

VIBRATORY PARTS-FEEDING APPARATUS

[Technical Field]

[0001]

The present invention relates to a vibratory parts-feeding apparatus in particular to a structure of the conveying apparatus which parts are conveyed along a spiral feeding path by rotational vibration around the axis line.

[Background Art]

[0002]

In general, with regard to a vibratory parts-feeding apparatus so-called “a parts feeder”, one type of the apparatuses is known that there is a bowl-type feed-vibrating body equipped with a spiral feeding path on its inner periphery face, and a large number of parts are stored on an inner bottom of the feed-vibrating body, and also a rotational vibration around the axis line is provided to the feed-vibrating body, consequently, the parts are gradually ordered while the parts are conveyed along the above spiral feeding path.

[0003]

With reference to this type of the parts-feeding apparatus, as shown in Fig. 10, it is necessary to fix the bowl-type feed-vibrating body 2 on a vibrational plate 1a of a rotational vibrator 1 which supplies with rotational vibration around the axis line. In the case of a small parts-feeding apparatus in order to convey a large number of tiny parts, as the first method of fixation, a through-hole 2a is formed vertically in the center of the bottom of the feed-vibrating body 2 formed as a single-piece product, and a bolt 3 is inserted through this through-hole 2a and is

screwed into the vibrational plate 1a of the rotational vibrator 1. Therefore, the center of the feed-vibrating body 2 is tightened and fixed to the vibrational plate 1a axially by this bolt 3.

[0004]

Further, in the case of a large parts-feeding apparatus so as to convey comparatively large parts, it is frequently used that a feed-vibrating body is equipped with a feeding path which is a spiral and belt-like metal plate connected to the inside of a cylindrical periphery wall formed by sheet-metal processing. When this feed-vibrating body uses, as the second method of fixation, a bottom of the above periphery wall of the feed-vibrating body is directly in close contact with an outer periphery portion of the vibrational plate from outside, and there are fixing portions in several places along a periphery where a tightened plate is attached to the bottom of this periphery wall and is radially tightened and fixed to the vibrational plate by bolts so that the fixing portions result in clamping the above bottom of the periphery wall. Thus, the feed-vibrating body is fixed to the vibrational plate (for example, refer to the following patent document 1).

[0005]

Furthermore, as the third method of fixation between the feed-vibrating body and the vibrational plate in the parts-feeding apparatus equipped with this large feed-vibrating body, there are also structures including a circular leg provided with the bottom of the feed-vibrating body and a mounting rib extending vertically from the vibrational plate. This circular leg engages with the outside of the mounting rib. In this condition, the circular leg and the mounting rib are directly tightened radially

and fixed each other by bolts inserted through the above circular leg and screwed into the above mounting rib (for instance, refer to the following patent document 2).

[0006]

Moreover, the fourth method of fixation is also known that an outer periphery flange expanding from an outer periphery portion of the vibrational plate is provided and also that a through-hole is obliquely formed in this outer periphery flange, and that an attaching block arranged on an outer periphery portion of the bottom of the feed-vibrating body placed on the vibrational plate, is tightened by a bolt inserted through the above through-hole and screwed, hence, that the attaching block axially presses down the bottom of the feed-vibrating body and firmly clasps the above outer periphery flange (e.g., refer to the following patent document 3).

[Prior Art Documents]

[Patent Documents]

[0007]

[Patent Document 1] Japanese Unexamined Patent Publication No.

H05-43030

[Patent Document 2] Japanese Examined Utility Model Publication No.

S37-3612

[Patent Document 3] Japanese Unexamined Utility Model Publication No.

H01-134614

[Patent Document 4] Japanese Patent Publication No. 4280291

[Summary of the Invention]

[Problem to be Solved by the Invention]

[0008]

However, in the above first method of fixation, since the outer periphery portion of the feed-vibrating body is not directly fixed to the outer periphery portion of the vibrational plate owing to the fact that the center of the bottom of the feed-vibrating body is merely tightened and fixed to the vibrational plate axially by the bolt, unnecessary vibration is generated in the outer periphery portion of the feed-vibrating body by the deformation of the feed-vibrating body and prevents from efficient parts-feeding and ordered parts-posture. As either the vibrational plate of the rotational vibrator or the feed-vibrating body fixed to the vibrational plate displaces relatively around the axis line with highly vibrational frequency due to the fact that the fixing force against the stress in a rotational direction is merely depending on the frictional force of the center of both the feed-vibrating body and the vibrational plate, some failures come about such as noise generation caused by wearing contact faces of both the feed-vibrating body and the vibrational plate, and fixing conditional change on account of scratches on the contact faces. Particularly, when the amplitude of the rotational vibration is increased by raising the driving voltage of piezoelectric drivers, some technical difficulties occur such as noise increase, inefficient parts-feeding by reason of parts-jumping generation, and disordering parts-posture.

[0009]

The above problems result from tightening and fixing force in the mere axis

line direction which affects the vibrational plate and the feed-vibrating body fixed each other near the axis line of rotational vibration. Therefore, the above problems do not resolve fundamentally although the tightening and fixing force increases. Further, another problem related to the difficulty of the feed-vibrating body lightning arises when the rigidity of the feed-vibrating body is enhanced in order to reduce the deformation. This feed-vibrating body lightning is an extremely significant problem when the frequency of rotational vibration increases so as to satisfy the recent demand for accelerating parts-feeding speed. In particular, in the case of small parts-feeding apparatuses, a rotational vibrator with piezoelectric drivers has become common in recent years. Thus, in the case of a heavy feed-vibrating body, some failures easily come about such as cost rise for improving stiffness of the piezoelectric drivers, and deteriorating durability of the piezoelectric drivers.

[0010]

On the other hand, in the second and third method of fixation, whereas the above problems do not occur provided that the outer periphery bottom of the feed-vibrating body is fixed to the vibrational plate, the rotational vibration cannot accurately transmit the feed-vibrating body by reason of shortage of axial fixing force and inadequately accurate fixation due to the fact that the feed-vibrating body is radially and directly tightened and fixed to the vibrational plate. Therefore, there is a problem that tiny electronic parts cannot convey efficiently and high-accurately. Additionally, since a feed-vibrating body using these methods of fixation tends to be connected to a metal plate by welding, unnecessary vibration is likely to arise resulting from that each portion of the metal plate vibrates in its thickness direction

when vibrational frequency increases so as to accelerate parts-feeding speed. Hence, there is a problem that the structure of the feed-vibrating body itself is also detrimental to the miniaturization of conveying parts and the acceleration of parts-feeding speed. Further, as it is necessary to construct that the feed-vibrating body and the vibrational plate are able to be directly fixed by a bolt, there are problems that the difficulties of processing and retaining the rigidity of the feed-vibrating body which is formed of a single-piece product forming article (including a machined article) provided with a highly precise shape in order to convey tiny electronic parts.

[0011]

Furthermore, in the fourth of method of fixation, since the feed-vibrating body is tightened and fixed to the vibrational plate axially, it is especially difficult to avoid displacing horizontally along a plane orthogonal to the axis line. Thus, in the same as the above, there is a problem that it is difficult to transmit rotational vibration efficiently and high-accurately. Further, as it is necessary to equip with the largely-expanding outer periphery flange around the vibrational plate, weight load relative to rotational vibration increases and it is difficult to downsize. In addition, since it is necessary to form an attaching portion equipped with an expanding face around the bottom of the feed-vibrating body, there is a problem that it is difficult to process and retain the rigidity of the feed-vibrating body formed of a single-piece product forming article (including a machined article) with a highly precise shape in order to convey tiny electronic parts apart from a feed-vibrating body formed by sheet-metal processing such as welding.

