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Armstrong

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[45] **Dec. 18, 1973**

[54] **SIZING SCREENS**

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[73] Assignee: **Coal Industry (Patents) Limited,** Grosnensor, London, England

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[30] **Foreign Application Priority Data**

Aug. 7, 1970 Great Britain 38,130/70

[52] **U.S. Cl.** **209/271,** 209/280, 209/309, 209/315, 209/400

[51] **Int. Cl.** **B07b 1/08**

[58] **Field of Search** 209/315, 254, 279, 209/280, 350, 351, 393, 395, 400, 394, 409, 309, 271

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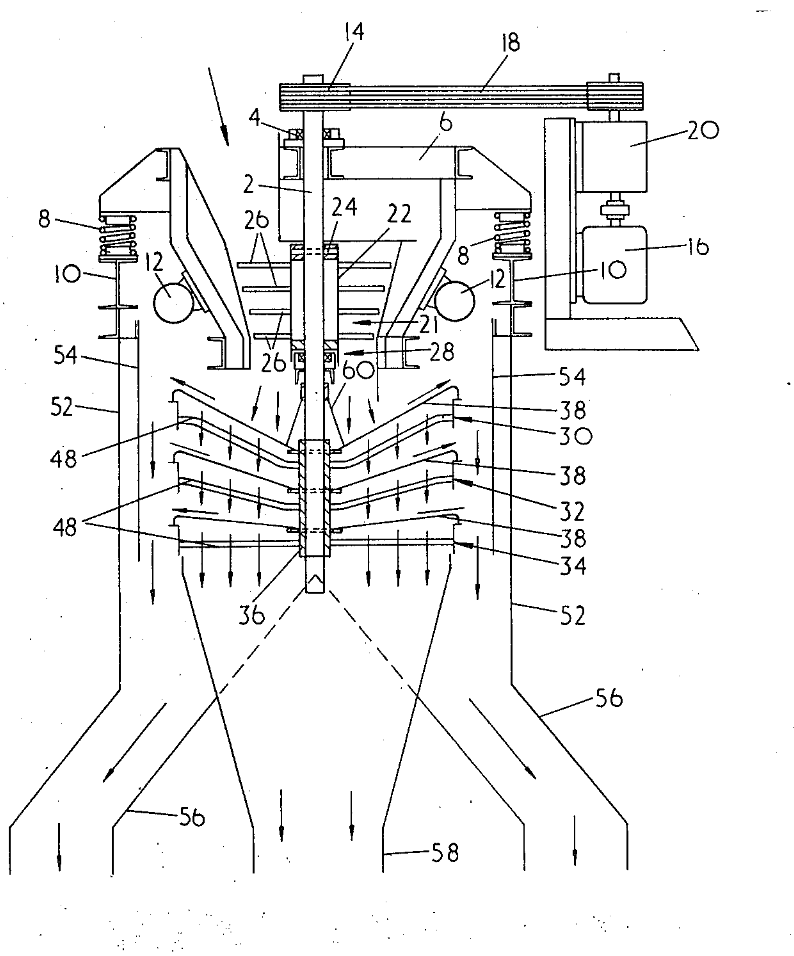
[57] **ABSTRACT**

A sizing screen for particulate material of different sizes has a series of generally horizontal circular screen surfaces which are rotated about a vertical axis so that undersize material passes through the surface and is collected in central chute and oversize material is ejected from the periphery of the surface and collected in a peripheral chute. With the various embodiments described it is possible to retreat both the undersize and the oversize material, or solely the undersize material, or solely the oversize material.

