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[54] **SPRING SYSTEM FOR VIBRATORY PARTS FEEDERS**

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[51] **Int. Cl.** **B65g 27/00**

[58] **Field of Search** ..... 148/220 BC, 220 CA

[56] **References Cited**

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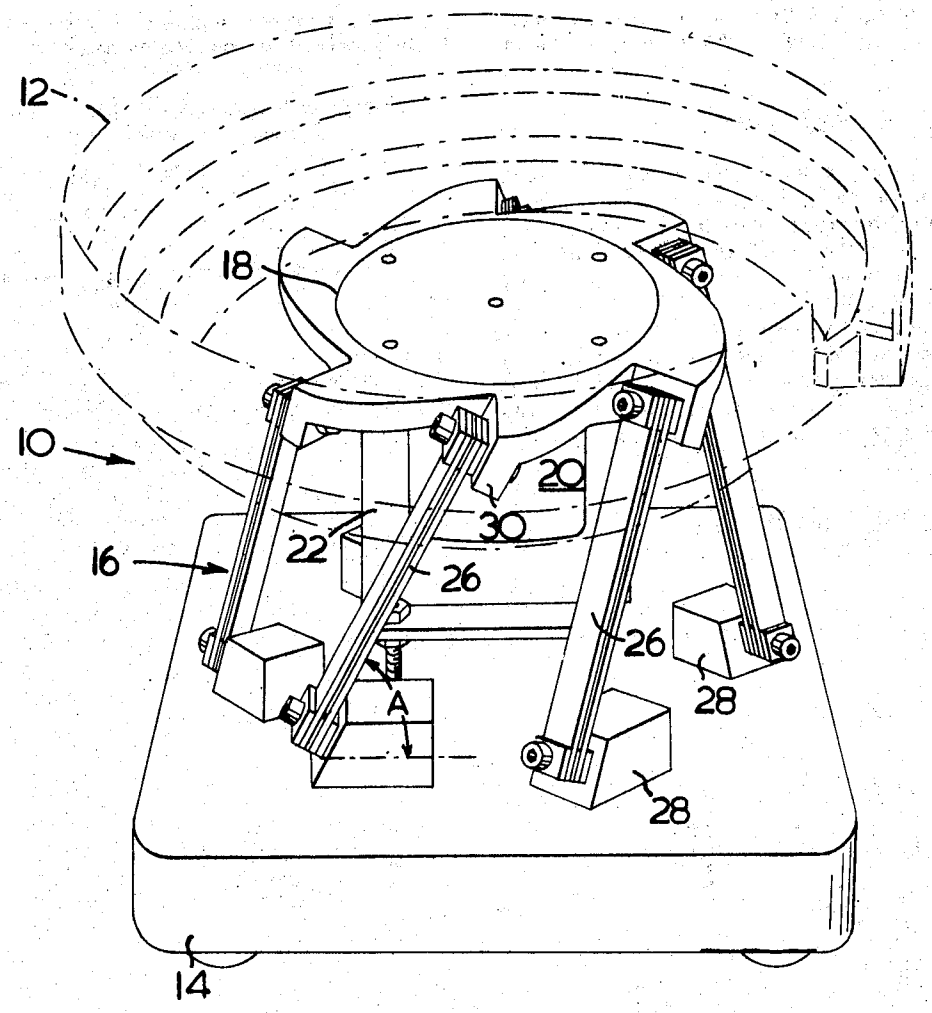
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[57] **ABSTRACT**

A vibratory parts feeder includes a massive base and a mount supporting a feeder bowl having an upwardly inclined spiral ramp therein along which the parts progress during operation. The feeder bowl mount is supported over the base by a plurality of elongated leaf spring units which are arranged in a generally circular array about a central region of the feeder. The elongated springs are each inclined at a primary angle relative to the base as measured in a vertical plane and are also each inclined inwardly from the vertical towards said central region by a relatively small secondary angle.

