Aug. 5, 1941. J. A. FLINT 2,251,586

VIBRATORY FEEDER AND SCREEN

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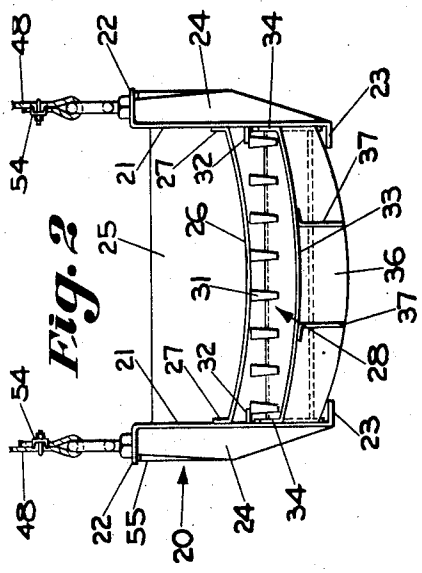


Fig. 2

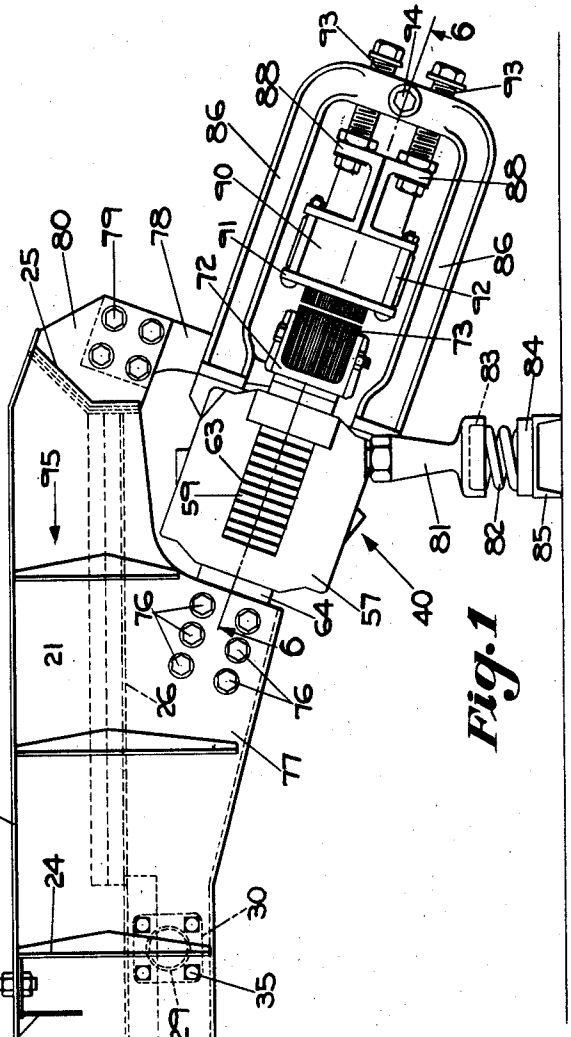


Fig. 1

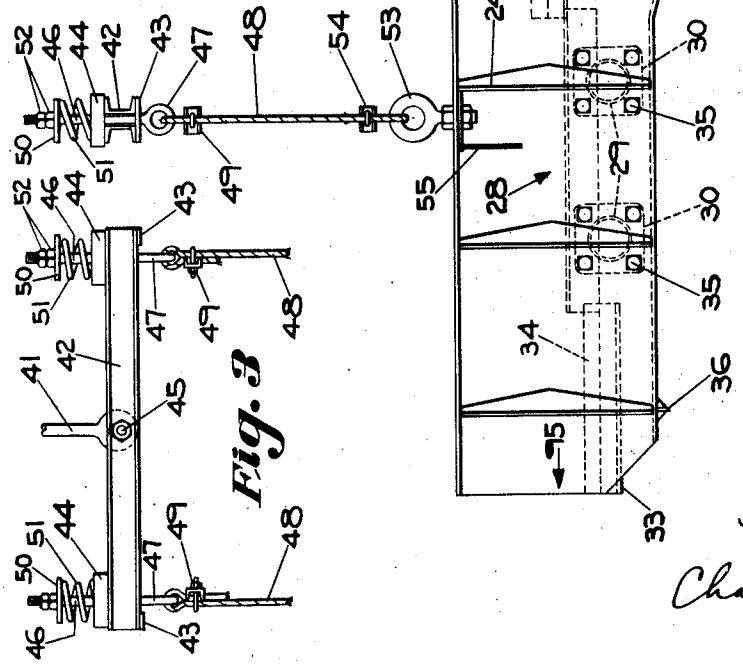


Fig. 3

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Fig. 4

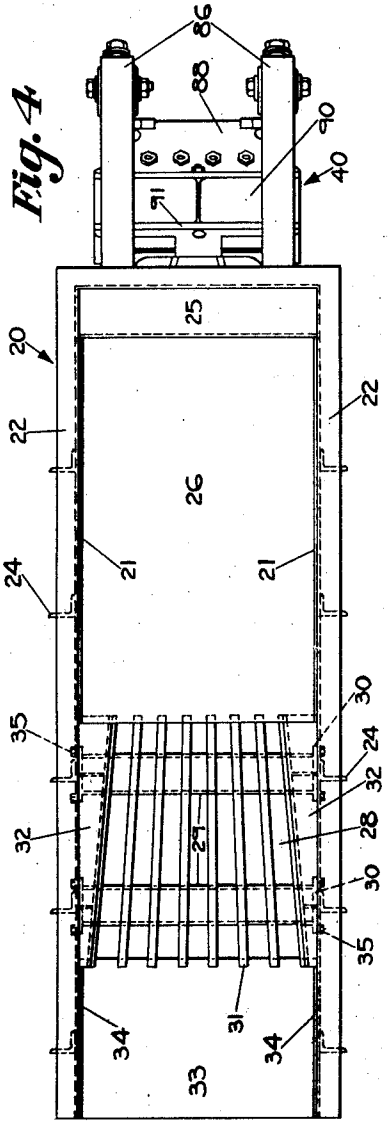



Fig. 5

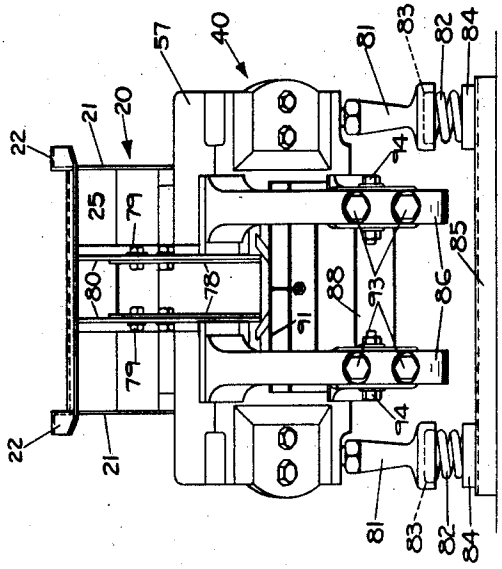
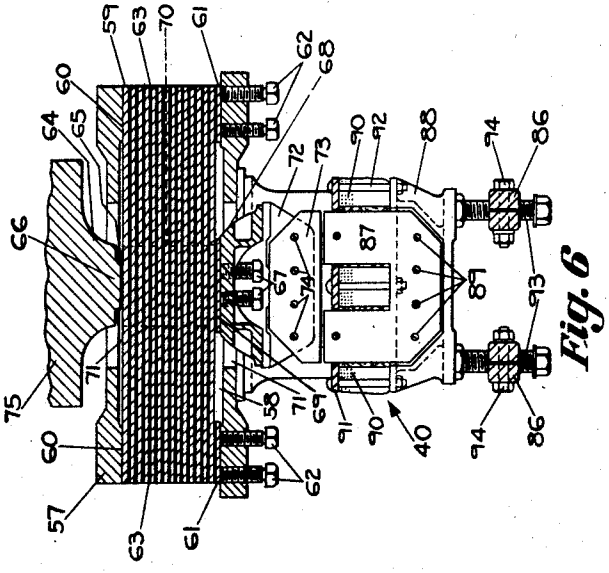



Fig. 6




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# UNITED STATES PATENT OFFICE

2,251,586

## VIBRATORY FEEDER AND SCREEN

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Application April 8, 1936, Serial No. 73,318

3 Claims. (Cl. 209—393)

This invention relates to a vibratory feeder and screen, particularly of the type adapted to operate at a high frequency from a vibratory type of electric motor.

An object of the invention is to provide an improved mechanism for supporting the deck of a vibratory feeder from the armature of the vibratory motor.

