Sept. 23, 1969 E. J. RENNER 3,468,418

NATURAL FREQENCY VIBRATING SCREEN

Filed June 21, 1967 4 Sheets-Sheet 1

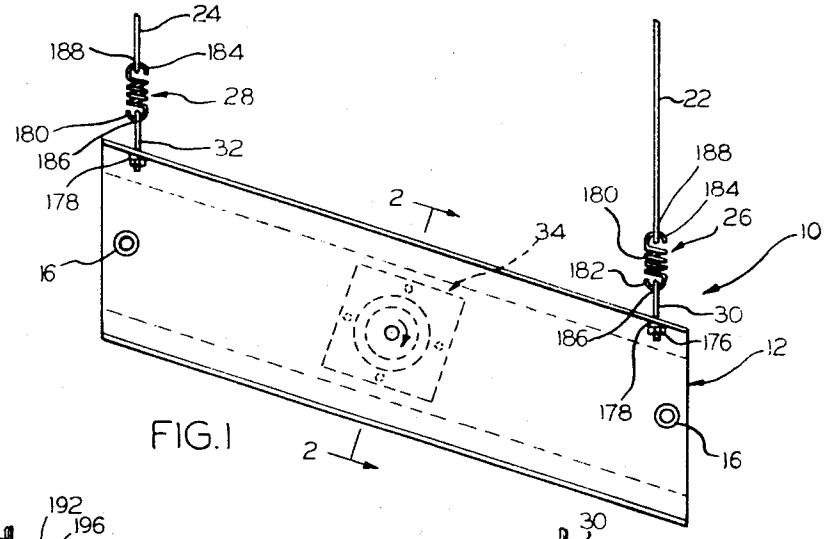

FIG.1

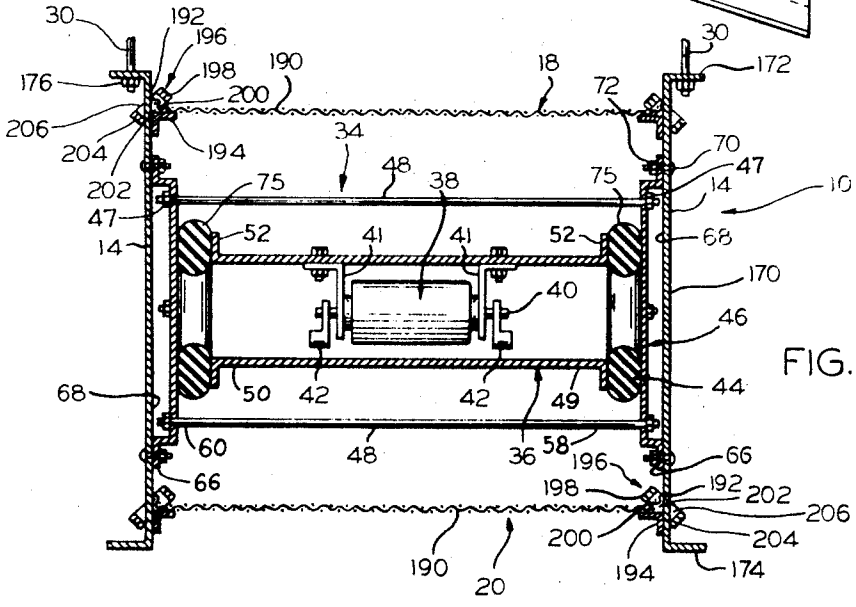

FIG.2

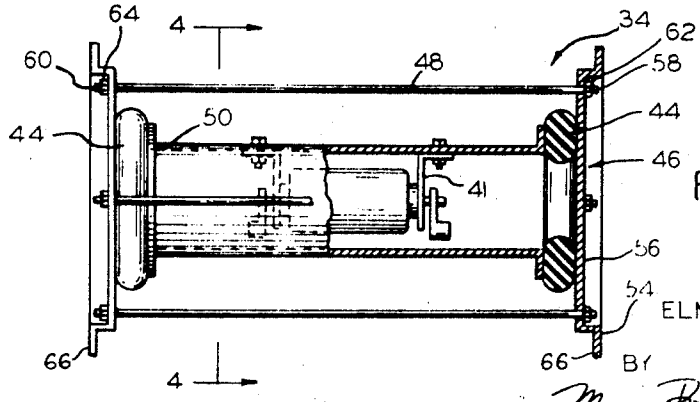

FIG.3

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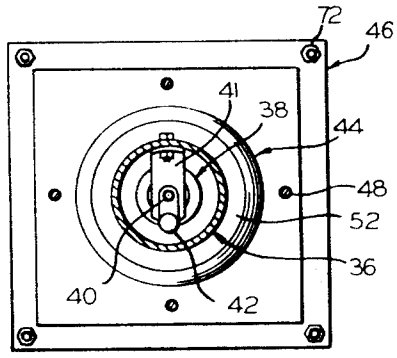