4 Claims, 3 Drawing Figures



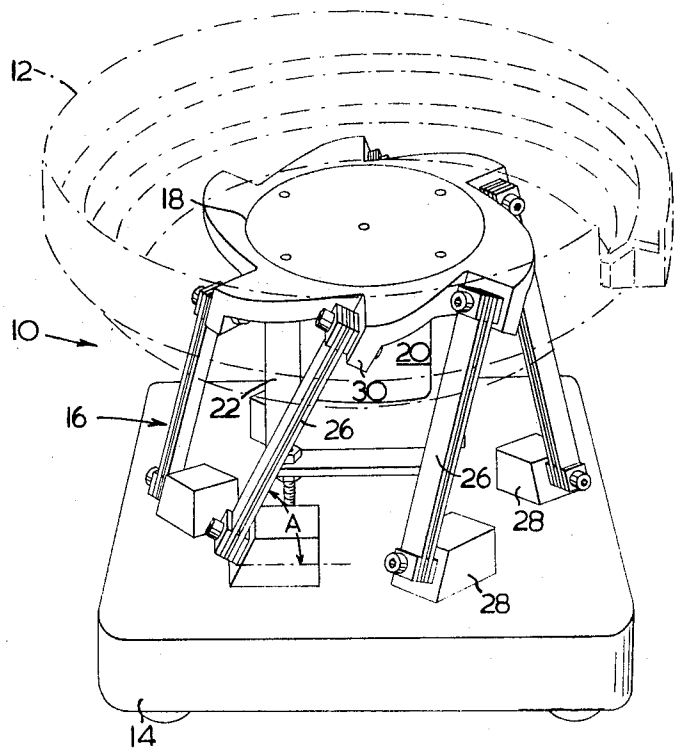


FIG. 1

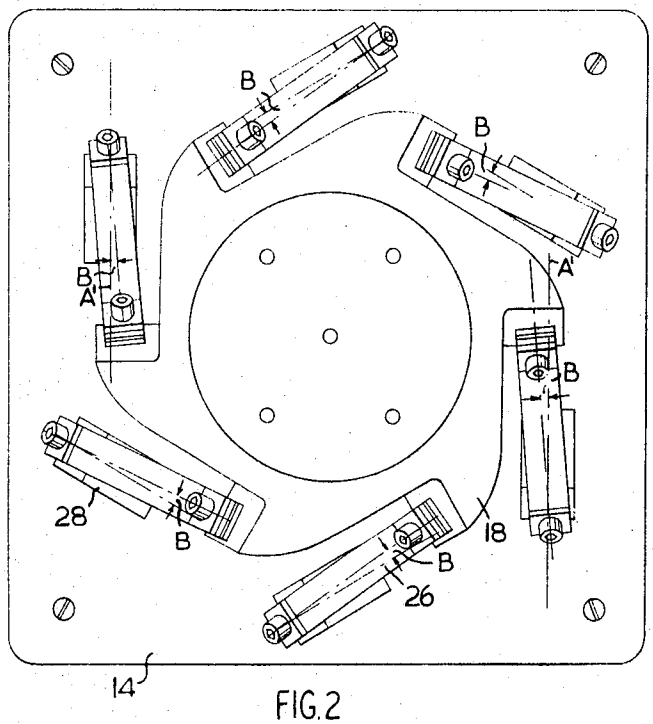


FIG. 2

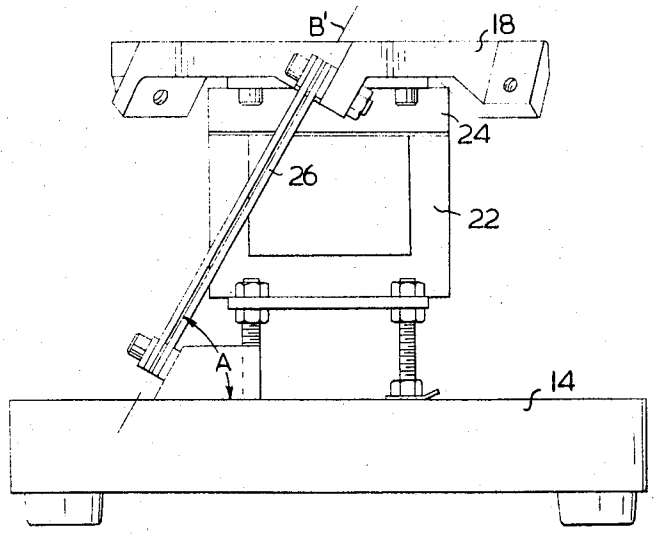


FIG. 3

SPRING SYSTEM FOR VIBRATORY PARTS FEEDERS

BACKGROUND OF THE INVENTION

This invention relates to a vibratory parts feeder, and particularly to improvements in spring mounting arrangements therefor.

Vibratory parts feeders are generally well known; the most common variety employs a feeder bowl which, as the name implies, comprises a bowl-shaped member having a helical inclined path or ramp running around its inner side wall. Means are provided to effect vibration of the bowl in such a manner that the objects in the bowl are induced by such vibratory movement to move up the ramp, usually in single file. The objects feed from a terminal portion of the ramp at the rim of the feeder bowl in one by one fashion whereby to permit them to be fed into further automatic processing machinery.

The means for inducing vibratory motion of the bowl employs a plurality of spring mounting units each including a leaf spring, or a plurality of such springs stacked together, each fixedly connected at one end to a massive base and at the other end to a plate which serves to mount the feeder bowl. The spring mounting units are spaced circumferentially about a vertical axis passing through the central portion of the feeder bowl. Each leaf spring or leaf spring stack is inclined at a suitable angle, e.g., 60° to 85°, to the horizontal. The feeder bowl is vibrated by a vibratory motor such as an electromagnetic motor consisting of a field core fixed to the massive base and surrounded by a coil winding. An armature is affixed to the bottom of the feeder bowl mounting plate in spaced relation to the pole face of the field core to define an air gap. Electrical energization of the coil winding in pulsating fashion causes the armature to be periodically attracted toward the field core thus periodically pulling the feeder bowl downward. Due to the angular orientation of the leaf springs, there is a horizontal component of movement of the feeder bowl along an arcuate path as well as a vertical component of movement. The leaf springs cause the feeder bowl to return to its normal position during the interval between current pulses. The repetitive or vibratory movement of the feeder bowl causes objects therein to propagate and travel along the helical path or ramp referred to above.

