

Specification

VIBRATORY TRANSPORTING APPARATUS

[Technical Field]

[0001]

The present invention relates to a vibratory transporting apparatus and in particular to a system constitution favorably used as a part feeder for carrying components by the vibration of a carrier.

[Background Art]

[0002]

In general, a vibratory transporting apparatus is constituted in such a manner that electromagnetic or piezoelectric vibrating bodies are coupled between a supporting body and a carrier installed over the supporting body to vibrate the carrier back and forth when viewed in the carrying direction, thereby allowing various types of components such as electronic devices to move in the carrying direction.

[0003]

For example, as shown below in Patent Document 1, the above-described conventional vibratory transporting apparatus is constituted in such a manner that vibrating bodies including a piezoelectric body and a resilient spring are coupled before and after at two sites of a carrier and these vibrating bodies are vibrated diagonally upward forward in the carrying direction, thereby guiding a component arranged on the carrier into the carrying direction.

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[Disclosure of the Invention]

[Problem to be Solved by the Invention]

[0004]

However, in the above-described vibratory transporting apparatus, a plurality of vibrating bodies arranged along the carrying direction must be synchronized for motions to drive a carrier, where the vibrating bodies are driven by a piezoelectric body. Thus, there is a problem that, since the vibrating bodies are required for adjustment of motions between them and not efficiently driven due to mutual actions resulting from these vibrating bodies, it is impossible to improve the carriage performance at a higher level while reducing electric power consumption.

[0005]

Therefore, the present invention has been made for solving the above problem, and an object of which is to provide a vibratory transporting apparatus which is free of adjustment of motions between vibrating bodies and capable of realizing an efficient carriage aspect.

[Means for Solving the Problem]

[0006]

In view of the above circumstances, the vibratory transporting apparatus of the present invention is a vibratory transporting apparatus comprising a supporting body (1, 1', 7) and a carrier (2, 2') arranged over the supporting body via a vibrating body (3, 4, 5, 6), wherein the vibrating body includes a piezoelectric body (3), a first resilient body (4), and a second resilient body (5), and the piezoelectric body whose upper end is connected to a supporting site (1a') of the supporting body extends downward from the supporting site, and the first resilient body is connected to the lower end of the piezoelectric body, extends upward at the rear of the piezoelectric body in a carrying direction, and is coupled with the carrier at a first position (2a'), and the second resilient body directly connects the carrier and the supporting body at a second position (2b', 1b') forward from the first position in the carrying direction, and the vibrating body is designed so that a coupling portion (6) of the piezoelectric body and the first resilient body acts as a free end, and the coupling portion is a spacer (6) made thick in the carrying direction, by which there is provided a clearance (D) in the carrying direction between the lower end of the piezoelectric body and the lower end of the first resilient body, and a driving unit constructed of the piezoelectric body, the coupling portion, and the first resilient body is formed of a U-letter shape as a whole.

[0007]

According to the present invention, the piezoelectric body is subjected to deflecting deformation, with the supporting site kept at the center, by which the coupling portion of the piezoelectric body with the first resilient body constituted as a free end is moved rotationally back and forth in the carrying direction and a rear part of the carrier resiliently supported along the carrying direction by the first resilient body and the second resilient body is swayed up and down or back and forth, thus making it possible to carry efficiently a component on the carrier. Therefore, no vibrating body is required to be arranged in plurality along the carrying direction, by which no adjustment of motions is required between the vibrating bodies to reduce production costs and also improve the efficiency of

motions. It is, thus, possible to improve the carriage performance at a higher level, while reducing electric power consumption. Furthermore, the piezoelectric body and the first resilient body can be effortlessly connected due to the fact that the spacer is used as the coupling portion and is situated between the piezoelectric body and the first resilient body. Moreover, the piezoelectric body and the first resilient body can achieve their deformation behaviors without any obstructions, respectively owing to the fact that the spacer prevents the piezoelectric body and the first resilient body from interfering each other. Additionally, the sway of the carrier can increase since the spacer in the carrying direction between the piezoelectric body and the first resilient plate is able to be secured.

[0008]

In one aspect of the present invention, the supporting body (1, 1', 7) comprises a supporting plate (1) and a supporting block (1'), and the supporting block is fixed on the supporting plate, contains the supporting site (1a') on the upper side and at the rear of the supporting block, and is formed into a crank shape at side view. According to this aspect, the supporting block is secured for sufficient rigidity in order to fix the base end of the piezoelectric body and also able to suppress an increase in mass in the vicinity of the vibrating body. Moreover, in the case of the inertia mass to be described later provided at the supporting body, the supporting block can enhance an increase effect of moment of inertia by this inertia mass.

[0009]

In another aspect of the present invention, inertia mass (7) is provided at the supporting body (1, 1', 7) backward from the first position in the carrying direction. According to this aspect, since the inertia mass is provided backward from the first position of the supporting body when viewed in the carrying direction, by which the carrier can be swayed efficiently, with the system downsized, to increase the driving force in the carrying direction.

