

[54] **WEAR RESISTING HOLD-DOWN MEANS FOR SCREENING MACHINE**

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[58] Field of Search 209/403, 405, 408, 319,
209/326, 372, 363, 364, 409, 415, 412;
188/1 B; 248/361 R, 361 A, 25

[56] **References Cited**

UNITED STATES PATENTS

2,114,406	4/1938	Simpson.....	209/403
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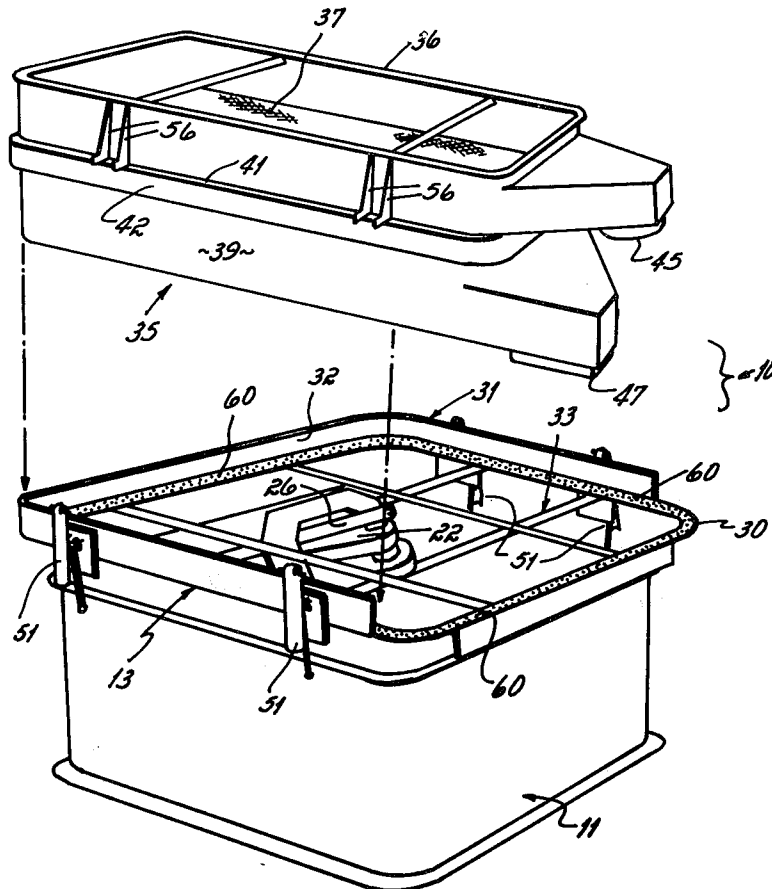
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[57] **ABSTRACT**

In a screening machine having a screen assembly which is demountably attached to a vibratory frame, the screen assembly is seated on a mounting surface of the frame, bounded by a lip which extends around the edge of the assembly but which does not engage it. The screen assembly is held on the mounting surface by detachable clamps. As the interface between the screen assembly and the frame at the mounting surface, a rigid, inelastic composite type friction material is used, to resist relative motion between the frame and the screen assembly and thereby eliminate abrasive wear and loss of the intended screening motion.

