

ROTARY VIBRATOR AND VIBRATORY CONVEYING APPARATUS USING THE SAME

[Technical Field]

[0001]

The present invention relates to a rotary vibrator and a vibratory conveying apparatus using this rotary vibrator and in particular to a driving mechanism of the rotary vibrator.

[Background Art]

[0002]

In general, in a vibratory conveying apparatus such as a bowl-type parts feeder equipped with a spiral track, there is used a rotary vibrator for tangentially vibrating a bowl-type conveyor. This rotary vibrator is provided with a vibration disc elastically supported on a base by a leaf spring, etc., and the vibration disc is given tangential vibration around the axis line by an electromagnetic driving body or a piezoelectric driving body. In recent years, there has been often found a structure in which a piezoelectric driving body supported on a base is connected to a vibration disc via an elastic member such as a leaf spring, thereby vibrating the vibration disc in the tangential direction by flexural vibration of the piezoelectric driving body.

[0003]

Rotary vibrators using the foregoing piezoelectric driving body include, for example, those described in Patent Documents 1 to 3 shown below. These rotary vibrators are structured in such a manner that a piezoelectric driving body fixed at the center on a base extends radially to the outer periphery side, the outer periphery part of the piezoelectric driving body is connected to an elastic member, and the elastic member is connected and fixed to the outer periphery part of the vibration disc. As described above, a horizontal-type rotary vibrator having a piezoelectric driving body which extends radially to the outer periphery side is advantageous in that a vibration disc can be vibrated efficiently in the tangential direction and the rotary vibrator can be constructed compact by reducing the height thereof.

[Prior Art Documents]

[Patent Documents]

[0004]

[Patent Document 1] Japanese Published Unexamined Patent Application No. S62-201710

[Patent Document 2] Japanese Published Unexamined Patent Application No. 2007-161454

[Patent Document 3] Japanese Published Unexamined Patent Application No. 2008-265967

[Summary of the Invention]

[Problem to be Solved by the Invention]

[0005]

Incidentally, recent years have seen a demand for conveying components at faster speeds. Under the circumstances, a piezoelectric driving body is increased in driving frequencies and also in amplitude, by which the piezoelectric driving body is subjected to greater driving loads to result in a problem of durability of the piezoelectric driving body. Further, the foregoing horizontal-type rotary vibrator is operated in a state that, for example, a bowl-type conveyor of a vibratory conveying apparatus is fixed on a vibration disc. In this instance, as described above, an increase in amplitude is required at high frequencies. Therefore, continuous operation of the rotary vibrator may result in a case where a clearance is found between the vibration disc and the conveyor or noises coming from between the vibration disc and the conveyor become greater.

[0006]

Therefore, the present invention is to solve the above problem, and an object of which is to provide a rotary vibrator higher in efficiency and greater in durability which is capable of responding to recent demands for conveying components at faster speeds.

[Means for Solving the Problem]

[0007]

In view of the above situation, the inventors of the present application have diligently conducted research to find the following problem. That is, in a rotary vibrator in which a piezoelectric driving body and an elastic member extend radially from the center of a base toward the outer periphery side thereof, a vibration disc is actually vibrated in the tangential direction by flexural deformation of the piezoelectric driving body. Therefore, a point at which a vibrating mechanism made up of the piezoelectric driving body and the elastic member is connected to the vibration disc is not an attempt to vibrate around the center of the base but an attempt to vibrate around a position deviated radially outwardly from the center of the base (for example, an intermediate position in the radial direction of the piezoelectric driving body). Thus, driving force is lost due to a difference between the vibration mode of the vibrating mechanism and that of the vibration disc. Further, every time reciprocating vibration takes place in the tangential direction, the piezoelectric driving body is subjected to tensile stress in the radial direction from the vibration disc and the vibration disc is subjected to compressive stress radially internally from the vibrating mechanism. Therefore, the piezoelectric driving body is reduced in durability by the above stress to result in breakage or the vibration disc is deformed by low rigidity of the vibration disc. Thereby, with the lapse of time, a clearance is developed on a face at which a conveyor is fixed to the vibration disc and noise is generated between the vibration disc and the conveyor.

