Dec. 21, 1937. H. E. WURZBACH ET AL 2,102,826

VIBRATORY APPARATUS

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Fig. 1.

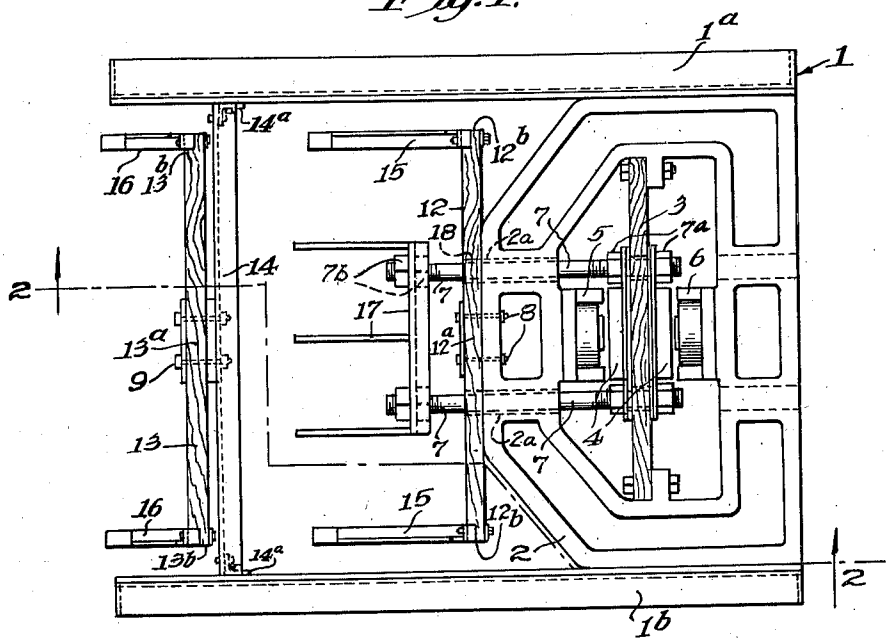


Fig. 2.

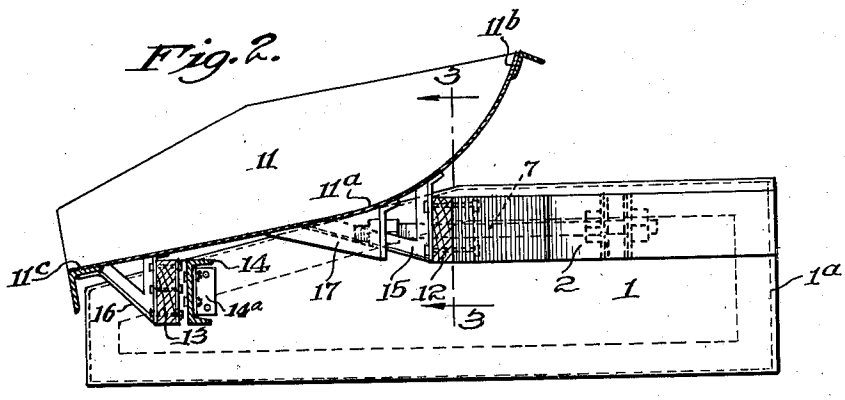
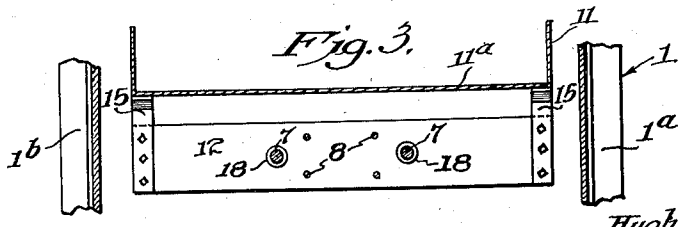


Fig. 3.



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VIBRATORY APPARATUS

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Fig. 4.

