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Kempa

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[54] **SCREENING APPARATUS**

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[52] **U.S. Cl.** **209/395;** 209/405; 241/73

[51] **Int. Cl.²** **B07B 1/12;** B07B 1/46

[58] **Field of Search** 209/393, 395, 400, 274, 209/281, 234, 405, 408, 409, 404, 99; 241/69, 73, 81

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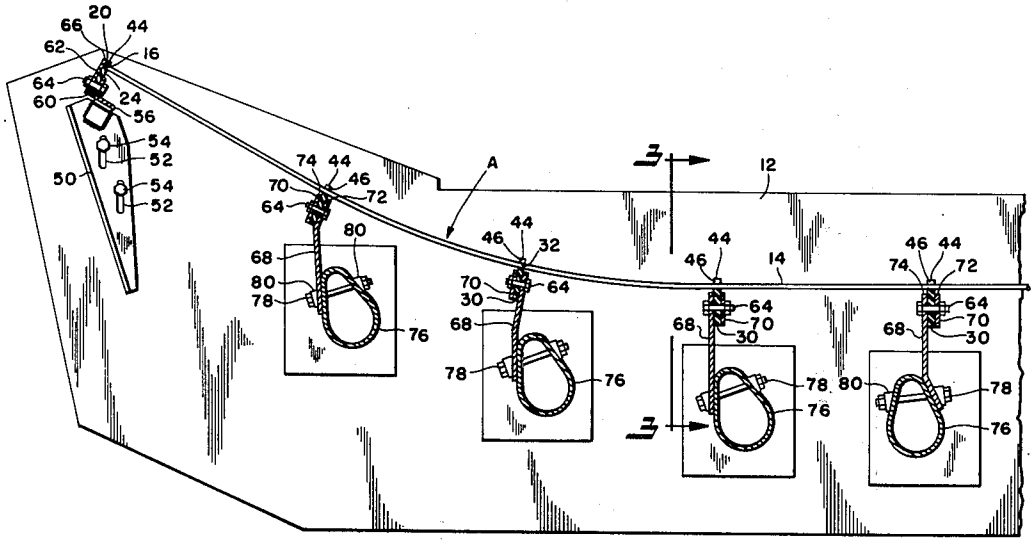
Primary Examiner—Robert Halper

Attorney, Agent, or Firm—Donnelly, Maky, Renner & Otto

[57] **ABSTRACT**

Screening apparatus includes a screen deck formed from a plurality of elongated spaced-apart parallel rods supported at their opposite end portions and at a plurality of longitudinally spaced intermediate locations by transverse elastomeric strips having holes snugly receiving the rods. An oversize screen deck having breaker means for breaking oversize particles may also be provided. Such breaker means may include a movable breaker device positioned in an upwardly facing pocket formed by bending the oversize screen deck rods into U-shaped bend portions adjacent their outer ends.

