TOGGLE ENGAGED

Fig. 9

TOGGLE ENGAGED; Gravity.

Fig. 10

TOGGLE ENGAGED; Back to parallelism with cranks.

Fig. 11

RELEASE TOGGLE; Hold weights 81 & 83 with cranks.

Fig. 12

TOGGLE RELEASED; Set weights 81 & 83 to new position with cranks. Weight 57 will stay in proportion by follow-up of chain.

Fig. 13

ENGAGE TOGGLE; Hold weights 81 & 83 with cranks, weight 57 will rotate into parallel position to weights 81 & 83 by linear movement of tightening chain.

Fig. 14
VIBRATORY SCREENING APPARATUS
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ABSTRACT OF THE DISCLOSURE

A vibratory screen is driven by three pairs of eccentric weights 57, 81 and 83 driven by shafts 42, 72 and 73 extending through tubes 47 connected to the side of the screening box. The weights 57 and 83 are in phase and are driven in the same direction while the weights 81 are driven at the same rate of speed as that of the weights 57 and 83 but in the opposite direction. The drive of the weights is through a chain 69 which can be disconnected from the weights 81 to permit the weights 81 and 83 to be rotated by indicating cranks 116 to new positions to change the phase relationship of the weights 81 relative to the weights 57 and 83. Lubrication is effected by the chain 69 carrying oil from a trough 123 to channel 121 from which it drops to a splot 125. The oil is received in groove 127 from the splot and is slung therefrom to bearing 63.

Plugging is objectionable for reasons well known to users of vibrating screens. It is a main object of the present invention to provide a screening apparatus overcoming the above disadvantages and in particular to provide such a screening apparatus wherein the weights are located at the sides of the screening box and rotateably mounted on fixed spindles carried by the box and driven, but not supported, by cross shafts which can be and therefore are lightweight and small, and hence can and do project through the box and between the decks at the level of the center of gravity of the screen and in symmetrical relation thereto without interfering with the screening process; to provide such an apparatus wherein the shaft and weight arrangement is such as to impart an elliptical or oval stroke uniformly to the box; to provide such an apparatus wherein the shape or configuration of the stroke can be varied from straight line, through elliptical to circular, if desired; to provide such an apparatus having three cross shafts each carrying a pair of flyweights and wherein the shafts are spaced substantial distances from one another and pass through tubular housing which is fixedly secured to the box to form a rugged box structure; to provide such an apparatus wherein the direction of the stroke may be altered readily and from the exterior of the machine; and to provide such an apparatus having a novel lubricating system.

Various other objects of the invention will be apparent from the following description taken in connection with the accompanying drawings wherein:

FIG. 1 is a top view of a screening apparatus of my invention;
FIG. 2 is a side view taken in the direction of the arrows 2—2 of FIG. 1;
FIG. 3 is a view of the opposite side taken in the direction of the arrows 3—3 of FIG. 4;
FIG. 4 is an end view taken in the direction of the arrows 4—4 of FIG. 2;
FIG. 5 is an enlarged view of the weight case of FIG. 2 with the case cover removed;
FIG. 6 is a sectional view taken along line 6—6 of FIG. 2;
FIG. 6A is a front view of part of the toggle;
FIG. 7 is a view showing the relationship between an adjustment crank and one of the weight driving shafts;
FIG. 8 is a vertical sectional view taken along line 8—8 of FIG. 2; and
FIGS. 9 through 14 are diagrammatic views showing various steps in the adjustment of the weight positions.

Referring to FIG. 2, the vibrating screen apparatus comprises a screening unit 13 which is supported for vibratory movement on a base 17 by four spring assemblies 19 (FIGS. 2 and 4). The screening unit includes a frame 23 in the form of an elongate structure having vertical side plates 25 and 28 (FIG. 4) which are connected by an upper horizontal rectangular grid 27 and a lower horizontal rectangular grid 29 to form an open box-like frame member. An upper screen 31 is supported by the upper grid 27 and a lower screen 33 is supported by the lower grid 29. The means of support is shown as being like that in my prior Patent No. 3,101,514.

The screening unit 13 is vibrated by a mechanism which includes a motor 41 mounted on the base 17, the motor driving a cross shaft 42 by means of a sheave 43 on the motor, a sheave 44 on the cross shaft, and a belt B drivingly connecting the sheaves. There is a spring biased idler sheave 49 engaging the belt B to accommodate the vibrating movement of the screening unit 13 while maintaining driving contact between the belt B and the sheave 44.