[0008]

Therefore, in order to solve the above problem, the present invention is a rotary vibrator which is provided with a base, a vibration disc arranged over the base, a piezoelectric driving body having an inner periphery part directly or indirectly connected to the base and extending radially outwardly from the inner periphery part and an elastic member connected between an outer periphery part of the piezoelectric driving body and the vibration disc, wherein the piezoelectric driving body and the elastic member vibrate the vibration disc in a direction in which rotation is made around an axis line of the vibration disc, and wherein the elastic member is a plate-like member extending in the radial direction in a range from an inner periphery side connection part connected to the outer periphery part of the piezoelectric driving body to an outer periphery side connection part connected to the vibration disc, and also which has a tangentially bent shape, and wherein the outer periphery side connection part of the elastic member extends in the radial direction on an extension line of the piezoelectric driving body. According to the invention, the elastic member is a plate-like member having the shape of extending in the radial direction and bending in the tangential direction, by which the elastic member is able to easily expand and contract in the radial direction in such a manner that the tangentially bent shape is changed. Therefore, it is possible to reduce radial stress applied to the piezoelectric driving body and the vibration disc at the time of operation due to the fact that a central point of the vibrating mechanism in a vibration mode in the tangential direction is not in alignment with the center of the base and that of the vibration disc. Thus, the piezoelectric driving body is reduced in driving loads to be received, thus making it possible to improve the durability of the piezoelectric driving body and also suppress the deformation of the vibration disc.

[0009]

In this instance, since the outer periphery side connection part of the elastic member extends in the radial direction on an extension line of the piezoelectric driving body, it is possible to transmit the driving force generated by the piezoelectric driving body reliably and efficiently to the vibration disc in the tangential direction orthogonal to the radial direction.

[0010]

In one embodiment of the present invention, in the elastic member, both the inner periphery side connection part and the outer periphery side connection part extend in the radial direction and, between the inner periphery side connection part and the outer periphery side connection part, there is an intermediate bent part which extends in the radial direction, which bends to one side in the tangential direction, thereafter, which bends to a reverse side in the tangential direction, and again which extends in the radial direction. According to this embodiment, the inner periphery side connection part and the outer periphery side connection part extend in the radial direction, by which driving force generated in the piezoelectric driving body can be added accurately to the vibration disc in the tangential direction orthogonal to the radial direction and the vibration disc can be vibrated more efficiently. Further,

since the intermediate bent part is constituted in a simple shape which bends to one side in the tangential direction and thereafter bends to a reverse side in the tangential direction, it is possible to obtain expansion and contraction properties in the radial direction without substantial reduction in vibration transmission efficiency.

[0011]

In another embodiment of the present invention, the outer periphery part of the piezoelectric driving body and the inner periphery side connection part of the elastic member are fixed each other in a state of being overlaid in the tangential direction, and the outer periphery side connection part of the elastic member is arranged on the side of the piezoelectric driving body viewing in the tangential direction comparing with the inner periphery side connection part of the elastic member due to the fact that the elastic member is formed in a tangentially bent shape. According to this embodiment, positional deviation in the tangential direction resulting from the fact that the outer periphery part of the piezoelectric driving body is connected to the inner periphery side connection part of the elastic member in a state of being overlaid in the tangential direction is corrected in such a direction that the deviation is reduced by the bent shape of the elastic member. Therefore, an extending direction of the driving mechanism made up of the piezoelectric driving body and the elastic member as a whole can be set in such a manner that the deviation from the radial direction is small, thus making it possible to transmit driving force efficiently to the vibration disc.