[0010]

In a different aspect of the present invention, the supporting body is installed over an installation base (9) via vibration isolators (8). The supporting body is installed via the vibration isolators, by which it is possible to suppress sway of the supporting body, reduce the leakage of vibration energy to the installation base from the supporting body and also improve the carriage efficiency.

[Best Mode for Carrying Out the Invention]

[0011]

Hereinafter, a description will be given of an embodiment of the present invention by referring to the drawings. Fig. 1 is a schematic configuration diagram showing a vibratory transporting apparatus of the present embodiment (linear feeder).

[0012]

In the vibratory transporting apparatus of the present embodiment, a supporting block 1' is fixed on a flat supporting plate 1 and the upper end (base end) of a piezoelectric body 3 is coupled with the upper rear part (supporting site) 1a' of the supporting block 1'. The piezoelectric body 3 is constituted so as to undergo deflecting deformation by laminating a piezoelectric layer on the surface of a resilient plate made of a shim plate or others and constituted, for example, as a piezoelectric actuator of a bimorph type (the piezoelectric layer is laminated on both sides) or a unimorph type (the piezoelectric layer is laminated on only one of them). The supporting block 1' may be that which is sufficiently rigid in fixing the base end of the piezoelectric body 3 on the supporting plate 1. In the illustrated example, the supporting block 1' is constituted so as to give a crank shape when viewed from the side, by which the supporting block 1' can be connected to both of a first resilient plate 4 and a second resilient plate 5. The supporting block 1' is secured for rigidity and also able to suppress an increase in mass in the vicinity of the vibrating body, thereby increasing the effect of moment of inertia by the inertia mass 7 to be described later.

[0013]

The lower end of the piezoelectric body 3 is couple with the front end part of a spacer 6, and the lower end of the first resilient plate (leaf spring) 4 is coupled with the rear end part of the spacer 6. The spacer 6 constitutes a coupling portion which couples the lower end of the piezoelectric body 3 with the lower end of the first resilient plate 4. Further, the spacer 6 is made thick in the carrying direction F, by which there is provided a clearance D in the carrying direction F between the lower end of the piezoelectric body 3 and the lower end of the first resilient plate 4.

[0014]

The upper end of the first resilient plate 4 is coupled with a rear site 2a' of the carrier arranged thereover (the rear end of a trough 2'). In the present embodiment, the carrier is constituted with a carriage plate 2 having a track 2s for guiding a component W and the trough 2' on which the carriage plate 2 is fixed.

[0015]

According to the above constitution, a driving unit composed of the piezoelectric body 3, the spacer 6 and the first resilient plate 4 is constituted so as to give a U-letter shape as a whole, and the coupling portion constituted with the spacer 6 is designed to act as a free end. In this instance, on the assumption that the upper rear part 1a' which is a supporting site is fixed, the front end of the spacer 6 (coupling portion) is subjected to deflecting deformation as indicated by the arrow T of drawing, with the base end O of the supporting site side kept at the center. Further, the upper end of a second resilient plate (leaf spring) 5 is coupled with the front site 2b' (front end of the trough 2') forward from the rear site 2a' in the carrying direction F and the lower end of the second resilient plate 5 is coupled with the lower front part 1b' of the supporting block. Thereby, the carrier 2 is kept supported respectively by the first resilient plate 4 and the second resilient plate 5 along the carrying direction F.

[0016]

Inertia mass 7 is fixed on the rear part of the supporting plate 1. The inertia mass 7 is to allow the center of gravity of the supporting body made up of a supporting plate 1, a supporting block 1a and the inertia mass 7 to move backward in the carrying direction F. The inertia mass 7 is constituted preferably in such a manner that the center of gravity thereof is positioned backward from a driving unit made up of the piezoelectric body 3, the spacer 6 and the first resilient plate 4, when viewed in the carrying direction F.

[0017]

In order to secure an efficient vibration of the carrier, the supporting body is constituted so as to be sufficiently greater in mass than the carrier. Further, the inertia mass 7 is made greater than the carrier in moment of inertia of the supporting body obtained when the base end O is kept at the center.

[0018]

The supporting plate 1 is mounted over an installation plate 9 via a plurality of isolation members 8 which are vibration isolators. The isolation member 8 is constituted with a resilient material such as rubber or a spring (coil spring), preventing the vibration of the supporting plate 1 from leakage to the installation plate 9. In particular, in the present embodiment, reaction to the supporting body resulting from the sway of a carrier to be described later is absorbed.