10 Claims, 10 Drawing Figures



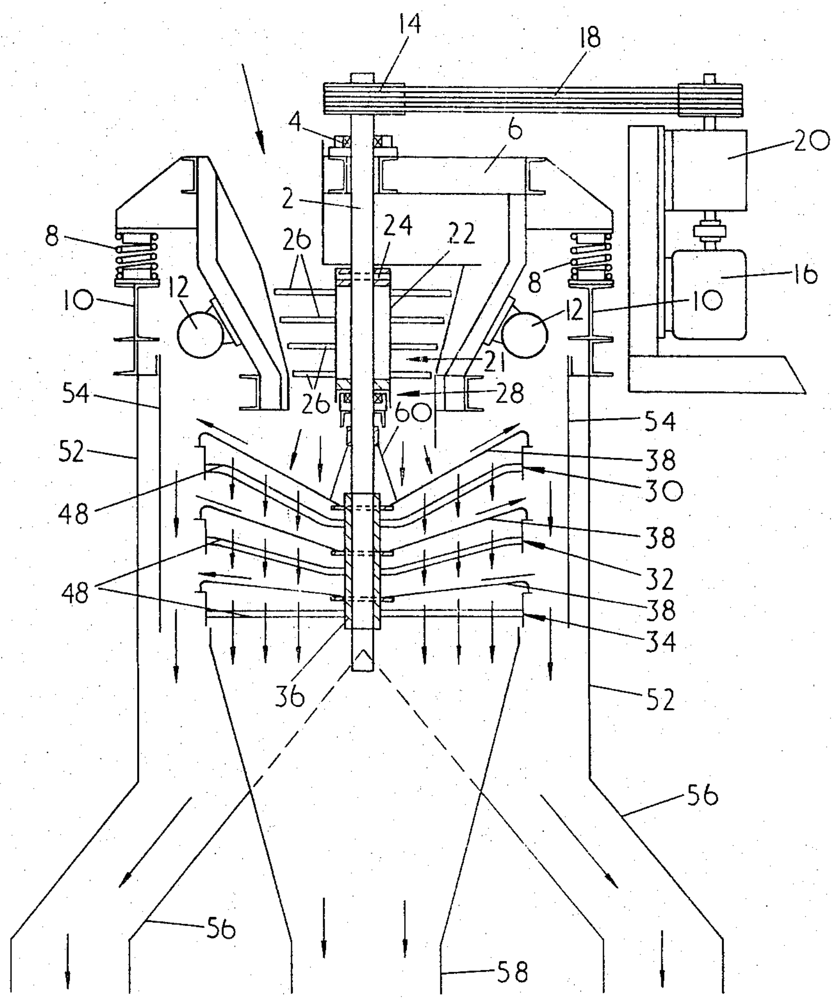


FIG. 1

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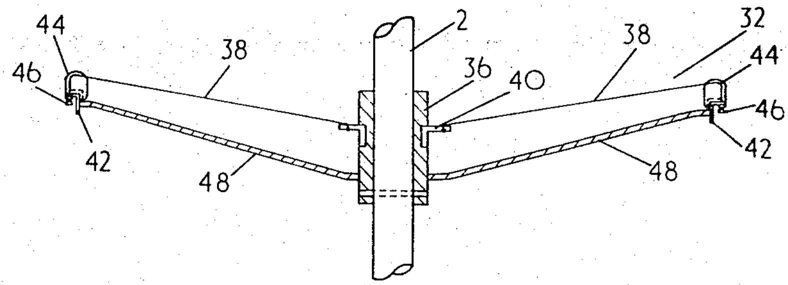

FIG. 2.

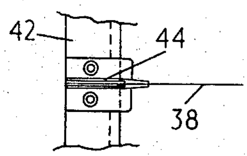

FIG. 5.

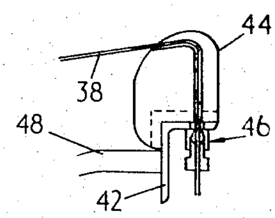

FIG. 4.

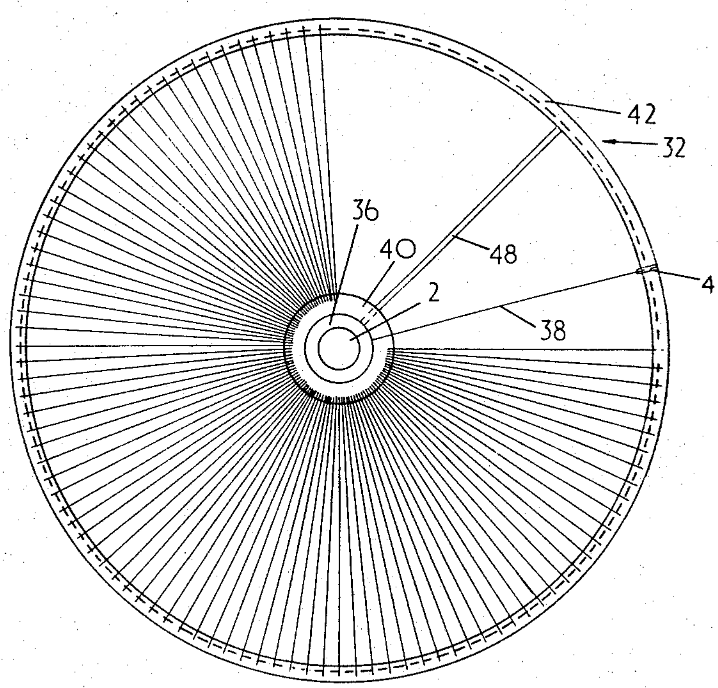

FIG. 3.