14 Claims, 3 Drawing Figures



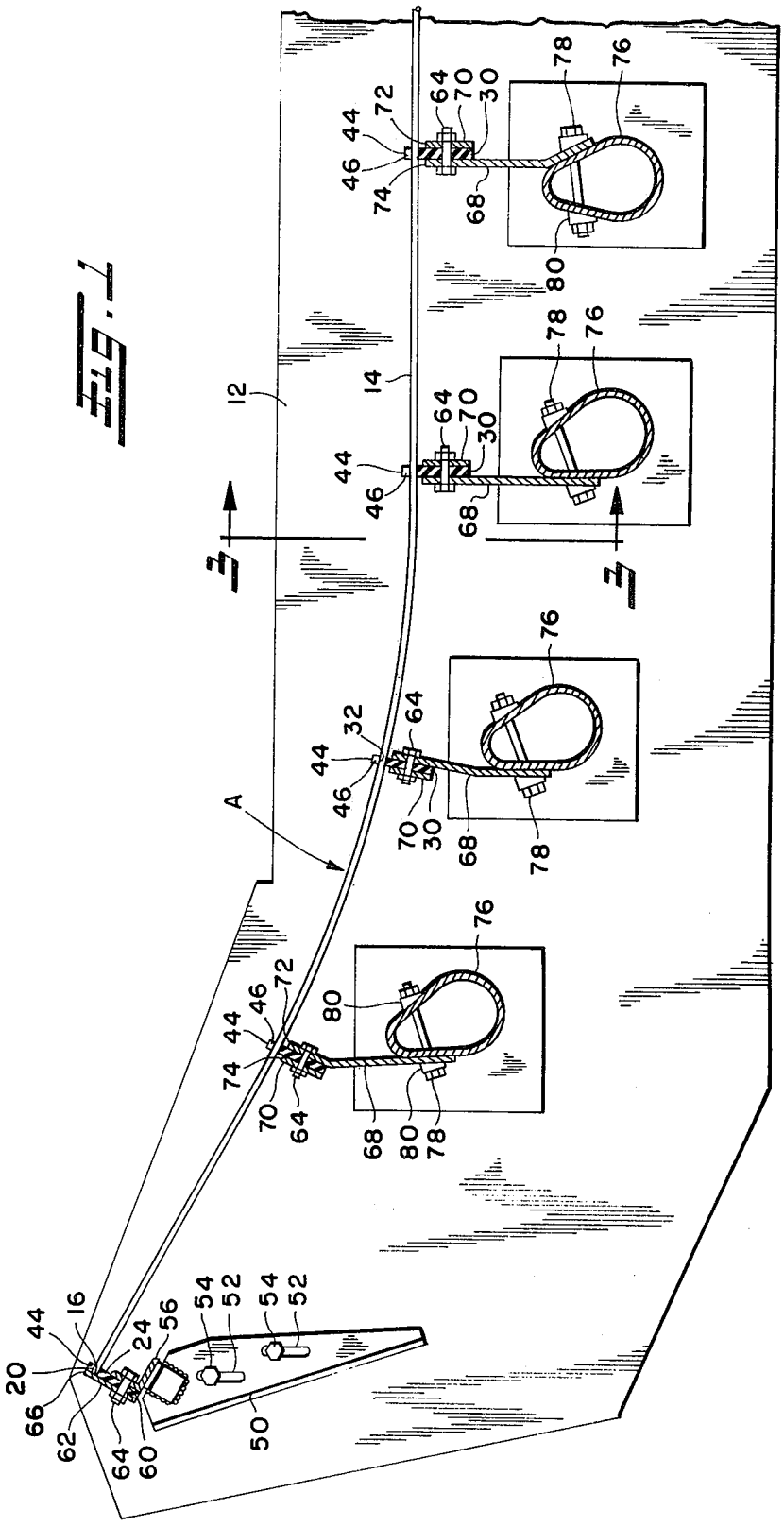

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FIG. 1

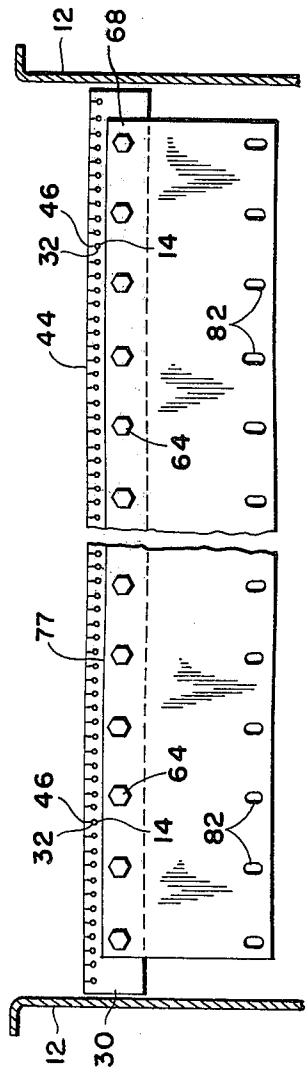

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FIG. 2

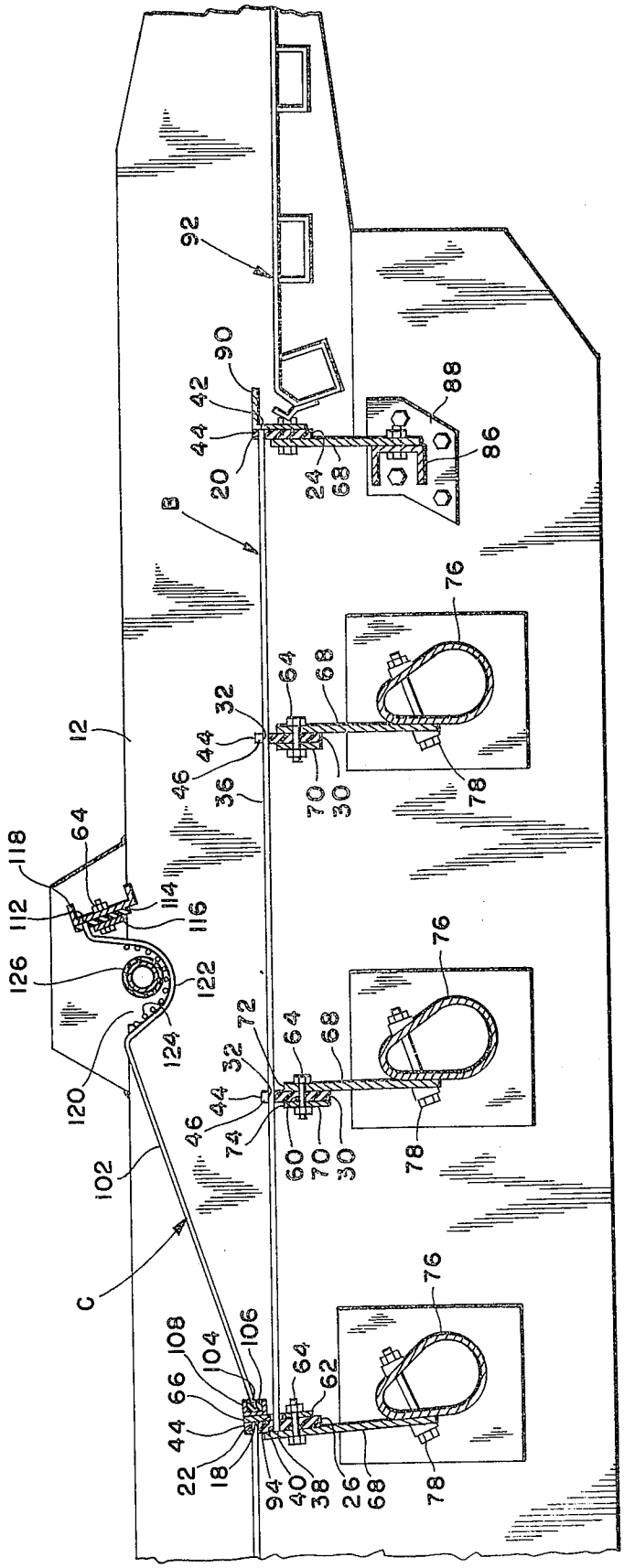

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102
C
76
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108
104
64
62
66
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94
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38
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68
78

Fig. 2

SCREENING APPARATUS

BACKGROUND OF THE INVENTION

This application relates to certain improvements in screening apparatus particularly of the type disclosed in U.S. Pat. No. 3,703,995, issued Nov. 28, 1972, to Kempa et al, and assigned to the same assignee as the present application, and the disclosure of said patent is hereby incorporated herein by reference.

The aforementioned patent discloses a screening apparatus for sizing green balls of iron ore concentrates or the like. The apparatus includes a main screen deck, and an oversize screen deck extending outward from the main screen deck in overlying relation thereto. The entire screening apparatus is vibrated, and green balls deposited on the main screen deck travel onto the oversize screen deck. Undersize green balls fall through the main screen deck onto a return conveyor, desirable size green balls fall through the oversize screen deck onto the main screen deck and discharge onto another conveyor for further processing. Oversize particles are retained on the oversize screen deck, and reduced in size by vibrations and action of a breaker device. The broken oversize particles fall through the oversize screen deck onto the main screen deck. Undersize particles then fall through the main screen deck onto the return conveyor to the balling apparatus, while desirable size particles travel along the main screen deck for discharge onto another conveyor as aforesaid.

In an apparatus of the type described, the screen decks are often times formed of elongated spaced-apart parallel rods rigidly connected together in longitudinal alignment at longitudinally spaced support locations. Such rigid connections between the rods may impart severe stresses to the rods during the vibrating action while material is advancing along the rods, and also dampen the vibrations.

SUMMARY OF THE INVENTION

The screening apparatus of the present invention includes upper and lower screen decks, and an oversize screen deck extending outward from the lower end of the upper screen deck above the lower screen deck.

In accordance with the present invention, the upper screen deck includes a plurality of continuous elongated spaced-apart parallel rods supported at their opposite end portions, and at a plurality of longitudinally spaced locations between their opposite end portions, by a plurality of transversely extending elastomeric strips having holes snugly receiving the rods.

In accordance with a preferred arrangement, the intermediate elastomeric strips have slits extending from their upper edges to intersect the holes therein so that the rods may be inserted into the holes of the intermediate strips by spreading of the slits.