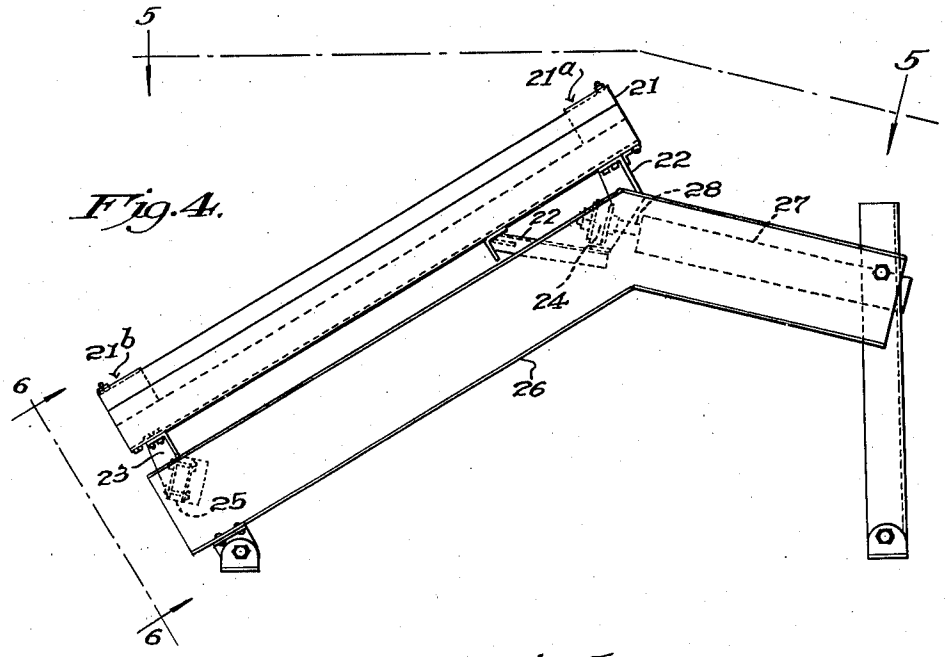


Fig. 5.

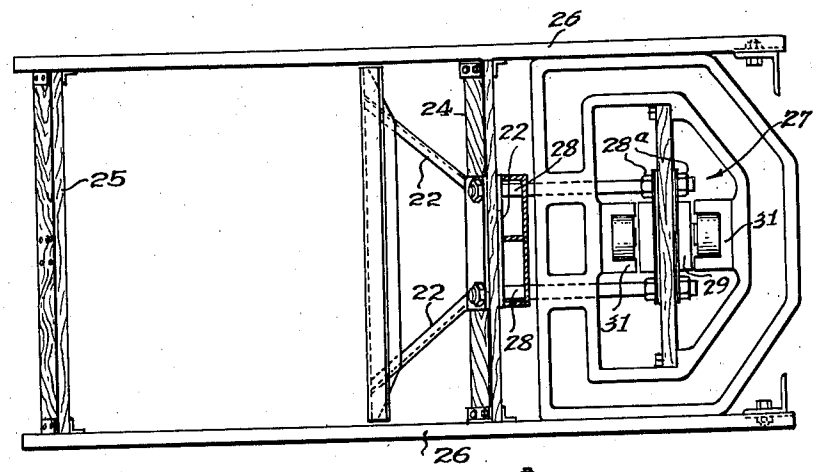
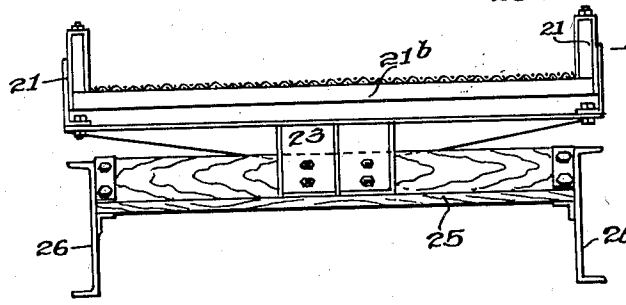


Fig. 6.



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VIBRATORY APPARATUS

Filed March 23, 1936 3 Sheets-Sheet 3

Fig. 7.