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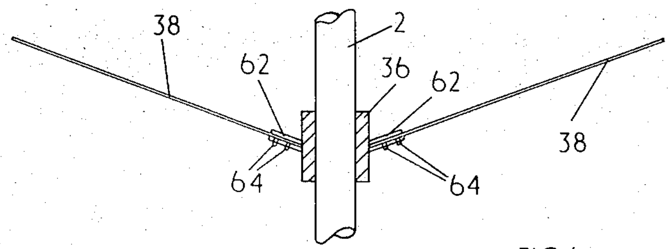

FIG. 6.

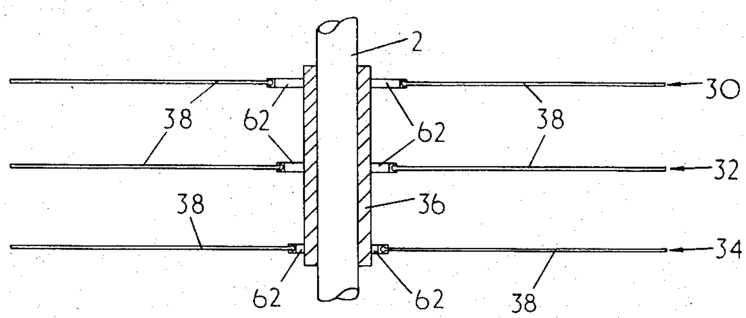

FIG. 7.

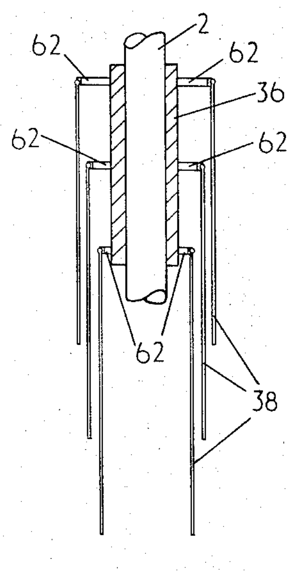

FIG. 8.

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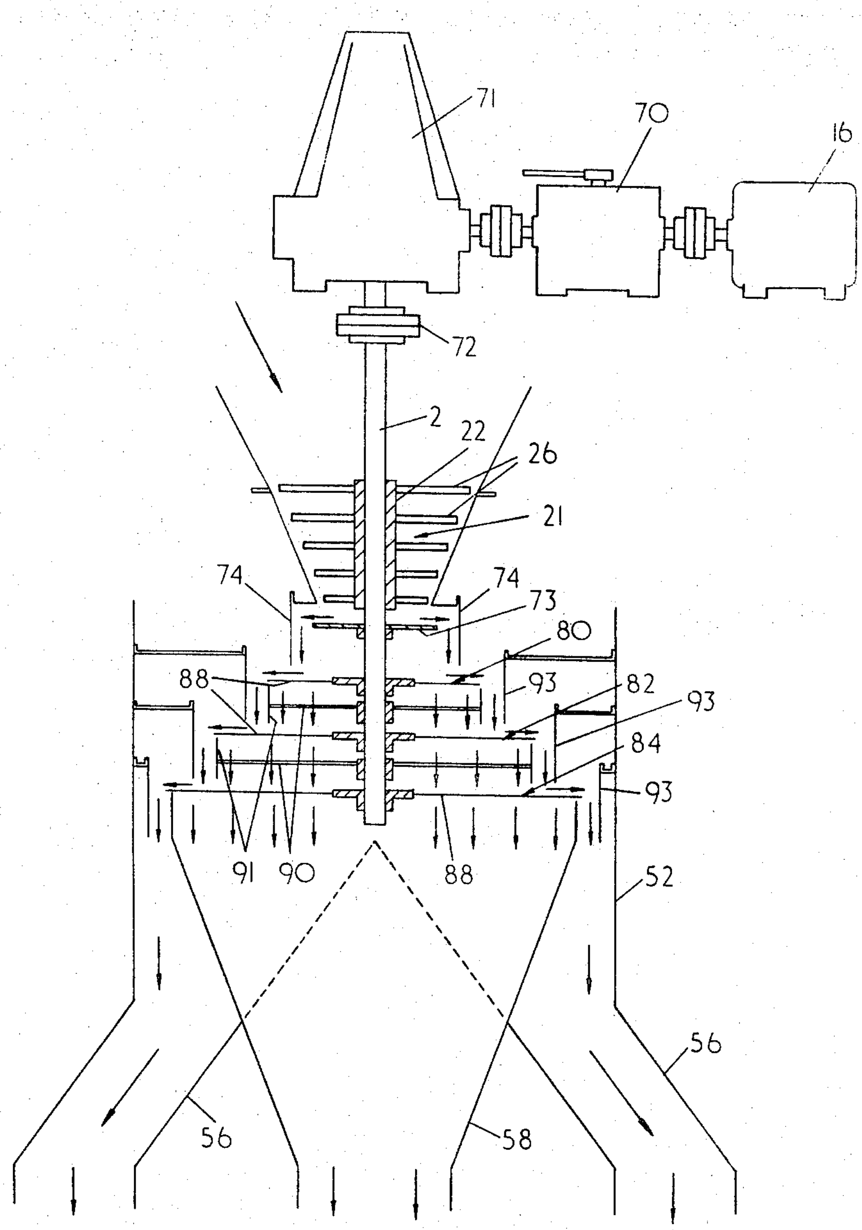

