June 26, 1923. 1,459,844

B. A. MITCHELL

VIBRATING SCREEN

Filed Dec. 22, 1919 4 Sheets-Sheet 1

Fig. 1.

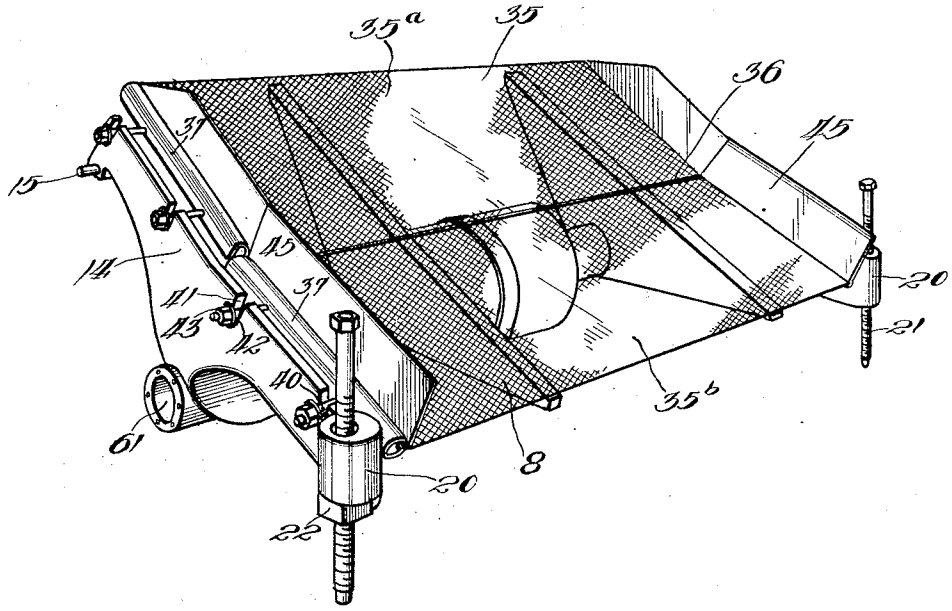
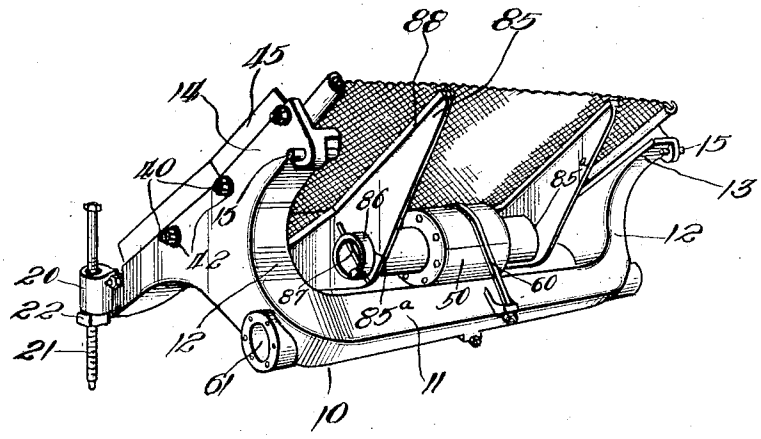


Fig. 2.



Witness.
Harry S. Gaither

Inventor.
Benjamin A. Mitchell
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Filed Dec. 22, 1919 4 Sheets-Sheet 2