[0012]

Moreover, from the above second method to the fourth method of fixation, each of the feed-vibrating bodies is directly fixed to the vibrational plate radially or axially and is clasped by the tightening plate or the attaching block. In the case of several places to tighten and fix, it is impossible to detach the feed-vibrating body from the vibrational plate and to attach the feed-vibrating body to the vibrational plate without unscrewing and screwing all bolts at the all fixing places. Consequently, there is also a problem that installing and releasing operations are cumbersome.

[0013]

Therefore, in order to solve the above problems, the present invention is to realize a vibratory parts-feeding apparatus which is capable of high-accurately ordering parts-feeding of tiny parts and also is capable of easily accelerating parts-feeding so as to be able to transmit the rotational vibration generated in the rotational vibrator to the feed-vibrating body efficiently and high-accurately.

[Means for Solving the Problem]

[0014]

In view of the above situation, the present invention is a vibratory parts-feeding apparatus comprising a rotational vibrator including a vibrational plate vibrating around an axis line, and a feed-vibrating body disposed on said vibrational plate and equipped with a spiral feeding path around said axis line, wherein said feed-vibrating body has an inner bottom portion and an outer periphery portion which is circularly-constructed on a radial outside of said inner bottom portion and

which is equipped with said feeding path, and a bottom face which is disposed in contact with a surface of said vibrational plate is formed on a bottom of said outer periphery portion, and said outer periphery portion of said feed-vibrating body is fixed to an outer periphery portion of said vibrational plate in several angular positions around said axis line by clamping structures on the outside of said bottom face in said feed-vibrating body, and each of said clamping structures has a clamp member which is connected to one outer periphery portion of either said vibrational plate or said feed-vibrating body and which includes a clamp face, and has an inclined engaging face formed on the other outer periphery portion and axially engaged with said clamp face of said clamp member, and said inclined engaging faces of said clamping structures are inclined relative to said axis line direction, and face the opposite side of said one outer periphery portion, and are constructed to face in a different direction from each other on a plane orthogonal to said axis line among at least two of said clamping structures, and said clamp faces of said clamp members are pressed in contact with said inclined engaging faces so that said feed-vibrating body is fixed to said vibrational plate, and said clamping structures are positioned on three or more angular positions around said axis line, and said clamp members of three or more clamping structures are individually attached and fixed to said one outer periphery portion so that tightening and fixing force of said clamp members applied to said other outer periphery portion is adjustable, and said clamping structures are constructed to be able to attach said feed-vibrating body on said vibrational plate and to detach said feed-vibrating body from said vibrational plate when remaining clamping structures excluding at least one of said clamping

structures and being constructed to be able to detach from said other outer periphery portion are simply handled.

[0015]

According to this present invention, when said clamp faces of said clamp members engage with said inclined engaging faces, said outer periphery portion of said vibrational plate and said outer periphery portion of said feed-vibrating body which is disposed in close contact with said surface of said vibrational plate are fixed by said clamping structures. In this condition, as rotational vibration generated in said vibrational plate is directly transmitted to said outer periphery portion of said feed-vibrating body, deformation or distortion of portion up to said feeding path in said feed-vibrating body is reduced. As a result, it is possible to transmit said rotational vibration to parts efficiently and high-accurately. Additionally, since said inclined engaging faces which are constructed to face in a different direction from each other on a plane orthogonal to said axis line among at least two of said clamping structures and which are inclined relative to said axis line direction are in close contact with said clamp faces, it is possible to fix said feed-vibrating body axially and horizontally as well as fixing force imbalance between said axis line direction and a horizontal direction is reduced comparing with the conventional methods relying on a frictional fixing force in either said axis line direction or the horizontal direction. As a consequence, said rotational vibration is transmitted efficiently and high-accurately from said vibrational plate toward said feed-vibrating body. Thus, it is possible to order tiny parts high-accurately during parts-feeding and to accelerate parts-feeding speed. Moreover, said clamp faces of

said clamp members are merely pressed to inclined directions so as to be in close contact with said inclined engaging faces and said inclined engaging faces are constructed to face in a different direction from each other on a horizontal plane among at least two of said clamping structures. In this case, as it is possible to fix said feed-vibrating body to said vibrational plate, there is an additional advantage that installing and releasing works are able to be handled without handling at least one of said clamping structures, comparing with a conventional parts-feeding apparatus which it is necessary to handle all fixing portions in order to install and/or release due to the fact that said feed-vibrating body and said vibrational plate are directly fixed or clasped each other.

[0016]

In one embodiment of the present invention, said inclined engaging face of said clamping structures faces in a radial direction on a plane orthogonal to said axis line, and said clamp member of said clamping structures is radially movably attached on said one outer periphery portion. According to this, in the case of each of said clamping structures, said inclined engaging face is formed toward a radial direction and said clamp member is constructed to become radially movable. Hence, when said clamp member radially moves, it is possible to control a contact force between said clamp face and said inclined engaging face, and to easily attach said feed-vibrating body on said vibrational plate, and to easily detach said feed-vibrating body from said vibrational plate. Particularly, said feed-vibrating body is fixed to said vibrational plate in a state of said clamp face pressing on said inclined engaging face radially from the outside to the inside due to the fact that said

inclined engaging face is formed radially outward on the above plane orthogonal to said axis line. As a consequence, it is possible to simplify said clamping structures and to ease the installing and releasing works. For instance, in the following embodiments described below, said inclined engaging face is formed radially outward on the plane orthogonal to said axis line, and a bolt is screwed into threaded holes formed on said one outer periphery portion and said clamp member is attached and tightened radially inward relative to said one outer periphery portion so that said clamp face presses on said inclined engaging face and said feed-vibrating body is able to be fixed said vibrational plate. Further, one of said clamp members is merely radially moved so that a contact condition between said inclined engaging face and said clamp face is formed or released and it is possible to handle an installation and release of said feed-vibrating body.

[0017]

In another embodiment of the present invention, said clamping structures are provided on three angular positions around said axis line, and said clamp member of at least one of said clamping structures among three of said clamping structures which are disposed on said three angular positions, is radially movably attached on said one outer periphery portion, and said clamping structures are constructed to be able to attach said feed-vibrating body on said vibrational plate and to detach said feed-vibrating body from said vibrational plate when said clamp member of at least one of said clamping structures is radially moved without moving remaining two clamp members among three of said clamping structures. In this condition, the above remaining two clamp members may construct to be radially

movable or immovable.

[0018]

In still another embodiment of the present invention, an engaging claw is formed on said clamp member, wherein said engaging claw engages with said one outer periphery portion and is prevented from moving toward said other outer periphery portion. According to this, since said clamp member is prevented from moving toward said other outer periphery portion, said clamp member is able to be immovably prevented from axial displacement while said clamp faces engage with said inclined engaging faces and said feed-vibrating body is fixed to said vibrational plate. Thus, the fixing condition of said feed-vibrating body is able to be stable. This engaging claw, for example, is able to be formed so as to engage with a corner portion on the opposite side of said other outer periphery portion in said one outer periphery portion.