FIG. 9.

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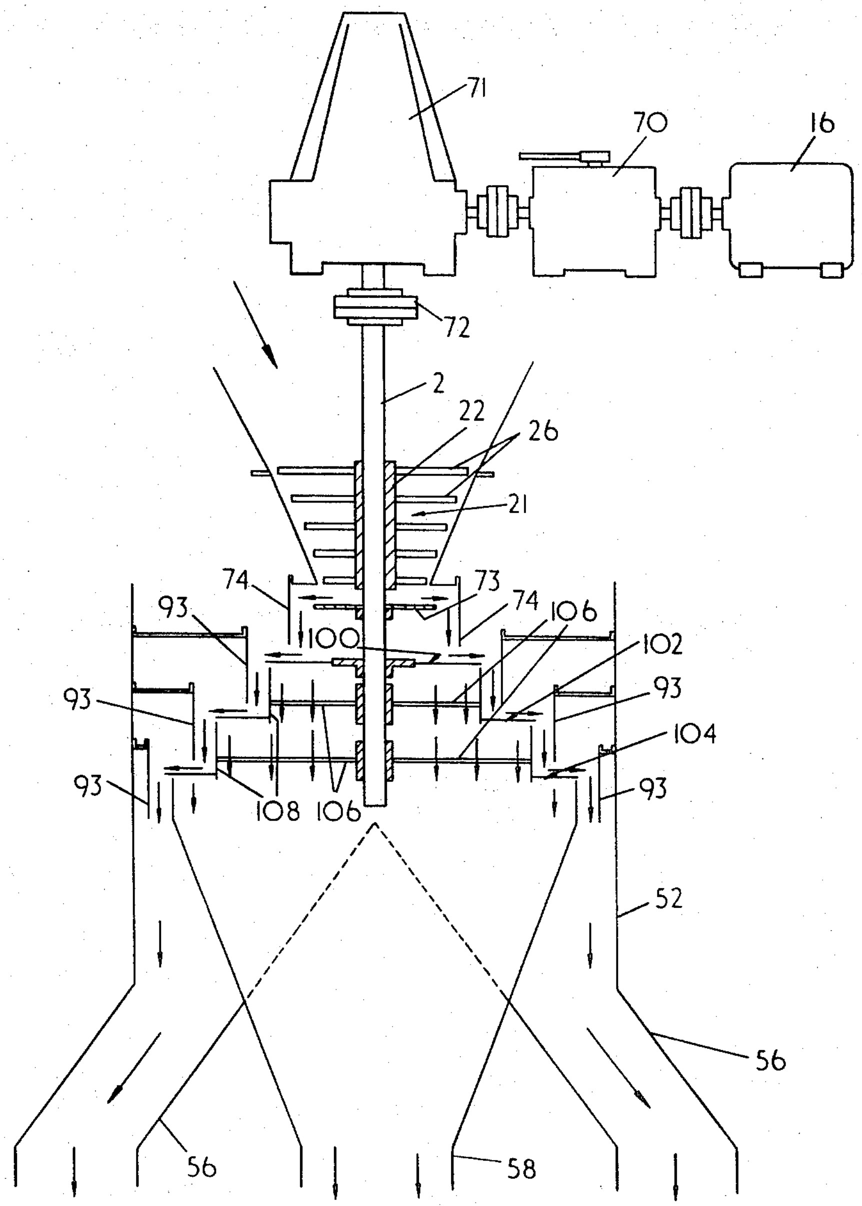