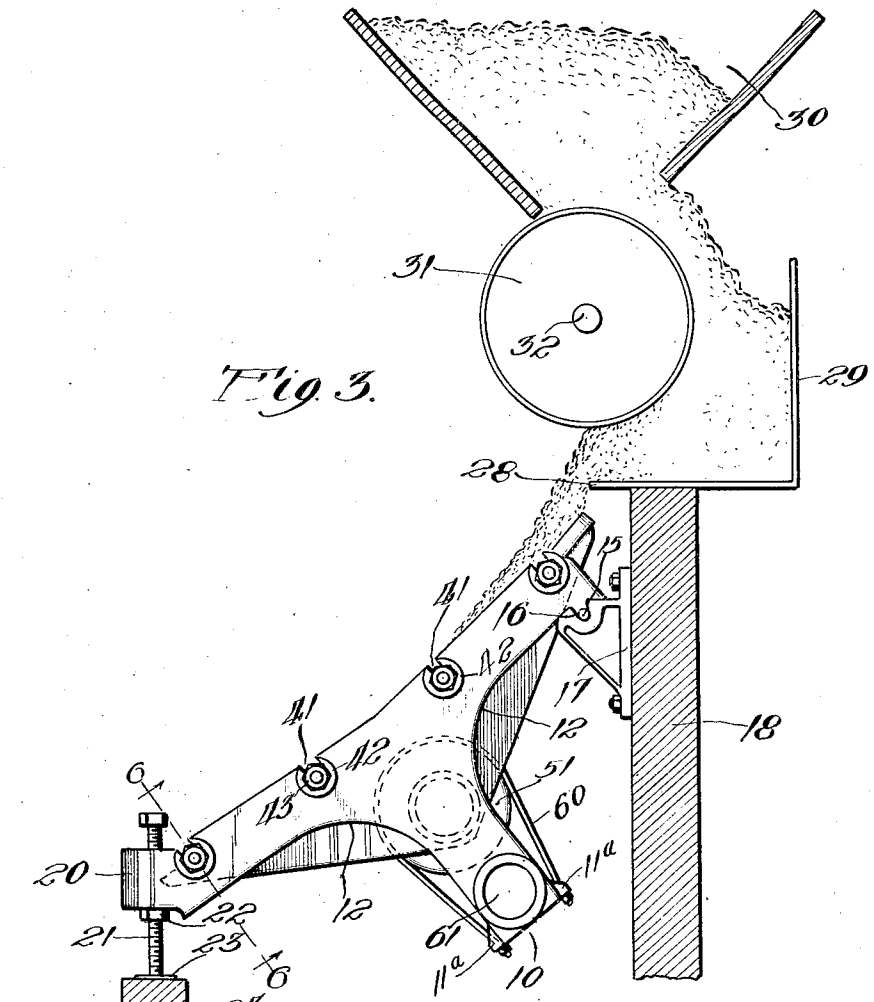


Fig. 3.

Fig. 4.

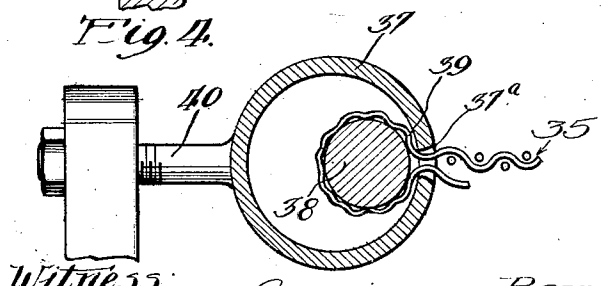
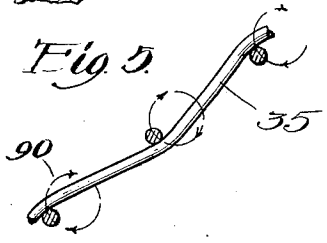


Fig. 5.



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4 Sheets-Sheet 3

Fig. 6.

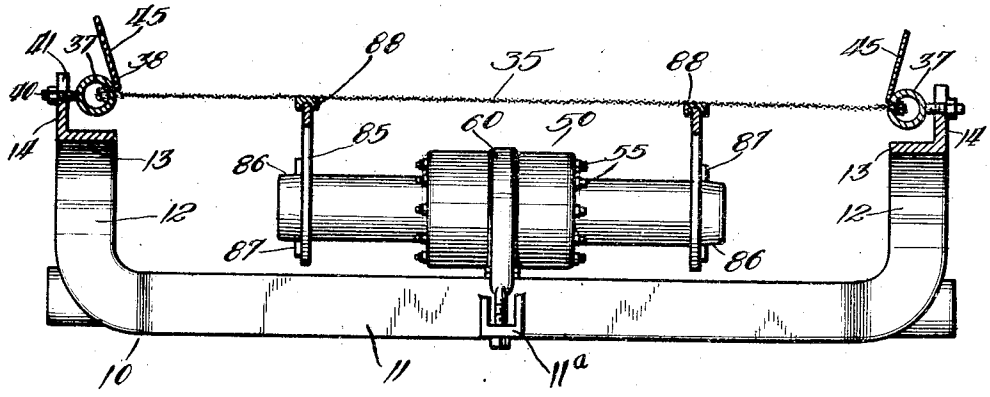
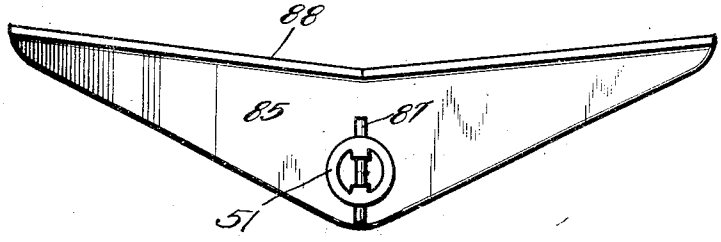


Fig. 7.