[0012]

In still another embodiment of the present invention, the elastic member is provided with outer edges on the upper and lower ends constituted in a recessed curve shape respectively. According to this embodiment, the outer edges both on the upper and lower ends of the elastic member are constituted in a recessed curve shape, by which the elastic member can be increased in flexibility in a torsional direction, and stress applied to the outer edges on the upper and lower ends of the elastic member can also be dispersed in the radial direction along the curve due to the distribution of modulus of rigidity lower at a central part. Therefore, when the elastic member is vibrated in the tangential direction by flexural deformation of the piezoelectric driving body, even when a torsional stress is applied to the elastic member due to the center of gravity of the vibration disc being located on the upper side, the elastic member is deformed in the torsional direction as a whole, thus making it possible to receive the stress in a dispersed manner across the entire length of the elastic member in the radial direction. Therefore, it is possible to prevent damage resulting from local concentration of stress, for example, at a boundary site of the inner periphery side connection part of the elastic member fixed to the outer periphery part of the piezoelectric driving body or a boundary site of the outer periphery side connection part of the elastic member fixed to the vibration disc.

[0013]

In a different embodiment of the present invention, the inner periphery part of the piezoelectric driving body is fixed to the end of the inner periphery side of an

attaching/fixing member equipped with a fixed face region which is fixed on the base in contact therewith to extend in the radial direction. According to this embodiment, the fixed face region extending in the radial direction is fixed to the base in contact therewith, by which the attaching/fixing member can be attached to the base at a higher fixing strength. Further, the inner periphery part of the piezoelectric driving body is fixed to the end of the inner periphery side of the attaching/fixing member, thus making it possible to bring the inner periphery part of the piezoelectric driving body closer to the center of the vibration disc.

[0014]

Next, the vibratory conveying apparatus of the present invention is provided with the rotary vibrator described in any one of the above descriptions and a conveyor equipped with a spiral conveying path extending in the tangential direction, which is fixed on the vibration disc.

[Effects of the Invention]

[0015]

According to the present invention, realized are such excellent effects that provide a rotary vibrator higher in efficiency and greater in durability which is capable of responding to recent demands for conveying components at faster speeds.

[Brief Description of the Invention]

[0016]

Fig. 1 is a schematic sectional view showing an outer appearance of an embodiment of a rotary vibrator.

Fig. 2 is a schematic plan view showing a state in which a vibration disc of the embodiment is removed.

Fig. 3 is a longitudinal sectional view of the embodiment.

Fig. 4 is a side elevational view of the embodiment.

Fig. 5 is a plan view of a vibrating mechanism of the embodiment.

Fig. 6 shows a plan view (a) and a side elevational view (b) of an elastic member of the embodiment.

Fig. 7 is a side elevational view showing a vibratory conveying apparatus equipped with a rotary vibrator of the embodiment.

Fig. 8 is a plan view of the vibratory conveying apparatus shown in Fig. 5.

[Modes for Carrying Out the Invention]

[0017]

Next, a detailed description will be given of the embodiment of the present invention with reference to the attached drawings.

[0018]

[Rotary vibrator]

Fig. 1 is a schematic perspective view showing an outer appearance of the embodiment which is the rotary vibrator of the present invention. Fig. 2 is a schematic plan view showing a state in which the vibration disc of the rotary vibrator is removed. Fig. 3 is a longitudinal sectional view of the rotary vibrator (a cross sectional view taken along the line B-B in Fig. 2). Fig. 4 is a side elevational view of the rotary vibrator.

[0019]

A rotary vibrator 10 of the present embodiment is provided with a base 11, a circular-disk shaped vibration disc 12 supported over the base 11, and a vibrating mechanism 13 arranged between the base 11 and a vibration disc 12 to support the vibration disc 12 and also cause vibration in the tangential direction, in other words, in a direction in which rotation is made around an axis line 10x of the rotary vibrator 10 (also the axis line of the vibration disc 12). In the illustrated example, a plurality of vibrating mechanisms 13 are provided around the above axis line 10x (three vibrating mechanisms in the illustrated example). The plurality of vibrating mechanisms 13 are installed around the axis line 10x at intervals of an equal angle. It is noted that the base 11 is supported on an installation base 10a via a vibration isolation member 10b such as rubber or a spring.