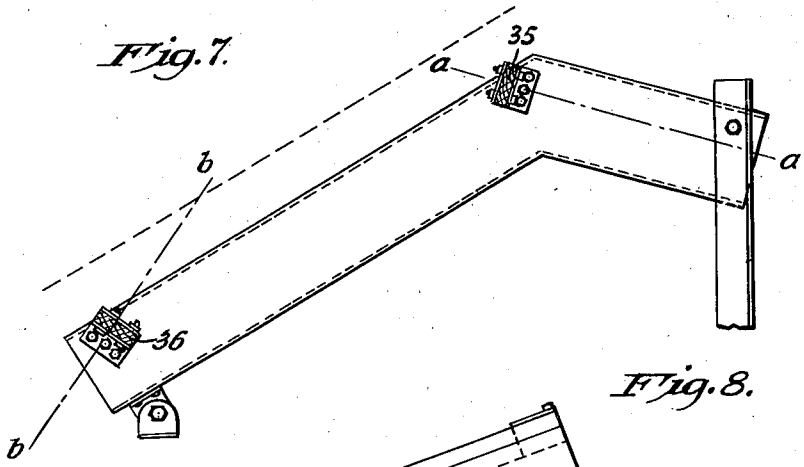


Fig. 8.

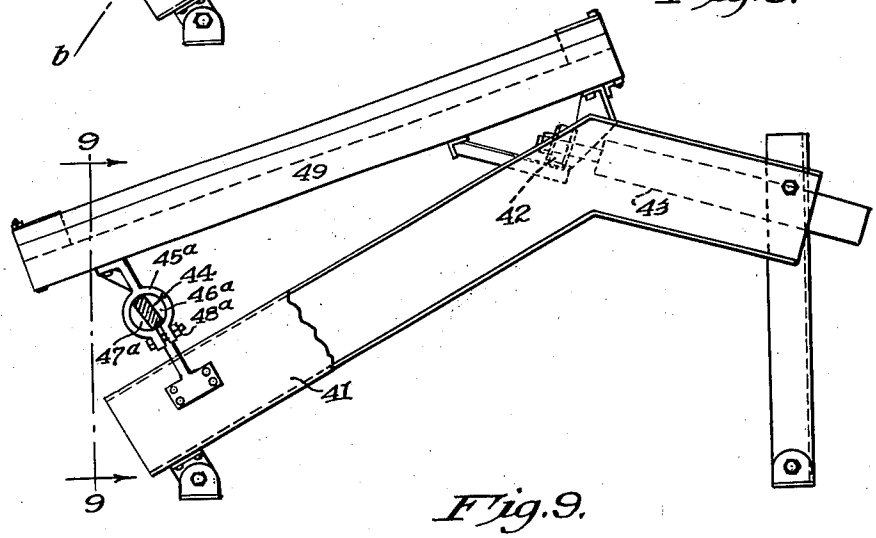
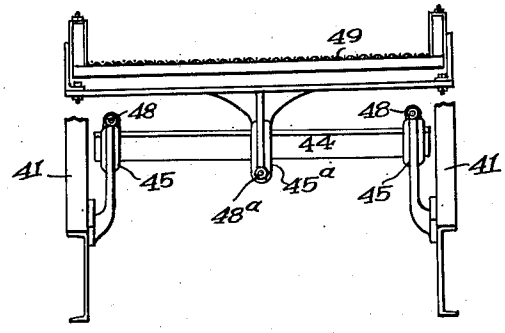


Fig. 9.



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UNITED STATES PATENT OFFICE

2,102,826

VIBRATORY APPARATUS

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Application March 23, 1936, Serial No. 70,418

13 Claims. (Cl. 198—220)

This invention relates to vibratory apparatus such as vibratory screens, feeders, conveyors, etc., and pertains particularly to means for mounting a vibrated member, independent of the means for driving said member to produce vibratory motion thereof, in such manner that the gravity load of said member does not exert any substantial modifying effect upon the vibratory movement thereof or upon said means for producing such vibratory movement.

The principal object of the invention is to provide an advantageous means for supporting a vibrated member, said supporting means being of high durability and adapted to maintain an established adjustment throughout the life of such apparatus without wear of movable parts, and being cheaply and readily constructed.

A further object of the invention is to provide a vibratory assembly in which a vibrated member is carried by an advantageous form of support means adapted to resiliently deform in the desired direction of vibratory movement while resisting deformation resulting from the gravity load of such vibrated member.

A further object of the invention is to provide a vibratory apparatus in which a vibrated member is mounted on a plurality of vibratory support elements extending transversely to the path of vibration, in which the vibratory support elements are each adapted for vibratory movement along a predetermined axis and in which the axes of vibratory movement of the separate vibratory support elements are subject to variable angular adjustment with respect to one another whereby the natural period of vibration of the vibrated element may be adjusted to such value as to efficiently cooperate with the period of vibration of the vibratory motor means associated with such vibrated member.