For a more complete understanding of the manner in which feeders of the nature referred to above function, reference may be had to a book entitled "Mechanized Assembly" by G. Boothroyd and A. H. Redford, McGraw-Hill, London, 1968 at Chapter 3.

Vibratory feeders have been very successful commercially. However they are still plagued with various problems. For example, there is a tendency for the feeder bowl to have or develop "dead spots" i.e., regions within the bowl where the parts remain more or less static and are not induced to travel up the inclined ramp as required. This constitutes a major annoyance and methods have been developed in an effort to deal with the problem. "Dead spots" appear to be caused in several ways. For example one or more of the spring mounting units may have been over stressed during shipment of the bowl feeder; this can easily happen if, for example, one attempts to lift or carry the entire feeder by applying lifting forces to the bowl alone. Because of the weight of the relatively massive base, the spring units may be over stressed. Such over stressing changes the vibration characteristics of the spring units and may give rise to the "dead spots" referred to above. In this case, replacement or reinforcement of certain of the spring units may be required. "Dead spots" may also appear if there is any imbalance in the bowl. Due to the presence of the helically inclined ramp in the bowl, a feeder bowl is non-symmetrical and thus, in its natural state, is unbalanced. In the past, it has been customary to balance these bowls at the factory by adding weights to the bowl before delivery to the customer. However, before the feeder is put into operation at the user's factory site, it is often necessary to mount additional auxiliary equipment on the bowl, especially in the region of the exit portion of the ramp, to effect a desired orientation of the parts before the latter are fed to further equipment. This auxiliary equipment is almost always supported directly on the bowl adjacent and edge of same, usually near the terminal end of the ramp. Since the weight of the auxiliary equipment creates an imbalance, it has been necessary to add counter weights to the diametrically opposed side of the bowl. This involves a costly time consuming operation, as trial and error methods must be used to achieve satisfactory feeder bowl performance. Since the auxiliary equipment in question is usually specially designed "custom" equipment, it is usually not possible for the manufacturer to supply the correct size of counter weight. The customers thus often face the problem of effecting bowl balancing themselves.