[0019]

In the present embodiment, the piezoelectric body 3 is subjected to

deflecting deformation T, by which the carrier is swayed as indicated by the arrow G of drawing (sway G) in an aspect having the center of sway below of swayed as indicated by the arrow U of the drawing (sway U) in an aspect having the center of sway forward and vibrated diagonally upward forward in the carrying direction F as a whole. Therefore, it is possible to carry a component W on the carriage plate 2 in the carrying direction F. Since the carrier is swayed as indicated by the arrows G and U, it is possible to carry a work efficiently in the carrying direction F, unlike a conventional vibratory transporting apparatus in which a driving unit made up of a piezoelectric body 3, a first resilient plate 4 and a second resilient plate 5 is inclined in a direction opposite to the carrying direction F. It should be, however, noted that this fact shall not be limited to an aspect where the driving unit assumes a perpendicular posture as illustrated in the above embodiment, but the piezoelectric body 3 and these resilient plates 4, 5 may be arranged so as to assume an inclined posture.

[0020]

In this instance, the spacer 6 is increased in thickness to make greater a clearance D in the carrying direction F at the coupling portion of the piezoelectric body 3 with the first resilient plate 4. Then, the first resilient plate 4 is vibrated vertically to a greater extent as indicted by the arrow S of the drawing due to the deflecting deformation T, thereby increasing the magnitude of the sway U. However, carriage efficiency varies depending on a relationship between the sway G and the sway U, therefore, in order to realize an optimal relationship between the sway G and the sway U to obtain an efficient vibration aspect suitable for the component W, it is necessary to set the clearance D appropriately.

[0021]

Further, the sway G and sway U of the carrier are not determined for the aspect only by a mass ratio of the supporting body (supporting plate 1, supporting block 1' and inertia mass 7) to the carrier (carriage plate 2 and trough 2') but also depends on a ratio of moment of inertia of the supporting body to the carrier, with the base end O kept at the center. In this instance, the inertia mass 7 is arranged along the carrying direction to increase the moment of inertia of the supporting body, thereby allowing the carrier to sway efficiently. In particular, in the present embodiment, the inertia mass 7 is arranged at the supporting body backward from the rear end part 2a' of the carrier (or the driving unit) when viewed in the carrying direction F, thus making it possible to suppress the length of a system in the back and forth direction, while increasing the moment of inertia.

[0022]

The vibratory transporting apparatus of the present invention shall not be limited to the above-described example and, as a matter of course, may be modified in various ways within a scope not departing from the scope of the present invention. For example, the above embodiment exemplifies a linear feeder (a transporting apparatus for arranging components and supplying them in line), however, to which the present invention shall not be, limited but is applicable, for example, to a vibrating hopper (a transporting apparatus for supplying a plurality of components as an aggregate to a bowl feeder of a linear feeder) and others.

[Brief Description of the Drawings]

[0023]

Fig. 1 is a schematic configuration diagram showing an embodiment of the present invention.

[0024]

- 1: Supporting plate
- 1': Supporting block
- 1a': Upper rear part
- 1b': Lower front part
- 2: Carriage plate
- 2': Trough
- 2a': Rear site
- 2b': Front site
- 3: Piezoelectric body
- 4: First resilient plate
- 5: Second resilient plate
- 6: Spacer

Claims

[Claim 1]

A vibratory transporting apparatus comprising a supporting body (1, 1', 7) and a carrier (2, 2') arranged over the supporting body via a vibrating body (3, 4, 5, 6), wherein

the vibrating body includes a piezoelectric body (3), a first resilient body (4), and a second resilient body (5), and

the piezoelectric body whose upper end is connected to a supporting site (1a') of the supporting body extends downward from the supporting site, and

the first resilient body is connected to the lower end of the piezoelectric body, extends upward at the rear of the piezoelectric body in a carrying direction, and is coupled with the carrier at a first position (2a'), and

the second resilient body directly connects the carrier and the supporting body at a second position (2b', 1b') forward from the first position in the carrying direction, and

the vibrating body is designed so that a coupling portion (6) of the piezoelectric body and the first resilient body acts as a free end, and

the coupling portion is a spacer (6) made thick in the carrying direction, by which there is provided a clearance (D) in the carrying direction between the lower end of the piezoelectric body and the lower end of the first resilient body, and

a driving unit constructed of the piezoelectric body, the coupling portion, and the first resilient body is formed of a U-letter shape as a whole.

[Claim 2]

The vibratory transporting apparatus according to claim 1, wherein the supporting body (1, 1', 7) comprises a supporting plate (1) and a supporting block (1'), and

the supporting block is fixed on the supporting plate, contains the supporting site (1a') on the upper side and at the rear of the supporting block, and is formed into a crank shape at side view.

[Claim 3]

The vibratory transporting apparatus according to claim 1 or claim 2, wherein inertia mass (7) is provided at the supporting body (1, 1', 7) backward from the first position in the carrying direction.

[Claim 4]

The vibratory transporting apparatus according to claim 3, wherein the supporting body is installed over an installation base (9) via vibration isolators (8).