Also in accordance with a preferred arrangement, the lower end portions of the upper screen deck rods and the inner end portions of the lower screen deck rods are supported by a common elastomeric strip having vertically spaced rows of holes therein. The upper row of holes snugly receive the lower end portions of the upper screen deck rods, while the lower row of holes snugly receive the inner end portions of the lower screen deck rods. The lower screen deck rods are also supported at a plurality of longitudinally spaced intermediate locations by elastomeric strips having holes snugly receiving the rods, and having slits extending from the upper edges of the strips to intersection with the holes.

In accordance with another aspect of the invention, a downwardly extending generally U-shaped pocket is formed by generally U-shaped downwardly extending bend portions in the oversize screen deck rods adjacent their outer ends. Oversize particles traveling along the oversize screen deck rods fall into the pocket where they are acted upon by a movable roll which breaks the oversize particles and forces them through the pocket. In a preferred arrangement, the pocket includes a plurality of spaced-apart transversely extending rods secured to the U-shaped bend portions inside the pocket to define a generally arcuate screen having rectangular openings therethrough. This eliminates formation of extremely long particles which might fall through the oversize screen deck diagonally onto the lower screen deck to be fed to the heating device.

In accordance with another aspect of the invention, the elastomeric strips are secured to vertically adjustable support brackets for positioning the top edges of the strips at desirable elevations.

It is a principal object of the present invention to provide an improved screening apparatus of the type desired for sizing particles.

Another object is to provide a screening apparatus including a plurality of screen decks, and having an improved arrangement for supporting the screen decks.

A further object is to provide an improved breaker device on an oversize screen deck for breaking up oversize particles.

An additional object is to provide an improved adjustable support arrangement for screen deck rods.

Still another object is to provide a vibrating screening apparatus having a support arrangement for providing enhanced vibratory action and minimizing stresses in the screen deck rods.

Other objects and advantages of the present invention will become apparent as the following description proceeds.

To the accomplishment of the foregoing and related ends, the invention, then, comprises the features hereinafter fully described and particularly pointed out in the claims, the following description and the annexed drawings setting forth in detail a certain illustrative embodiment of the invention, this being indicative, however, of but one of the various ways in which the principle of the invention may be employed.

BRIEF DESCRIPTION OF THE DRAWINGS

In the annexed drawings:

FIG. 1 is a cross-sectional elevational view of a portion of the improved screening apparatus constructed in accordance with the present invention;

FIG. 2 is a cross-sectional elevational view of the remainder of the screening apparatus of FIG. 1; and

FIG. 3 is a cross-sectional elevational view looking generally in the direction of arrows 3—3 of FIG. 1.

DESCRIPTION OF A PREFERRED EMBODIMENT

Referring now to the drawings, wherein the showings are for purposes of illustrating a preferred embodiment of the invention only and not for purposes of limiting same, FIGS. 1 and 2 show an improved screening apparatus constructed in accordance with the present invention. The screening apparatus desirably includes an upper screen deck A, a lower screen deck B, and an oversize screen deck C extending outwardly from the

lower end of upper screen deck A above lower screen deck B. The side outline of the screening apparatus is generally indicated at 12, and it will be recognized that the structure includes conventional supporting frame members and side plates, along with vibratory means, such as electro-magnetic transducers, for imparting high frequency vibrations to the entire screening apparatus.

In one arrangement, upper screen deck A includes a plurality of continuous elongated transversely spaced-apart metal rods 14 preformed to the curved shape shown in FIG. 1. However, it will be apparent that the rods 14 may be substantially straight if desired, and more than one rod may be used in place of each continuous rod. Upper screen deck rods 14 have opposite upper and lower end portions 16 and 18 snugly received in holes 20 and 22 extending through terminal elastomeric support strips 24 and 26, respectively. Upper screen deck rods 14 are supported intermediate opposite upper and lower end portions 16 and 18 at a plurality of longitudinally spaced locations by a plurality of intermediate elastomeric support strips 30 having holes 32 therethrough snugly receiving rods 14. Strips 24, 26 and 30 may be formed of natural or neoprene rubber, or rubber-like synthetic plastic materials. The strips are relatively soft, having a hardness of around 50–70 durometers on the shore A scale, and preferably around 60 durometers.