[0019]

In a different embodiment of the present invention, said inclined engaging face is constructed to face in a radial direction outward on a plane orthogonal to said axis line, and said clamp member is radially inward pressed onto said one outer periphery portion. According to this, it is possible to simplify an attaching structure of said clamp member to said one outer periphery portion and to ease installing and releasing works of said clamp member.

[0020]

In this case, it is preferable that each of said clamping structures further includes a bolts tightening said clamp member, a fixing hole formed in said clamp

member, through which said bolt is inserted, and a threaded hole formed in said one outer periphery portion of said vibrational plate, into which said bolt is screwed. According to this embodiment, despite a simple and inexpensive structure, it is possible to firmly tighten said clamp member. In addition to this embodiment, it is preferable that said bolt has a male thread portion and a cylindrical positioning axis portion formed on an axially different position from said male thread portion of said bolt, and said threaded hole has a female thread portion into which said male thread portion of said bolt is screwed, and a guide hole portion engaging with said cylindrical positioning axis portion of said bolt. According to this, owing to an engagement between said cylindrical positioning axis portion of said bolt and said guide hole portion of said threaded hole, it is possible to precisely position said bolt relative to said one outer periphery portion apart from threaded structures of both said bolt and said threaded hole. As said clamp member is precisely positioned on account of said precisely positioned bolt relative to said one outer periphery portion, said clamp member is immovably able to prevent from displacement while said feed-vibrating body is fixed to said vibrational plate due to the fact that said clamp face of said clamp member engages with said inclined engaging face. Consequently, the fixing condition of said feed-vibrating body is able to be stable.

[Effects of the Invention]

[0021]

According to the present invention, since said outer periphery portion of said feed-vibrating body is able to be firmly fixed to said outer periphery portion of said vibrational plate due to reducing displacement in either said axis line direction

or the horizontal direction, said rotational vibration is able to be efficiently and high-accurately transmitted from said vibrational plate to said feed-vibrating body. Therefore, realized are such excellent effects which are possible to high-accurately order tiny parts during parts-feeding and to accelerate parts-feeding speed.

[Brief Description of the Invention]

[0022]

Fig. 1 is a longitudinal sectional view omitted an internal structure of a parts-feeding apparatus of the first embodiment.

Fig. 2 shows a cross-sectional view (a), and a partial illustrative view (b) of a parts-feeding apparatus as well as partial illustrative views (c) and (d) showing other composition.

Fig. 3 is a front elevational view of a parts-feeding apparatus of the first embodiment.

Fig. 4 is an enlarged partial sectional view showing a clamp structure of a parts-feeding apparatus of the first embodiment.

Fig. 5 is an enlarged partial sectional view showing a clamp structure of a parts-feeding apparatus of the second embodiment.

Fig. 6 is an enlarged partial sectional view showing a clamp structure of a parts-feeding apparatus of the third embodiment.

Fig. 7 is a plane showing a state in which a vibrational plate of a rotational vibrator which is available for each embodiment is removed

Fig. 8 is a longitudinal sectional view of a rotational vibrator which is available for each embodiment.

Fig. 9 is a front elevational view of a rotational vibrator which is available for each embodiment.

Fig. 10 is a longitudinal sectional view omitted an internal structure of a parts-feeding apparatus of the prior art.

[Description of the preferred embodiments]

[0023]

Next, a detailed description will be given of the embodiment of the present invention with reference to the attached drawings. Firstly, a parts-feeding apparatus 10 of the first embodiment according to the present invention will be described with reference to Fig. 1 to Fig. 4.

[0024]

The parts-feeding apparatus 10 of the first embodiment is equipped with a rotational vibrator 11 and a feed-vibrating body 12 fixed on this rotational vibrator 11. The rotational vibrator 11 has a mounting plate 13, a base 15 supported via vibrational isolators 14 which consist of a rubber for a vibrational isolator (e.g. vibration-proof ring), a spring (e.g. a coil spring) or the like on this mounting plate 13, and a vibrational plate (i.e. a top plate, an upper plate) 16 installed on this base 15. An internal mechanism 17 (unillustrated in Fig. 1), installed inside the base 15, is positioned between the base 15 and the vibrational plate 16, and the vibrational plate 16 is horizontally supported on the base 15 via this internal mechanism 17.

[0025]

The internal mechanism 17, as shown in Fig. 7 and Fig. 8, is positioned along axis lines 22y extending radially centering on an axis line 10x, and has a

plurality of vibratory structures 20 equipped with series-connected structures which comprise plate-like piezoelectric drivers 22 and leaf springs 23. In illustrated example, three sets of the vibratory structures 20 are positioned equiangularly around the axis line 10x. These vibratory structures 20 provide the base 15 with rotational vibration around the axis line 10x due to being connected between the base 15 and the vibrational plate 16. The bottom faces of fixing portions 21s of fixing members 21 extending radially in parallel with the axis lines 22y are fixed in close contact with an inner surfaces 15a (the obliquely-upward face with an angle of slope θ described later) of the base 15. Inner ends of the piezoelectric drivers 22 are connected and fixed to inner ends 21a projecting from the ends of the above fixing portions 21s of these fixing members 21 rotationally around the axis line 10x.

[0026]

Each of the piezoelectric drivers 22 is not limited, however, has a laminated structure (i.e. an unimorph or a bimorph structure) of piezoelectric layer on one or both surfaces of an elastic plate. Each of the piezoelectric drivers 22, on the whole, extends radially along the axis lines 22y, and is also arranged so as to face obliquely-upward to one side of the rotational direction (i.e. in a counterclockwise direction in Fig. 7) with an angle of slope θ (refer to Fig. 9) relative to a vertical plane (i.e. a plane including both the axis line 10x and the axis line 22y). This angle of slope θ , generally set for 5-15 degrees, is provided appropriately according to parts-feeding behavior on a feeding path 12w in the feed-vibrating body 12. The leaf springs 23 are connected to outer ends of the piezoelectric drivers 22 respectively so as to extend radially and face obliquely

upward relative to the vertical plane at the same angle θ as well as the piezoelectric drivers 22.

[0027]

However, in this illustrated example, the leaf springs 23 bend to the other side of the rotational direction (i.e. to a clockwise direction in Fig. 7) on the way from an inner side to an outer side of the radial direction so that an outer end of the leaf springs 23 are disposed along the axis lines 22y extending radially. For this reason, the axis lines 22y of the piezoelectric drivers 22 are positioned on lines of the radial directions extending from the center of the axis line 10x to the outer ends of the leaf springs 23. Due to the flexural deformation of the piezoelectric drivers 22 generated by an applied voltage through an unillustrated path, operating trajectory of the outer ends of the leaf springs 23, which is provided when the outer ends of the leaf springs 23 supply vibrational plate 16 with the rotational vibration, can become an approximately circular arc shape around the axis line 10x. Thus, it is possible to be rotationally vibrated efficiently and high-accurately. In addition, both end edges in the across-the-width direction of the leaf springs 23 are formed in concave shapes, and the leaf springs 23 have constricted shapes in their middle portions respectively. This is for prevention of cracks in connected portions of the leaf springs 23 which are arranged on both sides of length direction owing to concentrating stress of twist direction in the middle portions of the leaf springs 23. This stress is produced by uneven distribution in across-the-width direction of load added by weight of the vibrational plate 16 and feed-vibrating body 12.

