the direction of the arrow **69** or in the counterclockwise direction, the upper weight **52** remains at its position **52** as shown in FIG. 3, fixed to the rotating motor shaft, and the upper weight **52** will lead the lower weight **54a** by an angle "d" as shown in FIG. 6.

On the contrary, when the upper weight **52** is rotatably disposed on the associated sleeve **58**, as shown in FIGS. 1 and 3, while the lower weight **54** is fixed on the associated sleeve **60**, as shown in FIG. **1**, then the lower weight **54** remains at its position **54** as shown in FIG. **6** fixed with respect to the rotating motor shaft, and the lower weight **54** leads the upper weight **52** by angle of "a" or "b" depending on the direction of rotation of the motor. Alternatively, when both weights are rotatably mounted on the motor shaft, e.g., with upper weight **52** of FIG. 3 and lower weight **54a** of FIG. 4, the upper weight lags behind the lower weight "a–c" or "b–d", depending on the direction of rotation of the motor.

It is to be understood that the angle between the weights can be varied by changing the length of either groove **60**. To this end, the motor shaft can have stops thereon and either the upper or lower sleeve or both can have a circumferential groove having any desired length.

Referring now to FIGS. 7 and 8, as one example of its use the vibration generating unit **28** is mounted on a self-separating vibratory finishing apparatus. The finishing apparatus has a hollow pedestal **10** disposed on a foundation (not shown) on a plurality of short legs **12** of any suitable shock absorbing material such as rubber and fixed to the bottom thereof, and a cover **14** enclosing a plurality of helical springs **16** fixed at one end to the top of the pedestal **10** and disposed at substantially equal angular intervals around a central axis of said pedestal. A horizontal base flange **18** is rigidly secured to the other ends of the helical springs **16**.

Rigidly secured to the base flange **18** is a vibratory finishing trough **22** in the form of a toroid. A cylindrical housing **26** extends through the hollow central portion of the trough **22** and is sealed thereto, and extends through the base flange **18**. The said vibration generating device according to the invention is fixed to the lower end portion of the interior of the cylindrical housing **26**.

As shown in FIG. **8**, a sieve **30** is fixedly secured on the top face of the trough **22** so as to fully cover one portion thereof. At one edge of the sieve **30**, a rockable flap **40** is pivotally mounted on a rod **38**. The flap **40** has a horizontal position in which it can be fixed by any desirable means (not shown in the figure) and where it is inoperative, and a pendent position in which it be tilted at a predetermined angle to the horizontal and extends down into trough **22** where it is operative.

The vibration generating unit **28** is energized to forcedly vibrate the trough **22** to impart a motion to a mass **70** in the trough, which mass includes workpieces and abrasives. The vibratory motion has two components, one of which causes the mass to move in an orbital path as shown by the arrows **76** and the other of which causes the mass to progress linearly in a direction determined by the direction of rotation of the motor **44**.

As is well-known in the art, the production of linear motion and orbital motion in a mass confined in a chamber is dependent upon many factors including the center of mass of the suspended apparatus, the position of the motor, and especially on the relative placement of eccentric weights. By calculation and experiments, an optimum placement of eccentric weights can be obtained for carrying out a finishing and separation operation, when the dimension of the trough, weight and volume of the mass in the trough, position of the motor, shape and mass of the eccentric weights and speed of rotation of the motor are known. For finishing, the mass must be moved in an orbital path with slight linear motion which is opposite to the direction of rotation of the motor shaft as shown by arrows **76** and **77** in FIG. **8**. For separation, the mass must be moved linearly with a slight orbital motion as shown by arrows **78** and **88** in FIG. **8**. For example, in the embodiment shown in FIGS. 7 and 8, clockwise rotation of the motor shaft is used for the finishing operation, the advance angle of the upper weight being automatically adjusted so as to be 15° to 30° by the structure as described above, and the mass effects a helical motion **76** and is shifted in the direction of the arrow 77, i.e., counterclockwise as viewed in FIG. **8**. On the other hand, counterclockwise rotation of the motor shaft is used for the separating operation, the advance angle of the upper weight being automatically adjusted so as to be **70** to **105** degrees by the structure as described above and the mass effects a helical motion **78** and **88** and is shifted in the direction of the arrow **79**, i.e., clockwise. The progressing mass causes the flap **40** to be rotated downwardly from its horizontal position about the axis of the rod **38** when the flap is released by any suitable means (not shown). Then the stream of the mass exerts a dynamic force upon the pendent flap tending to cause it to sink smoothly into the flowing mass until the flap is stably engaged at its periphery against the internal surface of the wall of the trough **22**. Thus the flap **40** blocks the stream of the mass.

Under these circumstances the successive portions of the flowing mass pushing against the flap **40** forcedly ascend the flap and are transferred to the sieve **30** where the finished workpieces are separated from the abrasives and then delivered in the direction of the arrow **34a** through a delivery port **34** to the succeeding processing section (not shown). The abrasives fall through the sieve **30** into the trough **22**. A flash gate **90** is caused to descend into the trough **22** during the separating operation to aid the flap in giving the mass upward motion.

When the separating operation is finished, the motor is again reversed and the flash gate is lifted by any suitable means (not shown). Then, the direction of flow of the mass is also reversed and the mass pushes the flap **40** upwardly to its inoperative position. The flap is fixed at its horizontal position, unfinished workpieces are put in the trough and the finishing operation begins.

As can be seen from the above description, workpieces can be easily separated from the abrasives after completion of vibratory finishing and the finishing operation can be easily restarted after completion of the separating operation by using said vibration generating device and by reversing the motor.

Although the invention has been particularly described and illustrated with respect to its application to a self-separating vibratory finishing machine, numerous other applications requiring two kinds of vibration in a vibratory machine will be immediately apparent. For example, the same vibration generating device can be used for grinding mills and a finishing machine with a vertical or horizontal motor axis in which two kinds of vibrating conditions are necessary. In a finishing machine, fine polishing can be carried out after rough finishing in one machine by reversing the motor when the vibration generating device according to the present invention is used. Otherwise, two sets of machines, separating machines and transportation means are required.

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

What is claimed is:

1. A vibration generating device for vibrating a vibratory machine to give two kinds of vibratory motion to said machine, comprising a reversible motor means having a rotor, at least two stops on said rotor spaced from each other in a direction around said rotor, and a pair of eccentric weights on said rotor, at least one of said weights being movably mounted for free angular movement around the axis of rotation of said rotor between said stops, said one weight rotating due to its inertia when said rotor rotates in one direction until it abuts one stop and rotating due to its inertia when said rotor rotates in the other direction until it abuts the other stop, said stops being at positions which when said one weight is against the one stop it leads the other weight by a predetermined angle during rotation of the motor means in one direction of rotation and when said one weight is against the other stop it leads the other weight by a predetermined angle during rotation of the motor means in the other direction, whereby reversal of the direction of rotation of said motor means causes said one weight to move automatically from one stop to the other stop for switching of the vibratory motion in said vibratory machine.

2. A vibration generating device as claimed in claim **1** wherein the other eccentric weight is fixed to said rotor of said motor means and only the one eccentric weight is freely movably mounted on said rotor.

3. A vibration generating device as claimed in claim **1**, wherein both of said eccentric weights are freely movably mounted to said rotor and two further stops are provided on said rotor between which the other eccentric weight is movable, said further stops being spaced around the rotor a different distance from the firstmentioned stops whereby said weights are responsive to rotation of said motor means to move angularly through predetermined different angles about the axis of rotation of the rotor in each direction of rotation thereof.

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