[0020]

The vibrating mechanism 13 is as a whole formed in such a shape that extends in the radial direction around the axis line 10x. The vibrating mechanism 13 is provided with a plate-like piezoelectric driving body 14 extending in the radial direction from the inner periphery side to the outer periphery side and a plate-like elastic member (leaf spring) 15 connected and fixed to the piezoelectric driving body 14. An inner periphery part 14a of the piezoelectric driving body 14 is fixed to an upper face 11a of the base 11 via an attaching/fixing member 16.

[0021]

The attaching/fixing member 16 is provided with a fixed region 16s extending radially from the inner periphery side to the outer periphery side, and a bottom face of the fixed region 16s is fixed to the base 11 by appropriate fixing means such as a bolt 17 in a state of being in contact with an upper face 11a of the base 11. An inner periphery end 16a of the attaching/fixing member 16 projects laterally from the inner periphery part of the fixed region 16s, by which the attaching/fixing member 16 is formed in an L-shaped planar shape as a whole. The inner periphery end 16a is fixed to the inner periphery part 14a of the piezoelectric driving body 14. As illustrated in the drawing, the piezoelectric driving body 14 and the attaching/fixing member 16 are fixed by a spacer (washer) and a bolt. In this instance, a face on which the inner periphery end 16a and the inner periphery part 14a are fixed in contact with each other is given as a face toward the tangential direction orthogonal to the above-described radial direction.

[0022]

The piezoelectric driving body 14 is that in which a piezoelectric driving

element is adhered on the surface of an elastic metal plate such as a shim plate and available as a bimorph type in which a piezoelectric driving element is provided on both front and rear sides of an elastic metal plate and a unimorph type in which a piezoelectric driving element is provided only on one side. The piezoelectric driving body 14 is constituted in a plate shape as a whole and the width direction thereof is fundamentally in a vertical direction, in other words, a direction which is along a direction connecting the base 11 with the vibration disc 12. Thus, the piezoelectric driving body 14 is installed in a posture extending in the radial direction. It should be, however, noted that in order to convey components along a spiral track by using a bowl-type conveyor to be described later, the vibration disc 12 is required to be vibrated diagonally upward around the axis line 10x, and the width direction of the piezoelectric driving body 14 is not a perfectly perpendicular direction but inclined diagonally upward.

[0023]

The outer periphery part 14b of the piezoelectric driving body 14 is fixed to the inner periphery side connection part 15a of the elastic member 15. The outer periphery part 14b and the inner periphery side connection part 15a are fixed by a spacer (washer), a bolt, a nut, etc., in a state of being overlaid in the tangential direction. The outer periphery side connection part 15b of the elastic member 15 is fixed to a projection-like connected part 12a provided in a projecting manner below at the outer periphery part of the vibration disc 12 by using a spacer (washer), a bolt, etc. The connected part 12a is arranged so as not to be in contact with the interior of a recessed opening part 11b provided on an outer periphery wall of the base 11.

[0024]

The elastic member 15 is constituted with an integrally-made elastic metal material and formed in a plate shape as a whole. In this elastic member 15, both the inner periphery side connection part 15a connected to the outer periphery part 14b of the piezoelectric driving body 14 and the outer periphery side connection part 15b fixed to the vibration disc 12 assume such a posture that extends in the radial direction. Then, in the present embodiment, there is provided an intermediate bent part 15c between the inner periphery side connection part 15a and the outer periphery side connection part 15b. This intermediate bent part 15c is a part formed in a tangentially bent shape in a manner deviating from the radial direction. In the present embodiment, the elastic member 15 having the intermediate bent part 15c is used, by which the vibrating mechanism 13 is allowed to expand and contract easily in the radial direction.

[0025]

In the illustrated example, the intermediate bent part 15c is formed in an S-shape which extends in the radial direction, as it is, like the inner periphery side connection part 15a, which bends to one side in the tangential direction (in the clockwise direction in Fig. 2), thereafter, which bends to a reverse side in the tangential direction (in the counterclockwise direction in Fig. 2) and again which extends in the radial direction. As described above, both the inner periphery side

connection part 15a and the outer periphery side connection part 15b extend in the radial direction, by which driving force between the piezoelectric driving body 14 and the vibration disc 12 is transmitted in the tangential direction, thus making it possible to transmit the driving force of the piezoelectric driving body 14 efficiently to the vibration disc 12.