10 Claims, 3 Drawing Figures



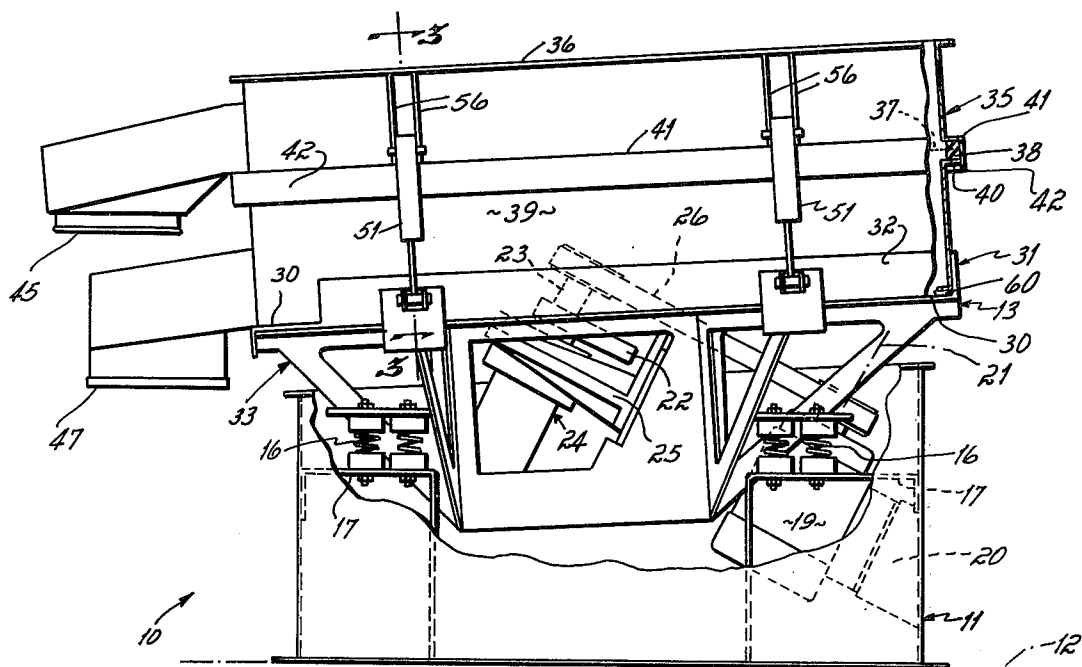


Fig. 1

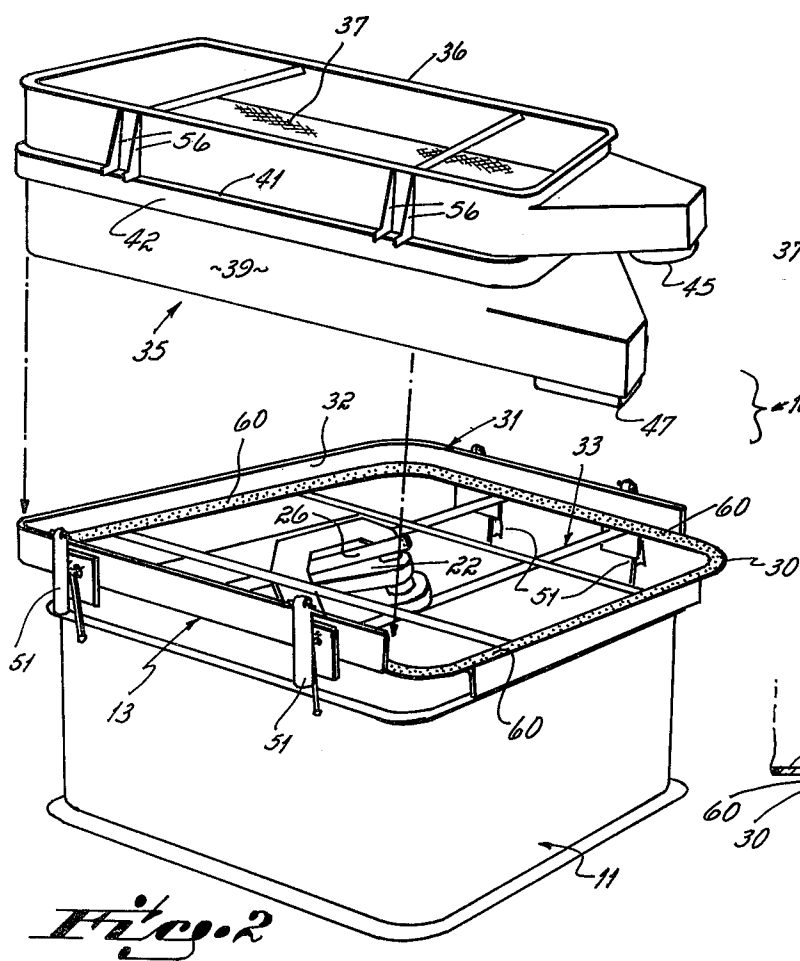


Fig. 2

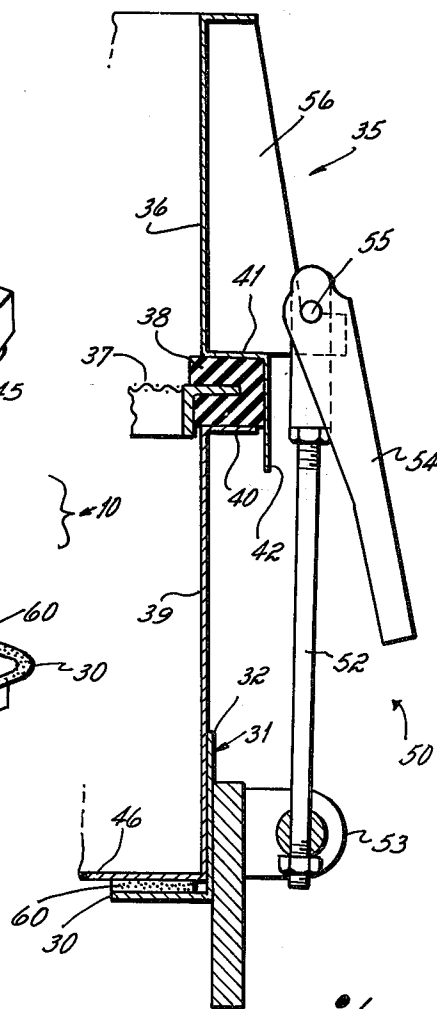


Fig. 3

WEAR RESISTING HOLD-DOWN MEANS FOR SCREENING MACHINE

This invention relates to screening machines of the type used to separate or classify mixtures of solid particles of different particle sizes into classes of different sizes. The invention also relates to screening machines of the type used for liquid-solid separations, i.e., for separating solid particles above a certain size from a liquid in which they are carried. More particularly, the invention relates to means for reducing wear caused by rubbing of the screen assembly on the vibratory frame of such machines.

In such machines the screen (which may be woven or an apertured plate) is mounted in what is often called a "screen deck" which includes a supporting edge around the periphery of the screen. Usually there are associated with the screen or deck other materials handling elements that are vibrated with it and that form walls or partitions above or below the screen, for containing the liquid and/or particulate materials adjacent to the screen and directing them to outlets. These elements may comprise a top cover and a pan beneath the screen. In the case of multiple deck units spacer pans or frames are provided between multiple screens. The screen or screens can often be removed from these elements for cleaning, replacement or installation of a screen of different mesh size. Together, the screen and these elements, whatever their exact nature, are referred to herein as the "screen assembly".

The screen assembly is demountable from a frame, table or box to which vibratory motion is imparted, typically by one or more eccentric rotors or other means of vibratory excitation. This frame, table or box is referred to herein as a "vibratory frame". The screen assembly is secured to the vibratory frame so that it can be removed for cleaning, change or replacement and also for ease of access to the vibratory drive.