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June 26, 1923

1,459,844

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VIBRATING SCREEN

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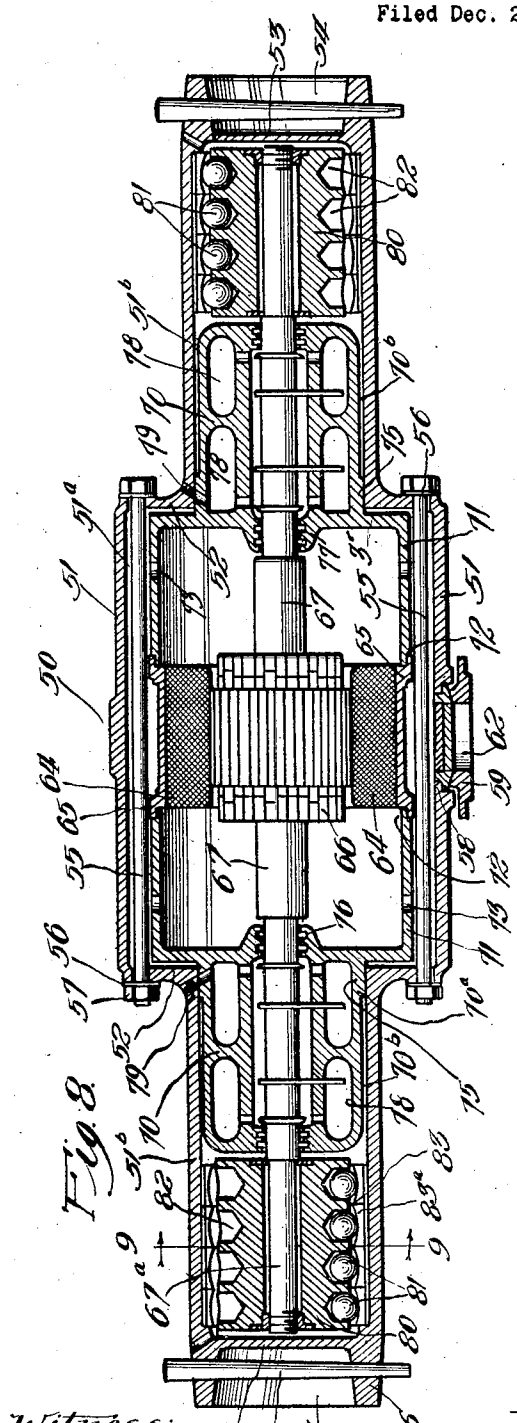


Fig. 8.

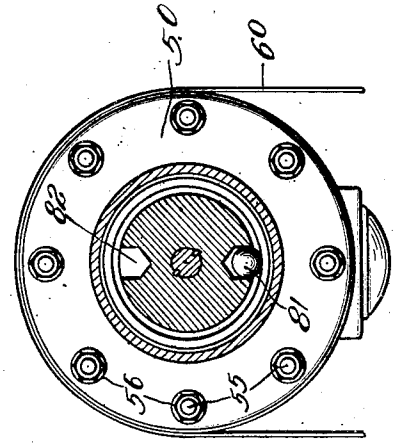


Fig. 9.

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Patented June 26, 1923. 1,459,844

UNITED STATES PATENT OFFICE.

BENJAMIN A. MITCHELL, OF GARFIELD, UTAH.

VIBRATING SCREEN.

Application filed December 22, 1919. Serial No. 346,751.

To all whom it may concern:

Be it known that I, BENJAMIN A. MITCHELL, a citizen of the United States, residing at Garfield, in the county of Salt Lake and State of Utah, have invented certain new and useful Improvements in Vibrating Screens, of which the following is a specification.