[0026]

In this instance, the elastic member 15 is not limited to the above-described bent shape but may include any bent shape, for example, an L-shape, a U-shape, a V-shape and a crank shape in a manner which allows the elastic member 15 to expand and contract in the radial direction by a change in the bent shape.

[0027]

The vibrating mechanism 13 made up of the piezoelectric driving body 14 and the elastic member 15 is in a posture facing in the tangential direction, when viewed above, and attached in an inclined posture having an inclination angle θ (refer to Fig. 4) with respect to the horizontal direction. In other words, a plate face of the piezoelectric driving body 14 and that of the elastic member 15 are in a posture facing diagonally upward in the tangential direction. The inclination angle θ allows a vibration direction S of the vibration disc 12 to face diagonally upward with respect to a horizontal tangential direction, and components on a conveyor to be described later are conveyed diagonally upward in the tangential direction along the vibration direction S by the vibration direction S. The inclination angle θ is usually in a range from 5 to 20 degrees but may be set appropriately depending on conveying characteristics to be required.

[0028]

Fig. 5 is a plan view of the vibrating mechanism 13 and the attaching/fixing member 16. On the base 11, the vibrating mechanism 13 made up of the piezoelectric driving body 14 and the elastic member 15 as well as the attaching/fixing member 16 extend parallel along the radial direction R (it is preferable that they are parallel but may not be parallel in a strict sense). An interval is provided between the vibrating mechanism 13 and the attaching/fixing member 16 depending on a projected amount of the inner periphery end 16a of the attaching/fixing member 16.

[0029]

The outer periphery part 14b of the piezoelectric driving body 14 and the inner periphery side connection part 15a of the elastic member 15 are fixed in a state of being overlaid in the tangential direction T. Therefore, the inner periphery side connection part 15a of the elastic member 15 is arranged at a position deviated in the illustrated counterclockwise direction with respect to the tangential direction T from an extension line 14y extending along the radial direction R from the piezoelectric driving body 14. It is noted that, in the illustrated example, the extension line 14y is a straight line passing through the axis line 10x and extending in the radial direction. On the other hand, the outer periphery side connection part 15b of the

elastic member 15 is arranged at a position deviated in the illustrated clockwise direction with respect to the tangential direction T from the inner periphery side connection part 15a by the intermediate bent part 15c, in other words, arranged at a position deviated to the piezoelectric driving body 14. As a result, in the illustrated example, the outer periphery side connection part 15b extends in the radial direction R on the extension line 14y of the piezoelectric driving body 14.

[0030]

As described above, a positional deviation in the tangential direction T resulting from the fact that the outer periphery part 14b of the piezoelectric driving body 14 and the inner periphery side connection part 15a of the elastic member 15 are fixed in a state of being overlaid in the tangential direction T is corrected by bending of the intermediate bent part 15c of the elastic member 15. Therefore, there is avoided a great deviation of the outer periphery side connection part 15b from the extension line 14y of the piezoelectric driving body 14. In the illustrated example, the outer periphery side connection part 15b is arranged on an extension line 14y. Since the driving mechanism 13 extends correctly in the radial direction R as a whole, it is possible to drive the vibration disc 12 efficiently in the tangential direction T.

[0031]

Fig. 6(a) is a plan view of the elastic member 15, and Fig. 6(b) is a side elevational view of the elastic member 15. In this instance, the above-described inner periphery side connection part 15a is constituted in a flat plate shape and formed with through holes 15t for inserting bolts. Further, the outer periphery side connection part 15b is also constituted in a flat plate shape and formed with through holes 15u for inserting bolts. Both the inner periphery side connection part 15a and the outer periphery side connection part 15b are constituted in a band shape extending in the width direction (vertical direction as illustrated). It is noted that, in the illustrated example, corresponding to the width of the outer periphery part 14b of the piezoelectric driving body 14 and the vertical width of the connected part 12a of the vibration disc 12, the inner periphery side connection part 15a is constituted so as to be wider than the outer periphery side connection part 15b.