The several embodiments of the present invention are particularly described in connection with a vibratory motor means of the type described in our Reissue Patent No. 19,816, and the objects of the present invention are best attained where a motor of this general type, or other type of motor which will operate to produce power driven motion of a vibrated member in both directions along the path of vibration, is employed. It will be appreciated that other forms of vibratory motor means may be employed in connection with vibrated apparatus provided with the advantageous type of support means herein described, without departing from the broad scope of the invention, inasmuch as the herein-described objects will be obtained in some degree by the use of such other forms of motors.

The vibratory apparatus of the present invention may comprise, essentially, a vibrated element or member adapted to receive a material to be screened or conveyed at or adjacent one end thereof and to effect discharge of at least a portion of such received material at or adjacent the other end thereof, and a working surface over which the material is moved longitudinally from the feed to the discharge ends. The vibrated member is supported on a suitable frame structure through the agency of a plurality of elongated resilient supporting bars extending transversely with respect to the direction of movement of material along the working surface of such vibrated member, said elongated supporting bars being spaced from one another in said direction and having a portion connected to said vibrated member and free to vibrate along an axis of vibration having a substantial component in such direction, each of said supporting bars having another portion secured to the aforesaid frame structure. The apparatus further comprises a vibratory motor means operatively connected to the vibrated member at a position adjacent the connection thereof to one of said supporting bars, in such manner as to produce vibratory motion of said vibrated member along a path defined by the paths of vibration of said bars. In certain embodiments of the invention, the elongated resilient supporting bars are of such shape and are so disposed with respect to the vibrated member, that the gravity load of such vibrated member produces little or no deformation of said supporting bars along the paths of vibration thereof, whereby no component, or only a relatively small component, of such gravity load is communicated to the vibratory motor means.

Other objects of the invention will be brought out in the following description thereof or will be apparent therefrom. The accompanying drawings illustrate several embodiments of the invention, and referring thereto:

Fig. 1 is a plan view of a preferred form of vibratory assembly according to the present invention, adapted to function as a vibratory feeder, the pan portion of the feeder being removed;

Fig. 2 is a longitudinal section thereof taken on line 2—2 in Fig. 1;

Fig. 3 is a transverse section thereof taken on line 3—3 in Fig. 2;

Fig. 4 is a side elevation of a modified form of vibratory mechanism according to the present

invention, adapted to function as a vibratory screen;

Fig. 5 is a plan view thereof, taken on line 5—5 in Fig. 4 with the vibrated screen member omitted whereby the supporting and driving structure may be more readily seen;

Fig. 6 is an end view thereof taken on line 6—6 in Fig. 4.

Fig. 7 is a partly diagrammatic view corresponding generally to Fig. 4, showing the transverse supporting bars disposed with their axes of vibration at an angle to one another, in a modified arrangement of such supporting bars;

Fig. 8 is a view corresponding to Fig. 4, showing a modified type of supporting hanger, providing for angular adjustment of the axis of vibration of one of the supporting bars; and

Fig. 9 is a transverse view taken on line 9—9 in Fig. 8, illustrating the arrangement of the hangers shown in Fig. 8 in somewhat greater detail.

Referring to Figs. 1 to 3, a frame structure is indicated at 1 comprising side members 1*a* and 1*b*, which carry a vibratory motor frame 2 rigidly secured thereto. The vibratory motor may comprise an elongated resilient vibratory member 3 secured at its ends to the motor frame 2 and carrying armature means 4 at its mid-portion. The armature means 4 are preferably disposed equi-distant between a pair of electromagnets 5 and 6 which may be secured to the frame structure, and the vibratory movement of the member 3 is communicated to the vibrated member with which the device is associated through the agency of drive rods 7, which may extend loosely through openings 2*a* in motor frame 2. The vibrated member, which in this form of the invention may comprise a feeder body 11 providing a working surface 11*a*, is supported on the frame 1 through the agency of two transversely extending resilient support members or bars 12 and 13 spaced from one another in the direction of travel of material over the vibrated member, namely, between the feed end 11*b* and the discharge end 11*c*.