This invention relates to screening apparatus for screening crushed ore, coal, or other loose materials with which the machine is adapted to be used.

The purpose of the invention is to provide an improved screening apparatus involving a new method of screening, whereby minute and substantially circular vibrations are set up in the screening medium, such as the ordinary woven wire screen cloth. The apparatus comprises a supporting frame, on which the screen cloth is mounted, in combination with improved adjusting means for setting up a high degree of tension in the screen cloth. Vibrations are produced in the screen cloth by means of a rotary vibrator embodying one or more unbalanced rotary elements which set up substantially circular vibrations in the vibrator casing. These vibrations are imparted directly to the screen cloth by rigid transmitting elements, thereby causing each particle of the screen cloth to travel in a substantially circular path of vibration perpendicular to the plane of the screen. An important feature of the invention is the provision of an improved supporting frame and an improved method of mounting the vibrator, the frame comprising end plates between which the screen cloth is mounted, and the underlying supporting member connecting the end plates and having the vibrator mounted in fixed position thereon. This frame is capable of angular adjustment, in order to regulate the flow by gravity of the loose materials thereover, and the screen cloth can be readily detached from the frame to permit replacement thereof when worn without interfering with the vibrating and transmitting mechanism. Other objects of the invention relate to various features of construction, operation, and arrangement which will be pointed out more fully hereinafter.

The nature of the invention will be understood from the following specification, taken in connection with the accompanying drawings, in which one embodiment is illustrated.

In the drawings—

Figure 1 shows a perspective view of the frame, screen cloth, and vibrator, looking toward the upper side thereof;

Fig. 2 is a perspective view of the apparatus illustrated in Fig. 1, looking toward the underside thereof, and illustrating the method of mounting the vibrator on the frame;

Fig. 3 shows an end elevation of the screening mechanism, showing the method of mounting the same in position to receive the loose materials from a feeding hopper;

Fig. 4 is an enlarged sectional view through one of the clamping rods and tubes at one end of the screen cloth, showing one means of connecting the screen cloth to the frame and adjusting the tension thereof;

Fig. 5 is an enlarged sectional view, taken in a vertical plane parallel to the path of travel of the materials over the screen, showing somewhat diagrammatically the character of the vibrations set up in the particles of the screen;

Fig. 6 is a longitudinal sectional view, taken on the line 6—6 of Fig. 3;

Fig. 7 shows an end elevation of one of the plates by which the vibrations are transmitted to the screen cloth;

Fig. 8 shows a longitudinal sectional view through the rotary vibrator; and

Fig. 9 shows a sectional view, taken on the line 9—9 of Fig. 8.

The supporting frame 10 in the screening apparatus comprises a longitudinal supporting base member 11 which connects in an integral manner the upstanding end members 12, shown as curving upwardly therefrom. The members 12 are increased in width as their upper edges are approached, and terminate in plates 13 having side plates 14 extending upwardly therefrom flush with the outer surfaces of the portions 12, thus giving the end walls of the frame an angular cross section. The end plates are provided at their upper ends with longitudinally projecting trunnions 15, which are adapted to engage the bearing notches 16 in the brackets 17, secured to the supporting wall 18. The lower extremities of the end plates 14 are formed integrally with hubs or bosses 20, which are provided with threaded ap-

ertures engaged by adjusting bolts 21. The adjusting bolts are secured in adjusted position by lock nuts 22, and rest at their lower ends on plates 23 mounted on the upper surface of a wall 24, which forms a dividing partition between the hopper 25 for the screen materials and another hopper 26 adapted to receive the coarse materials discharged over the lower edge of the screen. By adjusting the bolts 21 it is possible to regulate the angular position of the frame and of the screen carried thereby in order to secure the desired rate of flow thereover by gravity of the loose materials being screened. The loose materials are discharged onto the upper part of the screening medium from a ledge or plate 28, which is mounted on the upper part of the wall 18 and terminates along a line parallel to the upper edge of the screen cloth. A plate 29 extends upwardly from the rear edge of the plate 28, thus forming an intermediate receptacle adapted to receive crushed ore or other loose materials from a hopper 30, which is mounted above the plate 28 and adapted to discharge the loose materials onto a rotary feeding member 31, which rotates with a shaft 32 and is adapted to discharge the loose materials over the edge of the plate onto the screen.