In large commercial machines the weight of the screen assembly carried by the vibratory frame, and the weight of the material being processed in it, may total several hundred pounds or more. This represents a very substantial inertial mass which resists the rapid changes of motion that are applied to it by the rotary drive acting through the vibratory frame. As a result of these inertial forces, in operation there tends to exist a rubbing action between the vibratory frame and the screen assembly. The screen assembly must, of course, be secured to the frame sufficiently securely that the screen assembly essentially follows the vibratory motion of the frame.

Various securing devices are known for clamping screen assemblies to vibratory frames. In Simpson U.S. Pat. No. 2,114,406, a screen deck is clamped against a frame in the form of a box, there being a compressible elastic gasketlike sealing strip around the deck which is pressed against the frame. The clamp exerts a force directed perpendicularly to the planes of the screen and the frame, and thereby increases the frictional forces on the sealing strip which resist movement of the screen deck. Apart from and in addition to these clamping forces, movement of the screen relative to the frame is positively prevented by jack screws mounted in the frame which are set up to bear against the vertical side wall of the screen deck, so that the deck is held in rigidly fixed position in the frame.

In Nolte U.S. Pat. No. 3,433,357, issued Mar. 18, 1969, there are shown quick-release clamp means whereby overcenter clamps are detachably connectable between a box of the type shown in the Simpson patent previously referred to, and the cover of a screen assembly, to clamp the screen assembly against the frame. As each clamp is drawn closed, a compression force is exerted on the screen assembly which holds it immobile against vertical separation from the vibratory box. Rubber sealing strips are provided between the top cover and the screen, and between the screen and the vibratory box. Again, jack screws hold the screen assembly immobile in the direction parallel to the plane of the screen.