The support members 12 and 13 are preferably of such shape and so mounted as to be readily deflected under stresses applied in the direction of vibratory movement of the motor means, i. e., in the direction defined by the driving rods 7, and to resist deformation in a vertical direction resulting from the weight of the vibrated member and the gravity load thereon. Such relative resistance to deflection or deformation may be controlled by a selection of the transverse dimensions of said support members to provide a greater transverse dimension in the direction in which the principal proportion of the gravity load is applied (thus defining major transverse axes of said support members) and a lesser transverse dimension in the direction in which the vibratory motion is established (thus defining minor transverse axes of said support members). This may be accomplished, for example, by mounting the support members so that their longitudinal axes lie in substantially horizontal planes, with the major transverse dimension extending in a substantially vertical direction, and the minor transverse dimension extending in the direction of vibratory movement.

In the embodiment of the invention illustrated in Figs. 1 to 3, the vibrated member is shown as connected to the end portions of the transverse support members 12 and 13, and the central portions of these support members are connected to the frame structure 1. The support 12 may be secured at its mid-portion 12*a* to the motor frame 2, as by bolts 8, and the mid-portion 13*a* of the support 13 may be secured, as by bolts 9, to a substantially rigid transverse channel member 14, which is secured at its ends to frame members 1*a* and 1*b* as by means of bracket members 14*a*. The vibrated member 11 may be secured to the vibratory end-portions 12*b* and 13*b* of the transverse supports 12 and 13 through the agency of suitable brackets 15 and 16, respectively. Thus, each transverse support bar, 12 and 13, is connected to the vibrated member at positions spaced longitudinally of that bar and is connected to the frame structure at a position intermediate and spaced from the first-named positions, whereby the longitudinal portions of said bar, between said positions of connection, are free to flex.

Driving connection of the vibratory motor means to the vibrated member 11 may be effected through the agency of a bracket 17 to which the ends of the driving rods 7 are secured, and the several brackets 15, 16, and 17 may be welded or otherwise secured to the member 11. The driving rods 7 extend loosely through openings 18 in member 12.

The vibratory motor means may be operated by effecting alternate and successive energization of the two electromagnets 5 and 6, as disclosed in our above-mentioned reissue patent, causing a vibratory movement of the member 3 through the agency of the armature means 4, which vibratory movement will be directly communicated to the vibrated member 11 through the driving rods 7 and bracket 17, causing a comparable vibratory movement of the vibratory end-portions 12*b* and 13*b* of the transverse supports 12 and 13. The transverse supports 12 and 13 are preferably formed of a material of high resistance to fatigue failure, a material such as well-seasoned wood being preferable. Said support members are shown as rectangular in cross-section, with the minor axis of the rectangle extending in the direction of vibratory movement, and defining a path of vibration for each of said support members. By placing the support members so that the major transverse dimensions thereof are vertically disposed, so as to extend in the direction of application of the gravity load, the tendency of said support members to deform because of the gravity load is greatly reduced. It will be appreciated that the height and thickness, i. e., the two transverse dimensions of these transverse supporting members will depend on the weight of the vibrated member to be supported and the desired character of the vibratory movement. For example, the members 12 and 13 may be made relatively short in the direction of vibratory movement thereof, whereby the vibratory member 3 of the motor means is principally depended upon to establish the desired resilience of the system, in which event the vertical dimension of said members 12 and 13 will be made relatively long whereby adequate support of the gravity load will be obtained, or, alternatively, the support bars may be made heavy enough in the direction of vibration thereof to provide the principal proportion of the resilient resistance desired in the vibratory assembly. In general, a ratio of approximately three to one between the two perpendicular transverse dimensions, i. e., height and thickness, has

been found satisfactory, but this ratio obviously may be varied within relatively wide limits.