FIG.4

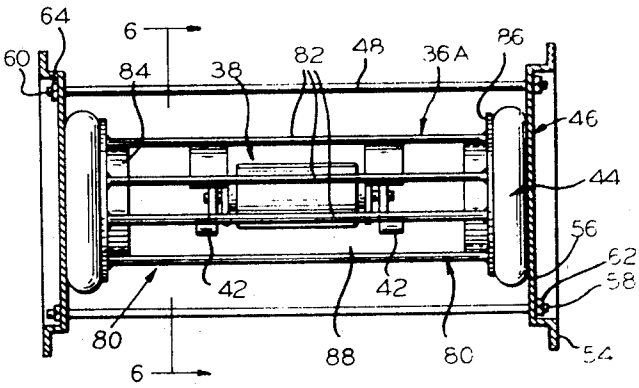

FIG.5

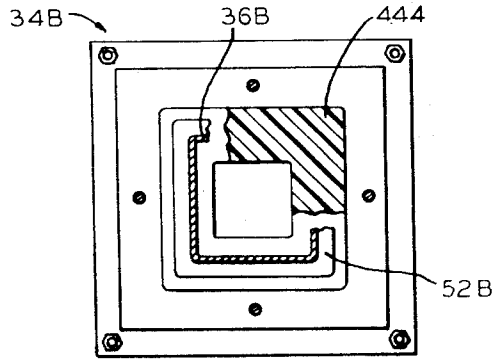

FIG.7

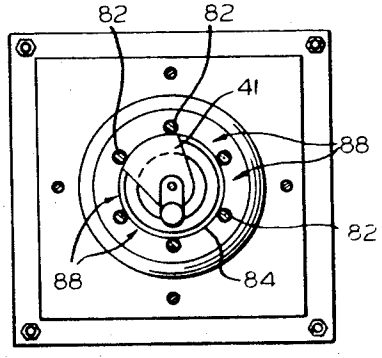

FIG.6

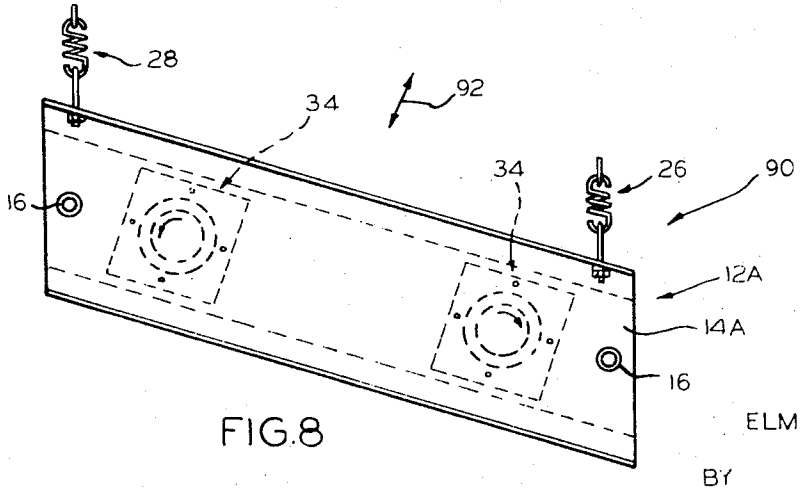

FIG.8

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NATURAL FREQENCY VIBRATING SCREEN

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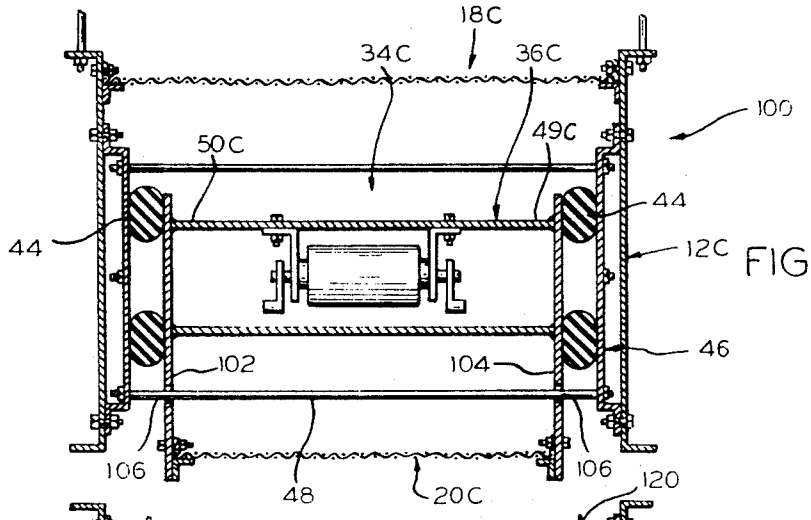

FIG.9

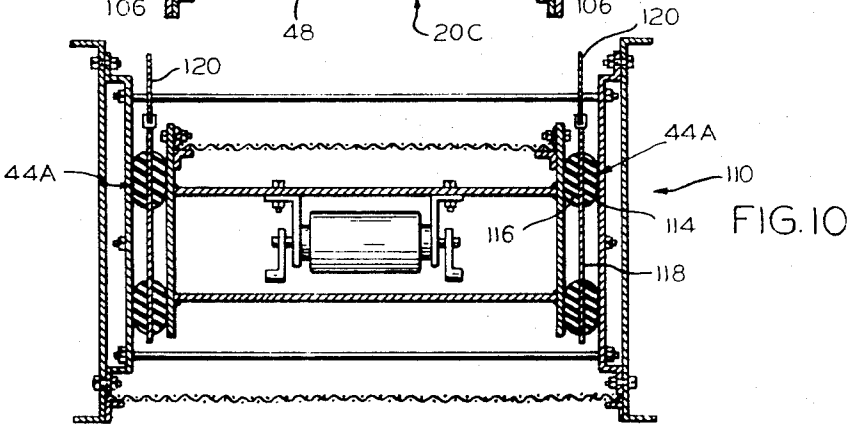

FIG.10

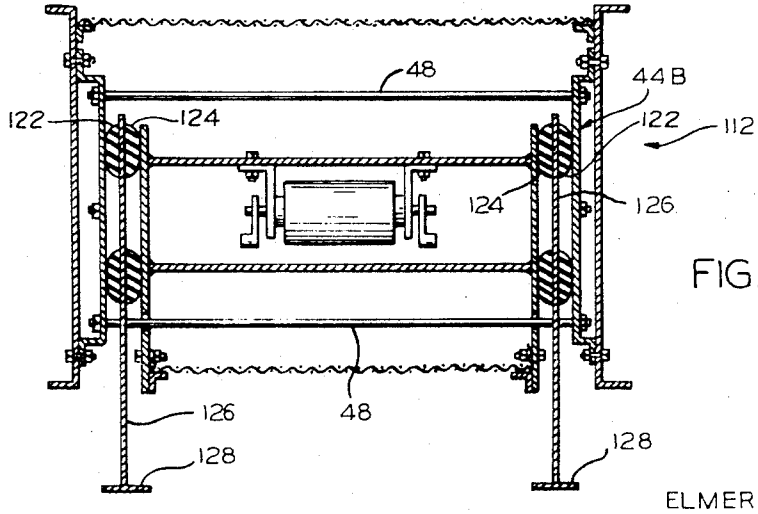

FIG.11

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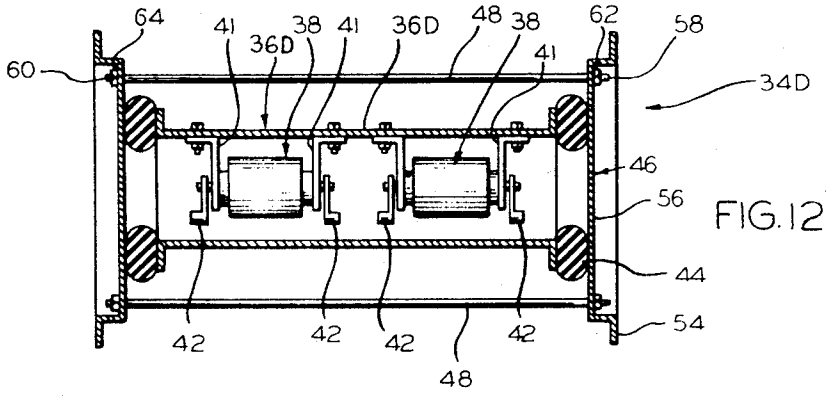