While jack screws are effective for the purpose intended in screening machines of the type shown in those patents, in some other types of machines use of jack screws is not desirable because they slow the screen changing process and because they require relatively heavy frame walls that will not buckle or bend under the stress which they exert.

In many screeners, the combination of operating frequency and cycle amplitude produces relatively low acceleration forces on the screen assembly. For example, commercial machines of the type shown in the Simpson and Nolte patents have a maximum stroke of 2 inch and a maximum frequency of 313 rpm. This establishes a maximum acceleration of 2.8 g acting on the screen assembly in the plane parallel to the screen. The jacks hold the screen assembly immobile in the frame against this force. However, in the absence of jacks or other positive abutments, it becomes increasingly more difficult to prevent relative rubbing motion of the screen assembly over the vibratory frame, if the frequency and/or amplitude of operation is increased such that the g forces are of the order of 4 or 5 or more. The usual clamping force by itself is insufficient to restrain such relative movement parallel to the plane of the screen, although it does prevent movement of the screen in the direction perpendicular to its plane.

The problem with relative motion between the vibratory frame and the screen assembly is that it causes rapid wear, wastes energy, generates heat, and destroys the desired screening motion. Since many machines are operated on an almost continuous basis, the wear builds up at a surprisingly rapid rate. Many of the materials to be processed are themselves at an elevated temperature, and this plus the additional heat generated by frictional losses through such rubbing create temperatures at the interface between the vibratory frame and the vibrated components which are so high as to lead to degradation of a gasket or seal.

In efforts to eliminate these problems but without the use of positive physical abutments such as jacks, a number of different approaches have been tested. The fact that none of them were commercially useful illustrates the difficulty of the problem. Specifically, these approaches were tried:

1. An over-center cam clamp mechanism of the type shown in the above described Nolte patent was utilized to provide clamping force on a metal-to-metal interface between the screen assembly and the vibratory frame table of a machine operating at 20 cycles per second with a stroke amplitude of ¼ inches, representing an acceleration of 5 g's. No jacks or other positive physical restraints against motion parallel to the plane of the screen were employed. Operation of the machine resulted in a

relative motion condition created by the inertial forces produced by the vibrating masses. This relative motion occurred over the metal-to-metal interface between the vibrating frame and the bottom pan of the screen assembly, and resulted in metal abrasion of an unacceptable degree.

2. A vulcanized rubber surface or cushion was added to the table of the machine described in (1) above, and the screen assembly was clamped against this resilient material. The result in operation was that the shear stresses on the rubber caused a heat buildup. The rubber soon became soft and sticky and degraded rapidly.

3. A hard vulcanized rubber was utilized in place of the softer rubber surface of test (2), and the screen assembly was clamped against this. In this case relative motion took place between the bottom pan and the rubber, and again the rubber rapidly started to wear and to heat up to an unacceptable degree.

4. In another test, an epoxy coating was applied to the metal surface of the vibratory frame, and the metal bottom pan was clamped against this. Again wear due to the relative motion began to occur rapidly and undue heat was evident.

5. Since the cause of the heat generation was the relative movement between the two assemblies which were clamped together, another approach was to eliminate the movement by provision of a positive constraint or abutment, rigidly preventing such motion. In place of jacks, interlocking means in the form of comb or tooth-like projections or bosses were welded onto the bottom pan at the clamp handle locations, and mating receiving members were affixed to the frame, such that a positive interlock (in the direction of the motion) was established when the screen assembly was clamped to the table. This approach did eliminate the motion and thereby solve the wear problem, but it was an undesirably expensive solution in terms of cost, and it lacked simplicity, required accurate alignment in assembly, and failed to present the smooth surface desirable for cleaning, etc.

Thus, none of the foregoing attempts to solve the wear problem provided a solution which would have been commercially acceptable.

We then found that if a rigid, inelastic composite friction material, such as a material of the type which is ordinarily used as brake linings or clutch pads, is secured at the interface between the screen assembly and the vibratory frame, and the screen assembly is clamped against this material but without other restraints, vibratory wear is almost completely eliminated. This material does not deform or undergo internal motion like rubber, or wear like non-composites, and no significant heat is generated. This solution is both inexpensive and easy to apply.