SUMMARY OF THE INVENTION

It is a general object of the present invention to provide improvements in vibratory feeders of the type under consideration for the purpose of alleviating the various problems referred to above.

In accordance with one aspect of the invention there is provided a vibratory parts feeder comprising a massive base defining a datum plane which is horizontally disposed when the feeder is in its operating condition and a mount for a feeder bowl or the like supported over said base by a plurality of elongated flexible spring means which are arranged in a generally circular array about a central region of the feeder and are each inclined at a selected primary angle relative to said base as measured in a first plane at right angles to said datum plane and are also each inclined inwardly from said first plane towards said central region by a secondary angle.

In accordance with a further aspect fo the invention said secondary angle is relatively small in comparison with said primary angle and is measured in a further plane parallel to the longitudinal axis of said elongated spring and at right angles to said first plane.

In accordance with a further aspect of the invention said spring means comprise flat leaf springs, each said further plane being generally parallel to the respective planes defined by the flat leaves of said springs.

By inclining the elongated flexible springs inwardly by the small secondary angle referred to above, a number of important advantages arise. The spring units are much less prone to over stressing by reason of forces applied to the bowl during shipment of the feeder units. Of greater importance is the finding that the need for the costly bowl balancing procedure is eliminated in all but extreme cases. In other words, by inclining the springs inwardly by said secondary angle, the problem of "dead spots" occurring as a result of bowl imbalance

is very significantly alleviated. The several advantages of the invention will be apparent from a reading of the following description of a preferred embodiment of the invention.

BRIEF DESCRIPTION OF THE VIEW OF THE DRAWINGS:

In drawings which show an embodiment of the invention;

FIG. **1** is a perspective view of a bowl-type parts feeder employing the principles of the present invention;

FIGS. **2** and **3** are plan and side elevation views of the parts feeder of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. **1** the vibratory parts feeder indicated at **10** includes feeder bowl **12** (shown in phantom) having an upwardly inclined spiral ramp therein supported on a relatively massive base **14** (which in operation is horizontally disposed) by equally spaced spring mounting units **16** arranged in a circular array. The spring mounting units **16** are each connected at one end to the base **14** and at the opposite end to a bowl mounting plate **18** to which the bowl **12** is bolted. An electromagnetic vibrator **20** including a field core **22** is secured to the massive base **14** beneath the central part of the bowl mounting plate **18.** An armature **24** (FIG. **3**) is secured to the lower side of mounting plate **18** in slightly spaced relation above field core **22.** When pulsating electrical energy is fed to vibrator **20,** vibratory motion of the feeder bowl is produced with the result that objects therein move up the spiral ramp in the feeder bowl in the maner well known in the art and for the reasons set forth in the aforementioned article of Boothroyd et al.

The spring mounting units **16** shown total six in number, but three, four or more may be employed. Each spring unit includes a leaf spring **26** including a plurality of flat spring leaves stacked together and spaced apart by suitable spacer members. The lower end of each spring **26** is bolted to a mounting block **28** which is suitably affixed to the base **14** while the upper end of each leaf spring is affixed to a respective lug **30** of the bowl mounting plate **18.**

The leaf springs **26** are equally spaced apart and equidistant from a vertical axis passing through the center of the bowl **12.** The leaf springs are each angularly inclined at a selected primary angle A relative to the horizontal base when measured in a vertical plane at right angles to the plane defined by the flat spring leaves; in the embodiment shown this angle A is about 60°. However, it is well known from the prior art that this angle can be varied within wide limits while still achieving satisfactory results. This primary angle of incline, as is well known, permits the springs to flex during operation to impart the motion described previously to the feeder bowl. The direction of incline of the springs determines whether the flow of parts in the bowl will be clockwise or counterclockwise.