Lower terminal elastomeric support strip 26 may also define a common support strip for the elongated transversely spaced-apart parallel rods 36 of lower screen deck B, which also desirably is continuous but may each consist of more than one rod if desired. Lower screen deck rods 36 have inner end portions 38 which are snugly received in a lower row of holes 40 spaced vertically below upper row of holes 22 in common elastomeric support strip 26. Outer end portions 42 of lower screen deck rods 36 are snugly received in holes 20 of terminal elastomeric support strip 24. Intermediate support strips 30 are also positioned at longitudinally spaced locations intermediate opposite end portions 38 and 42 of lower screen deck rods 36 for snugly receiving the rods 36 in holes 32 in the support strips at intermediate longitudinally spaced locations.

In a preferred arrangement, the intermediate elastomeric support strips 30 have slits 46 extending downward from upper edge 44 to intersect centrally the holes 32 therein as shown more clearly in FIG. 3. With this arrangement, slits 46 may be opened for insertion of rods 14 and 36 into holes 32. The terminal elastomeric support strips 24 and 26 desirably do not have such slits 46 so that the opposite end portions of rods 14 and 36 cannot be vertically displaced from the holes 20 and 22 therein. Rods 14 and 36 may be bent slightly for inserting the opposite end portions thereof axially into holes 20 and 22, and the rods may then be forced downward to open slits 46 in intermediate strips 30 until intermediate portions of the rods are snugly received in holes 32.

It will be apparent that various sizes of rods may be used depending on the type of balls being screened in the apparatus. Holes 20, 22 and 32 in the elastomeric support strips are sized substantially smaller than the diameter of the rods so that the rods will be a very snug fit in the holes.

It will be recognized that many different arrangements may be provided for supporting the elastomeric strips. In one arrangement, upper end supports for upper terminal strip 24 may include a plate 50 having vertically elongated slots 52 receiving bolts 54 secured to the side frame of the apparatus. This enables vertical adjustment of support plate 50 to vary the elevation of the upper edge 44 of terminal strip 24. An angle member 56 which spans the side frame of the apparatus may be bolted or welded to the upper edges of support plate 50, and all of the strips 24, 26 and 30 may have a row of mounting holes 60 therethrough, permitting the upper terminal strip 24 to be clamped between angle member 56 and a backing plate 62 having suitable holes therethrough for receiving bolt and nut assemblies 64 which extend through holes 60 in terminal strip 24. Backing plate 62 preferably overlies the holes 20 in terminal strip 24 thus to prevent displacement of upper end portion 16 of rods 14 completely through such holes.

Intermediate elastomeric support strips 30 are clamped between brackets 68 and backing plates 70 having suitable holes therethrough receiving bolt and nut assemblies 64 which extend through holes 60 in strips 30. The upper edges 72 and 74 of brackets 68 and backing plates 70 are located sufficiently below holes 32 in strips 30 to provide a free mass of elastomeric material between such upper edges and the screen deck rods. Brackets 68 are adjustably connected to cross support members 76 having suitable holes therethrough receiving bolt and nut assemblies 78 having bevel washers 80.

As shown in FIG. 3, brackets 68 have vertically elongated mounting slots 82 therethrough receiving bolt and nut assemblies 78 for allowing vertical adjustment of such brackets with respect to cross support members 76 to adjust the elevation of the rods 14 and 36 intermediate the ends thereof. Support brackets 68 and backing plates 70 desirably have a transverse length which is somewhat less than the transverse length of elastomeric strips 30 to avoid contact of the support brackets and backing plates with the metal side frames of the screening apparatus.

It will be recognized that certain of brackets 68 may be required to be longitudinally bent in order to support certain of intermediate strips 30 with their holes 32 axially aligned with the path of curvature of rods 14 on upper screen deck A.

Terminal support bracket 68 for supporting strip 24 at outer end portions 42 of lower screen deck rods 36 is secured to a channel member 86 welded to plates 88 suitably bolted to the opposite side frames of the screening apparatus. Terminal support strip 24 for outer end portions 42 of lower screen deck rods 36 may be clamped by a combination backing plate and discharge lip 90 over which the material being processed may be discharged onto plate 92 for deposit onto a conveyor leading to a heating device, not shown. Backing plate 62 for clamping common elastomeric support strip 26 also desirably overlies the holes 22 therein so that the lower end portions 18 of rods 14 cannot extend completely through such holes. A row of holes 94 somewhat larger in diameter than the diameter of the rods 36 are also provided in the backing plate 66 in alignment with the holes 40 in strip 26 for extension of the inner ends 38 of the rods 36 through the plate 62 into the holes 40 in strip 26.