The character of the vibratory motion at the working surface 11a is such as to produce a pronounced conveying action upon the material present upon the feeder pan. The movement of the armatures 4 will be purely horizontal, due to the disposition of the vibratory member 3, and in view of the vertical disposition of the support members 12 and 13, this purely horizontal movement is directly communicated to the working surface 11a. The vibratory motor means is thus not subjected to any strains resulting directly from the gravity load of the feeder pan and the load of material thereon, and the simple harmonic motion obtained by the symmetrical vibratory movement at the armatures may thus be realized at the working surface. Where the vibratory movement is produced by a power pulsation in but one direction along the path of vibration as is the case with the conventional apparatus, a motion approaching simple harmonic motion cannot be attained, and the power requirements of such an apparatus are unduly high. According to the present invention, the vibrated member is supported in a substantially unstrained rest position when the vibratory motor means is not operating, and is vibrated by positive power pulsations in both directions along the path of vibratory movement when the electromagnets are energized. The unstrained rest position may be obtained by adjusting the effective length of the rods 7, through adjustment of the nuts 7a and 7b, to cause the member 3 and the bars 12 and 13 to be placed in unstrained positions, with the armatures 4 substantially equally spaced between the electromagnets 5 and 6.

In the above-described form of apparatus the working surface of the member 11 is inclined at an angle to the vertical, whereby the desired feeding and conveying action from the feed end 11b to the discharge end 11c is secured with a purely horizontal movement of the vibrated member. Under some circumstances it may be desirable to produce a substantially horizontal movement of material over a flat working surface, in which event it may be desirable to incline the paths of vibration of the supports 12 and 13 (i. e., incline the minor transverse dimensions thereof) at a small angle to the horizontal, whereby an adequate vertical component of motion is imparted to the vibrated member. Such construction is obviously within the contemplation of the present invention.

In Figs. 4 to 6 we have shown an apparatus in which the vibrated member may comprise a screen or the like 21 disposed at a convenient angle to the horizontal and provided with supporting brackets 22 and 23 at its upper and lower ends respectively. The brackets 22 and 23 are shown as connected to the respective mid-portions of two transversely extending resilient supporting members 24 and 25, which are in turn connected at their end-portions to the frame structure 26. Thus, each transverse supporting member 24 and 25 is connected to the frame structure at positions spaced longitudinally of that member and is connected to the screen 21 at a position intermediate and spaced from the first-named positions, whereby the longitudinal portions of each of said members, between said positions of connection, are free to flex. A vibratory motor means 27, which may conform generally to that shown in connection with Figs. 1 to 3, is operatively connected to the screen 21 in any suitable manner, as by attachment of the vibratory driving rods 28 to the bracket 22 or to the support 24 adjacent said bracket. As a further modification of the structure shown in Figs. 1 to 3, the structure shown in Figs. 4 to 6 is arranged to cause vibration at the screen 21 in a direction having a small vertical component whereby a conveying action from the feed end 21a to the discharge end 21b is obtained. This type of vibratory movement is advantageously secured by inclining the paths of vibration or the minor transverse axes of the supports 24 and 25 at a slight departure from the horizontal. The degree to which the supports 24 and 25 are inclined will in general be relatively small, whereby but a small proportion of the gravity load of the screen member is realized as a component along the aforesaid paths of vibration. The vibratory motor means 27 is preferably disposed in such manner that the vibratory driving rods 28 act upon the associated support member 24 along the path of vibration of said member, as defined by the smaller dimension of the cross-section thereof, and it will be understood that the armature means 29 of the motor 27 are preferably positioned substantially symmetrically with respect to the electromagnets 31 when the screen member is under load, whereby the vibratory movement of the armature means will be substantially symmetrical each side of the rest or unenergized position thereof. This may readily be accomplished by adjustment of the nuts 28a on the driving rods 28, as will be apparent to one skilled in the art. In Fig. 5 the screen body 21 has been omitted, whereby the transverse support structure may be more readily discerned.

Fig. 7 is a partly diagrammatic showing of a modified structure in which two transverse supporting members are provided for a screen or the like, at the upper and lower ends thereof, respectively, as at 35 and 36, the upper support member 35 being inclined to one side of the vertical and the lower support member 36 being inclined to the other side of the vertical. The vibratory motor means may be caused to produce vibration of the upper support member 35, along the vibratory path or minor transverse dimension thereof, the direction of which is indicated by the line a—a. According to this construction, a small component of the gravity load of the upper end of the screen will result downwardly along the axis a—a, and a small component of the gravity load of the lower end of the screen will result downwardly along the path of vibration or minor transverse dimension, (the direction of which is indicated at b—b) of the lower support member 36. These two components may be caused to substantially neutralize one another, if desired, by suitable selection of the angle of inclination of the minor transverse dimensions or paths of vibration of the two support members, whereby the motor means remains substantially unaffected by such gravity load.