[0032]

As described previously, the intermediate bent part 15c is formed in a tangentially bent shape. However, when viewed in the width direction, outer edges 15d, 15e on both sides in the width direction (both upper and lower sides as illustrated) are formed respectively in a recessed curve shape (recessed circular-arc shape), by which the intermediate bent part 15c is formed to be narrower than both the inner periphery side connection part 15a and the outer periphery side connection part 15b. Then, these outer edges 15d, 15e in a recessed curve shape provide such a constitution that the modulus of rigidity (shear modulus of elasticity) of the elastic member 15 in the radial direction is distributed to be smallest at the center in the radial direction and becomes gradually greater toward the inner periphery side connection part 15a and the outer periphery side connection part 15b.

[0033]

The above-described radial distribution of the modulus of rigidity is effective in that the elastic member 15 is able to avoid the concentration of stress in a torsional direction receivable from the piezoelectric driving body 14 and the vibration disc 12 at a boundary line 15ac between the inner periphery side connection part 15a and the intermediate bent part 15c (for example, a part in contact with the end edge of a spacer (washer) used in connecting and fixing the piezoelectric driving body 14) and at a boundary line 15bc between the outer periphery side connection part 15b and the intermediate bent part 15c (for example, a part in contact with the end edge of a spacer (washer) used in connecting and fixing the vibration disc 12). In this instance, the stress in the torsional direction will inevitably occur due to such a constitution that the center of gravity of the base 11, to which the vibrating mechanism 13 extending in the radial direction is fixed, is located on the lower side and the center of gravity of the vibration disc 12, which is driven by the vibrating mechanism 13, is located on the upper side.

[0034]

In other words, for example, where the elastic member 15 is constant in the radial width, upon receipt of the stress in the torsional direction, the stress may be concentrated at the boundary lines 15ac, 15bc to cause damage such as crack and wear at the ends of these boundary lines in the width direction. However, in the present embodiment, the elastic member 15 is constituted so as to be narrower in width at the intermediate bent part 15c with distance from the boundary lines 15ac, 15bc toward an intermediate position in the radial direction, resulting in reduction in modulus of rigidity. Thus, deformation amount resulting from the stress in the torsional direction increases with distance from the boundary lines 15ac, 15bc. As a result, the stress in the torsional direction can be received by deformation of the elastic member 15 overall in the radial direction, thereby defects such as damage resulting from concentration of the stress are less likely to occur. Further, the outer edges 15d, 15e of the elastic member 15 are formed in a recessed curve shape, by which the stress in the torsional direction is dispersed along the outer edges more favorably.

[0035]

It is noted that an intermediate portion of the intermediate bent part 15c is reduced in rigidity in the tangential direction by the outer edges 15d, 15e formed in the recessed curve shape. However, the reduction in rigidity is suppressed by a tangentially bent shape of the intermediate bent part 15c. Therefore, the present embodiment is advantageous in that effects of the outer edges formed in the recessed curve shape can be obtained while reduction in tangential rigidity of the elastic member 15 is suppressed.

[0036]

In the present embodiment, as described above, since the elastic member 15 is bent in the tangential direction, it is allowed to expand and contract easily in the

radial direction. Therefore, it is possible to absorb stress in the radial direction which occurs between the vibrating mechanism 13 and the vibration disc 12 due to the fact that the vibration mode of the vibrating mechanism 13 is not a reciprocating rotational movement around the axis line 10x.

[0037]

In other words, if the vibration mode at the outer periphery part of the vibrating mechanism 13 is a reciprocating rotational movement around the axis line 10x, the above stress does not occur. However, in reality, it is extremely difficult physically to arrange the inner periphery end of the vibrating mechanism 13 on the axis line 10x. Further, on the assumption that the inner periphery end is to be arranged on the axis line 10x, the above vibration mode is actually obtained by the piezoelectric driving body 14 generating flexural vibration. In many cases, a central point of the vibration mode is located at an intermediate position of the piezoelectric driving body in the radial direction. Therefore, in any case, the radius of the vibration mode of the outer periphery side connection part 15b of the elastic member 15 is shorter than a distance between the connected part 12a of the vibration disc 12 and the axis line 10x, and stress in the radial direction which occurs between the vibrating mechanism 13 and the vibration disc 12 increases with an increased amplitude of the elastic member 15 in the tangential direction.