For convenience, the side of the screening unit 13 adja-
The cross shaft 42 extends through case 45 on the near side of the motor 41, which by the term "near side" of the unit, and the opposite side as the "far side." The cross shaft 42 extends through case 45 on the near side of the screening unit 13, through both pairs of side plates 23 and 25 of the frame F, and projects into a second case 46 on the far side of the frame F. Between the plates 23 and 25, the shaft 42 passes through a tubular housing 47 (FIGS. 1 and 6) which has end flanges 49 (FIGS. 4 and 6) secured by bolts 51 to the side plates 23 and 25.

Shaft 42 is made of light weight construction having a hollow central section 42a and solid (but not bored) end sub ends, one end 42b being shown in FIG. 6. Shaft 42 has a drive hub at each end thereof. The far side hub 53 being shown in FIG. 6. The shaft-receiving bore of such hub is eccentrically disposed relative to the geometric axis of the hub. The hub 53 is contained within the far side case 46, and is secured by bolts 55 to an eccentric weight 57. The bolt holes in hub 53 are on a circle eccentric with the geometric axis of the hub. The weight 57 is generally of semicircular form having a hub portion 57a which is counterbored to receive the outer race of an antifriction bearing 59, the inner race of which has a tapered inner surface fitting on the tapered exterior of a hollow support member 61. A nearest the upper end 65 retains the bearing 59 on the support member 61, and the associated bolts 51, previously mentioned, secure the support member 61 to the associated side plates 25 of the frame F. The near side drive hub (not shown) of shaft 42 has a weight identical to weight 57 and mounted in the same way. The bearing 59 could be a cylindrical roller bearing, instead of as shown, mounted on a cylindrical surface of hollow support member 61.

The far side drive hub 53 (but not the near side drive hub) of the shaft 42 carries a sprocket 67 which is driven by a chain 69 drives the sprockets 70 and 71 of two companion shafts 72 and 73 (FIG. 5). Shafts 42, 72, and 73 are equally spaced from one another and shafts 72 and 73 and like shaft 42 in form and manner of support, and extend through flanged tubular housings 75 and 77 which are like flanged tubular housing 47. The shafts 72 and 73 drive pairs of eccentric weights (of which 81 and 83 are shown) in the same manner as shaft 42 drives its pair of weights. However, the chain 69 passes under the sprocket 70 of the center weight 81, while it passes over sprockets 67 and 71 of the outer weights 57 and 83. Thus, outer weights 57 and 83 are driven in a counterclockwise direction as the parts are shown in FIG. 5, while in a clockwise direction.

Referring to FIG. 5, the drive chain 69 passes over a pair of idler sprockets 85 and 87, sprocket 87 being rotatably mounted on a short shaft 89. Sprocket 85 is carried by a pair of depending arms 91 of an offset bell crank, the other arms 93 of which are inclined upwardly, and disposed exteriorly of the case cover 95 of the side weight case 46. A toggle mechanism 99 connects the arms 93 to a fixed shaft 101 mounted on the near side case 46. The toggle mechanism includes a fixed-length link 103 pivotally connected at 105 to an extensible length link 107, the latter being pivotally connected to the bell crank arms 93. A compression spring urges extension of link 103 and causes it to bear against a stop lug 109 carried by the cover 95. When it is desirable to provide slack in the chain 69 (the sprocket can be forced over the lug 109), which action enables the rotation of the outer weights 57 and 83 to the center weight 81 to be changed.

Provision is made for adjusting the positions of the weights without requiring removal of the associated case covers. This will be explained in connection with the far side weights 57, 81 and 83. Referring to FIG. 5, the shaft 73 has a cross slot 111 formed therein which is accessible from the exterior of case 46 through a hole 113. A hole cover 115 normally covers the hole 113. The shaft 72 (but not shaft 42) is similarly provided with a cross slot, numbered 114, and such slot is similarly accessible. Each cross slot is parallel to and contained in the same radial plane as the radial axis of the associated weight so that the positions of the weights within the case 46 are known from the exterior thereof. The radial axis of symmetry of weight 83 is shown in FIG. 5 and designated by the letter r. Suitable adjusting cranks can be inserted through the access holes in the case cover 95 and have keys for fitting in the end slots of shafts 72 and 73. The crank for shaft 73 is shown in FIG. 7 and numbered 116b while such crank and also the crank 116a for shaft 72 are shown in FIGS. 11–14.

Both ends of each of the shafts 42, 72 and 73 are drilled and tapped to facilitate pressing on or withdrawing parts and also to facilitate securing the cranks 116 and 116b to shafts 72 and 73, respectively, while an adjustment is being made. One tapped hole is shown at 117 in FIG. 6, and one bolt 118 and its tapped hole 117 are shown in FIG. 7.