FIG.12

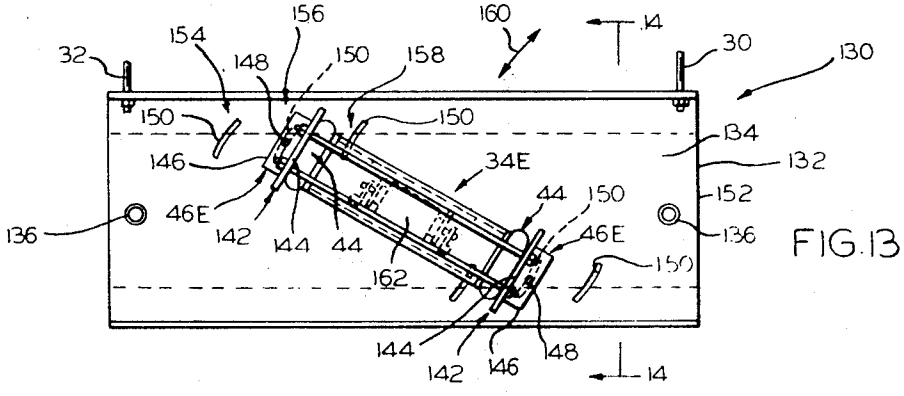

FIG.13

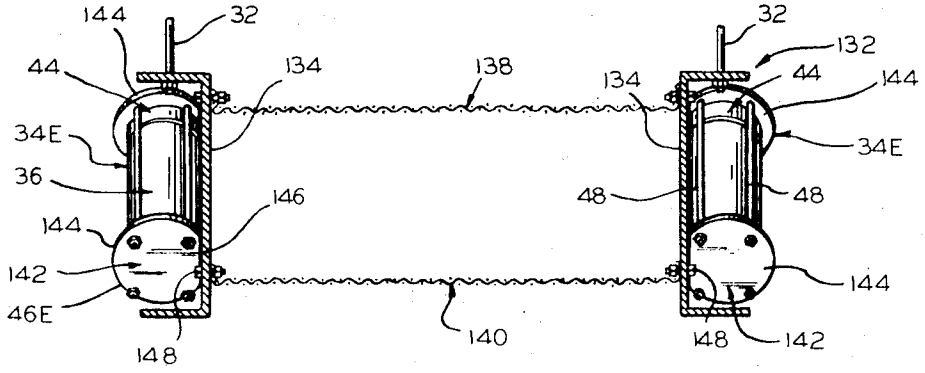

FIG.14

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United States Patent Office 3,468,418 Patented Sept. 23, 1969

3,468,418

NATURAL FREQUENCY VIBRATING SCREEN

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Filed June 21, 1967, Ser. No. 647,714
Int. Cl. B07b 1/34, 1/28
U.S. Cl. 209—315 24 Claims

ABSTRACT OF THE DISCLOSURE

A vibratory material handling apparatus provided with one or more exciters each independently resiliently suspended from the apparatus, and the specific forms disclosed relate to a natural frequency vibrating screen involving a screen supporting frame that is equipped with one or more special rotating eccentric type exciter units that are arranged in subassembly form, in which each unit includes a hollow or tubular structural support member in which the motor is mounted for rotating its eccentrics about an axis aligned with that of the structural support, with the structural support member being supported from the screen frame through annular shear springs that are compressed against the support structure by clamping members that are in turn secured to the screen frame, and with the motor being run at a speed approximating the resonancy of the spring system of which it forms a part.

Heretofore the so-called brute force type drives (drives which do not operate at or near the natural frequency of the vibrating system of which the screen forms a part) have been employed to operate vibrating screens, primarily because a rotary vibrating motion is what is customarily employed in vibrating screens (which are usually mounted in a tilted or inclined position to achieve directional movement of the material being screened), and brute force type drives in being circular motion providing mechanisms have been considered the most appropriate way to so actuate the screen for screening purposes. This has meant that screen drives have had to be considerably more rugged, and have involved considerably more power requirements to operate efficiently, than drive equipment employed for natural frequency conveyors, feeders and the like.

A principal object of this invention is to provide a natural frequency vibrating screen arrangement that provides the desired rotary vibrating screen motion with natural frequency amplification in a manner that eliminates the need to consider brute force type drives for vibrating screens.

A further object of the invention is to provide a novel drive unit for incorporation in vibrating screen arrangements to make them operate under the more desirable natural frequency operating conditions.

Yet a further object of the invention is to provide a vibratory material handling apparatus employing a pair of independently resiliently suspended exciter units in which the motors of the units automatically synchronize in operation and work together in applying vibratory forces to the apparatus involved.

Still a further object of the invention is to provide a basic drive unit for vibratory material handling apparatus, such as vibrating screens and feeding that permits a wide flexibility in designing specific arrangements that will operate under natural frequency conditions.

Additional objects of the invention are to provide a vibrating screen employing a simplified mechanical drive arrangement for utilizing natural frequency to drive the screen, to provide a natural frequency vibrating screen

arrangement that is specifically arranged to meet minimum head room requirements, and to provide a natural frequency vibrating conveyor arrangement that is economical of manufacture, convenient to install and operate, and is susceptible of being adapted to a wide variety of applications.

Other objects, uses, and advantages will be obvious or become apparent from a consideration of the following specification and the application drawings.