When a balancing angular disposition of the transverse support members is desired, we prefer to provide means for varying the angular inclination of one of said support members, whereby the two members may be caused to balance one another to any desired degree. Such a structure is shown in Figs. 8 and 9 and may comprise a frame structure 41 carrying a fixed transverse vibratory support member 42 to which a motor 43

may be attached, and an adjustable transverse vibratory support member **44** at the lower end of the screen. The member **44** may be supported on the frame **41** through the agency of split clamp members **45** of substantially circular shape, provided with two opposing "half-moon" key members (corresponding in position and function to the members **46***a* and **47***a* described below and shown in Fig. 8) having inwardly directed flat faces engaging the support member **44**. The clamp member **45** is preferably provided with a clamp bolt **48** whereby the key members may be caused to securely engage the support member **44** and constrain the same to a particular angle of inclination. The screen **49** may be secured to the central portion of the support member **44** through the agency of a clamp **45***a* provided with key members **46***a* and **47***a* and a clamp bolt **48***a*, in a manner comparable to the support members **45** above described. In the event that a change in the angle of inclination of the support member **44** is desired, it is merely necessary to de-energize the motor **43**, loosen the bolts **48** and **48***a*, rotate the member **44** to the desired setting, and then tighten the aforesaid bolts **48** and **48***a*.

The above-described construction providing for angular adjustment of the path of vibration of the lower transverse support member is of particular benefit where there is a change in the service to which the vibrated member is subjected, as in the case of screening problems where the live load of material on the screen is subject to change from time to time. It has been found that adjustment of the relative angles of inclination of the two transverse support members will provide some adjustment of the natural period of vibration of the screen and thus in part compensate for changes in the moment of inertia of the screen body and its live load, without requiring a change in the frquency of vibration produced by the motor means. It will be appreciated that for any given set of load conditions, etc., fixed setting of the relative angle between the paths of vibration of the two support members may be provided, and the feature of providing angular adjustment, as above described, increases the general usefulness of a commercially produced article in that it may be initially adjusted by the user to his particular operating conditions, irrespective of any subsequent adjustment for variation in operating conditions.

In each of the above-described embodiments, the electro-magnetic motor means is shown as operatively associated with the transverse supporting member which is located adjacent the feed end of the vibrated member, but it will be appreciated that this specific construction is not absolutely essential in that such motor means may be equally well associated with the transverse supporting member which is at the discharge end of the device. In General, however, the motor means is preferably removed from the space directly below the vibrated member, to facilitate inspection and repair, and in the case of screening devices, it is preferable to locate the same out of direct contact with the material which passes through the screen. Similarly, while the present described embodiments are shown as provided with two transverse supporting members, it will be appreciated that three or more of such supporting members may be provided along the length of the vibrated member, dependent upon the operating conditions, shape of the vibrated member, etc. Furthermore, a separate vibratory motor may be associated with any one or more of a plurality of such transverse supporting members, in which case the several vibratory motors are preferably synchronized in their movement, as by operating the same from a common source of alternating current energy. Other modifications of the invention will occur to those skilled in the art and we do not choose to be limited to the specific structural details herein set forth, but rather to the scope of the appended claims.

We claim:

1. In a vibratory apparatus, a frame structure constituting a relatively fixed member; a vibrated member having a feed end and a discharge end and a working surface over which material is to be moved longitudinally in a direction from said feed end toward said discharge end; a plurality of elongated resilient supporting bars having their longitudinal axes extending substantially horizontally and transversely with respect to said direction, said supporting bars being spaced from one another in said direction and each being connected to one of said members at two spaced positions along the length thereof and to the other of said members at a position intermediate and spaced from said two positions, the portions of said bars adjacent the positions of connection to the vibrated member being free to vibrate along paths of vibration, each having a component in said direction; and a vibratory motor provided with reciprocating driving means operatively connected to said vibrated member at a position adjacent the connection thereof to one of said bars, to produce a vibratory motion of said vibrated member along a path defined by the paths of vibration of said bars.

2. An apparatus as set forth in claim 1, said one bar having a materially greater resistance to deformation in the direction of the gravity load thereon, than to deformation along its path of vibration.

