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APPARATUS FOR WET SCREENING

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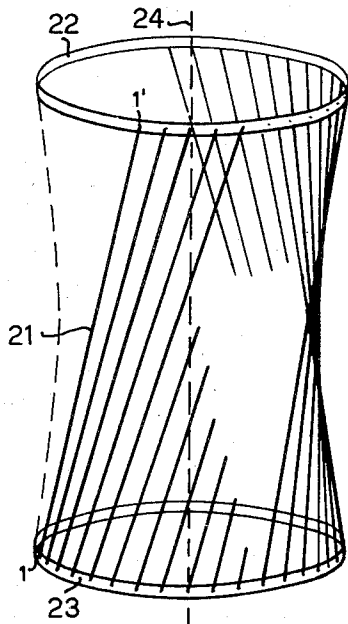


FIG. 1

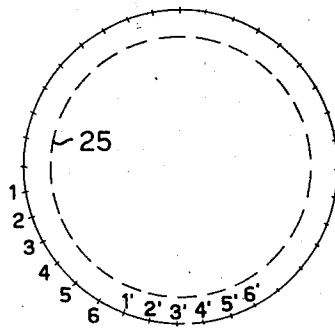


FIG. 2

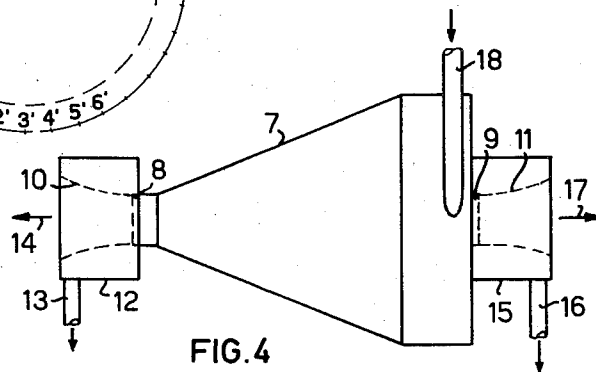
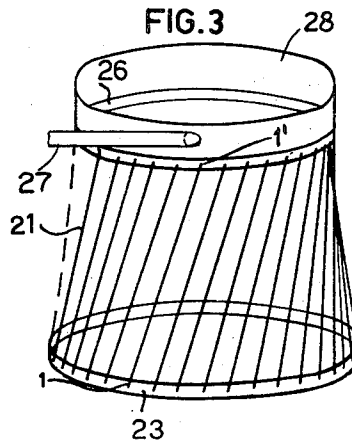


FIG. 4

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1

2,855,099

APPARATUS FOR WET SCREENING

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Application November 14, 1955, Serial No. 546,755

Claims priority, application Netherlands
December 1, 1951

8 Claims. (Cl. 209—273)

The present invention relates to particle separation and more particularly to a screening method and device for screening liquid-suspended mixtures of solid particles differing in grain size. This application constitutes a continuation in part of my copending application Serial No. 322,473, filed November 25, 1952.

The aforementioned application discloses a screening device consisting of a stationary radially-symmetrical body of revolution in which the body of revolution is a cylinder and the screening deck consists of a perforated plate. In the method disclosed, the suspension is sprayed tangentially onto the screening deck on the inside thereof, and moves on it along a spiral path to obtain an under-size and oversize fraction.

In such a device the suspension has to be brought onto the screening deck at a rather high velocity in order to prevent the material to be screened from getting clear of the screening deck. This tendency of the material to lose contact with the screening deck is promoted by the cylindrical shape of the screening deck, since the centrifugal force decreases as a result of the loss of speed of the material to be screened, owing to its friction on the screening deck. In addition, the perforations in the screening deck give rise to obstructions, especially when fine-grained material is being screened.

In order to obviate the above-mentioned disadvantages, the so-called "sieve bend" has been developed, which, in a preferred embodiment, consists of a bent bar screen not closed in itself, whose bars are parallel to the generatrices of the screening surface, and in which the material to be screened is supplied tangentially onto the inner surface of the screening deck and flows over the screening deck from the supply to the discharge end along planes perpendicular to the generatrices.