In preferred form, the invention comprises a screening machine wherein the vibratory frame on which the screen assembly is carried presents a planar peripheral mounting surface on which a layer of brake shoe composition is mounted. The mounting surface has an upstanding rim or lip around it, but which is oversize with respect to the screen assembly so that the latter can be seated on the mounting surface without contacting or bearing against the rim. This rim serves as a guide for approximate positioning of the screen assembly on the frame, but does not engage it or restrict its motion. There is no metal-to-metal contact between the screen assembly and the frame at the weight supporting interface, and no restraints (except the clamps) are needed.

The vibratory motion and the weight of the screen assembly are transmitted through the brake shoe composition. This enables the screen assembly to be placed on the brake shoe composition interface without being positioned precisely, and without jacks being tightened, lugs engaged, or the like. This is desirable not only from the standpoint of providing manufacturing tolerance but also because a close interfit would require accurate positioning and thereby slow rate of assembly, and also because a close interfit would tend to create localized stresses at high g loads.

The invention can best be further described and its operation explained by reference to the accompanying sheet of drawings, in which:

FIG. 1 is a side elevation, partly broken away, of a screening machine in accordance with a preferred embodiment of the invention;

FIG. 2 is an exploded perspective view of the machine of FIG. 1, showing the manner in which the screen assembly is seatable on the vibratory frame; and

FIG. 3 is an enlarged vertical section taken on line 3—3 of FIG. 1.

For purposes of explanation and not limitation, the invention is described in detail hereinafter by reference to a "single deck" machine of the type in which the feed material is separated by the screen into two fractions, oversize particles remaining on the screen and being taken off one end of the screen, while fines and/or liquid pass through the screen into a bottom pan from which they are removed. From the description which follows those skilled in the art will understand that the invention is not limited to this embodiment alone.

In the preferred embodiment shown, the screening machine designated generally at 10 includes a base 11 which rests upon and is secured to a floor or other support structure 12. A vibratory frame in the form of an inclined "table" 13 is resiliently mounted to the base 11 by a plurality of coil springs, each designated by 16, which are connected between the table 13 and bracket mounting means 17 on the base. An electric drive motor 19 is carried by a motor mount bracket 20 affixed to the base, with the motor axis of rotation 21 extending at an angle of 30° to vertical. An eccentric or rotor 22 is mounted to a shaft 23 which is journaled in a housing 24. The housing 24 is carried by a bracket 25 beneath the table. Rotor shaft 23 is parallel to motor axis 21 and power is transmitted from the motor to the shaft by drive belts 26.

The base, rotor drive, and spring mountings shown do not comprise this invention, and they are illustrated herein only as a part of an environment in which the invention is utilized. These elements may be conventional in form and therefore are not described in further detail herein.

The vibratory frame 13 presents a peripheral, planar mounting surface 30, which in the embodiment shown is inclined at an angle of 3° with respect to horizontal. Mounting surface 30 may comprise one leg of an angle or a flange generally designated at 31, which is mounted to the table understructure or bracings 33, by which the rotor bearing is carried. Flange 31 has an upright outer leg 32 which bounds the mounting surface 30, forming a lip or rim on three sides of the table.

A screen assembly generally at 35 is carried on and secured to mounting surface 30. The screen assembly is made up of the screen and the materials handling elements which are vibrated with it by motion imparted

through the frame. In the embodiment shown, the screen assembly comprises a top cover 36, a single screen 37 which is framed in a deck having a peripheral sealing strip or gasket or rubber 38, and a bottom pan 39. The screen deck is positioned between the top cover and the bottom pan and its sealing strip 38 is captured between them. The sealing strip 38 rests upon an outwardly turned shoulder 40 at the top of bottom pan 39, and top cover 36 has an outwardly turned leg or shoulder 41 around its lower edge which in turn bears upon sealing strip 38. A downturned skirt 42 extends from top cover shoulder 41 and extends below the shoulder 40 of bottom pan 39.