The screening medium 35 consists of a woven wire screen cloth formed, preferably, in two sections 35^a and 35^b, which join along a line 36 midway between the upper and lower edges of the screen. The two sections 35^a and 35^b are relatively inclined, the lower section having a lesser inclination to the horizontal than the upper section, so that the materials passing downwardly by gravity are retarded as they approach the discharge edge of the screen. The sections of screen cloth are secured to the frame by means of tubes 37 and rods 38. These tubes are considerably larger in diameter than the rods, and are provided with longitudinal slots 37^a, through which the screen cloth extends. The screen cloth is wound around the rod 38, and the free end thereof carried out again through the slot, so that when a pull is exerted on the tube 37 the edges of the slot exert a snubbing action on the screen cloth and force it against the rod 38, thus securely gripping the screen cloth between the tube and the rod, as shown at 39. The screen cloth is preferably so arranged that certain parallel strands thereof will extend longitudinally of the screen, while the other strands extend transversely thereto and parallel to the end plates 14. The slotted tubes 37 are formed integrally with or secured to bolts or studs 40, which are adapted to engage and project through slots 41 extending downwardly from the upper edges of the end plates 14. Washers 42 engage the projecting ends of the bolts and overlap the walls of the slots 41, and the nuts 43, engaging the bolts and seating against the washers, which are capable of adjustment in order to adjust the tension of the screen longitudinally thereof.

It will be observed that the end walls of the frame are somewhat angular in shape transversely to the connecting member 11, thereby conforming to the relative inclination of the complementary sections of the screen cloth. If desired, baffle plates 45 may be mounted at the ends of the screen cloth to prevent loose materials from passing over the tubes 37 at the ends of the screen. These baffles may be mounted in any desired manner, but are preferably provided with inturned lower edges, which enter the slots 37^a in the tubes and are gripped between the rods 38 of the walls of the slots.

The vibrator 50, utilizes the principle of rotating moments as set forth in my copending application, Serial No. 275,321, in producing vibration. It is arranged to be actuated internally and is mounted on the connecting member 11 midway between the ends of the supporting frame, and is housed in a casing 51, which is formed in two parts, each part including an enlarged central portion 51^a, of comparatively large diameter, and a smaller end portion 51^b, of small diameter. Each central portion has an end wall 52 which connects it with the reduced part 51^b, and each part 51^b has an end wall 53 which is spaced inwardly from the end thereof, leaving a circular depression 54. The two parts of the casing 51 are secured together by means of a series of bolts 55, which extend through apertures in the end walls 52 located just inwardly from the outer cylindrical walls of the parts 51^a. These bolts are engaged at their ends by washers 56 and 57, by which the two parts of the casing are securely clamped together. On its lower side the casing is provided, on the meeting line of the two parts of the casing, with an apertured boss having a bearing collar 58 mounted therein. The annular beveled surface of this bearing collar is adapted to coact with a similar beveled surface formed on a supporting collar 59, which is adapted to rest upon and be secured to the connecting member 11 of the frame. A strap 60 extends around the vibrator 50 above the collar 59, and the threaded ends of this strap extend through ears 11^a on the sides of the frame member 11, thus securely clamping the central part of the casing in position on the frame. For purposes of ventilation the connecting member is provided with an aperture 61 extending inwardly from one end thereof, and this aperture communicates with the opening 62 formed through the collars 58 and 59, so that air can flow or be forced into the interior of the centrally enlarged portion of the casing.