In accordance with the invention and with reference to FIGS. **2** and **3,** each leaf spring **26** is inclined inwardly generally toward the central region of the feeder i.e., toward that region underlying the central part of the feeder bowl such that the longitudinal axis of each spring is inclined from the vertical by a secondary angle B as measured in a further plane which is parallel to the longitudinal axis of the leaf spring as well as being parallel to the plane or planes defined by the major surfaces of the generally flat leaves of the spring. This further plane is at right angles to said vertical plane in which the primary angle A is measured. The vertical plane in which primary angle A is measured appears as a line A' in the plan view of FIG. **2** and is shown as being approximately at right angles to a vertical plane passing through the centre of bowl mounting plate **18,** while the further plane at right angles thereto, in which plane angle B is measured, appears as a line B' in the elevation view of FIG. **3** for the leaf spring **26** there illustrated (the other leaf springs **26** having been omitted for purposes of clarity). Secondary angle B appears larger in FIG. **2** than it actually is since the leaf springs all appear foreshortened due to their inclined relation to the horizontal.

The base **14** may be considered as defining a datum plane which is horizontally disposed when the feeder is in operation, with the planes in which each primary angle A is measured being at right angles to said datum plane.

In any particular embodiment, the longitudinal axis of each leaf spring **26** is, of course, inclined by the same secondary angle B from said vertical plane. The secondary angle B is relatively small in magnitude compared with primary angle A. Secondary angle B can be made quite small, e.g., somewhat less than 2°, and it can be made larger e.g. 5° or even greater while still producing beneficial results. As the size of angle B is increased however, it appears that each leaf spring will be subjected to an increased degree of torsion during each vibration cycle. Since undue torsional movement of each spring can be undesirable due to the stresses involved and the possibility of fatigue failure it is suggested that secondary angle B be kept fairly small e.g., between about 2° and about 5°. On the other hand if B is made unduly small e.g., as angle B is decreased much below, say 2°, there appears to be a gradual fall-off in the advantages associated withe the invention. If B is made equal to zero (in which event the vertical plane wherein the primary angle A is measured passes through the longitudinal axis of the leaf spring), then, of course, the performance of the vibratory feeder will be equal to that of the prior art. Thus, it appears that the magnitude of secondary angle B is dictated by practical considerations and it does not appear possible to set hard and fast upper and lower limits within which it can vary. For most applications a secondary angle B of 2° to 3° is suggested.

The invention is applicable to all practical vibratory feeder sizes normally encountered e.g., from small units having feeder bowls only a few inches in diameter (e.g. 5 inches) up to very large feeders e.g., those having feeder bowls some 3 feet in diameter.

The exact reasons why improved feeder performance (as described previously) results from the above described leaf spring orientation are not clearly understood. A mathematical analysis of the system would be difficult and thus a comprehensive theoretical analysis will not be attempted. However, it appears that the secondary angle B does provide a more "stable" configuration. The following observation seems to confirm the above suggestion. It has been noted that an unbalanced prior art vibrator bowl tends to oscillate about a dynamic centre which has a tendency to change location

e.g., precess, during operation. This precession of the dynamic centre was associated with the presence of "dead spots" in the vibrator bowl. With the revised spring arrangement according to the invention the location of the dynamic centre appears to be stable, and the tendency for the "dead spots" to appear is greatly reduced and, in many cases, eliminated.

Two additional advantages which, on the basis of present observations, also are believed to be attributable to the novel spring arrangement provided are given below.