In the drawings:

FIGURE 1 is a side elevational view of a simplified double deck or screen suspension mount embodiment of the invention, showing the novel drive unit therefor in dashed lines;

FIGURE 2 is a diagrammatic cross-sectional view through the screen substantially along line **2—2** of FIGURE 1, on a somewhat enlarged scale;

FIGURE 3 is an elevational view of the drive unit employed in the embodiment of FIGURES 1 and 2 as viewed along the plane of the screen shown in FIGURE 1, with parts being broken away;

FIGURE 4 is a transverse cross-sectional view taken substantially along line **4—4** of FIGURE 3;

FIGURE 5 is a view similar to that of FIGURE 3 but illustrating a modified drive unit;

FIGURE 6 is a cross-sectional view substantially along line **6—6** of FIGURE 5;

FIGURE 7 is a view similar to FIGURES 4 and 6 illustrating a further modified form of the drive unit;

FIGURE 8 is a view similar to that of FIGURE 1 illustrating a dual drive unit vibrating screen arrangement arranged in accordance with this invention;

FIGURE 9 is a view similar to that of FIGURE 2 illustrating a modified form of vibrating screen arrangement in accordance with this invention in which one of the screen decks is directly supported by the drive unit itself;

FIGURES 10 and 11 are cross-sectional views similar to that of FIGURE 2 illustrating further modified forms of the invention wherein the vibrating screen is supported from the neutral axis of the drive unit mounts;

FIGURE 12 is a view similar to that of FIGURE 3 illustrating a dual motor drive arrangement for the basic drive unit of this invention;

FIGURE 13 is a side elevational view of a further modified form of the invention that is especially adapted for minimum head room requirements as well as for providing adjustment of the drive units to vary the travel rate of the material across the screen and the amplitude of the stroke; and

FIGURE 14 is a cross-sectional view of the embodiment of FIGURE 13 taken substantially along line **14—14** of FIGURE 13.

However, it is to be distinctly understood that the specific drawing illustrations provided are supplied primarily to comply with the requirements of the Patent Code and that the invention may have other specific embodiments that will be obvious to those skilled in this art.

GENERAL DESCRIPTION

Reference numeral **10** of FIGURES 1 and 2 generally indicates a simplified embodiment of the invention in the form of a double deck suspension mount vibrating screen including a frame **12** made up of a pair of side members **14** of generally channel-shaped cross-sectional configuration joined together in any suitable manner, as by tubular cross struts **16** at either end thereof.

The screen decks **18** and **20** extend longitudinally of the frame **12** and convey bulk material to be screened from a point where it is received on the screen decks

at the upper end of the screen to a point where it passes from the respective screen decks into a suitable hopper or conveyor or the like. In the passage of the material across the screen, it is assumed that the usual screening practice is contemplated which consists of bringing each piece of the material against an opening in the respective decks of a different size, allowing the particle to pass through if it is small enough, and taking away if it is too large.

In the form of FIGURES 1 and 2, the frame 12 is inclined downwardly to employ gravity for the purpose of moving the bulk material longitudinally of the screen and is suspended by rods 22 and 24 connected between an overhead support and the respective spring devices 26 and 28 of either side of the screen which are in turn connected to the frame through suitable eye bolts 30 and 32. As is conventional, the spring devices 26 and 28 are relatively soft springs that vibrationally isolate the frame 12 from the ground so that it will vibrate essentially as a free mass system.

In accordance with this invention, the screen 10 is vibrated under natural frequency conditions by a special drive unit 34, which is separately shown in FIGURES 3 and 4, and is applied to the screen in the form of FIGURES 1 and 2 between the frame side members 14 at approximately the center of gravity of the screen 10.

As indicated in FIGURES 2, 3 and 4, the drive unit 34 comprises a hollow or tubular structural support member 36 having applied thereto a driving motor 38 that includes an operating shaft 40 rotating about the axial center of the support member 36 and provided with a pair of rotating eccentrics 42 disposed at either end thereof. Motor 38 is mounted in position between spaced brackets 41 affixed to member 36 in any suitable manner and in one form of the invention the motor may be an conventional A.C. three phase A.C. squirrel cage motor that operates at synchronous speed.

The motor support member 36 has applied at either end thereof a drive spring in the form of an annular shear spring 44, with the respective shear springs 40 being clamped against the ends of the support member 36 by clamping plate members 46, with the clamping members 46 being drawn together against the respective springs 44 by nuts 47 threaded on tension rods 48. Springs 44 are formed to have spring rates approximating but preferably slightly above the normal operating speed of motor 38.

In the form shown, the motor support member 36 at its respective ends 49 and 50 is formed with a flange portion 52 against which the respective shear springs 44 seat. The clamping members 46 are in the form of plate elements 54 dished as at 56 so as to receive the opposite ends 58 and 60 of tension rods 48 and their cooperating nuts 62 and 64 that are employed to draw the respective clamping members 46 against the respective ends of member 36 to place the shear springs 44 under firm compression.

As indicated in FIGURE 2, the drive or exciter unit 34 is proportioned transversely of the frame 12 so that the flanged rim portions 66 of the clamping members 46 seat against the respective inside surfaces 68 of the frame side members 14, with the respective clamping members 46 being secured in place in any suitable manner as by bolts 70 cooperating with nuts 72.

As indicated in FIGURES 2, 3 and 4, the shear springs 44, which may be formed from any suitable rubber or plastic material of the requisite qualities, are annular in nature and are concentrically arranged with respect to the axis of rotation of motor shaft 40 and its eccentrics 42. The arrangement of the drive unit 34 thus suspends the support member 36 and the driving motor supported thereby by shear springs acting under compression through the medium of clamping members 46 and tension rods 34. Springs 44 in effect form mounts for motor 38 and the mass connected to it, though in the subassembly 34 of which the motor and its support 36 form a part, the subassembly 34 is mounted in position by connections applied to its clamping members 46.

The screen 10 is operated by driving the motor 38 at a speed at or near the resonance or natural frequency of the vibrating system of which the frame 12 and its motor unit 34 forms a part, with the eccentrics rotating in the direction indicated by the arrow of FIGURE 1. The result is that the screen 10 and in particular the decks 18 and 20 vibrate under natural frequency conditions in a circular or near circular orbit, depending on the positioning of axis of motor shaft 40 with respect to the center of gravity of the screen 10 (if the axis of shaft 40 is aligned with the screen center of gravity the orbit will be circular, which is preferred, but some departure from the center of gravity is permissible as orbits that are moderately elliptical will be satisfactory).

It will thus be seen that in accordance with this invention the exciting or driving force for the screen acts along the axis or center line of shear springs 44 that support the exciting mechanism, and the mass units consisting of the support member 36 and the motor 38 it carries on the one hand, and the screen frame 12, the screen decks, the clamping members 46 and tension rods 48 on the other hand synchronously oscillate in a rotational manner with 180 degree phase opposition thereby providing the frame with the circular or nearly circular vibrational movement that is desired for screens of the type relying on gravity for directional movement of the material being screened. This oscillating movement is about the axes of motor shaft 40 and shear springs 44 and the result is that the right- and left-hand portions of springs 44 (with reference to the showing of FIGURE 2) are displaced with respect to each other about a central neutral or nodal portion 75 that is coplanar with the planes of the respective springs 44. The exciting force involved is a radar sweep type action with the force generated by the throw of the eccentrics being of a constant or uniform nature and acting radially or along the line of the sweep.