The air introduced into the casing is for the purpose of cooling an electric motor, which comprises a field winding 64 mounted in an annular metallic casing 65, which, with the casing 51, serves as the field frame of the motor. The armature 66 of the motor is mounted within the field winding 64 on a shaft 67 which extends longitudinally between the end walls 53. This shaft is journaled in bearing casings 70, which comprise enlarged parts 70^a located in the parts 51^a of the casing, and the reduced parts 70^b located in the end portions 51^b of the casing. The annular walls 71 of the part 70^a interlock with the frame member 65 of the motor, as shown at 72, and are provided with apertures 73, through which the air admitted through the aperture 61 is permitted to pass to the motor from the spaces around the bolts 55. The end portion 70^b of each bearing casing is provided with a part 75 at its end which closely fits the annular wall of the end portion of the casing 51^b, and the end walls of the bearing casings are provided with bearings 76 and 77, in which the shaft 67 is journaled. The reduced part 70^b of each end casing is hollowed out between the end walls thereof to form cavities 78 adapted to receive lubricating oil, which may be inserted through the apertures, which are normally closed by studs 79 adapted to prevent relative rotation of the bearing casing with respect to the casing 51. The end portions 67^a of the shaft project through the bearing casing 70 and are adapted to carry cages 80, which, with the spherical balls 81, form the unbalanced elements by which circular vibrations are imparted to the free ends of the casing. Each cage is provided on opposite sides thereof with a row of recesses 82, of circular cross section and conical formation, these recesses being adapted to receive the balls 81. The balls are located in one series of recesses only in each cage, leaving the recesses on the diametrically opposite side of the shaft vacant. The balls are carried around by the cage during the rotation of the shaft, and are adapted to travel on independent raceways 83, which are arranged side by side between the bearing casing and the end wall of the vibrator casing, and which are secured to the vibrator casing to prevent rotation thereof. These raceways are hollowed out annularly on their inner sides, as shown at 83^a, and the balls travel in these hollowed out portions during the rotation of the cage. Since the balls are located only on one side of the shaft, the rotation of the cage produces an unbalancing effect by reason of the centrifugal action of the balls, so that substantially circular vibrations are set up in the casing.

The vibrations so set up in the casing are transmitted to the screen cloth by means of a pair of transmitting plates 85. These plates are relatively wide at their central portions and taper toward their ends, and the enlarged central portions are provided with apertures 85^a which are adapted to engage the extremities 86 of the casing 51. These extremities are tapered on their outer surfaces to fit the corresponding tapered apertures 85^a, and after the plates have been driven to position on the casing they are secured thereon by means of transverse tapered keys 87, which engage oppositely disposed apertures in the parts 86. The plates are thus mounted rigidly with respect to the free ends of the vibrator casing, and they extend upwardly therefrom in planes normal to the planes of the screen sections and transverse to the direction in which tension is applied in the screen, and engage the under surfaces of the woven wire screen 35. The plates 85, which are of metal, are preferably provided along their upper edges with wooden transmitting members 88, which are somewhat wider than the plates 85 and which bear directly on the under surfaces of the screen sections. The upper edges of the plates are somewhat angular in contour, so that the wooden transmitting members 88 on each plate have an angular inclination corresponding to the relative inclination of the two sections 35^a and 35^b of the screen.

The cages 80, which are mounted in opposite ends of the vibrator casing, are preferably mounted in the same plane, and the balls 81 in one cage are preferably mounted diametrically opposite the balls 81 in the other cage. Since the central part of the vibrator casing is substantially fixed with respect to the frame and the projecting ends through it vibrate, the rotation of the cages in the ends of the casing will set up circular vibrations therein, and if the balls in the two cages are on opposite sides of the shaft the vibrations in one end of the casing will be out of phase with those in the other end, so that the casing as a whole tends to vibrate about its central part with the free ends of the casing traveling in paths of minute amplitude. The vibrations so produced are transmitted to the screen cloth by the plates 85, thereby setting up vibrations of small amplitude in each particle of the screen medium. The shaft of the vibrator is parallel to the planes of the screen sections so that the vibrations produced are in planes normal to the plane of the screen and transverse to the direction in which tension is applied in the screen. The vertical planes in which the vibrations take place also contain the paths of travel of the loose materials passing downwardly over the screen. The character of this vibration is illustrated somewhat diametrically in Fig. 5, which shows an enlarged sectional view of the screen cloth taken in a plane perpendicular

to the axis of the vibrator and transversely to the direction in which tension is applied to the screen. Each particle of the screen cloth tends to move in a path 90 shown as substantially circular in shape. With the vibrator located beneath the casing in the manner illustrated, the direction of rotation is preferably in a clockwise direction, as viewed in Fig. 3, so that the peripheries of the rotary elements of the vibrator are moving in a general upward direction when they are nearest to the screen cloth. This results in setting up of vibrations in the screen cloth which travel in the directions indicated by the arrows in Fig. 5. In the upper part of its vibration each particle of the screen cloth is moving momentarily toward the upper edge of the screen, thus tending to produce an instantaneous or momentary retardation of the particles of loose materials passing downwardly over the screen.