[0028]

Outer ends of the above vibratory structures 20 (that is, the outer ends of the leaf springs 23) are connected and fixed to connection portions 16a of the vibrational plate 16 in the form of projecting downwardly on outer periphery portions of the vibrational plate 16. The connection portions 16a, in this illustrated example, are positioned equiangularly at three angular positions corresponding to the above vibratory structures 20. Herein, depressed portions 15b are formed on outer periphery of the base 15 corresponding to the positions of the connection portions 16a, and each of the connection portions 16a protrudes into each of the depressed portions 15b. Therefore, the base 15 and the vibrational plate 16 are constructed to have no contact each other except areas where the internal structure 17 (the vibratory structures 20) intervenes between the base 15 and the vibrational plate 16.

[0029]

The vibrational plate 16 has a round shape on planar view, and its surface (upper surface) 16s thereof is constructed to be flat. The above feed-vibrating body 12 is disposed on this surface 16s of the vibrational plate 16. The feed-vibrating body 12 is, in a whole, a single-piece product forming article (including machined article) constructed of aluminum, aluminum alloy, stainless steel, or the like, having a bowl shape. The feed-vibrating body 12 has an inner bottom portion 12a with conically shaped an inner surface 12s and a circularly-constructed outer periphery portion 12b on a radial outside of this inner bottom portion 12a. An inner surface 12t of this outer periphery portion 12b has a slope face constructing an inverted cone

shape. On this inner surface 12t, a feeding path 12w (refer to Fig. 2) is formed into a spiral shape outward and upward gradually extending from the periphery (the lowest part) of the inner surface 12s of the inner bottom portion 12a. This illustration for detailed constructions of this feeding path 12w such as a cross-section shape or the like is omitted, for instance, a cross-section shape of the feeding path 12w is formed into a L-shaped groove on the inner surface 12t of the outer periphery portion 12b. A central hole 12g is formed on the center of the feed-vibrating body 12. The feed-vibrating body 12 is adjusted so as to obtain a rotational weight balance around this central hole 12g. The above periphery (lowest position) of the inner surface 12s of the inner bottom portion 12a is used as a storage for parts, then these stored parts are gradually conveyed upwardly on the above feeding path 12w when the rotational vibration is supplied to the feed-vibrating body 12. Whereas the spiral feeding path 12w is formed on the inner surface 12t of the outer periphery portion 12b in the present embodiment, it is also possible to form the spiral feeding path on an outer periphery inclined surface when an alternative storage for parts is formed on the outside of the feed-vibrating body 12 downwards.

[0030]

The inner bottom portion 12a is thinly formed in order to reduce the weight of the feed-vibrating body 12 by forming the opposite side of the inner surface 12s (bottom surface side) in concave. It is meaningful to reduce the weight of the feed-vibrating body 12 so as to accelerate the parts-feeding speed by high frequency of the rotational vibration at the feed-vibrating body 12. This is because efficient

vibration is produced when the feed-vibrating body 12 is driven by the rotational vibrator 11 near the resonance point and weight reduction of the feed-vibrating body 12 is demanded for increasing the resonant frequency. On the other hand, rigidity increase of the feeding-vibrating body 12 which results from the thickness of the outer periphery portion 12b enables parts to convey orderly and efficiently on the feeding path 12w. The rigidity of the outer periphery portion 12b is extremely significant for prevention of uncontrollable parts-jumping in the parts-feeding of the tiny parts. Provided that the feeding path 12 rotationally vibrates accurately in conjunction with the rotational vibration transmitted from the rotational vibrator 11, parts-posture is retained without uncontrollable parts-jumping and parts are conveyed smoothly and efficiently.

By comparison, parts come to jump uncontrollably and efficient parts-feeding become impossible when the rigidity of the outer periphery portion 12b is low, and then the feeding path 12w is vibrated in different modes from the above rotational vibration, and/or the above rotational vibration is absorbed before transmission to the feeding path 12w.

[0031]

The outer periphery portion 12b of the feed-vibrating body 12, depending on a cross section shape of the above inner surface 12t, has a cross section with radially thick bottom side and radially thin upper side as a whole. Additionally, a plain bottom face 12d (corresponding to the above outer placing surface) which is positioned on a portion projecting downward and is placed on and in close contact with the surface 16s of periphery portion of the above vibrational plate 16 is formed.

This bottom face 12d is formed into a circular ring shape around the axis line 10x and is in close contact with the surface 16s of periphery portion of the vibrational plate 16. In the present embodiment, the bottom face 12d provided in a bottom 12c of the feed-vibrating body 12 is merely formed in the outer periphery portion 12b and an area inside the bottom face 12d is not in contact with the vibrational plate 16 due to the fact that the bottom face 12d of the inner bottom 12a is formed into a concave shape. Thus, since rotational vibration of the vibrational plate 16 is merely transmitted to the outer periphery portion 12b of the feed-vibrating body 12 from the bottom face 12d provided in the periphery of the feed-vibrating body 12, the rotational vibration are efficiently transmitted to the feeding path 12w formed on the outer periphery portion 12b. Herein, in illustrated example, as an outer edge of the bottom 12c in the feed-vibrating body 12 expands to the outside of the periphery portion of the vibrational plate 16, an outer portion of the flat bottom face 12d is not in contact with the surface 16s of the vibrational plate 16. As described below, it is preferable that the whole flat bottom face 12d is in close contact with the surface 16s of the vibrational plate 16. However, this illustrated example indicates that, it is realized that the both periphery portions of the vibrational plate 16 and the feed-vibrating body 12 are fixed each other without any obstructions in order to use suitable clamp members 18 for dimensional changes of the feed-vibrating body 12 and the vibrational plate 16 despite the fact that the dimensional relations between the feed-vibrating body 12 and the vibrational plate 16 somewhat changes.

[0032]

As shown in Fig. 4, in an outer edge of the bottom 12c of the feed-vibrating body 12, namely, in a periphery of the bottom, a depressed groove 12e is formed. This depressed groove 12e includes a step part with an inclined engaging face 12f on the lower side (on the side of the vibration plate 16). These depressed groove 12e and inclined engaging face 12f in illustrated example are formed into a circular shape around the axis line 10x. For this reason, whereas any mounting positions of the feed-vibrating body 12 on the vibrational plate 16 are unlimited around the axis line 10x, the above depressed groove 12e and the inclined engaging face 12f may be simply formed on each angular position corresponding to each angular position of clamping structures described later unless it is necessary to mount the feed-vibrating body 12 on the vibrational plate 16 freely. In this case, the depressed groove 12e and the inclined engaging face 12f are formed into circular arc shapes centering on the axis line 10x in planar view, rotationally extending around the axis line 10x.