Both the top cover 36 and the bottom pan 39 are generally rectangular in plan with rounded corners, and have upstanding side walls. The material to be processed is discharged through the top cover 36, onto the screen 37. In operation of the machine, oversize particles too large to pass through the screen remain on the screen and move down its inclined surface, to an oversize outlet 45 at the lower end of top cover 36. Fines or liquid, i.e., materials which pass through the openings in screen 37, drop onto the bottom 46 of bottom pan 39 and are transported by the vibratory action to an outlet 47. The bottom 46 of the pan is adjacent to mounting surface 30 of the table or frame 13. The bottom pan is sized and positioned so that its side walls are confined within the upright flange or rim 32, but do not contact it. Preferably the clearance gap is about $\frac{1}{8}$ inch.

For reasons of ease of assembly and disassembly for cleaning, it is desirable that the screen assembly 35 is readily demountable from table 13. Preferably there is no physical connection (such as screws, bolts, etc.) between bottom pan 39 and the table on which it is placed, which would be difficult to clean and which would also slow assembly and disassembly. To maintain the stacked elements of the screen assembly in immobile relation with respect to one another and with respect to table 13, a plurality of over-center clamping means 50 are provided. In the embodiment shown, four over-center clamps 51 (two on each side) are used to clamp the top cover toward the table. The clamps 51 may, by way of example, be of the type which form the subject of the previously identified Nolte U.S. Pat. No. 3,433,357.

As best shown in FIG. 3, each clamp 51 includes a connecting member or shank 52 which is pivotally journaled between ears of a mounting bracket 53 affixed to the table 13, to rim 32. At the upper end of shank 52, an operating handle 54 is swingably mounted. The handle 54 has a pair of projecting ears or pins 55 which are disconnectably seatable on spaced lugs 56, 56 mounted to the side wall of top cover 36, generally in alignment with the bracket 53 below. As described in further detail in the Nolte patent, when the ears 55 are engaged with the lugs 56 and the handle is swung across its center position, shank 52 is put in tension and a downward or compressive force is exerted through the lugs 56 so that the top cover 36, the screen 37, bottom pan 38 and table 13 are clamped together.

As previously explained, there is a clearance gap between the side wall of the bottom pan and the table rim or flange 32 such that, absent clamping, the screen assembly while vibrating could shift laterally (within the plane of the table). Jacks (i.e., screws pressing the bottom pan sidewise against the flange) could immobilize it but these would have to be loosened each time the

assembly is removed. The screening assembly and the material being processed on it in operation may weigh several hundred pounds, but at high amplitude and frequencies the accelerational forces are so high that even though clamped, it tends to slip or move relative to the table in operation. Such motion is of course anti-productive, because it involves conversion of kinetic energy into frictional heat and causes increased wear on the table and on the bottom pan. Increasing the clamping force by shortening the effective length of clamp shank 52 is not an effective solution, because it is then very difficult to move the handle over-center, and also because the resulting compression forces on the sheet metal walls can cause buckling. Absent some means for effectively counteracting slip, tests have shown that a stroke amplitude of $\frac{1}{4}$ inch and a vibratory rate of 1200 rpm, the resulting wear can produce an oxide dust in the course of 24 operating hours. Eventually this abrasion would cause a bottom pan failure.

As described above, this type of slip has been found a surprisingly difficult matter to combat. As previously shown, a number of proposals, any of which would have seemed to be effective, in fact were not.

To overcome this problem of relative motion between the screening assembly and the screen table, the weight supporting interface between the screen assembly 35 and the frame 13 is surfaced with a layer 60 of a rigid, inelastic composite frictional material. This layer 60 may be secured to either the mounting surface 30 of the table, or to the lower surface of bottom pan 39; it is most convenient to mount it to the table. As shown in FIG. 2, a series of discrete strips of this composition are secured end to end along the mounting surface 30.

The nature of the material 60 is important to the invention. In particular, we have found that a rigid composite material containing metal or oxide particles and/or fibers, bonded in a rigid matrix, commonly known as brake shoe material and used on clutch shoes or brake bands, is especially effective. Such composite friction materials are well known per se, see for example U.S. Pat. Nos. 2,910,449; 2,861,964; 2,954,853; 2,970,675; and 3,344,094, to which reference is hereby made.