In accordance with another aspect of the invention, oversize screen deck C desirably includes a plurality of continuous elongated transversely spaced-apart metal rods 102 having inner end portions 104 snugly received

in suitable holes in elastomeric support holes in elastomeric support member **106** which is retained in channel **108** welded to backing plate **62.** The outer end portions **112** of rods **102** are snugly received in suitable holes in an elastomeric support member **114** clamped between backing plate **116** and support channel **118** by bolt and nut assemblies **64.** Support channel **118** may be suitably secured to the opposite side frames of the screening apparatus for supporting outer end portions **112** of rods **102** as shown in FIG. **2.**

In accordance with a preferred arrangement, oversize screen deck C is provided with a downwardly extending generally U-shaped transverse pocket **120** formed by generally U-shaped downwardly extending bend portions **122** in upper screen deck rods **102** adjacent outer end portions **112** thereof. A plurality of transversely extending spaced-apart rods **124** may be welded to rods **102** at bend portions **122** inside pocket **120** to define a generally arcuate screen having substantially square openings therethrough. A rubber covered roll **126** may be freely positioned in pocket **120** to act as a breaker means for breaking up the larger pieces of material in a manner to be subsequently described.

OPERATION

In operation of the apparatus, green balls from a balling drum or other balling device are deposited upon upper screen deck A adjacent upper end portion **16** thereof, and the entire apparatus is vigorously vibrated to cause the green balls to travel along upper screen deck A from left to right in FIG. **1.** Undersize green balls fall through upper screen deck rods **14** onto a return conveyor, not shown, for return to the balling apparatus. The desirable size green balls and oversize green balls travel onto oversize screen deck C, which permits the desirable size green balls to fall through oversize screen deck C onto lower screen deck B for discharge over discharge lip **90** for further processing. The oversize green balls are retained on the oversize screen deck C and are vigorously vibrated until broken up by such vibrations or until they fall into pocket **120** where they are broken up by roll **126** which bounces up and down and rolls back and forth within pocket **120** because of the vibrations to impact against such oversize green balls. As the oversize green balls are broken up by the roll **126** they are forced through the square openings formed by U-shaped bend portions **122** and transverse rods **124.** The smaller undersize particles formed by breaking up the oversize balls simply fall through lower screen deck B onto the return conveyor to the balling apparatus, whereas the desirable size broken particles fall onto lower screen deck B for discharge over discharge lip **90.** Without the transverse rods **124,** extremely large oversize particles might be broken up into elongated oversize particles and fall diagonally upon lower screen deck B to be carried over discharge lip **90.** The transverse rods **124** provide square openings so that the oversize particles are broken up into a desirable size in substantially all dimensions.

The size of the rods and their spacing will of course depend upon the size of green balls desired to be screened. Obviously, the rods for upper and lower screen decks A and B may be of substantially the same size and be spaced-apart substantially the same distance, while oversize screen deck rods **102** are spaced-apart a greater distance than the upper and lower deck rods and may have a greater diameter to withstand the breaking action.

Although the invention has been shown and described with respect to a preferred embodiment, it is obvious that equivalent alterations and modifications will occur to others skilled in the art upon the reading and understanding of this specification. The present invention includes all such equivalent alterations and modifications, and is limited only by the scope of the claims.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. Screening apparatus comprising an upper screen deck, said upper screen deck including a plurality of elongated spaced-apart parallel rods having upstream and downstream end portions, support means for supporting said rods at said upstream and downstream end portions and at a plurality of longitudinally spaced locations intermediate said upstream and downstream end portions, said support means including a plurality of transversely extending elastomeric strips having holes therethrough snugly receiving said rods at said upstream and downstream end portions and at a plurality of longitudinally spaced locations intermediate said upstream and downstream end portions, and a lower screen deck extending outwardly from said downstream end portions of said upper screen deck rods, said lower screen deck including a plurality of elongated spaced-apart lower screen deck rods having upstream and downstream end portions, said strips including a common strip having vertically spaced upper and lower rows of said rod receiving holes, said downstream end portions of said upper screen deck rods being snugly received in said upper row of holes and said upstream end portions of said lower screen deck rods being snugly received in said lower row of holes, and said lower screen deck rods being additionally supported at longitudinally spaced locations by a plurality of said elastomeric strips, said common strip being secured to a support bracket extending substantially the full length of said common strip, said support bracket overlying said lower row of holes in said common strip on the opposite side into which said upstream end portions of said lower screen deck rods are received to preclude extension of said upstream end portions of said downstream screen deck rods completely therethrough, the upper edge of said support bracket terminating beneath said upper row of holes in said common strip, and a backing plate on the opposite side of said common strip into which the downstream end portions of said upper screen deck rods extend to preclude extension of said downstream end portions of said upper screen deck rods completely therethrough, said backing plate having a row of holes therethrough for passage of said upstream end portions of said lower screen deck rods into said lower row of holes in said common strip as aforesaid.