[0033]

The above inclined engaging face 12f is formed into a face which faces radially outward and also obliquely upward. That is to say, the inclined engaging face 12f slopes on basis of the direction of the axis line 10x, and faces an opposite side of the vibrational plate 16 as well as in an orthogonal plane to the axis line 10x (a horizontal plane), three portions of the inclined face 12f in three clamping structures are constructed so as to face to mutually different directions. In illustrated example, while each of the three portions of the inclined engaging face

12f in the three clamping structures faces radially outward on the above horizontal plane, radial outside portions of the three angular positions among the clamping structures face the mutually different directions on the horizontal plane. As a consequence, the directions of the three portions of the inclined engaging face 12f on the horizontal plane are different from one another. Herein, generally, slope directions of at least two portions of the inclined engaging face 12f on the horizontal plane may be merely different from each other.

[0034]

It is preferable that an angle of slope ϕ of the inclined engaging face 12f with respect to the horizontal plane is within 20-70 degree, more preferably within 30-60 degree. This angle of slope ϕ is an angle on the condition that the feed-vibrating body 12 is fixed on the vibrational plate 16, that is to say, on the condition that the three portions of the inclined engaging face 12f are in close contact with clamp faces 18d formed on clamp members 18. Consequently, a direction of fixing force exerted by clamping claws 18b is determined in spite of the fact that the angle of slope ϕ is an angle of slope of the clamp faces 18d in this above condition. Even when the angle of slope ϕ exceeds the above angular range, there are some advantages compared with conventional structures. In this case, the direction of this fixing force faces either an axis line direction (the direction to which the feed-vibrating body 12 is pressed on the vibrational plate 16) or a radial direction. Hence, either a horizontal component of the fixing force provided by the differences of the directions among a plurality of the clamping structures or an axial component of the fixing force provided by each of the clamping structures (thereof

the direction to which the feed-vibrating body 12 is pressed on the vibrational plate 16) becomes insufficient, if not tightening torque of each of the clamp members is prone to become enlarged excessively in order to avoid this insufficiency.

[0035]

In this case, the rotational vibration transmitted from the vibrational plate 16 to feed-vibrating body 12 obtains a vibrating direction of obliquely upward relative to the rotational direction around the axis line 10x due to acquisition of parts-feeding performance. For this reason, when either the horizontal component or the axial component of the fixing force is insufficient, the vibrational plate 16 and the feed-vibrating body 12 come to be easily disposed each other to either direction. Accordingly, the transmission efficiency of vibration amplitude to the feed-vibrating body 12 decreases, and the parts-feeding efficiency deteriorates. Furthermore, the above displacement brings about an unnecessary vibration mode and the increase of uncontrollable parts-jumping. Especially, when vibration frequency is increased in order to raise the parts-feeding speed in conventional structures, a fixing function resulted from a frictional force in orthogonal direction to each fixing direction (i.e., the axial line direction in a portion which is tightened and fixed radially, or in the horizontal direction in a portion which is tightened and fixed axially) cannot be expected. Therefore, transmission loss of the rotational vibration increases, and accelerating parts-feeding speed becomes difficult, as well as an unnecessary vibration mode is raised and parts-postures of conveying parts become unstable.

[0036]

Threaded holes 16b having an axis line extending radially and horizontally are formed on a periphery surface of the vibrational plate 16, and the clamp members 18 are tightened and fixed on the periphery surface of the vibrational plate 16 by bolts 19 screwed into the threaded holes 16b. These threaded holes 16b, the clamp members 18, and the bolts 19 together with the above depressed groove 12e (the step part) construct the clamping structures of the present invention. These clamping mechanisms are positioned in plural angular positions around the axis line 10x. Particularly, it is preferable to provide the clamping structures on three or more angular positions in order to fix firmly with respect to horizontal direction. In illustrated example, the clamping structures are equiangularly arranged in three angular positions around the axis line 10x.

[0037]

Each of the clamp members 18 has a fixing hole 18a which is constructed as a stepped hole structure so as to insert the above bolts 19, and this fixing hole 18a has a radial axis line and radially penetrates every clamp member 18. The fixing hole 18a has a step portion which faces radially outward and which is formed in the middle of the fixing hole 18a. When each head of the bolts 19 engages with the step portion of the fixing hole 18a and each of the bolts 19 is tightly screwed into the threaded holes 16b of the vibrational plate 16, the clamp faces 18d of the clamp members 18 are pressed on the three portions of the inclined engaging face 12f in the feed-vibrating body 12.

[0038]

A clamping claw 18b projecting radially inward is provided at the upper portion of each of the clamp members 18 (a portion arranged on the feed-vibrating body 12 side). A step portion is formed on each of the clamping claws 18b. This step portion comprises one of said clamp faces 18d which are in close contact with the inclined engaging face 12f of the above depressed groove 12e. The clamping claws 18b and the clamp faces 18d of the clamp members 18 are formed into an inverted circular arc shape centering on the axis line 10x extending rotationally around the axis line 10x in planar view so as to engage with said depressed groove 12e and said inclined engaging face 12f respectively.

[0039]

An engaging claw 18c projecting radially inward is provided at the lower portion of each of the clamp members 18 (a portion at the opposite side of the feed-vibrating body 12). This engaging claw 18c engages with a corner edge between a periphery surface and a bottom surface of the vibrational plate 16, and limits a position of the feed-vibrating body 12 side of the clamp members 18. More specifically, due to the fact that the engaging claws 18c of the clamp members 18 engage with the vibrational plate 16 while the clamp members 18 are pressed to the vibrational plate 16 side by the bolts, movements of clamp members 18 to the feed-vibrating body 12 side (upward in illustrated example) relative to the vibrational plate 16 are limited. Herein, in the present embodiment, the clamping structures are positioned in angular positions, apart from the connection portions 16a of the vibrational plate 16 projecting downward (in this illustrated example, a

portion on a bisector of an angle between the plural connection portions 16a arranged rotationally between adjacent connection portions 16a). Thus, the above engaging claws 18c are able to engage with a lower corner of the periphery surface of the vibrational plate 16 without any obstructions of the connection portions 16a.

[0040]

According to the above construction, the clamp members 18 are radially movably attached on the outer periphery portion of the vibrational plate 16 by the bolts 19. In consequence, the clamp members 18 are easily able to engage with and detach from the lower periphery edge of the feed-vibrating body 12, and tightening and fixing force applied to the feed-vibrating body 12 is adjustable. For instance, when the bolts 19 are inserted into the fixing holes 18a of the clamp members 18 and are screwed into the threaded holes 16b of the vibrational plate 16, it is possible to tighten the clamp members 18 with the bolts 19, to engage the clamping claws 18b of the clamp members 18 with the depressed groove 12e, and to make the clamp faces 18d be in close contact with the inclined engaging face 12f. In this case, space between the outer periphery portion of the vibrational plate 16 and the clamp members 18 is arranged in such a way that the feed-vibrating body 12 is immovably positioned being subjected to fixing forces radially inward and is firmly pressed on the vibrational plate 16 being subjected to fixing forces downward. These radial and downward fixing forces are generated by the pressure of the clamping claws 18b due to the fact that the clamping claws 18b press sufficiently on the depressed groove 12e. Herein, as pointed in illustrated example, it is preferable that an inner circumference faces of the clamp members 18 are constructed so as to

be in contact with the periphery surface of the vibrational plate 16 on this positioning condition in order to improve the attachment stability of this clamp structure.