FIG. 10.

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SIZING SCREENS

This invention relates to sizing screens for particulate material of different sizes.

In particular, although not exclusively, the invention relates to sizing screens for screening moist, small size particles, e.g. less than one-fourth inch.

With a known sizing screen the efficiency of separation is reduced due to agglomeration of the undersize material and blocking of the screen surface apertures, especially when treating moist coal or clay-containing fine coal. In order to try and increase the efficiency of separation, it is known to have a vibrating screen surface but unfortunately such a surface does not impact the material with sufficient force to part all the conglomerated material.

An object of the present invention is to provide a sizing screen which can separate moist coal or clay—containing fine coal more efficiently than a known vibrating screen.

According to the present invention a sizing screen comprises a screen surface mounted for rotation about a generally vertical axis, means for feeding material onto the surface, first collection means positioned adjacent to the outer periphery of the surface for collecting oversize material, second collection means positioned below the surface for collecting undersize material, and drive means for rotating the surface.

Preferably, the screen surface is circular and comprises a plurality of elongated members projecting from a hub.

Preferably, the screen comprises a plurality of coaxially arranged circular screen surfaces which may be of the same outer diameter.

Alternatively the outer diameter of a relatively upper screen surface may be less than the outer diameter of a relatively lower screen surface. With such a screen the inner diameter of the relatively lower screen surface may be substantially equal to the outer diameter of the relatively upper screen surface.

Preferably, the screen surface is vibrated.

The screen surface may be horizontal and the elongated members may be pivotally connected to the hub. Alternatively, the screen surface may be inclined to the axis of rotation.

Advantageously, the means for feeding the material onto the surface comprises mixing apparatus for the material.

By way of example only, three embodiments of the invention and two modifications thereof will be described with reference to the accompanying drawings in which:

FIG. 1 is a diagrammatic sectional side view of a first embodiment of a sizing screen constructed in accordance with the present invention;

FIG. 2 is a sectional side view of a detail of FIG. 1 shown on an enlarged scale;

FIG. 3 is an incomplete plan of the detail of FIG. 2;

FIG. 4 is a side view of an item of FIG. 2 shown on an enlarged scale;

FIG. 5 is a plan of the item of FIG. 4 but shown in a position on the opposite side of the screen;

FIG. 6 is a sectional side view of a modified form of the detail shown in FIG. 2;

FIG. 7 is a sectional side view showing a further modified form of the detail shown in FIG. 2 and shows three such details in an operating position;

FIG. 8 is a sectional side view similar to that shown in FIG. 7 but with the details in a non-operating position;

FIG. 9 is a diagrammatic sectional side view of a second embodiment of a sizing screen constructed in accordance with the present invention; and

FIG. 10 is a diagrammatic sectional side view of a third embodiment of a sizing screen constructed in accordance with the present invention.

FIG. 1 shows a sizing screen for screening moist, small size particles of coal, e.g. particles less than one-fourth inch, into two size fractions. The screen comprises a vertical shaft 2 mounted in bearings 4 supported on a support frame 6. The frame 6 is carried on a plurality of coil springs 8 which are mounted on fixed, rigid beams 10 and which permit the frame 6 to be vibrated by a plurality of pairs of contra-rotating motors 12. The motors 12 have out-of-balance weights and are mounted on the frame 6 with their motor shafts horizontal so that the frame 6 together with the shaft 2 are vibrated up and down. Alternatively, the springs 8 may be replaced by rubber mountings.

A pulley 14 is drivably mounted on the upper part of the shaft 2 and is connected to a drive motor 16 by belts 18 and a gearbox 20. The gearbox 20 may be of constant or variable speed type.