In practice, the motor, or other driving means, which is employed to operate the vibrator, should preferably drive the shaft 67 at a relatively high speed. For example, a speed of thirty-six hundred revolutions per minute has been found to give satisfactory results in the screening of crushed ore. The screen cloth should, preferably, be under high tension, or in a substantially stiff and rigid condition. Where relatively coarse screens are used the tension therein may be considerably decreased, or eliminated altogether, and the amount of tension for the most satisfactory vibration of the screen cloth will vary, depending upon the character of the material being screened, the speed of vibration, and the nature of the screen cloth used. The proper conditions can best be determined by trial. When the parts of the mechanism are properly adjusted, the rotation of the vibrator will result in the setting up of high frequency vibrations in the screen cloth. These vibrations, although they are minute, are very pronounced in their effect upon the materials being screened, and serve to effect a more efficient screening operation than that attained by any other form of screening apparatus heretofore known. Due to the novel construction of the frame and method of mounting the vibrator, all of the parts of the vibrating mechanism are located beneath the screening medium, leaving the upper surface of the screen cloth entirely free, as well as the region beneath the screen at the upper and lower edges thereof. This makes it possible to mount the screening apparatus conveniently, and to operate it under all conditions with the highest efficiency.

Although I have shown and described one form of the invention for purposes of illustration, it will be understood that it may be constructed in various other embodiments without departing from the scope of the appended claims.

I claim:—

1. In screening apparatus, a supporting frame comprising upstanding parallel end members, a horizontal supporting base member arranged to connect integrally said end members, and means for pivotally supporting said frame.

2. In screening apparatus, a supporting frame comprising upstanding parallel end members, a horizontal supporting base member arranged to connect integrally said end members, said end members having edges adapted to support a screen frame, and means for pivotally supporting said frame.

3. The combination in screening apparatus of substantially parallel end frame members, a single connecting member extending between the central parts of said end frame members, a screening medium mounted between said end frame members, the lateral edges of said screening medium being unsupported and vibrating means mounted on said connecting member and connected to said screening medium to transmit vibrations thereto.

4. The combination in screening apparatus of an integrally formed frame comprising end walls and a connecting member, a screen cloth mounted between said end frame members, and vibrating means mounted on said connecting member and connected to said screen cloth to transmit vibrations thereto.

5. The combination in screening apparatus of parallel end frame members, a single connecting member extending between the central parts of said end frame members and having the body portion thereof located in a plane parallel to the plane of said end frame members, a screening medium mounted between said end frame members, a vibrator mounted on the body portion of said connecting member, and means for operatively connecting said vibrator to said screening medium to transmit vibrations thereto.

6. The combination in screening apparatus of an integrally formed supporting frame comprising upstanding end members and a horizontal connecting member, a screen cloth mounted between said end members, and means for mounting said frame with said screen cloth in an inclined position.

7. The combination in screening apparatus of an integrally formed supporting frame comprising upstanding end members and a horizontal connecting member, a screen cloth mounted between said end members a vibrator, means for mounting said frame with said screen cloth in an inclined position, and means for changing the angular position of said frame.

8. The combination in screening apparatus of a frame comprising end walls and a connecting member extending between said end walls, a screen cloth extending between said

end walls substantially parallel to said connecting member, and a vibrator mounted on said connecting member midway between said end walls and operatively connected to said screen cloth, said vibrator and said connecting member being located beneath said screen cloth.

9. The combination in screening apparatus of substantially parallel end frame members, a longitudinal frame member extending between the central parts of said end frame members, means connected to said end frame members for mounting them in an inclined position, a screening medium extending between said end frame members, and a vibrator mounted on said longitudinal frame member and operatively connected to said screening medium on the underside thereof.

10. The combination in screening apparatus of substantially parallel end frame members mounted in an inclined position, a screen cloth mounted in an inclined position between said end frame members, a longitudinal frame member located beneath said screen cloth and having the ends thereof upturned and connected to said end frame members, a vibrator mounted on said longitudinal frame member, and a transmitting member extending upwardly from said vibrator in a plane parallel to said end frame members.

11. The combination in screening apparatus of substantially parallel end frame members mounted in an inclined position, a screen cloth mounted in an inclined position between said end frame members, a longitudinal frame member located beneath said screen cloth and having the ends thereof upturned and connected to said end frame members, a vibrator mounted on said longitudinal frame member, a vibrator casing having its central part rigidly secured to said longitudinal frame member and having the end portions thereof free to vibrate, and plates secured to the free end portions of said vibrator casing and extending upwardly therefrom to engage said screen cloth.