As indicated in FIGURES 5 and 6, it is not essential that the support member 36 of the drive unit 34 be a tubular member as such. Thus, in the drive unit 34A, the support member 36A is in the form of a composite structural arrangement 80 made up of spaced tie rods 82 connected between annular end elements 84 that are flanged as at 86 for clamping engagement with the shear springs 44. The motor 38 has its mounting brackets 41 fixed as by welding to several of the spaced rods 82 for purposes of mounting the motor in place.

Thus, the rods 82 define openings 88 therebetween for ready access to the motor 38 and its rotating eccentrics 42.

The motor supports 36 or 36A, the motor support flange portions 52, and the shear springs 44 need not be circular in annular configuration. They may also be polygonal in configuration transversely of the axis of rotation of the motor, as indicated in FIGURE 7 for support 36B, which, as there illustrated, includes flange portion 52B and shear springs 444.

It will thus be observed that the motor units 34, 34A and 34B provide a self-contained drive or exciter unit of a unitary or subassembly type that may be readily applied to screens of the type shown in FIGURES 1 and 2. These motor units also provide a ready way of arranging screen units for different types of driving conditions.

For instance, in the screen apparatus 90 of FIGURE 8, two separate drive or exciter units 34 are applied between the side members 14A of frame 12A in the manner indicated in FIGURE 2 but in spaced apart relation and adjacent the ends of side members 14A at approximately equal distances from the center of gravity of the screen 90. The screen apparatus 90 is otherwise the same as that shown in FIGURES 1 and 2. On energization of the motors 38, they fall into synchronism with each other, and

with the position of eccentrics **42** being synchronized so that the eccentrics of the two motors work together in applying vibratory forces to the screen, with the screen vibrating as a free mass. By driving the thus independently resiliently suspended motors **38** of the respective units **34** so that they rotate in opposite directions (such as those indicated, though the opposite directions will work as well), the screen **90** is provided with a linear vibration in the direction indicated by the arrow **92** due to the cancelling action that the oppositely rotating eccentrics have on force components acting longitudinally of the frame **12**. This vibrating action is useful in providing additional directional feed action on the material being screened longitudinally of the screen.

Alternately, if the motors **38** of the units **34** are operated in the same direction (which should be in the direction of the right hand unit **34** of FIGURE 8), their rotational exciting effect will be additive to provide an increased amplitude of circular vibration of the screen.

It is to be noted that in the form of the invention shown in FIGURE 8, where the vibratory system is vibrated as a free mass, and where the two exciter units **34** impart their vibratory forces to the frame or main support member **12A** through shear springs designed to permit the system to operate at natural frequency, the forces delivered to the support member **12A** by the like drive units **34** are algebraically summed. In other words, if the motors of the drive units are operated in the same direction, the forces deivered to the support member **12A** are always added together, whereas, if the motors are driven in opposite directions, some forces will cancel each other, and others will add, thus making for the algebraic summation.

It should also be noted that the motors of the exciter units **34** are mounted on the frame **12A** with an orientation such that the forces delivered by the rotating masses are through the shear action of the rubber springs and are algebraically summed. For example, in the form of the invention shown in FIGURE 8, the axis of the respective motors is at right angles to the side frame members **14A**, and when the motors are operated in opposite directions, all forces parallel to the screen surfaces are cancelled out and only those forces which are perpendicular thereto are applied to the screen surface through the shear type drive springs **44**. Note also that in the embodiment of FIGURE 13 and 14, where the motors are mounted with their axes parallel to planes of the respective side frames, as hereinafter more fully described, all forces normal to the planes of the side frames are cancelled out, and only those forces which are parallel to the planes that include the axes of the two motors are transmitted to the supporting surface through the shear type drive springs **44** there employed.

In the screen apparatus **100** of FIGURE 9, the lower screen deck **20C** is supported by a connection with the support member **36C** of drive unit **34C**. In this embodiment of the invention, the screen is of the single drive unit type in which the drive unit is located in approximate alignment with the screen center of gravity, and the lower screen deck **20C** is supported by plate members **102** and **104** which are fixed as by welding to the respective ends **49C** and **50C** of the support member **36C**, which plate members also form the necessary abutting surfaces against which the shear springs **44** are compressed by the operation of tension rods **48**. Plates **102** and **104** are made sufficiently long in dimension lengthwise of the screen **100** to provide the desired screening surface for deck **20C** and are formed with suitable openings **106** to accommodate the passage of the lower tension rods **48** through same and permit the relative movement therebetween that will be induced by exciter or drive device **34**.

However, the arrangement of FIGURE 9 may be in the form of a dual unit drive apparatus with the drives **34C** being positioned where indicated in FIGURE 8 and plates **102** and **104** extending between the supports **36C** of both drive units.

It will be seen that in the embodiment of FIGURE 9, the lower screen deck **20C** is part of a mass that is separate from the mass to which the upper spring deck **18C** is connected to. By selecting the ratios of the masses that the respective screen decks **18C** and **20C** form a part of, a desired ratio of stroke characteristics may be obtained. For instance, if the ratio of the mass of which screen deck **18C** forms a part to the mass of which screen deck **20C** forms a part is two to one, the screen deck **18C** will have one-half the stroke of screen deck **20C**.

Consequently, the embodiment of FIGURE 9 contemplates a vibrating screen arrangement in which the screen decks involved may have different vibrating characteristics.

In the vibrating screens **110** and **112** of FIGURES 10 and 11, respectively, the screen is a direct mount screen, with the respective screen decks (which are arranged following the manner indicated in FIGURE 9 being supported from the neutral or nodal region of the shear springs **44A**).

In the embodiment **110**, the shear springs **44A** each comprise half sections **114** and **116** bonded to a center plate **118** (that is thus located at the neutral or nodal region of the springs **44A**), with the respective center plates **118** being connected to an overhead support by suitable cables **120** to suspend the screen from the overhead support.

In the embodiment **112** of FIGURE 11, the shear springs **44B** each comprise half sections **122** and **124** that are respectively bonded to a center plate **126** (that is similar in location and function to plate **118** of FIGURE 10), with the respective center plates **126** extending beneath the screen and being formed with suitable feet **128** for resting on suitable foundation (not shown).