Other objects of the invention will appear hereinafter, the novel features and combinations being set forth in the appended claims.

In the accompanying drawings—

Fig. 1 is a side elevational view of a vibratory feeder and screen comprising my invention;

Fig. 2 is a front end view of the device of Fig. 1;

Fig. 3 is a view showing equalizing supporting means for the device of Figs. 1 and 2;

Fig. 4 is a plan view of the device of Fig. 1;

Fig. 5 is a rear end view of the devices of Figs. 1 and 4, and

Fig. 6 is a sectional view of the vibratory motor of the devices of Figs. 1 and 5 and taken on the line 6—6 of Fig. 1 looking in the direction of the arrows.

In a number of problems which are presented in the handling of materials, it is desirable to feed the materials at a relatively constant rate; for example, as from a hopper to a crusher or to a belt conveyor. It frequently also happens that a separation of the materials according to size is desirable. For example, if material in a hopper is to be reduced to a predetermined size before being fed to a belt conveyor, the work done by the crusher may be reduced by separating the material which is already of desired fineness, and then feeding to the crusher only the material which is larger than said desired fineness.

In another example, it may be desirable to feed materials of two different size ranges to two different belt conveyors whereby separate treatment may be given to the materials of different sizes.

The devices disclosed in Figs. 1 to 5 are particularly constructed to perform the functions of transferring material as from a hopper at a relatively uniform rate and effecting a separation of the material into two different sizes whereby the material may be directed over different paths.

As seen in Figs. 1, 2, 3, 4 and 5, the vibratory feeder and screen comprises a deck 20 formed by spaced upright side walls 21, 21 which may be formed of steel plates which have outwardly extending top flanges 22, 22, and inwardly extending bottom flanges 23, 23. Reinforcing angle members 24 are provided to lend rigidity to said side walls 21. At its rear or material receiving end, the deck 20 is provided with a transversely extending end plate 25. Adjacent the material receiving end of the deck 20 and extending between the side walls 21 and rigidly attached thereto, as by welding, is a bottom plate 26. Said bottom plate 26 is provided with upwardly extending flanges 27 which may be welded to the side walls 21. The rear end of said bottom plate 26 is also preferably welded to the end plate 25.

Positioned between the side walls 21 of the deck 20 and forwardly of the bottom plate 26 and extending below said bottom plate 26 thereby to receive material discharged from said bottom plate, I provide a screen in the form of a grizzly or grating 28. Said screen 28 is formed by a pair of transversely extending cylindrical pipes 29 to the ends of which are rigidly attached square attaching plates 30, as by welding. The cylindrical pipes 29 are provided with grooves in the tops thereof adapted to receive upstanding grating or grizzly bars 31. Said bars 31 are preferably welded to said cylindrical pipes 29. As well illustrated in Fig. 2 of the drawings, the grating bars are preferably wedge shaped, that is, they are thicker across the top than across the bottom. As a consequence, any material which can pass between two adjacent bars 31 can freely fall therefrom due to the increasing space therebetween from the top downward. This prevents any clogging of the screen or grizzly.

It is furthermore to be noted, as seen in Fig. 4, that the bars 31 are placed in a fan-like manner; that is, the distance between adjacent bars increases progressively from the material receiving end to the material discharging end of the screen 28. As a consequence all of the material received from the bottom plate 26 by the screen 28 which is capable of passing through said screen 28, will not pass therethrough immediately. In other words, the screening action of screen 28 is progressive. As a consequence, there is a more uniform discharge of material through the screen 28 over the entire area thereof.

To compensate for the fan-shaped formation of the bars 31, a pair of inwardly extending plates 32 is provided which are attached at one edge to the side walls 21 and at the other edge overhang the outermost bars 31 of said screen 28. It may also be mentioned that the plates 32 aid in positioning the screen 28 as they determine the uppermost position to which it can be moved.

Adjacent the discharge end of the deck 20 there is provided another imperforate bottom plate 33 which extends between the side walls 21

and has upstanding flanges 34, 34 adapted to be welded to said side plates 21, 21. It is to be noted that the bottom plate 33 is positioned below the screen or grizzly 28 and receives the material which is too large to pass through said grizzly 28 discharging it from the end of the deck 20. It is to be noted that the screen or grizzly 28 may be removed as a unit. As a consequence, the screen may be replaced by a screen of a different size. To provide for this removable attachment, the attaching plates 30 are attached to the side walls 21 of the deck 20 by threaded bolts or studs 35. It will be evident that by removing the bolts or studs 35 the entire screen or grating 28 may be readily removed.