It is evident that the smallest increment of adjustment of the positions of the weights 57 and 83 will be determined by the number of teeth on the sprockets 67, 70 and 71. If it is assumed that each of sprockets 67, 70 and 71 has 45 teeth, it might be thought that the smallest increment of adjustment would be 8 degrees (360 degrees divided by 45). However, this is not so because any movement of the outer weights in one direction is accompanied by an opposite equal movement of the inner weight. Thus, if the outer weights are moved half of the effective width of a sprocket tooth in one direction, the center weight will be moved half the effective width of a sprocket tooth in the opposite direction, so that the extent of relative movement between the inner weight 81 and, one hand and either one of the outer weights 57 and 83 on the other, would be the effective width of one full sprocket tooth, i.e., twice the extent of movement of one weight. Therefore, the smallest increment of adjustment of the weights would be 4° rather than 8° if the sprockets 67, 70 and 71 had the number of teeth above assumed. It will be convenient to explain the adjustment of the weight positions by assuming the sprockets each has 45 teeth, but it must be remembered that this assumption is illustrative, not a limitation.

To aid in the adjustment operation, gauge marks are provided in accurate rows along the paths of movement of the handles of the cranks 116a and 116b, because the handles are in circumferential register with the centers of gravity of their respective weights. It is pointed out that there is a gauge mark for each increment of adjustment. For instance, if the increment is 4° the gauge marks might be provided from 61° to 17° at 4° intervals.

FIG. 9 shows the positions of the weights 57, 81 and 83 when their axes of symmetry are parallel. In the drawings, this parallelism occurs when the weights have their centers of gravity below and to the right of their respective axes of rotation (as the parts are shown in FIG. 9) and when the radial axes of symmetry of the weights are at 45 degrees to the horizontal. (Such axes will also be parallel when the weights are 180° from the positions in FIG. 9 but it is convenient for the present to ignore this point.)

It is assumed that FIG. 9 shows the instantaneous positions of the weights during operation of the machine, while FIG. 10 shows the approximate positions the weights assume (under the influence of gravity) when the machine is at rest. Since the outer weights 57 and 83 have twice the mass of the inner weight 81, the outer weights will assume positions below their FIG. 9 positions while the center weight will assume a position above its FIG. 9 position.

The steps in adjusting the weight positions are as follows. The machine is turned off to let the weights come to their rest positions (FIG. 10). The cover plates 115
are removed and the cranks 116a and 116b are secured to shafts 72 and 73, respectively. Crank 116b is turned counterclockwise to move the weights 57, 81 and 83 to the positions shown in FIG. 11, which are the same positions as shown in FIG. 9. Then both cranks are held while the toggle 99 is released to provide slack in the chain. Since weight 57 is not held by a crank, gravity will cause it to move clockwise to take up the slack in the lower reach of the chain 69 to provide slack in the upper reach. This slack is sufficient so that the chain drops away from the center sprocket 70 to clear the teeth thereof of any just rub thereagainst. The extent of movement of weight 57 has been exaggerated in FIG. 12 in order to clearly show that weight 57 does in fact turn under the described conditions. Now, the two cranks 116a and 116b are turned to their new positions where their radial axes of symmetry will be parallel. To make the adjustment operation clear, the new angle has been selected as 17 degrees (but this flat of an angle would be an unusual setting). As cranks 116a and 116b are turned from their FIG. 12 to their FIG. 13 positions, the lower reach of the chain will turn the weight 57 the same extent as weights 81 and 83 are moved. Now, the toggle 99 is released, and this action through chain 69 turns weight 57 counterclockwise an extent to bring it to a position with its radial axes of symmetry into parallelism with those of weights 81 and 83 (FIG. 14). Now the cranks 116a and 116b are released and the weights move to positions (not shown) dictated by gravity. The cranks 116a and 116b are now detached from their respective shafts and the cover plates 115 secured in place on the case cover 95. The machine is now in condition for operation.

To lubricate the rotating parts, there is provided a lubricating system for each rotary weight assembly. Since the systems are identical only one need be described. The system for the rotary weight system which includes weight 57 is shown in FIG. 6 and includes a pair of converging channels 121 carried by the fork side case cover 95. The lower reach of chain 69 travels through an oil trough 123 and picks up oil and carries it upwardly and slings it around the case cover 95. Some of this oil drains down into channels 121. The channels feed the oil into a spout 125 carried by the case cover 95. The spout directs the oil into a reentrant annular groove 127 formed in the end face of the hub 53. Rotation of the hub creates sufficient centrifugal force to cause the oil groove 127 to move outwardly into the reentrant portion 129 of the groove and from there to pass through one or more oil holes 129 provided in the hub 53. From there the oil will pass outwardly and through the bearing 59 to lubricate the same. There is also a similar lubricating system for the shafts 72 and 73, however, making use of the chain 69 as a common element.