12. The combination in screening apparatus of substantially parallel end frame members mounted in an inclined position, a screen cloth mounted in an inclined position between said end frame members, a longitudinal frame member located between said screen cloth and having the ends thereof upturned and connected to said end frame members, a vibrator mounted on said longitudinal frame member, a vibrator casing having its central part rigidly secured to said longitudinal frame member and having the end portions thereof free to vibrate, plates secured to the free end portions of said vibrator casing and extending upwardly therefrom to engage said screen cloth, and means in said vibrator casing for producing substantially circular vibrations in the free end portions thereof.

13. The combination in screening apparatus of parallel end frame members, a screen cloth stretched between said end frame members, a longitudinal frame member connecting said end frame members and located beneath said screen cloth, and vibrating means mounted on said longitudinal frame members and operatively connected to said screening cloth for producing minute circular vibrations therein.

14. The combination in screening apparatus of parallel end frame members, a screen cloth mounted in an inclined position and stretched between said end frame members, a longitudinal frame member extending between said end frame members beneath said screen cloth, and means carried by said longitudinal frame member for producing minute circular vibrations in said screen cloth, the direction of movement of each particle of the screen cloth being toward the upper edge of the screen cloth when in the upper part of its path of vibration.

15. The combination in screening apparatus of parallel end frame members, a screen cloth mounted in an inclined position between said end frame members, a longitudinal frame member extending between said end frame members beneath said screen cloth, means carried by said longitudinal frame member for producing minute circular vibrations in said screen cloth, the direction of movement of each particle of the screen cloth being toward the upper edge of the screen cloth when in the upper part of its path of vibration, and means for causing loose materials to pass downwardly over said screen cloth.

16. The combination in screening apparatus of end frame members, a screen cloth mounted in an inclined position between end frame members, means for causing loose materials to pass downwardly over said screen cloth transversely to the direction in which tension is applied, a longitudinal frame member extending between said end frame members beneath said screen, and vibrating means mounted on said longitudinal frame member and connected to said screen cloth for producing circular vibrations in said screen cloth in planes normal to the plane of the screen and transversely to the direction in which tension is applied.

17. The combination in screening apparatus of end frame members, a screen cloth mounted in an inclined position between end frame members, means for maintaining tension in said screen cloth longitudinally thereof, means for causing loose materials to pass downwardly over said screen cloth transversely to the direction in which tension is applied, a longitudinal frame member extending between said end frame mem-

bers beneath said screen, and vibrating means mounted on said longitudinal frame member and connected in operative engagement with said screen cloth for producing circular vibrations in said screen cloth in planes normal to the plane of the screen and transversely to the direction in which tension is applied, the direction of movement of each particle of the screen cloth in the upper part of its path of vibration being toward the upper part of said screen cloth.

18. The combination in screening apparatus of parallel end frame members, a screen cloth mounted in an inclined position between said end frame members and having tension maintained therein in a longitudinal direction, a longitudinal frame member extending between said end frame members beneath said screen cloth, a vibrator casing having the central part thereof mounted in substantially fixed position on the central part of said longitudinal frame member, said vibrator casing having free end portions, means comprising unbalanced rotary elements in said end portions for producing minute circular vibrations therein, and plates mounted on the free end portions of said casing and extending upwardly therefrom in planes normal to the plane of the screen and transversely to the direction in which tension is applied in said screen cloth for transmitting said circular vibrations to said screen cloth.

19. The combination in screening apparatus of parallel end frame members, a screen cloth mounted in an inclined position between said end frame members and having tension maintained therein in a longitudinal direction, a longitudinal frame member extending between said end frame members beneath said screen cloth, a vibrator casing having the central part thereof mounted in substantially fixed position on the central part of said longitudinal frame member, said vibrator casing having free end portions, means comprising unbalanced rotary elements in said end portions for producing minute circular vibrations therein, and plates mounted on the free end portions of said casing and extending upwardly therefrom in planes normal to the plane of the screen and transversely to the direction in which tension is applied in said screen cloth for transmitting said circular vibrations to said screen cloth, the vibrations in one end portion of said casing being out of phase with those in the other end portion of said casing.

In testimony whereof, I have subscribed my name.

BENJAMIN A. MITCHELL.