Mounted on the shaft 2 within a downwardly converging chamber 21 is mixing and dispersing apparatus for the coal comprising a hollow cylinder 22 which is secured at its upper end to the shaft 2 by a pin 24 and which has a plurality of rows of radially extending arms 26. The walls of the chamber 21 are secured to the frame 6 and the arms 26 of different rows have different lengths so that the free end of each arm 26 is adjacent to the converging wall of the chamber 21. At the bottom of the chamber 21 is a parallel sided outlet 28. The mixing apparatus is of the kind described and claimed in our prior British Patent Specification Ser. No. 961,833.

Also mounted on the shaft 2 below the mixing apparatus is a series of three coaxially arranged, circular screen surfaces 30, 32 and 34 secured to a central hub 36. The lower screen surface 34 is arranged horizontal, the middle screen surface 32 is inclined upwardly towards its outer periphery, and the upper screen surface 30 is further inclined upwardly towards its outer periphery. The three screen surfaces are all similar in construction and will be described with reference to FIGS. 2, 3, 4 and 5 which relate to the screen surface 32.

The screen surface 32 comprises a plurality of elongated members 38 in the form of wires or thin bars extending radially from the hub 36. The members 38 are attached to the hub 36 by passing through bores provided in an L-shaped ring 40 secured around the hub 36. At their radially outer ends the members 38 are attached to an L-shaped rim 42 after passing around a groove in a tensioning component 44 (see FIGS. 4 and 5). Each member 38 passes around its associated tensioning component 44 which is narrow so that the outer periphery of the upper part of the screen surface 32 is substantially open and forms little or no restriction to oversize coal flowing radially off the surface. The outer ends of the members 38 pass through apertures in the rim 42 and are clamped in position by a clamping arrangement 46 as shown in FIG. 4. Alternatively, the ends of the members 38 are threaded and are engaged by nuts which can be turned so as to adjust the tension of the members **38**. The rim **42** is supported by eight radially extending spokes **48** (two of which are shown in FIG. 2) which are located beneath the members **38**. The hub **36** is secured to the shaft **2** by a pin **50**.

Referring once again to FIG. **1**, it can be seen that the screen surfaces **30, 32, 34** are located within a casing **52** around the inside of which is hung in flexible rubber curtain **54**.

At the bottom of the casing **52** are two peripheral outlet chutes **56** for oversize coal falling from around the outer periphery of the screen surfaces **30, 32** and **34** and a central outlet chute **58** for undersize coal which has passed through the screen surface **34**.

A downwardly diverging cone **60** is positioned adjacent to the outlet **28** from the chamber **21**, to protect the hub **36** and to assist in distributing coal falling from the chamber **21** onto the upper screen surface **30**.

In operation an inlet chute (not shown) is provided for feeding coal into the top of the mixing apparatus where it is throughly mixed before being discharged through the outlet **28** onto the vibrating upper screen surface **30**. The path of material flow is indicated by the arrows in FIG. **1**. The cone **60** ensures that the coal does not fall too near the center of the surface **30** where, because of the small area of the surface, problems of wear and over-loading of the screen would arise. Instead the coal is evenly distributed over a relatively large area of the surface and overloading problems are largely avoided.

When the coal encounters the rotating screen surface **30**, the larger particles are struck by the elongated members **38** and are moved radially outwards over the screen surface **30** either directly as a result of being struck by the members **38** or because of centrifugal force. The tensioning components **44** are such as to form little or no obstruction to oversize particles leaving the outer periphery of the screen surface. As the coal particles may leave the screen surface with a considerable radial velocity the curtains **56** act to absorb the momentum of the particles and reduce degradation and the possibility of rebound of particles back onto the screen surfaces **30, 32, 34**. The larger particles then fall down into the outlet chutes **56** from where they are collected by any suitable means.

Some of the smaller particles of coal pass straight through the screen **30**. Others of the smaller particles may be struck by the rotating members **38** and moved radially outwards to another part of the screen surface **30** where they may either pass through the screen surface **30** or be struck once again by the members **38** and moved further radially outwards. A particle of undersize coal may be struck by the rotating members several times before it passes through the screen surface **30**.

Upon passing through the screen surface **30** the particles of undersize coal must encounter the screen surfaces **32** and **34** before finally passing into the central outlet chute **58** from where they may be collected by any suitable means.