[0038]

The above stress increases stress loads in the radial direction which are applied to the piezoelectric driving body 14, causing breakage of the piezoelectric driving body 14 and also decreasing the durability. Further, stress deformation is caused to the vibration disc 12, thereby deforming, for example, a supporting face 12s of the vibration disc 12 which supports and fixes a conveyor to be described later. Deformation of this supporting face 12s causes distortion of the conveyor, development of a clearance between the conveyor and the vibration disc 12 resulting in the reduction of vibration efficiency, and also noise increase from a place of contact between the conveyor and the vibration disc 12.

[0039]

In the present embodiment, the elastic member 15 is formed in a bent shape, thus making it possible to reduce the stress in the radial direction. It is, therefore, possible to decrease stress loads in the radial direction given to the piezoelectric driving body 14 and deformation of the vibration disc 12. Accordingly, it is possible to realize the breakage prevention, improved durability of the piezoelectric driving body 14, weight reduction of the vibration disc 12, prevention of noise, decreased distortion of the conveyor, and improved transmission efficiency of vibration from the vibration disc to the conveyor.

[0040]

Next, a description will be given of an embodiment of the vibratory conveying apparatus according to the present invention with reference to Fig. 7 and Fig. 8. Fig. 7 is a schematic side elevational view showing one example of the

vibratory conveying apparatus according to the present invention and Fig. 8 is a schematic plan view of the apparatus. A vibratory conveying apparatus 4 is a so-called bowl-type parts feeder and arranged on a supporting base 3 supported by interposing a vibration isolation member 2 such as a coil spring at a plurality of sites on an installation base 1. The above-described rotary vibrator 10 is installed on the supporting base 3 and a bowl-type conveyor 42 is fixed on the vibration disc 12 of the rotary vibrator 10. Inside the conveyor 42 which is formed in a reverse conical shape, there are formed a bottom 42a for accommodating components and a conveying path (track) 42b leading from the bottom 42a gradually upward in a spiral manner. This conveying path 42b is constituted so as to reach finally to an outer periphery upper part of the conveyor 42 and deliver at the leading end 42c thereof components to a conveying path 52a of a different vibratory conveying apparatus 5 separately arranged over the supporting base 3.

[0041]

The above-described different vibratory conveying apparatus 5 is a so-called linear-type parts feeder and provided with a vibrating mechanism 51 installed on the supporting base 3 and a conveyor 52 equipped with a linear conveying path 52a supported on the vibrating mechanism 51. Further, there is installed on the side of this vibratory conveying apparatus 5 a different vibratory conveying apparatus 6 having a conveyor 62 equipped with a linear collection path 62a on a vibrating mechanism similar to that described above. This vibratory conveying apparatus 6 receives defective components and other components which are not in a normal posture and removed from a component removing part provided in the middle of the conveying path 52a, among components conveyed along the conveying path 52a to the right side as illustrated, conveys them to the left side as illustrated, that is, in a direction reverse to the conveying path 52a inside a collection path 62a, and returns them to a component receiving part 42d inside the conveyor 42 of the vibratory conveying apparatus 4.

[0042]

In the vibratory conveying apparatus 4, the conveyor 42 is fixed on the vibration disc 12 of the rotary vibrator 10 by using a bolt 43, etc. Then, when the vibration disc 12 vibrates in the tangential direction as described above, the conveyor 42 vibrates in the tangential direction in synchronization with the vibration disc 12. At this time, in the present embodiment, stress which is applied to the vibration disc 12 in the radial direction is reduced. Similar results are obtained also in the conveyor 42, thereby preventing the conveyor 42 from being distorted. Further, where the supporting face 12s of the vibration disc 12 is deformed by the above stress, there may be possible development of a clearance between the vibration disc 12 and the conveyor 42, resulting in unwanted vibration or an increase in noise. In the present embodiment, deformation of the supporting face 12s can be suppressed leading to the reduction of unwanted vibration and noise.