The embodiments of FIGURES 10 and 11 are otherwise substantially the same as shown in FIGURES 1 and 2, with the plates **118** and **126** being formed with appropriate openings through which the respective tension rods **48** pass, and to accommodate the relative compression therebetween that will be involved.

The motor drive or exciter unit **34D** that is shown in FIGURE 12 includes a pair of motors **38** and their rotating eccentrics **42** mounted for operation within a support member **36D**. Unit **34D** is otherwise the same as unit **34**, and the motors **38** may be operated either additively or in opposition to achieve effects similar to that described in connection with the embodiment of FIGURE 8. Unit **34D** may be substituted for the unit **34** of FIGURE 1 to achieve results similar to those described in connection with FIGURE 8.

In the vibrating screen **130** of FIGURES 13 and 14, the screen comprises frame **132** comprising a pair of channel shaped side members **134** joined together by suitable tubular cross struts **136** or the like and shaped and suspended by spring devices similar to those shown in FIGURE 1 to be disposed in a horizontal operating position. Screen **130** is of the double deck type providing upper deck **138** and lower deck **140**, and in accordance with this embodiment of the invention, screen **130** is driven by a pair of exciter or drive units **34E** which are each arranged in the manner indicated in FIGURE 3 and for natural frequency operation of screen **130**, except that the clamping members **46E** each comprise an angle member **142** including a clamping portion **144** and a flange portion **146**; the clamping portions **144** of the respective units **34E** are clamped against shear springs **44** by tie rods **48** in the manner indicated in FIGURE 3, while the flange portions **146** are each formed with appropriate bolt holes to receive bolts **148** that are applied to pairs of arcuate slots **150** formed in the webs **153** of side members **130**.

In the form shown, the side members **132** are each formed with three sets **154**, **156** and **158** of such slots

150 with the slots 150 of each set being struck on arcs having the same radius from a point or center 162 midway between them. The slot sets 156 are located to dispose the centers 162 of units 34E at or near alignment with the center of gravity of screen 130, while sets 154 and 158 are formed to dispose units 34E at locations spaced substantially equally either side of the central position illustrated or at any other spaced relation that might be desired for a specific application.

Thus, assuming the units 34E are mounted in the set 156 of slots 150 of the frame member 132, since the drive units 34E are inclined and at an acute angle with respect to the decks 138 and 140, operation of the exciter units 34 under natural frequency conditions of the type already described to provide movement of their eccentrics in opposite directions will provide a screen linear vibrational movement of the type indicated by the double headed arrow 160 of FIGURE 13, which will insure a material feeding action longitudinally of the frame 132 to the right of FIGURE 13 in a manner comparable to that of a vibrating feeder, and under natural frequency conditions.

If the nature of the material or the like indicates the need for a slow or faster travel of the material across the screen decks, the bolts 148 may be loosened to rotate the units 34E about an axis 162 to achieve this end. In the showing of FIGURE 13, if the unit 34E is rotated in a counterclockwise direction the feed rate will be reduced, while movement in a clockwise direction will increase feed rate.

Applying the units 34E to the central pair 156 of slots 150 will provide the screen 130 with a feed stroke amplitude that will be uniform along its length. If it is desired to have the material receiving end of the screen have a larger stroke amplitude than the material delivering end, the units 34E are shifted to the pairs of slots 154, while if the deliverying end of the screen is to have the larger stroke amplitude, the units 34 are shifted to the slot pairs 158.

The screen 130, being horizontally disposed, is specifically applicable to situations where head room conditions are critical, such as in vibrating screens for portable screening plants. The arrangements of FIGURES 13 and 14 also permits the screen to have a number of closely spaced screen decks with the number being limited only by the material depth on each of the decks. In the showing of FIGURE 14, only two decks are shown but the decks may be four or five in number for the proportioning indicated. This is because the drive units 34E are loctaed on the outwardly facing sides of frame side members 152.

SPECIFIC DESCRIPTION

Referring now back to the embodiment of FIGURES 1–4, the specific arrangement of the screen frame 12 per se may be widely varied in accordance with known practices and the frame 12 and its decks 18 that are specifically illustrated are shown primarily to represent a convenient frame arrangement.

In addition to the vibration isolating arrangement that is illustrated, the frame 12 may also be mounted on legs provided with soft rubber feet or on airbags, as will be obvious to those skilled in the art.

With regard to the frame 12 itself, the channel shaped configuration of side members 14 is preferred, though the materials employed to make same and to secure same to each other may be of any convenient type or arrangement.

The side members 14 each define a web portion 170 having flange portions 172 and 174 extending laterally of the upper and lower edges thereof, with the frame being suspended from spring devices 26 by eyebolts 30 and 32, respectively, extending through the flange portions 172 and being held in place by suitable nuts 176 seating against appropriate angled seats 178.

Spring devices 26 in the form shown are soft tension springs 180 formed with hooked ends 182 and 184 that are applied to eye shaped ends 186 and 188, respectively, of rod members 30 and 22.

Decks 18 and 20 each comprise metal screening 190 of a mesh suitable for the purpose intended and having its longitudinally extending edges 192 clamped against angle shaped support bars 194, that are fixed as by welding to the respective side members 14, by bolt devices 196 that each include a bolt 198 drawing a clamping member 200 against the side edge 192 of the screening and a clamping member 202 through cooperation of a nut 204 seated against a seat 206.

However, it is to be understood that the decks 18 and 20 may be of any suitable conventional type and applied in any suitable manner to the frames 12. Examples are shown in Catalogue No. 66 of Stephens-Adamson Mfg. Co., Aurora, Ill., at pp. 527 through 534.

With regard to the drive or exciter units 34, their support members 36 may have the configurations already referred to, although the essential thing is that they mount the motor 38 so that its shaft axis coincides with the axial center of shear springs 44. While the member 36 may have the tubular configuration shown in FIGURES 1–4, it is preferable that it be of skeletal framework design, such as in the embodiment of FIGURES 5 and 6, to provide for ready accessibility to the motor and its eccentric weights.

The motor 38 may be of any suitable type and may be connected to a suitable source of electric power in any suitable manner, as through appropriate openings in the support member 36. By making motor 38 a variable speed motor, the rate of movement of the material across the screen decks may be varied by varying the speed of the motor. However, motor 38 may be of the type which makes no provision for speed adjustment and thus is a constant speed motor, where amplitude of vibration is to be fixed or varied in some other manner.