One brand of such material which is commercially available is a Johns-Manville material sold by the Scara Pack Corporation, under their designation JM 232. This particular material has a coefficient of friction, at 350° F., of 0.45, is approximately $\frac{1}{4}$ inch thick, and has ability to withstand a pressure of 100 psi in operation, a rubbing speed of 5000 feet per minute and a maximum operating temperature of 500° F. The material may be cemented to the flange mounting surface 30, for example by an epoxy cement sold by 3-M Company, under the designation Structural Adhesive 2216B/A.

By the interposition of the composition layer 60 between the bottom pan and the table 13, relative motion between the screening assembly and the table is reduced to a level of essentially zero or which in any event is so small as to be acceptable. Tests show that over a period of 1,300 hours, there was no noticeable abrasion or heat buildup due to relative motion between the bottom pan and the table.

Provision of the composite friction material presents the further advantage that it involves no mechanical connection between the bottom pan and the table, such

as lugs, bolts, etc., so that the screen assembly is merely seated on it and the clamps secured. No jack screws, bolt connections, etc., are necessary and assembly involves mere positioning rather than interengagement. Moreover, the structure is easy to clean, the bottom pan surface being continuous and presenting no protrusions. At the same time, need for a close fit between the pan and flange, and its undesirable attributes of sticking and/or difficulty in positioning, are obviated.

Having described the invention, what is claimed is:

1. A screening machine comprising,
 - a base,
 - a vibratory frame having a peripheral mounting surface which is resiliently mounted to said base for vibratory movement with respect to the latter,
 - a drive for imparting a vibratory motion to said vibratory frame,
 - a screen assembly including a screen,
 - said screen assembly being seated on said vibratory frame,
 - a layer of rigid, inelastic composite friction material affixed to one of said screen assembly and said frame, said material extending for a substantial portion about said peripheral surface and facially engaging the other thereof in a plane parallel to the plane of said screen, said composite material presenting a weight-supporting interface between said screen assembly and said frame, the weight of said assembly being applied to said frame through said composite material at said interface, and
 - clamping means detachably connected between said screen assembly and said frame, said clamping means acting in a direction generally perpendicular to the plane of said screen and exerting an inelastic clamping force on said composite material at said interface, said clamping force holding said screen assembly on said frame for vibratory movement therewith,
 - the screen assembly being positioned with respect to said frame solely by the force of said clamping means acting through said composite material.
2. The machine of claim 1 wherein said vibratory frame is oversize with respect to said screen assembly at said interface such that said frame does not confine said assembly to a rigidly fixed position.
3. The machine of claim 2 wherein an upstanding rim extends substantially around said vibratory frame, the said rim having dimensions sufficiently greater than said screen assembly such that said screen assembly does not engage said rim.
4. The machine of claim 1 wherein said frame comprises a table having a flat surface, and

said composite friction material is interposed between said assembly and said flat surface.

5. The machine of claim 1 wherein said composite friction material is a brake lining material.

6. The machine of claim 1 wherein said composite friction material comprises a layer having an upper surface and a lower surface, one of which is adhesively secured to one of said assembly and said frame, the other of which surfaces engages the other of said assembly and frame.

7. The machine of claim 1 wherein said screen assembly includes a top cover, a screen, and a bottom pan, said screen being disposed and held between said cover and said pan.

8. The machine of claim 7 wherein the clamping means include clamps connectable between the top cover and the frame to draw said top cover, screen and bottom pan against said frame.

9. In a screening machine having a screen assembly which is demountably seated on a peripheral planar mounting surface presented by a vibratory table having a vibratory drive to vibrate said table, and wherein clamps generally perpendicular to said surface are engaged between the table and the screen assembly and exert a clamping force holding the screen assembly on the said surface, there being an interface between the table and the screen assembly at said surface,

the improvement comprising,

a rim around said surface which is oversize with respect to the dimension of the screen assembly at the interface, and

a layer of rigid, inelastic composite friction material extending for a substantial portion of said peripheral surface at the interface between the table and the screen assembly, the weight of the screen assembly being applied to the table through the composite material at the interface,

the clamping force acting through the composite material in a direction generally perpendicular to it,

there being no mechanical abutment between the screen assembly and the vibratory table to restrain said screen assembly from movement in the plane of said surface, except through said composite material,

said material preventing relative motion between said screen assembly and said table at said interface which would occur in the absence of said material.

10. The improvement of claim 9 wherein said vibrating drive is operable to establish an acceleration on said screen assembly of at least about 4 g.

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