It appears that the spring arrangement provided makes the feeder bowl less sensitive to the actual load carried thereby insofar as the lateral movement of parts from the central regions of the bowl to the inlet of the ramp is concerned. In prior art vibrators, the effect of load weight on the lateral movement of the parts was sufficiently great as to warrant a change in vibration frequency in accordance with load weight changes to offset any detrimental effects on parts movement. In the case of the present invention observations suggest that vibration frequency changes are not required for the above purposes. For example, a test was carried out on a feeder having an 18 inch nominal diameter feeder bowl which would normally carry a load of 15–20 lbs. of parts. The feeder was put into operation and the parts in the bowl behaved in the usual fashion. The bowl was then loaded very heavily i.e., a load of about 150 lbs. was placed in the bowl. No significant detrimental effect on the lateral movement of the parts within the bowl was noted during operation under this extremely heavy load. Another surprising feature noted during testing was that the required amount of electrical power input to the electromagnetic vibrator could be reduced substantially when using the spring arrangement provided herein as compared with a prior art feeder of the same overall size.

In the foregoing disclosure and the claims which follow reference is made for purposes of convenience to the orientation of certain components relative to the horizontal or to the vertical. It is to be understood that such components are oriented as stated relative to the horizontal and vertical when the vibratory feeder is in its normal operating position with its massive base horizontally disposed.

A specific embodiment of the invention has been described by way of example. For definitions of the invention reference is had to the following claims.

We claims:

1. A vibratory parts feeder comprising a massive base defining an imaginary datum plane, and a mount for a feeder bowl or the like supported over said base by a plurality of elongated flexible leaf springs which are arranged in a generally circular array about a central region of the feeder, each leaf spring being inclined at a selected primary angle relative to said base as measured in a respectively associated first plane at right angles to said datum plane, each said leaf spring also being inclined inwardly from its respectively associated said first plane towards said central region of the feeder by a secondary angle, said secondary angle being relatively small in comparison with said primary angle with each secondary angle lying and measured in an imaginary surface which is parallel to the longitudinal axis of a respectively associated one of said elongated leaf springs and parallel to a major surface of said leaf spring, each said imaginary surface being at right angles to a respectively associated one of said first planes, and means for producing vibration of said mount relative to said base.

2. The feeder according to claim 1 wherein said leaf springs are flat.

3. In apparatus for use in a vibratory parts feeder of the type having a feeder element which includes an upwardly inclined spiral ramp along which parts progress during operation, and including:

a. a massive base which, in operation, is horizontally disposed,

a mounting means for the feeder element located above said base,

c. a plurality of elongated substantially flat leaf spring units located in circumferentially spaced relation about a central region of the apparatus, one end of each leaf spring connected to said mounting means and the other end thereof connected to said base,

d. each of said elongated leaf springs being inclined from the horizontal by a selected primary angle as measured in a respectively associated vertical plane, the improvement wherein:

e. each of said elongated leaf springs is inclined inwardly toward said central region of the apparatus such that the longitudinal axis of each of said elongated leaf springs is disposed at a secondary angle with respect to the respectively associated vertical plane in which said primary angle is measured, each secondary angle being relatively small in comparison with the primary angle and being measured and lying in an imaginary plane parallel to the plane defined by a major surface of the flat leaf of a respectively associated one of said springs, which imaginary plane is at right angles to said respectively associated vertical plane.

4. In a vibratory parts feeder including:

a. a feeder bowl including an upwardly inclined spiral ramp therein along which parts progress during operation,

b. a massive base disposed below said bowl which base is horizontally disposed for operation of the feeder,

c. a plurality of elongated leaf springs each of which is inclined at a selected primary angle to the horizontal as measured in a respectively associated vertical plane and arranged in a generally circular array about a region below a central part of the feeder bowl, each leaf spring connected at one end to said bowl and at its other end to said base whereby to resiliently support said bowl over said base,

d. a vibrator for inducing vibration of said bowl relative to said base,

e. the improvement wherein the longitudinal axis of each said leaf spring is inclined inwardly from its respectively associated vertical plane in which said primary angle is measured toward said region below the central part of the feeder bowl by a secondary angle which is substantially smaller than said primary angle, each secondary angle lying in an imaginary surface which is parallel to a major surface of a respectively associated one of said leaf springs, each said imaginary surface being at right angles to a respectively associated one of said vertical planes.

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