To lubricate the bearings for the case 45, lubricating systems similar to the above are provided for each bearing, except that slinger discs on the shaft ends are used for sling ing the oil instead of a chain. These slinger discs are mounted on the hubs for those ends of the shafts 42 and 72 which project into said case. One slinger disc is shown in FIG. 3. These discs ride in an oil bath in the bottom of case 45 and throw oil around within the case. Part of this oil drains down the walls and into channels (like channels 121) from whence it travels in the manner previously described. Since the slinger discs are of lesser diameter than the weights they have offset hub portions so that the discs for shafts 42 and 72 do not contact or interfere with one another.

Each of the spring assemblies 139 comprises a pair of compression springs 141, the lower ends of which fit over the retainer studs 143 (FIG. 8) of a base member 145. The latter is secured to the base 17, which may be of any suitable form, but is shown as being of open rectangular form. The upper ends of the springs 141 fit on the retainer studs 147 of a mounting member 149 which is con-
occur, provided, of course, that the screening unit were horizontal. If the screening unit were inclined, then, of course, travel in the direction of inclination of the screening unit could be obtained.

An important advantage of the elliptical or oval stroke imparted to the screening unit over the straight line reciprocating motion is that there is much less possibility of the screening unit being clogged with "arrowheads," that is, pointed rocks that tend to wedge in the screen openings. With straight line movement, the arrowheads tend to jam in place and there are no lateral forces to dislodge them. With the elliptical stroke, lateral dislodging forces are imparted to the arrowheads to tend to rock them out of a jamming position.

Another important feature of my screening apparatus is that my apparatus requires very little head room because the motor and the vibrating weights are located below the upper edges of the screening unit, rather than being superposed thereabove as is the general practice now. Thus, in places where a low overhead screening apparatus is desirable, and these instances are quite frequent, the present structure provides a definite solution. By eliminating the overhead vibrating mechanism there is no obstruction to the passage of large rocks over the top screen. This is a very desirable feature.

Another important advantage of my machine is the use of weights in sets of two, because by this, the great stability for the machine is obtained versus machines having weights in sets of two because in the latter case, a teeter-totter action is imparted to the screening unit which imposes undue stresses and strains on the frame and other parts. Stability is also achieved in the present screening apparatus by locating the axes of the weights at the center of gravity of the screening unit.

Other advantages of my machine are that less horsepower is required to drive the machine because of its unique stability arrangement and lubricating system. It is also pointed out that the three cross tubes 47, 75 and 77 stiffen the frame and make the screening unit safer. It is further pointed out that the three shafts 42, 72 and 73 may be spaced further apart than is now possible with two shaft screening units. For instance, the end shafts of my unit may be located, say 33 inches apart, whereas in two shaft units, twelve inch spacing between adjacent shafts is about the best that can be obtained.

As mentioned before, the hubs for the shafts are bored off-center. This means that the stroke of the shaft is only one-third that of the main screen, and because the shafts are made of light weight construction, this, in combination with their small stroke means that there is considerably less chance of their breakage or fracture than heretofore has been possible. Also, the shafts do not function as a vibrating member and virtually no radial load is placed on them other than produced by their slight eccentric motion. Their only loading is the driving torque of turning one weight in the case of shafts 72 and 73, and all weights by shaft 42; once set in motion very little torque is required as proved by the very low power required. In addition, the radius of gyration of one of my weights is a multiple of the radius of gyration of the "self-counterweighted" shaft machine. This means that to obtain the same vibrating force, the mass of the shafts of the latter machine must be a multiple of the mass of the weights of my machine. So, my lighter weights considered together with the spindle support for the weights (rather than the motor bracket) means that I can use a very light and small shaft without danger of breakage.

Another important advantage of my screening apparatus is that the oval stroke imparted to the screening box gives better accuracy in that the rolling action imparted to the particles being screened gives them more opportunity to pass through the screen than is the case with a box having a reciprocating, or essentially reciprocating, vibrating action.

The toggle 99, previously mentioned, has jam nuts 201 on a threaded portion of the link 107, and the compression spring 203 bears against a collar-carrying washer 205 which bears against the jam nuts 201. The upper end of the compression spring 203 bears against the closed end of a collar-carrying clevis 207 which is connected by the pivot 195 to the link 103. A reduced diameter portion of link 107 projects through an opening in the closed end of the clevis 207 and is threaded to receive a pair of jam nuts 209 whose sole purpose is to prevent separation of the clevis 207 and the link 107 when the toggle is released.