This construction has the advantages that practically the entire screening surface is actually utilized, so that the screening surface may be rather small, and the maximum grain size of the material passing through the screen is about half as great as the slot between two screening bars, by reason of which, the danger of blockage, if not excluded, is considerably reduced, and furthermore the separation can be made very sharp.

The application of screening bars parallel to the longitudinal axis instead of a perforated plate on the well-known cylindrical screen has the disadvantage that the separation is less sharp, while the disadvantages mentioned above, applicable to the cylindrical screen, remain in full force. However, in some circumstances, which will be described in more detail, the application of a screen in the form of radially-symmetrical body of revolution can be advantageous.

Accordingly, it is the object of the present invention to provide a screening device in which the material to be screened follows a spiral path through the device, which device obviates the disadvantages of the cylindrical screens heretofore known and obtains all the advantages of the sieve bend as noted above.

Another object of the present invention is the provision

2

of a novel method of screening liquid-suspended mixtures of solid particles differing in grain size wherein such mixture is moved in a spiral path through a hyperboloid bar screen in such a manner that the direction of flow is substantially perpendicular to the bars.

A further object of the present invention is the provision of a novel apparatus and method of the type described which is operable to utilize the kinetic energy in the discharge fraction of a hydrocyclone to accomplish further separation.

Still another object of the present invention is the provision of a novel screening deck, the entire surface of which can be utilized to perform useful separation work and which operates efficiently at relatively low feed velocities.

A still further object of the present invention is the provision of a novel screening deck which can be economically produced and maintained but yet achieves sharp separation and minimizes clogging.

These and other objects of the present invention will become more apparent during the course of the following detailed description and appended claims.

The invention can best be understood with reference to the accompanying drawings wherein illustrative embodiments are shown.

In the drawings:

Figure 1 is a diagrammatic representation of the construction of a screening device in the shape of a hyperboloid with straight screening bars;

Figure 2 is a top view of Figure 1;

Figure 3 is a preferred embodiment of a screening device according to the invention;

Figure 4 is a diagrammatic representation of a hydrocyclone on which screening devices according to the invention have been placed.

The screening device according to the invention can be built up of straight bars 21, which connect two arcuately displaced points of a pair of rings 22 and 23 concentrically arranged around the axis of rotation 24 and having equal radii. These bars 21 are preferably rectangular in cross section and, in general, are similar to the bars disclosed in copending application Serial No. 475,251, filed December 14, 1954, by Freerk J. Fontein. The connecting points with the rings are displaced, as shown in Figure 2, so that point 1 on ring 23 will be connected to point 1' on ring 22, point 2 will be connected to point 2', etc. In this way, the bars 21 all intersect the axis 24 at equal angles. The body thus formed has the shape of a hyperboloid whose smallest diameter lies halfway between the two rings 22 and 23.

When at or near the ring 22 a suspension is supplied tangentially onto the screening surface, perpendicular to the bars 21, this suspension will travel across the screening surface towards the ring 23 along a spiral path. The majority of the liquid and the fine particles, which have to be screened off, will be discharged as under-size product through the slots formed between the bars 21. As a result of friction, the speed of the moving mass will decrease, causing the centrifugal force to diminish so that the retained material will tend to leave the wall. However, this is prevented by the reduction in the diameter of the screening device toward the middle of the hyperboloid. Beyond the middle the diameter increases again and the material to be screened will get clear of the screening surface if the velocity of this material is too low.

In Figure 3, there is shown a preferred modification of the device which is arranged to obviate this latter consideration. In this embodiment the straight bars 21 connect a pair of rings 23 and 26 in a manner similar to that shown in Figure 1; however, the ring 26 has the same internal diameter as the circle 25 inscribed within

3

the bars 21 in Figure 1 at the place of minimum diameter (see Figure 2).