The screen frames and decks of the embodiments of FIGURES 9–11 may be arranged following the specifics described in connection with the embodiment of FIGURES 1–4, with the exceptions already indicated. The suspension arrangement of FIGURES 10 and 11 may be applied to screens of the type shown in FIGURE 8 by locating the exciter units involved and having the screen decks extend only between the exciter units so that both screen decks may be carried by the screen side frame members 14A without interfering with supports 120 (FIGURE 10) or 128 (FIGURE 11).

In the embodiment of FIGURES 13 and 14, it is assumed that the motor 38 employed is a constant speed motor, although it will be obvious that a variable speed motor may be employed in which case the units 34E may be permanently mounted in position in installations where it is contemplated that the vibration amplitude should be uniform throughout the length of the screen.

It will also be noted in connection with the embodiment of FIGURES 13 and 14 that the securement of the drive or exciter devices 34E to the outer sides of frame side members 132 provides for maximum accessibility to the drive units for servicing and repair.

The foregoing description and the drawings are given merely to explain and illustrate my invention and the invention is not to be limited thereto, except insofar as the appended claims are so limited, since those skilled in the art who have my disclosure before them will be able to make modifications and variations therein without departing from the scope of the invention.

I claim:

1. In a vibrating screen for bulk materials,

a frame having side members and supporting therebetween a relatively flat screen surface,

means for vibrationally isolating the frame from the ground,

exciter means for vibrating the screen surface to give it essentially a circular gyratory motion,

said exciter means and said frame forming a vibrating system,
said exciter means comprising a pair of spaced-apart rubber springs adapted to act in shear and having a common axis,
said frame including rigid members outboard of the springs,
a hollow structural member inboard of the springs,
means for drawing the rigid members together to clamp the structural member between the rubber springs with a predetermined pressure,
and motor means mounted within the structural member on said common axis and having eccentric weights rotatable about said axis for applying radial forces to the structural member with a predetermined frequency,
which frequency is at or near the natural frequency of the said vibrating system,
and means including the exciter means for moving the bulk material longitudinally along the screen surface.

2. A vibrating screen for bulk materials comprising:
a frame including spaced side members,
said frame supporting a relatively flat screen surface,
means for vibrationally isolating said frame,
means for vibrating said screen surface under approximately natural frequency conditions,
said frame and said vibrating means forming a vibrating system,
and means including said vibrating means for moving the bulk material longitudinally of said screen surface ,
said vibrating means comprising a vibrating unit including:
a structural support member,
motor means carried by said support member and including one or more eccentrics rotating about a common axis.
a clamping member at each end of said support member,
shear spring means interposed between the respective clamping members and the respective ends of said support member about said axis and having an axis common with said common axis,
and means for clamping said clamping members against the respective shear spring means,
said clamping members being respectively secured to said frame,
and means for driving said motor means at a speed approximating the resonancy of said system,

3. The screen set forth in claim **2** wherein:
said shear spring means each comprise a resilient annular member concentrically related to said axis.

4. The screen set forth in claim **2** wherein:
said vibrating means frame structure comprises a tubular member having flanged end portions disposed concentrically of said axis against which said shear spring means are respectively clamped.

5. The screen set forth in claim **2** wherein:
said vibrating means frame structure comprises a skeletal frome having flanged end portions disposed concentrically of said axis against which said shear spring means are respectfully clamped.

6. The screen set forth in claim **2** wherein:
said motor means comprises a single motor with said common axis being approximately aligned with the center of gravity of said screen.

7. The screen set forth in claim **2** wherein:
said motor means comprises several motors each driving one or more of said eccentrics.

8. The screen set forth in claim **2** wherein:
said means for vibrationally isolating said frame includes means for supporting said screen from the neutral axes of said shear spring means.

9. The screen set forth in claim **2** wherein:
said vibratory means comprises a pair of said vibrating units spaced apart longitudinally of said frame.

10. The screen set forth in claim **2** wherein:
said clamping members of said vibrating unit are respectively secured to the respective side members with said axis extending transversely of said screen surface,
said screen surface being inclined with respect to the horizontal and said screen inclination forming part of said bulk material moving means.

11. The screen set forth in claim **2** wherein:
said vibrating means comprises a pair of said vibrating units spaced apart transversely of said frame,
with one of said vibrating units being secured to one of said members at said clamping members thereof and the other of said units being secured to the other of said side members at said clamping members thereof,
said frame being horizontally disposed and said units being disposed with respect to said frame to have their said axes parallel and inclined at an acut angle with respect to said screen surface.

12. The screen set forth in claim **11** including
means for securing said units to said frame for adjustment longitudinally of said frame and for adjusting the angle of their said axes with respect to said screen surface.

13. In a vibrating screen for bulk materials including a frame including spaced side members, with the frame supporting a relatively flat screen surface, means for vibrationally isolating said frame, means for vibrating said screen surface under approximately natural frequency conditions, said frame and said vibrating means forming a vibrating system, and means including said vibrating means for moving the bulk material longitudinally of said screen surface, the improvement wherein said vibrating means comprises a pair of vibrating units, with each of said units comprising:
a structural support member,
motor means carried by said support member and including one or more eccentrics rotating about a common axis,
a clamping member at each end of said support member, shear spring means interposed between the respective clamping members and the respective ends of said support member about said axis,
and means for clamping said clamping members against the respective shear spring means,
and means for driving said motor means at a speed approximating the resonancy of said system,
said vibrating units being spaced apart transversely of said frame,
with one of said units being secured to the outwardly facing side of one of said frame side members at said clamping members thereof and the other of said units being secured to the outwardly facing side of the other of said frame side members at said clamping members thereof,
said vibrationally isolating means including means for mounting said frame in a horizontal position,
said units being disposed with respect to said frame to have their said axes parallel and inclined at an acute angle with respect to said screen surface and thereby forming part of said moving means,
said driving means including means for driving said motors in opposite directions.

14. The improvement set forth in claim **13** including:
means for securing said units to said frame side members for adjustment longitudinally of said frame and for adjusting said angle of said axes with respect to said screen surface.

15. In a vibratory bulk material handling apparatus, the combination of a member adapted to convey bulk material and spring means supporting said member to allow said member to vibrate as a free mass, and a plurality of identical vibratory motors interconnected with said member to cause vibratory forces to be applied to said member and a consequent feeding movement in

said member, each of said motors being independently suspended on said member by identical drive springs.