[0041]

In this present embodiment, as shown in Fig. 2(a) and Fig. 2(b), all of the clamping structures formed in three positions have the same structures (rotationally symmetric structures). Then, these clamping structures are equiangularly positioned (in 120 degree intervals) around the axis line 10x. The clamp members 18 in clamping structures are constructed so as to be radially movable relative to the vibrational plate 16 by rotating the bolts 19. When one of the bolts 19 is loosened and one of the clamp members 18 in one of the clamping structures is radially moved, it is possible to detach the feed-vibrating body 12 from the vibrational plate 16 without handling the other two of the bolts 19 in the other two of the clamping structures. Further, with the condition that the screwing depth into the vibrational plate 16 is prospectively set in two of the clamping structures, when one of the bolts 19 is loosened in remaining one of the clamping structures, it is possible to fix the feed-vibrating body 12 on the vibrational plate 16 by placing the feed-vibrating body 12 on the vibrational plate 16 engaging the feed-vibrating body 12 with the clamping claws 18b of two of the clamp members 18 and clamping this one bolt 19 of this remaining one of the clamping structures. This is because the inclined engaging face 12f in each of the clamping structures is merely pressed by the clamp faces 18d in inclined directions, not fixing by using conventional structures such as directly tightening fixation structure and clasping fixation structure, therefore,

fixation of all clamping structures are able to be set and released by a simple work of selected one or more of the clamping structures. Generally, installation and release works are possible without moving at least one of the clamp structures 18 in the clamping structures. However, as the present embodiment indicates, it is easy to construct to be able to install and release by handling the mere one of the clamping structures without handling the remaining two or more of the clamping structures. Herein, in this case, it is unnecessary to handle the bolts 19 in remaining clamping structures other than selected clamping structure. Therefore, the clamp members 18 of one or more said remaining clamping structures may be mounted to be immovable (only attachable to fixed positions) with respect to the vibrational plate 16.

[0042]

In the present embodiment described above, the bottom 12c positioned on the outer periphery portion 12b of the feed-vibrating body 12 is disposed on the surface 16s in the outer periphery portion of the vibrational plate 16, and also the clamping claws 18b of the clamp members 18 engage with the depressed groove 12e formed in the bottom 12c of the feed-vibrating body 12, and then the feed-vibrating body 12 is fixed on the vibrational plate 16 by close contact between the inclined engaging face 12f and the clamp face 18d. Therefore, owing to the fact that the fixing force on the basis of clamping function not only presses the feed-vibrating body 12 to the vibrational plate 16 axially (vertically) but also applies radially inward, horizontal components of fixing force in three portions of the clamping structures are given in mutually different directions. For this reason, as the

feed-vibrating body 12 is horizontally and axially fixed, the rotational vibration of the vibrational plate 16 is able to be efficiently and accurately transmitted to the feed-vibrating body 12, furthermore, an unnecessary vibration mode is able to be prevented in the feed-vibrating body 12 and noise is reduced, compared with conventional structures which have depended on frictional force in either the horizontal direction or the axis line direction.

[0043]

In further detail of the parts-feeding apparatus 10 of the present embodiment, rotational vibration in oblique direction relative to the horizontal plane (a plane vertical to the axis line 10x) is generated by the rotational vibrator 11, and this rotational vibration is transmitted to the feed-vibrating body 12. As one of the conventional methods of fixation on periphery, in case of fixing the feed-vibrating body by tightening axially relative to the vibrational plate, whereas the axial (vertical) component of the rotational vibration is able to be efficiently transmitted, it is possible to produce horizontal displacement between the feed-vibrating body 12 and the vibrational plate 16. Hence, it is impossible to transmit the rotational vibration efficiently, it is difficult to accelerate parts-feeding speed, and it tends to generate parts-jumping and noise.

[0044]

On the contrary, in the clamping structures of the present embodiment, since the feed-vibrating body 12 is able to be firmly fixed horizontally and axially by a plurality of the clamping structures positioned in mutually different directions on the horizontal plane and also providing tightening forces in slope direction

relative to the axis line direction, the rotational vibration is able to be entirely and accurately transmitted from the vibrational plate 16 to the feed-vibrating body 12. Therefore, it is realized to convey parts efficiently especially in parts-feeding at high speed with high frequency, and it is possible to accelerate parts-feeding speed, to prevent parts-jumping, and to reduce noise. Moreover, as described above, each of the clamping structures simply presses onto oblique direction relative to the axis line in order that the clamp faces 18d are in close contact with the inclined engaging face 12f, and the feed-vibrating body 12 is fixed on the vibrational plate 16 due to providing a plurality of the clamping structures with plural portions of the inclined engaging face 12f set in mutually different directions on the horizontal plane. Thus, it has an advantage that installing and releasing work are easy compared with a conventional method of direct fixing radially or axially by screwed structure with the bolts. Specially, owing to the clamping structures for giving tightening stress to the feed-vibrating body 12 radially inward by the clamp members 18, the clamping structures become simple and installing and releasing work become easier. In addition, since fixing functions in the axis line direction and the horizontal direction are provided at the same positions, it is possible to suppress an unnecessary vibration mode generated on the feed-vibrating body 12. Furthermore, more flexibility is given to the design of fixing portion between the feed-vibrating body 12 and the vibrational plate 16 by using the clamp members 18, and that is makes easier to increase the rigidity of superficial neighborhood area of the feed-vibrating body 12 by using the inclined engaging face 12f, compared with forming a horizontal surface used in fixation to a direction along the axis line 10x. Therefore,

there are advantages to being capable of simplified clamping structures and sufficient rigidity of fixing portions as well as cost reduction for processing.

[0045]

On the other hand, compared the parts-feeding apparatus 10 of the present embodiment with the method of fixation as shown in Fig. 10, there are beneficial effects as follows. In respect of the method of fixation as shown in Fig. 10, since the central portion of a feed-vibrating body 2 is simply fixed by one bolt 3, rotational vibration transmitted from a vibrational plate 1a leads to distortion in the feed-vibrating body 2 and an unnecessary vibration mode is generated in a periphery of the feed-vibrating body 2. For this reason, some failures occur such as inefficient parts-feeding, uncontrollable parts-jumping during parts-feeding, and noise generation. Further, as the feed-vibrating body 2 is simply fixed by a frictional force on the center portion of the feed-vibrating body 2 in rotational direction relative to a vibrational plate 1a, vibrational components in rotational direction are easily absorbed in the fixing portion and transmission efficiency of vibration is significantly decreased on the condition of vibrational frequency increase. On the contrary, in the present embodiment, since outer placing surface (the bottom face 12d) placed on the surface 16s of the vibrational plate 16 is provided in the outer side of the bottom of the feed-vibrating body 12 and the outer periphery portion of the vibrational plate 16 is fixed on the outer periphery portion 12b of the feed-vibrating body 12 by the clamping structures, the rotational vibration is axially transmitted from the outer periphery portion of the vibrational plate 16 to the feeding path 12w formed on the outer periphery portion 12b of the

feed-vibrating body 12 including the bottom 12c which is in contact with the outer periphery portion of the vibrational plate 16. Therefore, vibration behavior of the feeding path 12w becomes close to that of the vibrational plate 16 and it is possible to transmit the rotational vibration from the vibrational plate 16 to the feed-vibrating body 12 efficiently and high-accurately. Hence, it is possible to convey the parts at high speed stably and to prevent shortage of parts-feeding performance for parts, uncontrollable parts-jumping on the feeding path 12w, and noise generation. Additionally, as the outer periphery portion of the vibrational plate 16 is fixed to the outer periphery portion 12b of the feed-vibrating body 12, it is capable of reduction in weight of an inner portion of the feed-vibrating body 12 and high speed parts-feeding becomes easier.