It may also be noted that the bottom plate 32 is reinforced by a transversely extended upstanding plate 36 (Fig. 2), and a pair of longitudinally extending gusset plates 37, 37. It may also be pointed out that both the bottom plates 26 and 33 are concave. It has been found that this gives the most rigid form of bottom plate and prevents any tendency for the plates to vibrate of themselves under the vibratory action imparted to the deck 20.

In order to impart a vibratory motion to the deck 20 I provide a vibratory type of electric motor 40 which is of the continuous circuit or non-make-and-break type. Said motor 40 is so attached to the deck 20 that it will impart vibratory motion to said deck, which motion has both a vertical and a horizontal component relative to the plane of the deck. It is also preferred that the line of force transmitted by the motor 40 to the deck 20, pass through the center of percussion of said deck 20, thereby to realize the greatest utilization of said force. Said motor 40 is preferably of the type described in my Patent No. 1,846,326, issued February 23, 1932, though it is more specifically of the type disclosed in full detail in my application, Serial No. 27,230, filed June 18, 1935, for a Vibratory conveyor now Patent No. 2,094,785 dated Oct. 5, 1937.

Before describing in detail the structure of said motor 40, attention is directed to Figs. 1, 2 and 3, and to the means for supporting the deck 20 which is supplementary to the support afforded by said motor 40. Said supporting means includes a main hanger rod 41 pivotally attached to the center of an equalizing beam 42 formed by a pair of spaced channel members rigidly attached together, as by plates 43, 43 and blocks 44, 44. A pin 45 provides for said pivotal connection between the main hanger rod 41 and the equalizing beam 42.

Each of said blocks 44 is provided with an aperture through which extends a rod 46, the lower end of which is provided with an eye 47 adapted to receive a cable 48 clamped to said eye by a clamp 49. Adjacent the top of each of said rods 46 is a washer 50 adapted to ride upon a coil spring 51 which rests upon block 44. Adjusting and locking nuts 52 are provided on the upper end of rod 46. The lower ends of the cables 48 are attached to eyes 53 by clamping means 54, said eyes 53 being carried by the flanges 22 of the deck 20. Reinforcing brackets 55 may be provided to reinforce the flanges 22 adjacent the position of attachment of eyes 53. It will thus be evident that by hanging the main hanger rod 41 from a super-structure the deck 22 will be resiliently supported for free vibratory movement in either a vertical or horizontal direction with a load on said deck being carried equally by the two cables 48. It will be evident that this supporting of the deck 22 is supplementary to that afforded by the motor 40, as will be evident from the following description.

Referring particularly to Figs. 1, 4, 5 and 6, attention is directed to the construction of said motor 40. Said motor 40 is of the vibratory non-make-and-break type and comprises a base casting 57 which is of heavy construction, being made of cast iron, which casting is provided with a longitudinally extending opening 58 through which extends a plurality of spaced spring leaves or vibrator bars 59, best illustrated in Fig. 6. These spring leaves 59 are clamped adjacent their ends between bosses 60 on the base casting 57 and clamping plates 61, by means of clamping screws 62. Appropriate spacers 63 are provided between the spring leaves 59 adjacent their clamped area. It is thus evident that each of the spring leaves 59 is mounted for free flexure.

Rigidly clamped to the center of the spring leaves 59 is an armature shaft 64 having an opening 65 therein through which said spring leaves 59 extend. The armature shaft 64 has a boss 66 extending into the opening 65 to bear against one of the end spring leaves 59. The armature shaft 64 on that side of the leaf spring 59, opposite the boss 66 comprises a web 68 which carries a plurality of clamping screws 67 which extend through the web 68 in position to bear against a clamping plate 69 which fits against another end spring leaf 59. Appropriate spacers 70 are stacked alternately between the spring leaves 59 in alignment with the boss 66 and the clamping plate 69. It is thus evident that upon the screwing home of the clamping screws 67, the armature shaft 64 will be rigidly attached to the centers of the spring leaves 59 and consequently the leaf spring 59, 63, 70 resiliently connects the armature shaft 64 to the base casting 57.

The base casting 57 is provided with a transversely extending opening 71 through which the armature shaft 64 extends. Said armature shaft 64 carries a bracket 72 upon which is mounted an armature 73 formed of laminated sheet steel, and rigidly attached to said bracket 72 by tie bolts 74.

The armature shaft 64 also carries an integral head 75 which is rigidly clamped to the deck 20 by means of clamp bolts 76 which co-operate with appropriate brackets or side plates 77 rigid with said deck 20. The axis of the armature shaft preferably passes through the center of percussion of the deck 20. In addition, a bracket 78 (Fig. 1) may be provided which is rigidly clamped to the deck 20 at one end by appropriate clamp bolts 79 and brackets 80 and at the other end to the armature shaft 64 adjacent the bracket 72. If desired, this bracket 78 may be omitted but I prefer to employ it so that the vibratory movement of the armature shaft 64 will be more widely distributed along the trough 21. This bracket 78 will also make a more rigid deck construction and will reduce any tendency of buckling by said deck 20. In addition, this additional bracket 78 eliminates the cantilever structure of armature shaft 64 due to the static load presented by the weight of the deck 20. That is, the static moment transferred to armature shaft 64 through bracket 78 about the leaf spring 59, 63 as a fulcrum, will oppose the static moment transferred thereto through brackets 77, thus distributing these static forces to opposite ends of armature shaft 64.

The base casting **57** is preferably flexibly supported upon standards **81**, of which there is one adjacent each side, which standards **81** are mounted on coil springs **82** adapted to fit cupped recesses **83** in said standards **81** and to be carried adjacent their bottom end in clamp plates **84** which may be rigidly attached to a base **85**. Due to the weight of the base casting **57**, only small vibrations will be manifest therein but it is preferred that these vibrations be not transferred to the base **85**, and thus the coil springs **82** are provided to make a flexible support for said base casting **57**.

Rigidly attached to the base casting **57** is a pair of spaced U-brackets **86**. Mounted upon the U-brackets **86** is a field structure for the vibratory motor **40** which comprises a U-shaped magnetic field core **87** preferably formed of sheet steel laminations which are carried between brackets **88** and are rigidly attached thereto by tie bolts **89**. Surrounding each leg of the magnetic field core **87** is a field coil or solenoid **90** which is held in place by plate **91**, which plate **91** is mounted on the brackets **88** by tie bolts and spacers **92**. The entire field assembly, comprising the U-shaped magnetic field **87**, constitutes an electro-magnetic motor having spaced poles separated by air gaps from the adjacent armature **73**.

The field coils **90** and the brackets **88**, as well as the other parts rigidly attached thereto, are adjustably supported on the U-shaped brackets **86** by a plurality of threaded rods **93**. These threaded rods **93** may be adjusted with respect to the U-shaped brackets **86** to adjust the air gaps between the poles of U-shaped magnetic core **87** and the armature **73**. These air gaps are so adjusted that the armature **73** and the field **87** will never come into contact with each other during operation. Clamping bolts and nuts **94** are provided for clamping the threaded rods **93** in any adjusted position, as allowed by the split condition of brackets **86**.

The field coils or solenoids **90** may be connected either in series or in parallel and when energized from any source of constant frequency alternating current as, for example, a source of commercial alternating current of 25, 30, 50 or 60 cycles, the armature **73** will be attracted to the field **87** twice during each cycle of operation and will be effectively released when the flux in the magnetic field **87** passes through zero in changing its direction. Therefore, the armature **73** will operate at a frequency of 7200 cycles per minute for a current of 60-cycle frequency. The operating frequency thereof for currents of 25, 30, 50 and 60 cycles per second will be obvious. When the armature **73** is attracted to the field **87**, the spring leaves **59** will be deflected to store energy therein. When the flux in the magnetic field **87** passes through zero or approaches zero, as aforesaid, the armature **73** will be released and the energy stored up in the spring leaves **59** will be effective to move the armature **73** away from the magnetic field **87**. It is thus evident that when the field coils **90** are energized from a source of alternating current, the armature shaft **64** will be vibrated at a frequency twice the frequency of the energizing current. In order to control the amplitude of vibration of the armature **73** and thus the rate of travel of the material along the bottom **26**, a variable rheostat may be placed in series with said field coils **90**.

It is also contemplated that the field coils **90** be energized simultaneously from sources of alternating current and direct current, generally termed "mixed current." That is, a source of direct current, such as a direct current generator, is connected in series with the field coils **90** leading to a source of alternating current. As a consequence, there will be no actual reversal of current flow in the field coils **90** and the armature **73** will be attracted only once during each cycle of the alternating current source. Under these conditions, the armature **73** will operate at a frequency of 3600 cycles per minute where the source of alternating current is 60 cycles per second. The operating frequency of armature **73** for currents of 25, 30, 50 and 60 cycles per second will be equal to their frequency rather than twice the amount as was the condition when alternating current alone was employed. Such a system for operating a screen motor for "mixed current" is disclosed in my above mentioned patent for an Electric reciprocatory motor, No. 1,846,326, granted February 23, 1932.

The operating frequency is preferably as high as possible and the angle of vibration of the deck, as pre-determined by the inclination of armature shaft **64**, is so related to the frequency of vibration that the downward component of movement of the material supporting bottom **26** is at such a rate that any material thereon will fall at a lower rate and thus not ride as a dead load on said bottom **26**. That is, the deck bottom **26** will move downwardly faster than a particle will fall, whereby particles will not ride down on the bottom **26**. The bottom **26** will thus never carry the material as a dead load but, when moving upwardly, will strike downwardly moving particles a sharp blow, similar to a baseball bat striking a ball, and thereby throw or impel the particles through space, through which they travel in a series of hops along the bottom **26** only contacting therewith at intervals and then only for a time sufficient to receive another blow or impulse. Where the operating frequency of the trough **21** is 7200 vibrations per minute, and the amplitude of vibration is $\frac{1}{32}$ in. the angle of inclination of the armature shaft **64** may be 10 degrees, though 15 degrees is a common setting. For lower frequencies, the angle must be increased to compensate therefor. It is contemplated that angles as high as 40 degrees may be employed where the lower vibrating frequencies, above mentioned, are employed. As a consequence, the natural period of vibration of the deck **20**, and parts rigid therewith, will be independent of the actual load thereon and will be constant at a definite value. Where lower frequencies are employed, the angle of inclination of shaft **64** will be increased to maintain this condition.

It is to be noted that the deck **20** is partially supported from the armature shaft **64** and as it is rigidly attached to said deck **20**, the vibratory movement of the armature shaft **64** will be transferred to said deck **20**. Said deck **20** and the armature **73** and any parts which are rigidly attached to either, therefore constitute a vibratory structure which is vibrated by the motor **40**. This vibratory structure will have a natural period of vibration which is determined primarily by the weight thereof and by the restoring force of the spring leaves **59**. That is, the restoring force of the spring leaves **59** is so related to the weight of the vibratory structure that the natural period of vibration of said vibratory structure will be pre-determined at a desired value. In

practice, it has been found to be extremely desirable to pre-determine this natural period of vibration of the vibratory structure at a frequency which is near to, but slightly different from, the frequency at which the armature **73** of the motor is vibrated. For example, if the armature **73** is vibrated by a current having a frequency of 60 cycles per second and at a frequency of 7200 cycles per minute, the natural period of the vibratory body is preferably selected at a value slightly above or slightly below 7200 cycles per minute, for example, at 7000 or 7400 cycles per minute.

It is entirely possible, but not desirable, to operate the device by pre-determining the natural period of vibration of the vibratory structure at exactly the period of vibration of the armature **73** which, in the example given, would be 7200 cycles per minute. It has been discovered, however, that if the period of vibration of said vibratory body is in exact resonance with the frequency of vibration of the armature **73**, the amplitude of vibration of the deck **20** will vary appreciably with the load which is placed on said deck or, in other words, with the amount of material carried on the material supporting bottom **26**.

In addition, it has been found that when no material whatever is carried on the material supporting bottom **26**, there is danger of the armature **73** striking the poles of magnetic field core **87** and causing damage to either or both if exact resonance is maintained. This is due to the fact that when a vibratory body is operating at its natural frequency, the energy necessary to vibrate said body is represented only by the frictional losses thereof and there is a possibility of the amplitude of vibration becoming unduly large. However, by vibrating the vibratory structure at a period slightly different from its natural period, either above or below the natural period, the vibrations thereof are forced and there is always a minimum amount of artificial load on said vibratory structure. This prevents any damage to the motor when the actual physical load—for example, the material carried on the bottom **26**—is reduced to zero. In addition, it means that the variations in the actual physical load represented by the material carried on the bottom **26** will not have a great effect upon the amplitude of vibration of the deck **20**. As a consequence, the amplitude of vibration of said deck **20** will be substantially constant regardless of the actual physical load carried on the material supporting bottom **26**.

Furthermore, by operating the vibratory structure at a frequency which is near its natural period, the amount of energy necessary to vibrate said vibratory structure is very materially reduced over what it would be if said vibratory structure was not operated near its natural frequency but were operated at a frequency distantly removed therefrom. This results in a great saving in operating costs, due to the use of a small amount of energy, and makes possible the employment of a motor **40** which is of much smaller size than would otherwise be required.

It is to be noted that the axis of vibration of the armature shaft **64** is parallel with the longitudinal axis of said shaft **64** and this axis forms an acute angle with the deck **20** and the material supporting bottom **26**. This acute angle may vary between 10 and 40 degrees and in practice is usually set at 15 or 20 degrees. This angle is very important and it is so selected that at the rate of vibration of the deck and for a minimum operating amplitude of vibration the time of downward movement of the deck, between its extreme positions, during each oscillation, will be greater than the time the material will fall this distance. This means that the bed of materials will not operate as a dead load on the deck and will therefore not appreciably affect the natural period of vibration thereof, regardless of the actual load thereon. The natural period of operation of the deck is therefore independent of the load thereon. Due to the mode of vibration of the deck **20**, the vibratory action of the bottom **26** will have both a vertical and a horizontal component. The vertical component will be effective to impel the particles of material upwardly from the bottom **26** and the horizontal component will be effective to transfer said particles in the direction indicated by the arrows **95**. Due to this construction, the material will therefore be effectively conveyed from the material receiving end to the material discharge end.

In the operation of the device, material will be fed to the rear end of the deck **20** onto the bottom plate **26**. The vibratory action of the motor **40** on the deck **20** will convey the material to the left, as seen in Fig. 1. The material will be discharged from the bottom plate **26** in cascade fashion to the screen **28**, where it will be effectively separated according to size; those particles of material which are sufficiently small size passing through said screen **28**. Large materials will be conveyed by the screen **28** to the bottom plate **33** of deck **20**, material moving in cascade fashion from screen **28** to bottom plate **33**. The large particles of material will then be discharged over the end of the bottom plate **33**.

Obviously those skilled in the art may make various changes in the details and arrangement of parts without departing from the spirit and scope of the invention as defined by the claims hereto appended, and I therefore wish not to be restricted to the precise construction herein disclosed.

Having thus described and shown an embodiment of my invention, what I desire to secure by Letters Patent of the United States is:

1. In a vibratory conveyor, the combination with a deck, of a vibratory electric motor for supporting and vibrating said deck to impart a conveying action to any material carried thereby, said motor comprising a main frame carrying a plurality of leaf springs anchored thereto at their ends and lying in planes which make acute angles with the plane of said deck, an armature shaft anchored to the center of the leaf springs, brackets attaching said armature shaft to said deck both forwardly and rearwardly of said leaf springs, and means for vibrating said armature shaft.

2. In a vibratory conveyor, the combination with a deck, of a vibratory electric motor for supporting and vibrating said deck to impart a conveying action to any material carried thereby, said motor comprising a main frame carrying flat leaf spring means anchored at its opposite ends to said main frame and lying in a plane making an acute angle with the plane of said deck, an armature shaft anchored to the center of said leaf spring means and constructed and arranged to provide a supporting connection between said deck and said leaf spring means, brackets attaching said deck to said armature shaft both forwardly and rearwardly of said

leaf spring means, and means for vibrating said armature shaft.

3. In a vibratory conveyor, the combination with a deck, of a vibratory electric motor for supporting and vibrating said deck to impart a conveying action to any material carried thereby, said motor comprising a main frame carrying flat leaf spring means anchored at its opposite ends to said main frame and lying in a plane making an acute angle with the plane of said deck, an armature shaft anchored to the center of said leaf spring means and constructed and arranged to provide a supporting connection between said deck and said leaf spring means, means constructed and arranged to produce a torque on said spring means which opposes that caused by the aforementioned connection to said deck thereby relieving the twisting strain on said leaf spring means due to the aforesaid supporting connection thereof to said deck, and means for vibrating said armature shaft.

JAMES A. FLINT.