16. In a vibratory feeder, the combination of a member adapted to convey bulk material and spring means supporting said member to allow said member to vibrate as a free mass, and a plurality of vibratory motors interconnected with said member on opposite portions thereof to cause vibratory forces to be applied to said member and a consequent material feeding movement in said member, each of said motors being independently suspended with respect to said member by springs, said springs having spring rates substantially matching the normal operating speed of said motors, said motors being identical to each other and said springs being identical to each other.

17. A feeder as set forth in claim 16 wherein said member is in the form of an elongated trough, said motors are mounted on opposite sides of said trough and each of said motors is mounted to direct vibratory forces in the same direction and upwardly inclined with respect to said trough.

18. A vibratory bulk material handling apparatus including a pair of generally parallel and spaced supporting frame members, an electrical motor suspended by spring means from each side frame member, each motor being identical and being formed and adapted to impart vibratory forces through said spring means, respectively, to each of said frame members, a bulk material conveying member supported on and fixed to said frame members between said vibratory motors, the spring rates of said spring means being such as to be substantially the same as the normal operating speed of said motors, and isolation springs positioned between said frame members and a supporting structure therefor.

19. A vibrating unit for application as an exciter to vibrating equipment, said unit comprising:

a structural support member,

motor means mounted on said support member and including one or more eccentrics rotating about an axis extending longitudinally of said support member,

a clamping member at each end of said support member,

torus shaped shear spring means interposed between the clamping members and the respective ends of said support member about said axis with the centroid of said shear spring means being substantially on said axis,

and means for clamping said clamping members together to thereby put the shear springs in compression along said axis and to firmly clamp the support member and motor means between said clamping members.

20. A natural frequency vibrating screen for bulk materials comprising:

a frame including spaced side members,

said frame supporting a relatively flat screen surface,

means for vibrationally isolating said frame,

means for vibrating said screen surface,

said frame and said vibrating means forming a vibrating system,

and means for moving the bulk material longitudinally of said screen surface,

said vibrating means comprising:

a hollow structural support member having flanged ends,

said support member defining a central axis extending longitudinally thereof,

a clamping member at each end of said support member and centered on said axis,

a shear spring interposed between the respective clamping members and the respective ends of said support member,

said shear springs being centered on said axis,

a plurality of rods disposed about said support member in parallel relation therewith and extending between said clamping members,

means for securing said rods to the respective clamping members including means for drawing said clamping members against the respective shear springs at either end of said support member to stress said shear springs in compression and stress said rods in tension uniformly about said axis,

and motor means carried by said support member and positioned within same,

said motor means including one or more eccentrics rotatable about said axis,

means for driving said motor means at a speed approximating the resonancy of said system, whereby said stressed shear springs serve as drive springs for vibrating said system,

and means independent of said securing means for securing the respective clamping members to said frame to mount said vibrating means on said frame as a unit,

whereby said vibrating means comprises a self-contained exciter unit providing a driving force acting in a circular manner about said axis, and that is secured to the frame by connecting said clamping members to said frame.

21. A self-contained vibrating unit for application as a natural frequency excited to vibrationally isolated vibrating equipment, said unit comprising:

a hollow structural support member having flanged ends, said support member defining a central axis extending longitudinally thereof,

a clamping member at each end of said support member and centered on said axis,

a shear spring interposed between the respective clamping members and the respective ends of said support member,

said shear springs being centered on said axis,

a plurality of rods disposed about said support member in parallel relation therewith and extending between said clamping members,

means for securing said rods to the respective clamping members including means for drawing said clamping members against the respective shear springs at either end of said support member to stress said shear springs in compression and stress said rods in tension uniformly about said axis,

and motor means carried by said support member and positioned within same,

said motor means including one or more eccentrics rotatable about said axis,

and means for driving said motor means,

said clamping chambers being formed for securement to the vibrating equipment independent of said securing means,

whereby said exciter unit provides a driving force acting in a circular manner about said axis, and said unit may be secured to the vibrating equipment by connecting said clamping members thereto for vibrating the equipment under natural frequency conditions when said motor means is driven at a speed approximately the resonancy of the equipment, whereby said stressed shear springs serve as drive springs for vibrating the equipment.

22. In a vibratory system for handling bulk material, the combination of a support for such bulk material, and means for vibrating said support to produce a controlled vibratory motion of said support, said means comprising at least two motors carrying eccentric masses rotatable about substantially parallel axes lying in a common plane, means for driving said motors in opposite directions at substantially the same speed, each of said motors being operatively connected to said support by spring means substantially tuned to the frequency of said rotatable masses.

23. In a free mass vibratory system for handling bulk material, the combination of a support for such bulk material, and means for vibrating said support to produce a controlled vibratory motion of said support, said vibrating means comprising at least two motors each carrying rotatable eccentric masses, means for driving said motors at substantially the same speeds, and means for mounting said motors on said support through the intermediary of spring means substantially tuned to the frequency of said rotatable masses and to the masses in the vibratory system, said motors having their axes of rotation oriented with respect to said mounting means so that the system operates at or near natural frequency with the forces transmitted from the rotating masses to said support being algebraically summed.

24. A vibrating unit for application as an exciter to vibrating equipment, said unit comprising: a motor support member, a clamping member at each end of said support member, a rubber shear spring interposed between the clamping members and the respective ends of said support member, motor means mounted on said support member and including one or more eccentrics rotating about an axis aligned with the centroids of said springs and extending longitudinally of said support member, and means for drawing said clamping members toward each other to hold the unit assembled and to

place the rubber shear springs in compression along said axis of the support member, said last named means being adapted to permit said support member to vibrationally move relative to said clamping members through the action of said rubber springs acting in shear on actuation of said motor means.

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TIM R. MILES, Primary Examiner.

U.S. Cl. X.R.

74—61, 87; 198—220; 209—326, 346, 366.5, 367

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,468,418 September 23, 1969

Elmer J. Renner

It is certified that error appears in the above identified patent and that said Letters Patent are hereby corrected as shown below:

In the drawings, Sheets 1, 2, 3 and 4, the title, "NATURAL FREQENCY VIBRATING SCREEN" should read -- NATURAL FREQUENCY VIBRATING SCREEN --. Column 9, line 59, "frome" should read -- frame --. Column 10, line 19, "acut" should read -- acute --.

Signed and sealed this 26th day of May 1970.

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents