My invention pertains primarily to the art of vibrating screens of the general type commonly employed today for grading or separating aggregate materials fed to the screen unit in bulk and required to be separated into different sizes after the well-known manner.

So-called vibrating screens of the class to which my present improvements relate customarily involve a construction including a supporting or dead frame and a live or vibrating screen unit comprising one or more superposed screen frames or sections, said unit carried by the supporting frame and vibrated by suitable power mechanism connected therewith. Screens of the type of my invention as designed for certain uses employ dust covers above the screen unit, beneath the unit, and leading from the discharge end of the screen or screens of the unit.

One of the problems of the construction of vibrating screens of the types heretofore proposed resides in the difficulty of removing and replacing the screen or screens of the screen unit, for necessarily these screens are subjected to considerable wear under practical conditions of service.

It has therefore been one of the primary objects of my present invention to so design my vibrating screen as to enable the quick and ready removal of the screen members, and their replacement. While heretofore in many instances the screen removal and replacement operations have necessitated the detachment of the dust covers when they are employed, my present improvements eliminate the necessity of such dust cover detachment by provisions for displacing and replacing the screen members laterally from the vibrating screen unit in a manner novel as compared with provisions heretofore employed for the purpose. Moreover, with the foregoing objective in mind, the supporting frame for the vibrating screen unit, in my invention has been constructed with a view to facilitating the foregoing displacing and replacing operations for the screen members by provisions of clearance spaces at the sides of said supporting frame.

Incidental to the foregoing phase of my improvements, I employ a screen unit which comprises a novel construction of screen frames or sections united by special fastening means, enabling the separation of the screen unit frames or sections in a relatively short time for screen removal purposes and the restoration of the said frame members or sections to their original positions properly holding the screen members in place, in a correspondingly short period of time. The fastening means of my invention, used for holding the screen sections or frame members of the screen unit together are located in a novel manner at the opposite sides of said unit, readily accessible from opposite sides of the supporting frame and said unit, so that they may be removed and replaced without difficulty and without disturbing in any way the attachment of the dust covers that may be employed in conjunction with the vibrating screen of my invention, and dependent upon particular conditions of use.

By reason of the foregoing provisions, the operations of attaching a worn out screen or screens from one or more screen holding frames or members of the screen unit are rendered very simple, quick of performance, and the replacement thereof with fresh or new screen members is correspondingly effected by the manipulation of a minimum number of fastening devices with a similar reduction in the time factor, something highly essential for the purposes of screen devices of the class to which my improvements apply.

Still another objective in the development of the improvements hereof has been the provision of a vibrating screen unit which is disposed in a horizontal position, with the meshed screens similarly so disposed, and which is subjected to a novel vibrating action in a direction slanting upwardly toward the discharge end of the screen unit such action maintaining the mesh openings of the screen members in positions such that their sizing or grading functioning is in no way interfered with; the said peculiar vibrating action of the screen unit at the same time compels a traveling movement of the material being screened toward the discharge end of the unit by the multitudinous vibrating impulses imparted to the screen unit during the operation thereof. The advantage in employing a screen unit which is generally horizontally disposed will be more apparent upon reference to the following detail description, it being notable, however, that when vibrating screen units are disposed in generally inclined or slanting positions, the efficiency of the separating or grading action of the screen members themselves is reduced through the inclination of the mesh openings of said screen members.

Having in mind the foregoing outline of the general operating or vibrating movement of the screen, my invention comprises novel instrumentalities in the form of supporting spring or resilient members providing a unique spring suspension for the vibrating screen unit by reason of which, under the operation of the vibrating motive forces, the peculiar movement of the screen members is effected in an upward inclined direction toward the discharge end of the unit, as above referred to.

Subsidiary to the phase of my invention involving the special provisions pertaining to the removability and replaceability of the screen members, the spring or resilient suspension means
above mentioned are so designed, to support the vibrating screen unit upon the dead frame, that the resilient suspension and supporting parts will not interfere with the displacement and replacement of the screen members. Likewise, as regards the separating of the screen frames or sections of the screen unit to afford the advantages of removal and replacement of screen parts or members, the provisions of the peculiar fastening means between the said sections of the screen unit, according to my present improvements, permit such removal and replacement operations to be performed independently in reference to upper and lower screen members, or substantially at the same time if desired, all with a reduced time factor for such operations as compared with corresponding operations in prior art screen devices of the type of my invention.

My present improvements involve, furthermore, novel tension and clamping devices for tensioning and clamping the screen members in position upon the screen unit, clamping devices that are quickly and readily operable from a side of the apparatus or screening device so that again there is no necessity for removing and replacing dust covers in order to handle the screen members in the manner referred to.

My invention further involves driving devices associated with the dead or supporting frame of the vibrating screen and with the vibrating screen unit, power driven by any suitable power mechanism, and which drive devices may be reversed so as to carry the drive to the screen unit from either side of the screen, this being advantageous, having in view the necessity for locating the screen device in different places in a factory or building.

In the drawings:

Figure 1 is a side elevation of a vibrating screen embodying the novel features of my invention.

Figure 2 is an end view of the screen, showing that end at which are located the driving instrumentalities for vibrating the screen unit.

Figure 3 is a top plan view of the screen, partially broken away near one end to condense the view and partially showing the screen cloth of the upper screen members.

Figure 4 is a longitudinal sectional view of the screen, bringing out more clearly the superposed screen members of screen cloth and the mounting means between the screen unit and the supporting or dead frame; also certain of the clamping and tensioning means for the screen members, the view being taken on line 4—4 of Figure 3.

Figure 5 is a transverse sectional view taken about on the line 5—5 of Figure 3.

Figure 6 is a transverse sectional view of the screen unit alone, showing somewhat more clearly the operating means for the intermediate clamping bars coaxing with the adjacent ends of the upper screen members.

Figure 7 is a detail view, enlarged, showing a corner portion of the screen unit, bringing out more clearly the arrangement of the corner hanger bolts and the attaching means for the upper and lower screen members.

Figure 8 is a plan view broken away at the middle, showing one of the upper screen members of the screen unit.

Figure 9 is a view similar to Figure 8, but illustrating the lower screen member of the screen unit, the middle portion of the screen broken away in the illustration.

Figure 10 is a fragmentary plan view showing a modified form of upper screen member attaching instrumentalities.

Figure 11 is a detail sectional view taken about on the line 11—11 of Figure 10.

Figure 12 is a side view showing more clearly the screen member attaching or clamping means illustrated in Figures 10 and 11, the view looking toward the screen unit in the direction of the arrows 12—12 of Figure 10.

Figure 13 is a somewhat diagrammatic view illustrating my vibrating screen apparatus with cover means therefor, and dust covers leading from the sections of the screen unit, showing somewhat more clearly the side clearances enabling the removal of the screen members without affecting the dust covering or enclosing elements.

Figure 14 is a perspective view of one of the upper screen clamp plates, the lower two, as used in the modification of Figures 10 to 12.

Figure 15 is a fragmentary view in section of the screen unit sections clamped together, showing the structure at one end of the unit.

Figure 16 is a view similar to Figure 15 but showing the sections as when separated for the removal of the screens, and disclosing the tension means for longitudinally pulling the lower screen taut, as shown in the opposite end of the unit.

Figure 17 is a sectional view, broken away, of one of the two like bearing structures between the sides of the middle section of the screen unit, and the vibrating shaft and long spring supports for the unit, showing details not elsewhere illustrated.

Figure 18 is a fragmentary view of one of the vibrating shaft pulleys showing the structure by which it interlocks with said shaft.

For the purposes of the following description, I shall refer to the main supporting frame of my screen as the supporting or dead frame, the vibrating screen proper as the screen unit comprising top, middle, and bottom frame sections or members, and the screen cloth parts as screen members, the preferred construction of my invention including three upper screen members in the same plane and a lower single or continuous screen member extending from end to end of the apparatus. However, it is understood that the upper screen members might be consolidated into or substituted by a single screen member and the lower screen member could be made in sections if desired, within the purview of my invention.

Referring to the drawings, and designating the various parts of my construction, the base supporting or dead frame is composed of lower longitudinal members or angles 1, transverse members or angles 2 connecting the members 1 at the ends or corners of the frame. Upstanding from the parts 1 and 2 at the corners where they join are the corner posts 3 made from angles or any suitable metal shapes, preferably. At the sides of the screen, by which term I designate the entire screening apparatus, are the longitudinal bars 4 preferably made from channels. These bars are part of the supporting frame and are spaced above the longitudinal members 1 of the supporting frame and are attached at their ends by bolts or rivets 5 to the angle posts or uprights 3. At one end of the supporting frame the members 3 are connected by a transverse bar 6, seen best in Figures 2 and 3, this member 6 rigidifying the supporting frame structure and carrying certain parts of the driving mechanism.

In Figure 2 the driving means illustrated com-
prises the driving pulley 7 which may be belted to a suitable motor to operate at high speed the driving shaft 8 which shaft is supported by a bearing sleeve 9 having a lower plate extension 9a integral therewith and attached to the cross member 8 by the fastenings 10, preferably bolts. The shaft section 14 passing through the pulley 7 is a short shaft, just a little longer than the bearing sleeve 9, and is equipped at its end with a universal joint connection 11 with a driven shaft section 12, the end of which shaft section 12, opposite the bearing 8, is connected by a universal joint 13 with adjacent shaft section 14 disposed adjacent the side of the supporting frame opposite at which the sleeve 9 is located. The shaft section 14 is mounted in a horizontal bearing sleeve 15 similar to the sleeve 9 and adjustably and removably carried by the middle section 16 of the vibrating screen unit which, as previously mentioned, includes the top section 17 and the bottom section 18. The supporting means for the bearing sleeve 15 includes a vertical bracket 19 secured by a bracket plate 20 to the outer side of the mid-section 18 of the screen unit at the driving end thereof, detachable fastenings 21 being used to attach the vertical bracket 19. The sleeve 15 has a hanger member 22 pivoted at 23 to the plate 19 adjacent to one end of the sleeve, and near the outer end of the sleeve 15 a horizontal arm 24 on the sleeve 15 is adjustably connected by a removable bolt or bolts 25 with the side of the mid-section 16 of the vibrating screen unit. At its outer end the shaft section 14 carries a driven pulley 26 around which passes the belt 27 leading to a second driven pulley 28 on the vibrating shaft 29 carried in bearings in the vibrating screen unit, as will later be described.

The purpose of the detachable fastenings 10 and 25 is to permit the shaft members 8, 12, and 14 to be reversed end for end in reference to the supporting frame and the vibrating screen unit, the middle section 18 of the latter having vertical slots at both ends through which the bracket 19 may pass, dependent upon near which side of the mid-section 18 of the vibrating screen unit the bearing member 19 is mounted. Likewise, the end member 6 of the supporting frame has near its opposite ends suitable openings for the bolts 10 so that the member 82 can be attached to the member 6 at either end of the latter for facilitating the reversal of the driving shaft means 8, 12, 14, with the pulleys supported thereby. The fastening bolt or bolts 25 pass through a slot in the side portion of the mid-section 18 of the screen unit, dependent upon at which side the bearing member 19 is mounted, as controlled by the reversibility of the location of the parts 9 and 18.

I next describe the construction of the vibrating screen unit made up of the top section 17, the middle section 18 therebeneath, and the bottom section 18 beneath the middle section. In other words, these frame sections of the vibrating unit are superposed, practically speaking, one above the other, and the two lower sections 16 and 18 may be said to be hung from the top section 17 by reason of provisions of various instrumentalities now to be described.

The top section 17 of the vibrating unit is equipped at the corner portions thereof with horizontal outwardly projecting hanger plates 30. Depending from the hanger plates 30 are the hanger bolts 31 having turning heads 32 at their upper ends engaging the upper surfece of the plates 30. Each of these bolts 31 extends downwardly from its associated plate 30 through an angle bracket 33 extending horizontally from the adjacent corner portion of the mid-section 16 and rigidly attached to the latter. From the bracket 33, through which the bolt 31 loosely passes, said bolt extends downwardly and has its threaded portion passing through a threaded opening 34 of an outwardly projecting hanger bracket 34 attached to the adjacent end of the lowermost section 18 of the vibrating screen unit. Thus, the hanger bolts 31 form corner connections between the upper screen unit sections 17 and the middle and lower sections 18 and 16, respectively. Between the brackets 33 and the top corner brackets 30 are interposed coiled springs 35 used for a purpose to be later described. The hanger bolts 31 are both hanger members and connecting members for the several unit sections 16, 17, and 18.

At the opposite side of the vibrating screen unit the sections of the unit are connected by additional connecting means in the form of a series of bolts for virtually clamping the upper section 17 to the section 16, and a second series of bolts for clamping the section 18 to the section 16. Figure 1 shows these connections most clearly, and, referring to said figure hereof. It will be noted that the middle section 18 of the screen unit carries double bolt brackets 36 outstanding therefrom, each having one threaded opening and one non-threaded opening therein. At the opposite sides of the top screen section 17 are carried single bolt brackets 37 having plate openings therethrough. At the opposite sides of the lower section 18 are carried single bolt brackets 38 having threaded openings therethrough and reversely disposed in arrangement as compared with the top brackets 37.

Passing through the unthreaded openings of the top brackets 37 and screwed into the threaded openings of the brackets 36 are the connecting bolts 39 for the screen unit sections 17 and 18. The bolts 39 are provided with socket heads for receiving a wrench for turning, and by turning the bolts in one direction the members 16 and 17 may be tightly brought together; by removal of the bolts 39 their bolting effect is eliminated and they are removed as obstacles for the lateral displacement of the upper screen members 40 shown in Figure 8, will later be described.

Now in regard to the brackets 36, bolts 41 similar to the bolts 39 are utilized to connect the brackets 36 and the brackets 38, having screw connection with the latter and being displaceable as described with regard to the bolts 38. The bolts 41 are utilized to clampingly connect the mid-section 18 of the screen unit to the bottom section 18.

I have thus far described the general construction of the frame parts or sections of the vibrating screen unit, and I now refer to the screen members associated with these units. I prefer to utilize three screen members for the top screen element of my unit, and a single screen member for the bottom screen element. One of the upper three screen members is shown in Figure 8 at 48, as previously mentioned, and each of these extends transversely across the space between the screen sections 17 and 18. Each member 48 is made up of screen cloth, at the side edges of which, speaking with reference to the sides of the screen unit, are riveted or otherwise fastened the plates 42 having the slotted extensions 43. When the three screen members 40 are disposed between the sections 17 and 18, the plates 42 are engaged by the adjacent bot-
bottom and top surfaces, respectively, of the sides of the members 17 and 18. Therefore, obviously, the tightening of the bolts 32 and 39, bringing the screen sections 17 and 16 together, will be by impingement clamp the plates 42 in position. Before final tightening adjustment of the bolts 32 and 39, vertical wedges 44, see Figure 6, may be driven through the slots in the extensions 43 of the plates 42, and, binding against the outer surfaces of the sides of the section 17, are adapted to place the screen members 40 under lateral tension.

The foregoing disposes of the tensioning or fastening or the screen members 40 laterally of the screen unit parts 17 and 16.

The adjacent edges of the screen members 40, as seen in Figures 3 and 4, are adapted to be tightly clamped by special clamping mechanism operable from a side of the screening apparatus. Figures 5 and 6 show the clamping mechanism as well as Figure 4.

The clamping means, as to the parts upon the top section 17, includes the cross beams 45 extending transversely between the sides of the member 17, and rigidly attached thereto. Depending strut 46 on the upper clamp plates 47. The middle webs of these clamp plates 47 project downwardly into slots of transverse movable beams 48 in vertical line with the beams 45 and beneath the clamp plates 47.

The movable beams 48 are supported for vertical bodily movement between the sides of the section 16 and are movable carried on sleeves 49 at the upper ends of spaced levers 50, two pairs of which are located between the sides of the section 16 for each of the beams 48. Cross parts or beams 51, each comprising a metal plate member, span the space between and are secured to the sides of the mid section 16, and the lower ends of the levers 50 are pivotally secured at 52 to the adjacent beam 51. Each set or pair of levers 50 is virtually a lifting jack.

Obviously, by moving the upper ends of the parts of levers 50 beneath beam 48 toward each other, the movable clamp beams 48 will be shifted upwardly to clamp against the edges of the screen members 40 received between the stationary T-members 47 and said beams 48, see Figure 4. The movement of the levers 50 is adapted to be effected by means operable from a side of the apparatus as seen in Figure 6 and including operating members in the form of socket headed screws 53 having threaded portions 54, one screw 53 being provided for the two sets of levers 50, or the two jacks, for each beam 48. The threaded portion 54 of each screw 53 is threadedly connected near the right end of the screw with the sleeve 49 on the right jack or pair of levers 50, as seen in Figure 6. Said screw near its outer end is movably connected with the left sleeve 49 between two collars 57 fixed against sliding and mounted on the screw 54. A turning of each screw 53 in one direction will bring the upper ends of the jacks 50 toward each other for raising the sleeves 49 and movable beam 48, and an opposite direction turning of the screw 53 will separate the upper end of the jacks 50 for lowering of the beam 48. In this manner the clamping and unclamping action of the beam or beams 48 is effectively controlled in relation to the transverse end edges of the screen members 40, and the parts 48 and 41 clampingly maintain tension on the screen members 40 in a lengthwise direction of the entire vibrating screen unit. Later I shall describe how the jacks 50 cause for action on the clamp plates or beams 51 to assist in holding the lower screen 62 taut.

Proper separation of the sections 17 and 16 of the screen unit, as later described, after removal of the wedges 44 and bolts 39, enables a displacement or removal of the screen members 40 laterally and outwardly from the space between the parts 17 and 16.

At its end portions the upper section 17 of the screen unit is equipped with angle clamp members 58, one connected by struts 59 with a superposed cross beam 60, and each angle plate 55 constitutes a clamping member of each end of the unit section 17, adapted to seat upon and clamp the screen cloth material at the adjacent transverse edge of each end of the screen members 40. In other words, the plates 55 might be characterized as half-T plates or single flange clamp plates as distinguished from the double or T-clamp plates 41. The plates 55 work in conjunction with the end members 61 of the frame of the unit section 16.

I now proceed to a description of the lower screen member. As previously indicated, this member is preferably continuously continuous from end to end of the vibratory screen unit, though, if desired, it could be made of sections in a manner similarly to the members 40 and held in place by similar clamping means.

It is contemplated that the lower screen member shall be mounted between the sections 16 and 18 of the vibratory screen unit, and it is likewise displaceable laterally from either of opposite sides of the apparatus by reason of the structure of the supporting or dead frame which provides the necessary clearance spaces through which the members 40, or the lower screen member 62, is removed and replaced, see Figures 4, 5 and 9.

The cross members or beams 51 previously referred to as being carried by the middle section 16 of the screen unit form upper bearing surfaces for the screen member 52 at points intermediate its ends as seen in Figures 4 and 5 and beneath the members 51 and providing lower bearing surfaces for such portions of the screen member 52 are the cross beams 63 carried by or attached to the ends thereof to the sides of the member 52. The member 62 is thus supported and clamped intermediate its ends between the members 51 and 63. The ends of the lower live frame members 65 are formed, as best seen in Figures 4 and 7, with recesses 64 adapted to receive the end plates 62a of the screen member 52 and when the sections 16 and 18 are firmly clamped together, one end of section 16 bearing down upon the angle plate 65 secured thereto clamps the adjacent plate 62a at one end of the screen member 52 into the groove 64 of the adjacent rigid cross member of the frame section 18. At the opposite end of the screen member 62 the cross or end member of the frame section 18 designated 62c is movable slightly in a longitudinal direction as seen best in Figure 7, sliding on an angle plate 66 and moving in recesses in the ends of the sides of the section 18. This movable cross member 62c of the section 18 is therefore capable of longitudinal sliding in relation to the body of the section 16, and there are provided screw bolts 67 suitably headed for wrench application purposes adjustable and cooperating with the lower members 62 in a lengthwise direction of the entire vibrating screen unit.
is a tension beam or cross member. In this manner, as seen in Figure 7, with the adjacent end of the screen member 82 clamped between the end of the section 16 and the tension beam 18a, turning of the members 87 will enable the placing of the screen member 82 under tension whenever desired in placing this member in position for use. An opposite movement of the member 87 will of course relieve tension and enable the screen member 82 to be displaced, upon separation of the middle section 16 from the lower section 18 of the vibratory screen unit.

The means by which the vibrating screen unit is supported is in relation to the tensioning or dead frame 1 for the desired vibrating action of the said unit are shown best in Figures 1, 2, and 3 of the drawings, and referring to Figures 1 and 2, it is noted that I employ at opposite sides of the live frame or screen unit longitudinal flange members comprising main supporting springs 68 equipped at the extreme portions thereof with bearings 89 attached to the underside thereof, which bearings receive, as shown in Figure 5, the eccentric or end crank pins 10 of the shaft 29. Turning of the crank pins in the bearings 89 will cause a longitudinal movement of the springs 68 and an up and down movement of the central portions of the said springs according to their mounting now to be set forth. The corner brackets 33 at one end of the screen have connected to their inner portions of shiftable elements in the form of flat inclined springs 71, the lower ends of which are attached to angle brackets 72 secured within the angles of the posts or upright members 3 at the adjacent corner portions of the dead or supporting frame 1. At the other end of the screen the springs 71 are attached to the outer portions of the brackets 33, at the upper ends, and to the sides 4 of the frame 1 at the lower ends of the springs. There are two of the springs 71 at each side of the vibratory screen unit for connecting the angle brackets 33 at such side to the members 3 and 4 by means of the parts 72, These parts 71 thus form constitute independent resilient or spring-like plates that connect the vibratory screen unit with the base or supporting frame at the four corners of the latter, the members 71 at each side inclining in the same direction or toward one end of the apparatus. The extreme ends of the main springs 68 have connection with the sides of the middle section 16 of the vibratory screen unit by the provision of shiftable members or elements in the form of vertical resilient plates 73 attached at the upper ends to the members 68, as shown at 74, and secured at their lower ends to lateral angle brackets 75 which are inserted in any rigid manner to the part 16. There are two of the resilient plate connections 73 at each side of the apparatus for attaching the opposite ends of the associated spring 68 to the vibratory screen unit.

In addition to the foregoing parts, I provide at each side of the apparatus other inclined inner spring plates or members 78 attached at their upper ends by suitable fastenings to the associated spring 68 some short distance from the ends of the spring and secured at their lower ends to the upper horizontal frame bar 4 of the dead supporting frame by means of open sleeve-like or channel members 77 attached to the part 4 on each side of the supporting frame, as shown at 78. The last mentioned spring or resilient plates 78 incline in a direction opposite to the plates 71 at the same side of the apparatus.

Summarizing, therefore, it will be apparent that the main springs 68 are directly attached to the supporting frame member 4, each by means of two plates 76 inclined toward one end of the apparatus. Likewise, each spring 68 is connected to the middle section 16 of the screen unit by the normally substantially vertical resilient means 73. Then finally the vibratory screen unit is connected by means of two end resilient plates 71 to the corner post and frame parts 3 and 4, respectively of the supporting frame. It will be seen therefore that the means supporting the screen unit of the frame includes the springs 68 and parts 73 and 76, and the shaft 29, cranks 76, and pillow blocks for the cranks 76. The manner of operation of the supporting connections between the springs 68 and the supporting or dead frame of the apparatus, the connections between said springs and the live or vibratory screen unit, and the direct connecting parts between the vibratory screen unit will be more fully set forth hereinafter.

The vibrating shaft 29, which is carried by the middle section 16 of the screen unit passes through the tubular housing member 18 which extends transversely across the middle of said unit between the sides of the section 16. The ends of the shaft 29 carry the eccentric crank elements 70 previously mentioned as being received in the bearings 89 of the main supporting springs 68, bearings that constitute pillow blocks.

A modified form of attachment means for the upper screen members is illustrated in Figures 10 to 12 inclusive of the drawings. In this modified construction it is contemplated that the screen cloth alone shall be used in sections, dispensing with the plates 43 described as being used in conjunction with the screen members 40. For clamping the side edges of the screen cloth of the screen members 43 as shown in the modification, I contemplate mounting on the lower faces of the sides of the upper screen section 17 clamp plates having the vertical flanges 81 and the horizontal portions 82, also having outwardly projecting slotted extensions or lugs 83. On the facing portions of the sides of the middle screen section 16 I provide similar U-shaped clamping plates in reverse direction to those above mentioned, having the downwardly extending vertical flanges 84 and the horizontal portions 85; also having the slotted extensions 86 to correspond with the extensions 83, and lie beneath the latter so that the tension wedges 87 when driven through the slots of the extensions 83 and 86 of the upper and lower flange clamping plates may exert tension on the member 80 on its opposite outer edges, assuming that the sections 17 and 16 of the vibratory screen unit are assembled and fastened together by the upper bolts 38. The said clamping plates are adapted to move horizontally because the vertical flanges 84 and 86 are spaced apart a slightly greater distance than the thickness of the base members of the sections 17 and 16, thus permitting the wedging action of pulling out the clamping plates incident to the driving of the wedges 87 through the extensions 83 and 86.

In Figure 13 I have shown in a somewhat diagrammatic manner the apparatus of the present invention with the top dust cover 88 having bellows connection at 89 with a supply chute 90. Likewise, at the delivery end of the vibrating screen unit are the dust cover or enclosure members 91.
adapted to have bellows connection with a suitable hopper to which is supplied the aggregates coming from the upper screen members 48; also the dust cover means 92 having bellows connection with another hopper to which the aggregates coming off the lower screen member 62 will be delivered. This view simply typifies the manner in which the dust covers may be arranged permanently and nevertheless permit of the removal of any one or more of the screen members without disturbance of the dust covers or enclosures in any way whatsoever. To this end the screen members are removable and adapted to be replaced laterally of the screen unit from between the several sections 16, 17 and 18, as will be more fully set forth.

The general operation of screening apparatus of my invention involves the special unique actuating movements imparted to the screen unit by means of driving mechanism operated by a suitable motor not shown transferred to the driving shaft made up of the sections 8, 12, and 14, actuated by the pulley 7 on the shaft section 8. Driving action of the said sectional shaft is transferred, as previously set forth, by a pulley wheel 26 having the belt connection 21 with the pulley wheel 28 carried by the vibrating shaft 18.

The shaft 28 is driven at high speed and the operation of the screen unit in reference to the vibrating forces imparted thereto is substantially as follows:

In describing the operation of this apparatus, it should be understood that the screen unit is elevated from its normal low position to its upper position on an inclined path and suddenly returned in the reverse direction to the lower position, during which time rectangular reciprocation the screen unit is maintained in a true horizontal position. These reciprocatory motions upwardly and downwardly in the inclined plane referred to take place at relatively high speed—in the order of 1000 reciprocations per minute. It is this sudden reciprocatory motion which imparts to the screen the jumping action that effects a travel of the aggregates continuously toward the discharge end of the unit and incidental falling of these aggregates through the full effective area of the screen mesh.

The operation of this screen unit in the manner above stated is caused by the action of the crank pin 70 at the ends of the shaft 28 upon the longitudinal springs 68 through the full orbit of these pins of 360°, in conjunction with the suspension of the unit upon the resilient flexible end members 71 and the resilient intermediate members 75, as well as the substantially vertical slightly laterally movable members 73 attached to the extreme ends of the longitudinal springs 68.

More specifically setting forth this action and describing the operation of the parts on one side of the apparatus, referring to Figure 1, for example, the operation of the parts at the opposite sides being identical, it is first assumed that the crank pin 70 is at the top of its orbit path with the associated longitudinal spring 68 substantially straight and the vibratory screen unit at the lower position. As the crank pin 70 moves counterclockwise toward the position shown in dotted lines in Figure 1 of the drawings, it first bows the longitudinal spring 68 at the center during the first half turn and effecting a leftward movement bodily of said spring during the second quarter of said turn, which, in turn, tends to bring the spring members 76 toward a vertical position, flexing the end springs 72 from their vertical position laterally leftward. In the foregoing movement, the spring 68 is symmetrically distorted. This action, in which each half of the spring acts as a lever with the associated spring 76 acting as a fulcrum, raises the screen unit vertically through the lifting effect of the springs 68 on the substantially vertical flexible members 75. As a result of this elevating motion, the screen unit is shifted to the right and upward by virtue of the flexing of the inclined end springs 71 toward a vertical position. In other words, the lifting effect on the vibratory screen unit exerted by the substantially vertical members 75 produces a rightward upward shifting of the upper ends of the inclined spring members 71 to cause the screen unit to move in the slantingly rightward upward path of reciprocation. This path in reality is a relatively large arc. This inclined movement upwardly with the screen unit in its horizontal position throughout, as stated above, takes place through the first 90° movement of the crank pin from its top center to its lower center shown in Figure 1.

The return of the screen to its lower position by reciprocation in the reverse direction over said arc is to take place incident to the movement of the crank pin 70 during the final half or 180° of its movement from the lowermost position of Figure 1 to its topmost position in the orbit, the various parts being thereby restored to the initial positions assumed thereby when the spring 68 is substantially straight or with its central position at the uppermost limit of its movement. That is to say, as the crank pin 70 rises, the spring 68 is shifted bodily toward the right, during the last quarter of turn accompanied by the movement of the spring members 75 to their original inclined position from which the descending operation commenced, the spring members 73 moving rightward toward their vertical positions. As this action is produced, the screen unit is caused to move downwardly, which downward movement is accompanied by the shifting of the end inclined springs 71 toward their initial inclined position to the left. During the complete cycle of movement of the parts as above described, the top point of the member 76 and the corresponding point of the top of the end connecting member 71 move forward and from each other, speaking with reference to each pair of said members at each end of the spring 68. It is this compound action of the suspension members which effects the travel of the screen unit in the reverse or downward path of reciprocation on the inclined plane.

Now it will be apparent that by reason of the disposition of the longitudinal springs 68 at opposite sides of the screen unit and in relation to the supporting frame 1—3—5, when it is desired to remove an upper screen member 48 or more than one of these members, the upper bolts 39 at opposite sides of the screen unit will be unscrewed, thereby releasing the clamping effect of these bolts and the bolts at one side will be removed. The hanger bolts 32 will be unscrewed from the brackets 34, and the coil springs 35 by their expanding effect will raise the section 11 of the screen unit from the section 16, so that several screen members 40 may be displaced laterally from the side of the screen unit where the bolts have been entirely removed under the above conditions. If only one of the screen members 48 is to be removed, it is only necessary to displace completely the two bolts 39 at the end of this screen member at the side of the unit from which...
the screen member is to be displaced, for obvious reasons. After a screen member 48 has been removed and a fresh screen member replaced in its stead, the displaced bolts 39 will be replaced and all the bolts 39 screwed down again to clamp the section 17 of the unit against the section 16 of the unit; likewise the corner hanger bolts 32 will be tightened down again on the corner brackets 30.

Now if the lower screen member 62 is to be displaced, the various lower bolts 41 at opposite sides of the screen unit will be unscrewed. The bolts 41 at one side of the screen unit, at which side the screen member 62 is to be displaced or removed, will then be entirely removed from the unit. Thereafter, the corner hanger bolts 32 will be unscrewed and this action will enable the gravitational lowering of the section 10 of the screen unit to enable it to separate from the section 17 in a spacing manner and free the screen 62 for removal operation. Of course, before removal of the screen 62 the tension bolts 67 will have to be operated to release the pull on the tension beam 62 so as to facilitate the removal of the screen 62. The operations above referred to are simply reversed after the screen 62 has been removed and a fresh screen member is to be emplaced in its stead.

Now in the above screen member handling operations involving removal and replacement of said members, it will be obvious that a relatively small number of bolts have to be removed and replaced, and simple other detaching operations performed. Moreover, there is no necessity for disturbing any dust covers attached to the screen apparatus because the screen members are removed and replaced from the sides of the apparatus and not from above or below. Those of the clamping devices used for the screen members are of course operated to release the screen members when they are to be removed and to re-clamp the fresh screen members in a manner obvious to those skilled in the art and the general presentation of these details of the invention.

Because of the simplicity of the screen member removal and replacement operations, a material saving in time for effecting these operations is obtained, this being a very important desideratum.

One further advantage provided by the present invention is to permit flow of the screened materials along the upper screen toward the delivery end of the upper screen (the right end as seen in Figures 1 and 4).

As seen in Figure 3 the long springs 68 are formed near opposite ends with openings 78a, or bolts 76b may be adjusted for adjustably securing the upper ends of the flexible members 76. Likewise, the brackets 77 may be adjustable on members 4 for a like adjustment of the lower ends of the springs 68, opening 78a at intervals in the members 4 being provided for adjustment of the fastenings 78 (see Figure 1).

Adjustment of the springs closer than in Figures 1 and 3, by the above means 76b and 78 increases the severity of the vibration of the screen unit; opposite separations adjustment lessens the severity of the said unit vibration.

Intermediate its end portions and transversely of the screen unit, the lower long screen 62 is clamped in each of two places (see Figures 4 and 6) by the beam member that includes the previously described plate 51, strut 54a, and a lower cross plate 54b. The plate member 51 is provided with stiffening flanges 51c to which the jacks 50 are pivoted. But intermediate the flanges 51c the parts 51 and 51b of the beam member can flex or yield. Therefore, the action of the jacks 50 is not only that of raising the clamp beams 48, but also that of bearing down equally to effect clamping action of the beams 51, 51a, 51b, upon the lower screen 62 thereby to hold the latter tensioned transversely at the two places where the said last beams are located.

Thus the jacks 50 have a double clamping function in coating with the upper screen members 45, and the lower screen member 62.

Since the construction of the shaft 29 and connections by the bearings 69 to the long springs 68 is peculiar and cannot be completely illustrated in Figure 5, reference is made to Figures 17 and 18 for an understanding thereof. In Figure 17 the shaft 29 is partially shown within its housing 79 that is secured at its ends to the inner faces of the sides of the section 10 of the screen unit. Said shaft passes through said sides, each of which supports bearings 55 in the housing 79 for receiving the shaft end adjacent. The eccentric member or crank pin 70 is integral with each shaft end as seen, and each pulley 28 is formed as shown in Figure 18 with a recess 85 and opening 97. The recess receives the end of the shaft 29 at its juncture with the crank pin 70. The pin 70 passes through the opening 87 which is eccentric to the recess 85. This construction interlocks the pulley 28 to the shaft preventing rotation of the pulley relatively to the shaft so no key or spline is required.