The screening device can also be constructed by providing around the rings 22 and 23 a straight bar screen whose bars run parallel to the axis of rotation 24, and by further turning the ring 22 in its own plane through an angle with respect to the ring 23. The embodiment according to Figure 3 can then be obtained by providing at the place of minimum diameter in Figure 1 a band around the bars and fastening this band to the bars, as by soldering, welding or the like, whereafter the hyperboloid is cut in two.

The screening device formed in this way is especially suitable for screening suspensions which carry out, besides a linear movement, a rotary movement as well. This condition is found, for example, at the apex discharge opening and the central overflow opening of a hydrocyclone.

Figure 4 is a diagram of a hydrocyclone 7 having an apex discharge opening 8 and a central overflow opening 9 to which screening devices 10 and 11 have been connected. The screening devices are so constructed that the bars are perpendicular to the direction of the flow formed by the resultant of the linear and tangential velocity components.

Around the screening device 10 there is a collecting box 12 for the undersize issuing between the slots formed by the bars thereof, which box is provided with a connecting element 13 for the discharge conduit for the undersize. The material retained by the screen leaves the apparatus at 14. In like manner, the screening device 11 is surrounded by a collecting box 15 having a connecting element 16 for the discharge conduit of the undersize coming from the screening device. The material retained by the screen is discharged at 17. The material is supplied to the cyclone by the feed pipe 18. If the hydrocyclone is utilized as a hydrocyclone washer operating with heavy suspension, the heavy suspension can be discharged at 13 and 16, with the width of the slots between the bars of the screening devices 10 and 11 being 0.4 mm. The advantage obtained with this arrangement is that use is made of the kinetic energy present in the materials discharged from the hydrocyclone to effect further separation.

The application of the screening device according to the invention is not restricted to placing it on a hydrocyclone, however. It can be provided in all those cases where the material to be treated carries out a linear and a rotating movement around the central axis. For example, in Figure 3 there is shown an arrangement for feeding a mixture of particles and a suspending liquid to the screen through a pipe 27. The pipe leads tangentially to a cylinder plate 28 having an interior diameter equal to the interior diameter of the ring 26. The plate 28 serves to direct the suspension issuing from the pipe spirally onto the feed end of the screen so that it passes thereon substantially perpendicular to the bars.

It can thus be seen that there has been provided by the present invention a particle separating device which includes a screening deck having the shape of a hyperboloid and which comprises a bar screen whose bars are rectilinear and connect the circumferences of two circles in such a manner as to intersect the axis of revolution of equal angles.

Stated differently, the present device includes a cylindrical bar screen whose bars run parallel to the longitudinal axis and whose one end is fixed by clamps, the other end being turned through an angle with respect to the clamped end in a plane perpendicular to the longitudinal axis. In this case the circles connected by the bars have, according to the invention, the same diameter. The smallest diameter of the hyperboloid is then half-way between the two end faces.

According to the invention it is, however, also possible, and preferred, to give the two circles mentioned before

4

different diameters. The body of revolution formed in this way has the shape of a hyperboloid which is cut in two through the middle, perpendicular to the longitudinal axis, one end of which body of revolution has a larger diameter than the other end. The circles may consist of rings made of metal, synthetic resin or another suitable material, on which the bars are fixed.

The present invention also provides a novel wet screening method wherein the suspension is tangentially supplied at least in one place, situated at or near one of the ends, onto the inside of the screening device in a direction substantially perpendicular to the screening bars. The result is that a separation can be obtained equally sharp as that obtained with a sieve bend. When the feed rate is low, it is recommended that the suspension be supplied onto the screening deck at or near the end having the greater diameter, so that the reduction of the flow rate of the material retained by the screen is compensated wholly or partly by the gradual decrease in the diameter of the screening device. The slots between the screening bars gradually decrease from the input end of the screen, where the diameter is greatest, to the delivery end, which has the smallest diameter, but this can have only a favourable influence on the screening effect. This is especially important if the suspension is supplied onto the infed end of the screening surface as a jet rotating about a central axis.