In connection with the spring assembly 19, it should be mentioned that the manner of connection of each mounting member 149 to its bracket 151 by means of a trunnion 231 carried by the bracket 151 and turned by a split joint 235, the lower part of which is secured to the mounting member 149.

FIG. 2 shows in phantom lines an infed box 301 into which rock to be separated is poured. The phantom lines 303 and 305 show discharge chutes for the upper and lower decks of the apparatus, whereas 307 shows side supporting plates for the chutes. It is pointed out that while the drawings show a screening apparatus with two decks it could have more or fewer decks if desired. I claim:

1. In a vibrating screening apparatus, a base, a screening box mounted on said base for vibratory movement, a pair of first eccentric weight means mounted on said box and having a predetermined combined mass, a second eccentric weight means mounted on said box between said pair of first eccentric weight means and having a mass substantially less than said predetermined combined mass, drive means for driving said first eccentric weight means in phase and in the same direction and for driving said second eccentric weight means in the opposite direction at the same rate of speed as that of said first eccentric means, phase adjusting means for adjusting the position of said second eccentric weight means relative to said first eccentric weight means whereby an oval stroke is imparted to said box, said eccentric weight means including three parallel timing shafts extending in crosswise relation to said box and having their axes lying substantially in a horizontal plane passing through the center of gravity of said box, said three timing shafts including one center shaft and two outer shafts, said eccentric weight means also including weights for the opposite ends of said shafts, and non-rotating spindles secured to said box and rotatably supporting said weights to relieve the shafts of this burden, said drive means including motor means for driving one of said outer shafts, flexible drive transmitting means between said one of said outer shafts and the other shafts, said timing shafts being disposed in driving but non-supporting relation to said weights, said shafts being rotatably supported on said spindles by virtue of their driving connection to said weights, said phase adjusting means including means for interrupting the driving connection between said center shaft and said flexible drive means to enable the outer shafts to be turned relative to the center shaft and thus vary the orientation of the weights of the outer shafts to those of the center shaft.

2. An apparatus as set forth in claim 1, wherein the flexible drive transmitting means is disposed at one set of ends of said shafts, a common case enclosing said flexible drive means and the associated shaft ends and weights,
said having openings therein registering with at least certain of said shaft ends, said certain shaft ends having means for engagement by adjustment means projected through said openings whereby to facilitate adjustment of the weight positions without removal of said case.

3. An apparatus as set forth in claim 2, wherein said box is of the multiple deck type and wherein the shafts extend through said box at a level between said decks, and wherein there are tubular housings for said shafts fixedly secured to the sides of said box.

4. In a vibratory screening apparatus, a screen including a pair of laterally spaced side plates having aligned holes and screen means mounted on the side plates and supported thereby, a base, means mounting the screen on the base for floating movement relative thereto, three parallel tubular housings secured to the side plates and extending between the side plates, three pairs of tubular spindles mounted on the outside faces of the side plates in alignment with the ends of the tubular housings, three shafts extending through and adapted to rotate in the tubular housing and holes in the side plates and the tubular spindles, three pairs of external bearings mounted on the spindles, three pairs of laterally aligned eccentric weights rotatably mounted on the bearings and supported solely by the bearings, connecting means keying the shafts to the weights and supporting the shafts from the weights, a middle and two outer sprockets keyed to the shafts at one side of the screen, a chain passing over and around the two outer sprockets and under the middle sprocket, tensioning means normally tightening the chain to pull a course of the chain up into engagement with the middle sprocket and releasable to permit said course of the chain to drop out of engagement with the middle sprocket, a pair of housing means mounted on the side plates and enclosing the weights, the bearings, the spindles, the connecting means and the sprockets to form with the tubular housing a dirt free space, manually operable means for releasing the tensioning means, and manually operable means for turning the middle sprocket relative to the chain while the middle sprocket is released from the chain to adjust the phase relationship of the weights.

5. The apparatus as set forth in claim 4 wherein the housing means contain supplies of a liquid lubricant and including lubricating means driven by the shaft for applying the lubricant to the bearings.

6. The apparatus as set forth in claim 5 wherein the housing means includes a well forming a reservoir of the lubricant and the lubricating means includes means guiding the chain through the well and means for guiding lubricant lifted by the chain into one of the bearings.

7. The apparatus as set forth in claim 4 wherein the manually operable means comprises a pair of cranks for driving the middle and one of the outer sprockets.

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