[0043]

As a matter of course, the rotary vibrator and the vibratory conveying apparatus in the present invention shall not be limited to the above illustrated examples and may be modified in various ways within a scope not departing from the gist of the present invention. For example, in the above embodiment, the base 11 and the piezoelectric driving body 14 are indirectly connected and fixed via the attaching/fixing member 16, but the base 11 and the piezoelectric driving body 14 may be directly connected and fixed. Further, in the above embodiment, the piezoelectric driving body 14 and the elastic member 15 are directly connected and fixed but may be connected and fixed by interposing some members between them. Still further, in the above embodiment, the elastic member 15 and the vibration disc 12 are directly connected and fixed but may be connected and fixed by interposing some members between them.

[Description of Symbols]

[0044]

10: Rotary vibrator
10x: Axis line
11: Base
11a: Upper face
12: Vibration disc
12a: Connected part
12s: Supporting face
13: Vibrating mechanism
14: Piezoelectric driving body
14a: Inner periphery part
14b: Outer periphery part
14y: Extension line
15: Elastic member
15a: Inner periphery side connection part
15b: Outer periphery side connection part
15c: Intermediate bent part
15d, 15e: Outer edge
16: Attaching/fixing member
16a: Inner periphery end
16s: Fixed region
4: Vibratory conveying apparatus
42: Conveyor
42a: Conveying path

Claims

[Claim 1]

A rotary vibrator comprising:

a base;

a vibration disc arranged over the base;

a piezoelectric driving body having an inner periphery part directly or indirectly connected to the base and extending radially outwardly from the inner periphery part: and

an elastic member connected between an outer periphery part of the piezoelectric driving body and the vibration disc, wherein

the piezoelectric driving body and the elastic member vibrate the vibration disc in a direction in which rotation is made around an axis line of the vibration disc, and wherein

the elastic member is a plate-like member extending in the radial direction in a range from an inner periphery side connection part connected to the outer periphery part of the piezoelectric driving body to an outer periphery side connection part connected to the vibration disc, and which has a tangentially bent shape, and wherein

the outer periphery side connection part of the elastic member extends in the radial direction on an extension line of the piezoelectric driving body.

[Claim 2]

The rotary vibrator according to claim 1, wherein

Both of the inner periphery side connection part and the outer periphery side connection part extend in the radial direction, and the elastic member having an intermediate bent part between the inner periphery side connection part and the outer periphery side connection part, which extends in the radial direction, which bends to one side in the tangential direction, thereafter, which bends to a reverse side in the tangential direction, and again which extends in the radial direction.

[Claim 3]

The rotary vibrator according to claim 1 or claim 2, wherein

the outer periphery part of the piezoelectric driving body and the inner periphery side connection part of the elastic member are fixed each other in a state of being overlaid in the tangential direction, and the outer periphery side connection part of the elastic member is arranged on the side of the piezoelectric driving body viewing in the tangential direction comparing with the inner periphery side connection part of the elastic member due to the fact that the elastic member is formed in a tangentially bent shape.

[Claim 4]

The rotary vibrator according to claim 1 or claim 2, wherein
the elastic member having outer edges on the upper and lower ends which
are formed in a recessed curve shape respectively.

[Claim 5]

The rotary vibrator according to claim 1 or claim 2, wherein
the inner periphery part of the piezoelectric driving body is fixed to the end
of the inner periphery side of an attaching/fixing member equipped with a fixed face
region which is fixed on the base in contact therewith to extend in the radial
direction.

[Claim 6]

A vibratory conveying apparatus comprising:
the rotary vibrator according to the claim 1 or claim 2; and
a conveyor equipped with a spiral conveying path extending in the
tangential direction, which is fixed on the vibration disc.