The utilization of the screen according to the invention is of particular advantage if the screen is disposed coaxially on the apex discharge opening and/or the central overflow opening of a hydrocyclone and the bars are substantially perpendicular to the direction in which the material is discharged from the hydrocyclone.

With this arrangement, it is possible to utilize the kinetic energy present in the material to be screened at the discharge openings. The material leaves the hydrocyclone in a whirling motion, the velocity of which can be resolved into a tangential and an axial component. By a proper choice of the direction in which the bars of the screening device are disposed, the bars can be placed perpendicular to the direction of flow. As the material leaves the hydrocyclone over the entire brim of the apex discharge or overflow opening, as the case may be, the screen according to the invention can be utilized in full.

In order to prevent the occurrence of back-pressure within the hydrocyclone it is to be preferred that the screens adjoin the apex discharge and/or the central overflow opening of the hydrocyclone with their ends of smaller diameter.

The application of a screening device according to the invention in combination with a hydrocyclone, as described above, is useful, for example, when the hydrocyclone serves for washing coal or ore in a heavy suspension and this suspension can be screened from the separated fractions immediately behind the cyclone. In this case the slots may have a width of, say, 0.3–0.5 mm.

It thus will be seen that the objects of this invention have been fully and effectively accomplished. It will be realized, however, that the foregoing specific embodiment has been shown and described only for the purpose of illustrating the principles of this invention and is subject to extensive change without departure from such principles. Therefore, this invention includes all modifications encompassed within the spirit and scope of the following claims.

I claim:

1. A screening device for screening liquid-suspended mixtures of solid particles differing in grain size comprising a stationary radially-symmetrical body of revolution including a screening deck having the shape of a hyperboloid, said screening deck comprising a plurality of rectilinear bars arranged so that opposite end portions connect the circumferences of two circles and so that said bars cross the axis of revolution at equal angles, and means for feeding the liquid suspended mixture tangen-

5

tially to the interior of the screening deck in a direction perpendicular to the bars.

2. A screening device as defined in claim 1 wherein said circles have equal diameters.

3. A screening device as defined in claim 1 wherein said circles have unequal diameters.

4. A screening device for screening liquid-suspended mixtures of solid particles differing in grain size comprising a plurality of bars defining a radially-symmetrical screening deck having the shape of a hyperboloid, said bars further defining a plurality of spaced, elongated slots extending through said screening deck and at an angle to the axis of revolution through which an undersize fraction of the mixture is arranged to pass as the latter flows in a spiral path along the surface of said screening deck, the interior of said screening deck being unobstructed, and means for mounting said screening deck in a stationary position so as to receive adjacent one end thereof liquid suspended mixtures of solid particles fed tangentially to the interior thereof in a direction perpendicular to the bars.

5. A screening device for screening liquid-suspended mixtures of solid particles differing in grain size comprising a plurality of rectilinear bars stationarily mounted radially equidistantly about a common longitudinal axis, said bars being disposed at equal angles with respect to said axis and together defining a hyperboloid screening deck having a plurality of slots therein through which an undersize fraction of the suspended mixture is arranged to pass as the latter flows along the inner surface of said screening deck in a spiral path coaxial with said axis, and

6

means for feeding the liquid suspended mixture tangentially to the interior of the screening deck in a direction perpendicular to the bars.

6. A screening device as defined in claim 5 wherein said bars are rectangular in cross-section.

7. In combination, a hydrocyclone having an apex discharge opening and an overflow opening, and a screening device mounted to receive the material issuing from at least one of said openings, said screening device comprising a radially-symmetrical body of revolution disposed coaxially with respect to said opening, said body including a screening deck having the shape of a hyperboloid, said screening deck comprising a plurality of spaced rectilinear bars arranged so that opposite end portions thereof connect the circumferences of two circles and so that said bars cross the axis of revolution at equal angles.

8. The combination as defined in claim 7 wherein one of said screening devices is mounted at each of said openings.

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