[0046]

Further, in the present embodiment, since the engaging claws 18c are provided in the clamp members 18 and these engaging claws 18c engage with a corner edge opposite side of the surface 16s in the vibrational plate 16, the movement of the clamp members 18 is limited to the feed-vibrating body 12 side relative to the vibrational plate 16. Therefore, it is possible to realize a firm and stable (reproducible) clamp condition using the clamp members 18.

[0047]

Furthermore, in the present embodiment, three sets of the vibratory structures 20 are equiangularly provided in the rotational direction in the rotational vibrator 11, and these vibratory structures 20 generate the rotational vibration driving the vibrational plate 16 at three positions equiangularly arranged in

rotational direction, and also the vibrational plate 16 and the feed-vibrating body 12 are fixed at the three positions equiangularly arranged in the rotational direction by the clamping structures. Thus, it is possible to spread equally stress of the clamping structures affected according to the rotational vibration and each of the clamping structures is able to receive its equal stress, and it is possible to stabilize a transmission condition of the rotational vibration.

[0048]

Next, the second embodiment relating to the present invention is described with reference to the Fig. 5. In this second embodiment, a clamping structure shown in Fig. 5 and its neighborhood construction are merely different from the above first embodiment. The other constructions of the second embodiment are the same as those of the first embodiment. For this reason, the explanation for the same other constructions is omitted.

[0049]

In the second embodiment, whereas it is identical to the first embodiment in attaching clamp members 18' by bolts 19' screwed into the threaded holes 16b formed on the outer periphery portion of the vibrational plate 16 and in fixing the outer periphery portion 12b of the feed-vibrating body 12 by clamping claws 18b' of the clamp members 18', the structure of the clamp members 18' itself is different. These clamp members 18' do not have the engaging claws 18c shown in the first embodiment. Therefore, the clamp members 18' are constructed so as to be attached on angular positions of the above connection portions 16a in the vibrational plate 16 as well as other angular positions.

[0050]

Moreover, in the second embodiment, guide hole portions 16b' (corresponding to the above guide portions in the first embodiment) which have cylindrical inner faces without female threads are formed on the aperture side areas in said threaded holes 16b, which are at different positions in the axis line directions relative to portions with the female thread. On the other hand, positioning axis portions 19c' (corresponding to the above positioning portions in the first embodiment) which have a cylindrical outer faces without male threads are formed in the bolts 19', on their heads 19b' side area which are at different positions in axis line direction relative to portions with male threads 19a' which meet the female threads of the threaded holes 16b. When the bolts 19' are screwed into the threaded holes 16b and the positioning axis portions 19c' are installed into the above the guide hole portions 16b', the bolts 19' and the vibrational plate 16 are determined each other with necessarily positioned accuracy. Further, whereas the positioning axis portions 19c' are inserted into fixing holes 18a' provided in the clamp members 18', in this case, the bolts 19' and the clamp members 18' are determined each other with necessarily positioned accuracy by the positioning axis portions 19c. Therefore, the clamp members 18' are axially retained with necessarily positional accuracy relative to the vibrational plate 16 via the above positioning axis portions 19c. As a consequence, due to the fact that it is possible to obtain easily the positional accuracy of the clamping claws 18b in an axis line direction relative to the depressed groove 12e, the feed-vibrating body 12 is able to be firmly and stably (reproducibly) fixed to the vibrational plate 16.

[0051]

Furthermore, in the second embodiment, since whole area of the bottom face 12d in the feed-vibrating body 12 is in contact with the surface 16s of the vibrational plate 16, the feed-vibrating body 12 is positioned on the vibrational plate 16 in a more stable condition. Then, for adapting to this placing structure, protruding length in an inner radial direction of the clamping claws 18b' in the clamp members 18' is extend so that the clamping claws 18b' reach to the depressed groove 12e of the feed-vibrating body 12. Nevertheless, as shown by dot-line in Fig. 5, a periphery edge of the bottom 12e in the feed-vibrating body 12 may expand outward beyond the vibrational plate 16 and may be formed so as to engage with clamping claws adapted thereto.

[0052]

Next, the third embodiment relating to the present invention is described with reference to the Fig. 6. In this third embodiment, a clamping structure shown in Fig. 6 and its neighborhood construction are merely different from the above first embodiment. The other constructions of the third embodiment are the same as those of the first embodiment. For this reason, the explanation for the same other constructions is omitted.

[0053]

In the third embodiment, a periphery edge of the bottom 12c of the feed-vibrating body 12 is expanded outward beyond the bottom face 12d placed on a vibrational plate 16', and the depressed groove 12e is formed thereon. Then, clamping claws 18b'' are provided on clamp members 18'' apart from the vibrational

plate 16' outward, adapting to shape of the periphery edge of the bottom 12c of the feed-vibrating body 12. In this way, the clamp members 18'' are formed by adapting to the shapes of the vibrational plate 16' and the feed-vibrating body 12 combined each other so that it is possible to deal with various sorts of combinations thereof easily. Herein, engaging claws 18c'' are formed on the clamp members 18'' in the third embodiment and these engaging claws 18c'' engage with a lower corner of the vibrational plate 16' as well as the first embodiment. Owing to the fact that these engaging claws 18c'' are provided on the clamp members 18'', it is possible to achieve a stably clamping condition even when the periphery edge of the feed-vibrating body 12 expands outward beyond the outer periphery surface of the vibrational plate 16.

[0054]

Incidentally, while in the above embodiment as shown in Fig. 2(b), the inclined engaging face 12f and the clamp faces 18d are formed along a rotational direction R around the axis line 10x on a horizontal plane, the inclined engaging face 12f and the clamp faces 18d may be formed so as to intersect with the rotational direction R as shown in Fig. 2(c) or Fig. 2(d). Here, the construction shown in Fig. 2(c) is an example which shows that the inclined engaging face 12f and the clamp faces 18d face to the axis line 10x on the horizontal plane but they are formed into a flat shape so that they intersect with the rotational direction R along an arch line. Furthermore, the construction shown in Fig. 2(d) is an example which shows that the inclined engaging face 12f and the clamp faces 18d face to different directions from the axis line 10x so that they intersect with the rotational direction R on the

horizontal plane (in illustrated example, these above faces are flat on the horizontal plane but they may have circular arc shapes). In these cases, in at least one of the plural clamping structures, when the inclined engaging face 12f and the clamp faces 18d are constructed so as to intersect with the above rotational direction R on the horizontal plane, the feed-vibrating body 12 is fixed to the vibrational plate 16 in close contact with at least inclined faces relative to the rotational direction R and it is possible to additionally increase the fixing force relative to the rotational direction R. Therefore, it is possible to improve the effects of the present invention. In this case, it is more preferable to construct intersecting conditions including an intersection angles or the like in the clamping structures in order that at least two clamping structures face mutually different directions relative to the rotational direction R. Whereas the above explanation indicates an example that the inclined engaging face 12f faces radially outward on the horizontal plane and the clamp face 18d faces radially inward on the horizontal plane, it is possible to construct that the inclined engaging face 12f faces radially inward and the clamp face 18d faces radially outward.