3. An apparatus as set forth in claim 1, said one bar comprising a wooden member having a transverse dimension in a direction parallel to said path smaller than the transverse dimension thereof normal to said path.

4. An apparatus as set forth in claim 1, said one bar having its path of vibration directed at a relatively small angle to the horizontal and having a materially greater resistance to deformation under vertical load than the deformation under forces along said path.

5. An apparatus as set forth in claim 1, said one bar having its path of vibration substantially horizontal, and having a materially greater resistance to deformation under vertical load than to deformation along said path.

6. An apparatus as set forth in claim 1, one of said bars being so disposed that the path of vibration thereof is inclined at an angle to the path of vibration of at least one of the remaining bars of said plurality of bars.

7. In a vibratory apparatus, frame means; vibrated means having a feed end and a discharge end and a working surface over which material is to be moved longitudinally in a direction from the feed end toward the discharge end; a plurality of elongated resilient supporting bars extending transversely with respect to said vibrated means and spaced from one another in said direction, each of said supporting bars being connected to one of said means at two positions spaced longitudinally of that bar and connected to the other

of said means at a position intermediate and spaced from said two positions, whereby said bars serve to support said vibrated means for vibratory motion along a path of vibration having a substantial component in said direction; and a vibratory motion provided with reciprocating driving means operatively connected to said vibrated means and operable to produce vibratory motion of said vibrated means along said path.

8. An apparatus as set forth in claim 7, a transverse dimension of each of said bars in a direction parallel to said path being smaller than the transverse dimension thereof normal to said path.

9. In a vibratory apparatus, a frame structure; a vibrated member having a feed end and a discharge end and a working surface over which material is to be moved longitudinally in a direction from the feed end toward the discharge end; a plurality of elongated resilient supporting bars extending transversely with respect to said vibrated member and spaced from one another in said direction and each having its central portion free to vibrate along a path of vibration having a substantial component in said direction, the end portions of said bars being rigidly supported on said frame structure and the central portions thereof being connected to said vibrated member and serving to support the same for vibratory movement; and a vibratory motor provided with reciprocating driving means operatively connected to said vibrated member, to produce vibratory motion of said vibrated member along a path defined by the paths of vibration of said bars.

10. In a vibratory apparatus, a frame structure; a vibrated member having a feed end and a discharge end and a working surface over which material is to be moved longitudinally in a direction from the feed end toward the discharge end; a plurality of elongated resilient supporting bars extending transversely with respect to said vibrated member and spaced from one another in said direction and each having its end portions free to vibrate along a path of vibration having a substantial component in said direction, the central portion of each of said bars being rigidly supported on said frame structure, said end portions of said bars being connected to said vibrated member and serving to support the same for vibratory movement; and a vibratory motor provided with a reciprocating driving means operatively connected to said vibrated member, to produce vibratory motion of said vibrated member along a path defined by the paths of vibration of said bars.

11. In a vibratory apparatus, frame means; vibrated means having a feed end and a discharge end and a working surface over which material is to be moved longitudinally in a direction from the feed end toward the discharge end; a pair of elongated resilient supporting bars extending transversely with respect to said vibrated means and spaced from one another in said direction, each of said supporting bars being connected to one of said means at two positions spaced longitudinally of that bar and connected to the other of said means at a point intermediate said two positions, whereby said bars serve to support said vibrated means for vibratory motion along a path of vibration having a substantial component in said direction; each of said bars having a major and a minor transverse axis, said major transverse axes of said bars being disposed at an angle to one another and the transverse dimension of each of said bars in a direction parallel to said path at the position of connection of the bar to said vibrated means being smaller than the transverse dimension thereof normal to said path at such position; and a vibratory motor provided with reciprocating driving means operatively connected to said vibrated means and operable to produce vibratory motion of said vibrated means along said path.

12. An apparatus as set forth in claim 11, one of said bars being rotatively connected to said frame means and to said vibrated means for rotation about its length, to provide for rotative adjustment of the major transverse axis thereof.

13. An apparatus as set forth in claim 11, and comprising in addition: rotatable clamp means secured to one of said bars at each of said three positions of connection thereof to said frame means and said vibrated means, said clamp means providing a rotatively adjustable connection of said one bar to said frame means and said vibrated means for rotative adjustment of said bar about an axis extending longitudinally thereof.

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