The crank pin 70 projects outward from the pulley 28 to enter the bearing member or pillow block 89 of the adjacent coacting spring 68 (see Figures 1 and 4), and is provided with the reduced threaded end 78c that receives nut 90. The nut 98 holds in place the inner race for the ball bearings 93 between the pin 70 and the bearing member or block 89 and is secured to spring 68. The outer race of the bearings 93 is held in place by the inner race, as is obvious. A closing cap 100 is used to close the bearing means and may be frictionally or otherwise attached to the member 85. The construction of Figures 17 and 18 is in duplicate for the opposite sides of section 16 of the screen unit.

It will be noted from the foregoing disclosure of my invention that my screen unit is flat or horizontal in its general position during vibration operation, which permits perfect sizing of the material and gravitation of the material at a right angle to the moving screen members and material thereon. The screen unit is designed to have a conveying action of the material over its surface which is at a controlled speed.

By reason of the construction of the screen unit in three sections, top, middle, and bottom frames, virtually speaking, there are afforded quick change advantages for the screen members independently of each other, and also they can all be removed and replaced at the same time relatively quickly, to afford material saving in time and labor, as previously indicated. Necessarily, this advantage increases the operative productive capacity of the unit.

The full floating driven shaft and housing means are carried in the vibrating unit completely and employed solely to function to set up the vibrating impulses in the specially designed spring suspension that supports the vibrating unit. Under these conditions, it requires very little power to drive the shaft 29 with its eccentric end members or cranks, thereby reducing the shock throughout the entire screen, affording an
15 economy in the maintenance cost of the apparatus.

My improved arrangement and design of the spring suspension means for the vibrating screen and actuating means, therefore, will impart a positive action to the vibrating screen unit with every revolution of the shaft 29, effecting said vibration at a substantially 60° angle to the flat screen surfaces of the screen members.

All fastening means for the sections of the screen unit are accessible from the outside as well as the clamps or clamping devices that are manipulated for clamping inner edges of certain screen members or tensioning the screen members at various points. All stretching action of the screen members is effected also from the outside of the unit.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent of the United States is—

1. In vibrating screen apparatus of the class described, in combination, a base or supporting frame, a vibratory screen unit mounted thereon and comprising screen members carried by said unit, a floating mounting between the screen unit and the supporting frame including a transverse driven shaft connected to the screen unit at approximately the middle portion thereof, a pair of longitudinal springs on each side of the screen unit, eccentric driving connections at the ends of the driven shaft connecting with said springs for effecting longitudinal back and forth movement of the longitudinal springs and upward and downward movement of the middle portions of said springs, substantially vertical members depending from the ends of the longitudinal springs and having connection with the supporting frame near the ends of the latter, and members connecting the longitudinal springs adjacent to the ends thereof with the supporting frame, said last members being normally inclined in one direction.

2. A screen apparatus as claimed in claim 1, combined with members movably connecting the ends of the supporting frame and the ends of the screen unit.

3. A screen apparatus as claimed in claim 1, combined with members movably connecting the ends of the supporting frame and the ends of the screen unit, the last mentioned members having a normal inclination opposite to that of the inclined members which connect the longitudinal springs near the ends thereof with the supporting frame.

4. In screening apparatus of the class described, the combination of a supporting frame; a vibratory screen unit associated with said frame; means for suspending the screen unit on said frame including a longitudinally extending flexible member at each side of the screen unit, shiftable elements connecting the flexible members to the supporting frame and to the screen unit maintaining the screen unit in horizontal position, said elements being disposed in such positions to impart movements to the screen unit vertically, and actuating means carried by said screen unit and operably connected to the longitudinally extending flexible members to effect flexure and longitudinal movement of the last mentioned members and reciprocatory movements of the screen unit in an inclined plane while said unit is maintained in a horizontal position.

5. In vibrating screen apparatus, in combination, a screen unit, screen members mounted thereon, a supporting dead frame for carrying the screen unit during its vibrating operation, means for effecting vibratory operation of the screen unit comprising an actuating shaft mounted on the screen unit, long springs at opposite sides of the screen unit, eccentric members on said shaft having spring bearing connections with said long spring members intermediate the ends of the latter for vibrating said spring members upward and downwardly and longitudinally, first members at the ends of the long spring members connecting the same with the screen unit, second members connecting the long spring members with the supporting dead frame, and other members connecting the screen unit with the supporting dead frame, said spring members, first and second members, and other members referred to operating to control free floating movement of the screen unit and to maintain said unit horizontal during vibration thereof.

6. A vibrating screen apparatus as claimed in claim 5, wherein the second members mentioned are inclined toward one end of the long springs to which they are connected.

7. A vibrating screen apparatus as claimed in claim 5, wherein the second members mentioned are inclined toward one end of the long springs to which they are connected, and in which the other members referred to as connecting the screen unit with the supporting dead frame are inclined oppositely to the direction of inclination of said second members.

8. A vibrating screen apparatus as claimed in claim 5, wherein the second members mentioned are inclined toward one end of the long springs to which they are connected, in which the other members referred to as connecting the screen unit with the supporting dead frame are inclined oppositely to the direction of inclination of said second members, and in which the first members that connect the ends of the long spring members to the screen unit are normally vertically disposed and are movable longitudinally of the apparatus for permitting the longitudinal shifting of said spring members.

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