[0055]

Further, an inventor has conducted experiments that drive a conventional parts-feeding apparatus shown in Fig. 10 and the above parts-feeding apparatus 10 as shown in the first embodiment in the same vibrational frequency. In the experiments, it was confirmed that the parts-feeding apparatus 10 can achieve faster parts-feeding speed and more stable parts-posture comparing with the conventional apparatus as a whole. In particular, when the driving voltage for the piezoelectric

drivers 22 had increased and the amplitude of the rotational vibration had increased, the conventional parts-feeding apparatus obtained some failures such as noise increase, difficulty in parts-ordering on account of parts-jumping on the feeding path, and inefficient parts-feeding. In contrast, the parts-feeding apparatus in the present invention obtained little noise generation, no parts-jumping, and faster parts-feeding speed. Both of the parts-feeding apparatuses comparing with each other as mentioned above are small types for feeding tiny parts (e.g. Light Emitting Diode (LED) chips, etc), width, depth and height of which are 0.2-1.5 mm each. Furthermore, the parts-feeding apparatus 10 is able to accelerate the parts-feeding speed to approximate 1.5-2 times comparing with the conventional apparatus. Even when driving voltage of the parts-feeding apparatus 10 was lower than that of the conventional apparatus, the parts-feeding apparatus 10 obtained preferable parts-feeding speed.

[0056]

As a matter of course, the parts-feeding apparatus 10 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 each embodiment, the clamp members 18 are attached to the outer periphery portion of the vibration plate 16 by the bolts 19 or the like and the inclined engaging face 12f with which the clamp faces 18d of the clamp members 18 engages is formed on the outer periphery portion of the bottom 12c in the feed-vibrating body 12. In contrast to this, the clamp members 18 may be attached to the outer periphery portion of the bottom 12c in the feed-vibrating body

12 by the bolts 19 or the like and the inclined engaging face 12f with which the clamp faces 18 engages may be formed on the outer periphery portion of the vibrational plate 16. Moreover, whereas each of the portions in the inclined engaging face 12f faces radially outward on the horizontal plane in the above embodiment, at least two portions of the inclined engaging face 12f corresponding to the at least two clamp members 18 among the plural clamping structures may face in mutually different directions. Therefore, other portions of the inclined engaging face 12f may face radially inward or may face in other directions on the horizontal plane.

[Description of Symbols]

[0057]

10: Parts-feeding apparatus

10x, 22y: Axis line

11: Rotational vibrator

12: Feed-vibrating body

12a: Inner bottom portion

12b: Outer periphery portion

12c: Bottom

12d: Bottom face

12e: Depressed groove

12f: Inclined engaging face

12g: Central hole

12s, 12t: Inner surface

12w: Feeding path
13: Mounting plate
14: Vibrational isolator
15: Base
15a: Inner surface
15b: Depressed portion
16, 16': Vibrational plate
16a: Connection portion
16b: Threaded hole
16b': Guide hole portion
16s: Surface
17: Internal structure
18, 18', 18'': Clamp member
18a, 18a': Fixing hole
18b, 18b', 18b'': Clamping claw
18c, 18c'': Engaging claw
18d: clamp face
19, 19': Bolt
19a': Male thread
19b': Head
19c': Positioning axis portion
20: Vibratory structure
21: Fixing member

21a: Inner end

21s: Fixing portions

22: Piezoelectric driver

23: leaf spring

R: Rotational direction

Claims

WHAT IS CLAIMED IS

1. A vibratory parts-feeding apparatus comprising:
 - a rotational vibrator including a vibrational plate vibrating around an axis line,
 - and
 - a feed-vibrating body disposed on said vibrational plate and equipped with a spiral feeding path around said axis line, wherein
 - said feed-vibrating body has an inner bottom portion and an outer periphery portion which is circularly-constructed on a radial outside of said inner bottom portion and which is equipped with said feeding path, and a bottom face which is disposed in contact with a surface of said vibrational plate is formed on a bottom of said outer periphery portion, and said outer periphery portion of said feed-vibrating body is fixed to an outer periphery portion of said vibrational plate in several angular positions around said axis line by clamping structures on the outside of said bottom face in said feed-vibrating body, and
 - each of said clamping structures has a clamp member which is connected to one outer periphery portion of either said vibrational plate or said feed-vibrating body and which includes a clamp face, and has an inclined engaging face formed on the other outer periphery portion and axially engaged with said clamp face of said clamp member, and
 - said inclined engaging faces of said clamping structures are inclined relative to said axis line direction, and face the opposite side of said one outer periphery portion, and are constructed to face in a different direction from each other on a

plane orthogonal to said axis line among at least two of said clamping structures,
and

said clamp faces of said clamp members are pressed in contact with said
inclined engaging faces so that said feed-vibrating body is fixed to said vibrational
plate, and

said clamping structures are positioned on three or more angular positions
around said axis line, and said clamp members of three or more clamping structures
are individually attached and fixed to said one outer periphery portion so that
tightening and fixing force of said clamp members applied to said other outer
periphery portion is adjustable, and

said clamping structures are constructed to be able to attach said feed-vibrating
body on said vibrational plate and to detach said feed-vibrating body from said
vibrational plate when remaining clamping structures excluding at least one of said
clamping structures and being constructed to be able to detach from said other outer
periphery portion are simply handled.

2. The vibratory parts-feeding apparatus according to claim 1, wherein
said inclined engaging face of said clamping structures faces in a radial
direction on a plane orthogonal to said axis line, and said clamp member of said
clamping structures is radially movably attached on said one outer periphery portion.

3. The vibratory parts-feeding apparatus according to claim 1 or claim 2,
wherein

said clamping structures are provided on three angular positions around said axis line, and

said clamp member of at least one of said clamping structures among three of said clamping structures which are disposed on said three angular positions, is radially movably attached on said one outer periphery portion, and

said clamping structures are constructed to be able to attach said feed-vibrating body on said vibrational plate and to detach said feed-vibrating body from said vibrational plate when said clamp member of at least one of said clamping structures is radially moved without moving remaining two clamp members among three of said clamping structures.

4. The vibratory parts-feeding apparatus according to claim 1, further comprising:

an engaging claw formed on said clamp member, wherein

said engaging claw engages with said one outer periphery portion and is prevented from moving toward said other outer periphery portion.

5. The vibratory parts-feeding apparatus according to claim 1, wherein

said inclined engaging face is constructed to face in a radial direction outward on a plane orthogonal to said axis line, and said clamp member is radially inward pressed onto said one outer periphery portion.

6. The vibratory parts-feeding apparatus according to claim 5, wherein

each of said clamping structures further includes;
a bolts tightening said clamp member,
a fixing hole formed in said clamp member, through which said bolt is inserted,
and
a threaded hole formed in said one outer periphery portion of said vibrational
plate, into which said bolt is screwed.

7. The vibratory parts-feeding apparatus according to claim 6, wherein
said bolt has a male thread portion and a cylindrical positioning axis portion
formed on an axially different position from said male thread portion of said bolt,
and
said threaded hole has a female thread portion into which said male thread
portion of said bolt is screwed, and a guide hole portion engaging with said
cylindrical positioning axis portion of said bolt.