2. Screening apparatus comprising an upper screen deck including a plurality of elongated spaced-apart parallel rods having upstream and downstream end portions, support means for supporting said rods at said upstream and downstream end portions and at a plurality of longitudinally spaced locations intermediate said upstream and downstream end portions, an oversize screen deck extending outwardly from the downstream end portions of said upper screen deck rods, and a lower screen deck extending outwardly from the down-

stream end portions of said upper screen deck rods beneath said oversize screen deck, said lower screen deck including a plurality of continuous spaced-apart parallel rods, said lower screen deck rods having upstream and downstream end portions, and support means for supporting said lower screen deck rods at said upstream and downstream end portions thereof and at a plurality of longitudinally spaced locations intermediate said upstream and downstream end portions, thereof said oversize screen deck including a plurality of elongated spaced-apart oversize screen deck rods having upstream end portions supported adjacent said lower end portions of said upper screen deck rods and downstream end portions supported outward from said upstream end portions of said oversize screen deck rods, said oversize screen deck rods being downwardly bent into generally U-shaped bend portions adjacent said downstream end portions thereof.

3. Screening apparatus for sizing green balls of iron ore concentrates and the like comprising an upper screen deck, said upper screen deck including a plurality of spaced-apart parallel rods having upstream and downstream end portions, support means for supporting said upper screen deck rods, an oversize screen deck extending outwardly from said upper screen deck rods adjacent the downstream end portions thereof, and a lower screen deck extending outwardly from said upper screen deck rods adjacent the downstream end portions thereof beneath said oversize screen deck, said lower screen deck including a plurality of spaced-apart parallel rods, and support means for supporting said lower screen deck rods, said support means including a plurality of transversely extending elastomeric strips having holes therethrough snugly receiving said rods at a plurality of longitudinally spaced locations, and cross support members, support brackets secured to said cross support members and said strips, said support brackets extending substantially the full length of said strips and having a plurality of vertically elongated slots therein, and clamping fasteners extending through said slots secured to said cross support members, whereby said brackets are adjustable relative to said clamping fasteners for adjusting the elevation of said rods.

4. The screening apparatus of claim **3** wherein said strips include a common strip having vertically spaced upper and lower rows of said rod receiving holes, said upper screen deck rods having downstream end portions which are snugly received in said upper row of holes and said lower screen deck rods having upstream end portions which are snugly received in said lower row of holes.

5. Screening apparatus for sizing green balls of iron ore concentrates and the like comprising an upper screen deck, said upper screen deck including a plurality of spaced-apart parallel rods having upstream and downstream end portions, support means for supporting said upper screen deck rods, an oversize screen deck extending outwardly from said upper screen deck rods adjacent the downstream end portions thereof, and a lower screen deck extending outwardly from said upper screen deck rods adjacent the downstream end portions thereof beneath said oversize screen deck, said lower screen deck including a plurality of spaced-apart parallel rods, and support means for supporting said lower screen deck rods, said support means including a plurality of transversely extending elastomeric strips having holes therethrough snugly receiving said rods at a plurality of longitudinally spaced locations, said strips including a common strip having vertically spaced upper and lower rows of said rod receiving holes, said downstream end portions of said upper screen deck rods being received in said upper row of holes and said lower screen deck rods having upstream end portions which are snugly received in said lower row of holes, said common strip being secured to a support bracket extending substantially the full length of said common strip, said support bracket overlying said lower row of holes in said common strip on the opposite side into which said upstream end portions of said lower screen deck rods are received to preclude extension of said upstream end portions of said lower screen deck rods completely therethrough, the upper edge of said support bracket terminating beneath said upper row of holes in said common strip, and a backing plate on the opposite side of said common strip into which the downstream end portions of said upper screen deck rods extend to preclude extension of said downstream end portions of said upper screen deck rods completely therethrough, said backing plate having a row of holes therethrough for passage of said upstream end portions of said lower screen deck rods into said lower row of holes in said common strip as aforesaid.

6. The screening apparatus of claim **5** wherein said oversize screen deck includes a plurality of elongated spaced-apart oversize screen deck rods, and means are provided on said backing plate above said row of holes therein for mounting of the upstream end portions of said oversize screen deck rods thereto.

7. Screening apparatus for sizing green balls of iron ore concentrates and the like comprising an upper screen deck, said upper screen deck including a plurality of spaced-apart parallel rods having upstream and downstream end portions, support means for supporting said upper screen deck rods, an oversize screen deck extending outwardly from said upper screen deck rods adjacent the downstream end portions thereof, and a lower screen deck extending outwardly from said upper screen deck rods adjacent the downstream end portions thereof beneath said oversize screen deck, said lower screen deck including a plurality of spaced-apart parallel rods, and support means for supporting said lower screen deck rods, said support means including a plurality of transversely extending elastomeric strips having holes therethrough snugly receiving said rods at a plurality of longitudinally spaced locations, said strips being of a uniform rectangular cross section and are clamped between a pair of mounting plates connected together by nut and bolt assemblies below said holes in said strips which receive said rods, the upper edges of said strips extending slightly above said rods and being free of protrusions thereon.

8. The screening apparatus of claim **7** wherein said upper screen deck rods are continuous and extend substantially the full length of said upper screen deck, and said support means supports said upper screen deck rods at said upstream and downstream end portions and at a plurality of longitudinally spaced locations intermediate said opposite upstream and downstream end portions, said oversize screen deck extending outwardly from the downstream end portions of said upper screen deck rods, and said lower screen deck rods extend outwardly from the downstream end portions of said upper screen deck rods beneath said

oversize screen deck, said lower screen deck rods being continuous and extending substantially the full length of said lower screen deck, said lower screen deck rods having upstream and downstream end portions, and said support means supporting said lower screen deck rods at said upstream and downstream end portions thereof and at a plurality of longitudinally spaced locations intermediate said upstream and downstream end portions thereof.

9. Screening apparatus for sizing green balls of iron ore concentrates and the like comprising an upper screen deck, said upper screen deck including a plurality of spaced-apart parallel rods having upstream and downstream end portions, support means for supporting said upper screen deck rods, an oversize screen deck extending outwardly from said upper screen deck rods adjacent the downstream end portions thereof, and a lower screen deck extending outwardly from said upper screen deck rods adjacent the downstream end portions thereof beneath said oversize screen deck, said lower screen deck including a plurality of spaced-apart parallel rods, and support means for supporting said lower screen deck rods, said oversize screen deck including a plurality of elongated spaced-apart oversize screen deck rods having upstream end portions supported adjacent the downstream end portions of said upper screen deck rods and downstream end portions supported outward from said upstream end portions of said oversize screen deck rods, said oversize screen deck rods being downwardly bent into generally U-shaped bend portions adjacent said downstream end portions thereof.

10. The screening apparatus of claim **9** further comprising a plurality of elongated spaced-apart transverse rods extending across said U-shaped bend portions to define an arcuate screen having a plurality of rectangular openings.

11. The screening apparatus of claim **10** wherein said transverse rods are secured inside of said U-shaped bend portions so that said transverse rods are above said U-shaped bend portions of said oversize screen deck rods.

12. The screening apparatus of claim **9** wherein said support means includes a plurality of transversely extending elastomeric strips having holes therethrough snugly receiving said rods at a plurality of longitudinally spaced locations.

13. The screening apparatus of claim **12** wherein said strips include opposite end strips and a plurality of intermediate strips, said intermediate strips having upper edges with slits therein extending from said upper edges to said holes therein, whereby said rods are positionable in said holes in said intermediate strips by opening of said slits.

14. The screening apparatus of claim **9** wherein said upper screen deck rods are continuous and extend substantially the full length of said upper screen deck, and said support means supports said upper screen deck rods at said upstream and downstream end portions thereof and at a plurality of longitudinally spaced locations intermediate said upstream and downstream end portions, said oversize screen deck extending outwardly from the downstream end portions of said upper screen deck rods, and said lower screen deck rods extend outwardly from the downstream end portions of said upper screen deck rods beneath said oversize screen deck, said lower screen deck rods being continuous and extending substantially the full length of said lower screen deck, said lower screen deck rods having upstream and downstream end portions, and said support means supporting said lower screen deck rods at said upstream and downstream end portions thereof and at a plurality of longitudinally spaced locations intermediate said upstream and downstream end portions thereof.

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