The screen surfaces **30, 32** and **34** are inclined at different inclinations to the horizontal and have the elongated members **38** spaced differently. The members **38** are close together on the bottom surface **34** and are most widely spaced from one another on the upper surface **30**. This together with the inclination of the surfaces ensures that predominantly the largest coal particles are ejected from the outer periphery of the upper surface **30** and smaller particles of oversize are ejected from the outer periphery of the lower surface **34**.

As each screen surface **30, 32** or **34** comprises only radial members **38** at equal angular spacing, each surface presents a series of radially extending continuously widening apertures. Such a surface greatly reduces the possibility of particles becoming wedged in the apertures which is a condition which frequently occurs with known sizing screens having parallel sided apertures.

When any conglomerate of particles is struck by a relatively rapidly moving member **38**, the conglomerate is broken and any undersize particles contained in the conglomerate may then pass through the screen surface.

Under static conditions, each screen surface presents a series of expanding apertures the width at any point along the aperture being in direct proportion to the radius at that point. When the screen is rotating at a constant velocity, the tangential velocity at any point along the members **38** is also in direct proportion to the radius. Therefore, to particles falling on to the rotating screen surface, the width of the apertures will appear the same wherever the position at which the particle falls onto the surface. Thus, particles of equal size falling with the same vertical velocity have an equal probability of passing down between the radial elements irrespective of the radial distance from the center of the surface at which they encounter the surface. The effective screening size for particles presented to the screen surface in a similar manner will be, therefore, the same at any point of the surface.

The effective screening size will be determined by the number of elongated members **38**, the speed of rotation of the screen surface, and the falling velocity of the particles. The screening size will decrease, as the number of members **38** and/or the speed of rotation of the surface **30, 32, 34** increases. The screening size will increase as the falling velocity of the particles increases.

Due to the rotation of the screen surface **30, 32, 34**, the screening size will be substantially smaller than the width of the aperture. This permits separation of the smaller particles with less tendency for damp particles, which normally tend to adhere to the members **38**, to bridge over and "blind" the apertures.

A further advantage of the sizing screen constructed in accordance with the invention is that since the effective screening size is dependent on the speed of rotation, the incorporation of a variable speed drive would enable the screening size and hence the ratio of oversize to undersize products to be varied either by manual or automatic control, while the screen is operating. Such a variation may be required to meet changing market requirements or the requirements of subsequent processing or blending operations.

With the embodiment of the screen shown in FIGS. **1** to **5** the undersize material is retreated on each of the two lower screen surfaces **32, 34**. The oversize is not retreated once it has been ejected from the outer periphery of any one of the screen surfaces **30, 32, 34**.

FIG. **6** shows a modified form of screen surface in which the elongated members **38** are in the form of spring steel rods of equal length located in radial bores, provided in a series of angularly spaced elements **62** secured around the hub **36**. The rods are retained in the bores by screws **64**. With this form of screen surface the outer ends of the members **38** are unsupported and no obstruction is presented to the radial movement of the oversize or to the downward movement of the undersize.

FIGS. 7 and 8 show three screen surfaces of equal size arranged along a common axis in an operating position and in a non-operating position, respectively. The elongated members 38 are in the form of rods pivotally connected for movement about a horizontal axis to the elements 62 secured around the hub 36. The elements 62 of the different screen surfaces 30, 32, 34 have different lengths so that the members 38 can hang vertically when the screen is stationary and may adopt an almost horizontal position due to a centrifugal force when the screen is in operation.

Movement of the members 38 between the operating to the non-operating positions provides this arrangement with a self cleaning feature.

FIG. 9 shows a second embodiment of sizing screen for screening moist, small size particles of coal, e.g. particles less than one-fourth inch, into two size fractions. The second embodiment of sizing screen comprises a vertical shaft 2 driven by an electric motor 16 via a variable speed gearbox 70 which may be manually or automatically controlled and an agitator worm reduction gearbox 71 which includes bearings (not shown) supporting a stub shaft which is connected to the shaft 2 by a rigid coupling 72. The drive equipment is supported by a frame (not shown) which unlike the frame described with reference to the first embodiment is not suitable for vibrating the sizing screen.

As with the previously described embodiment mixing and dispersing apparatus for the coal are mounted on the shaft 2 within a converging chamber 21. The apparatus comprises a hub 22 fixedly secured to the shaft 2 and a plurality of rows of radially extending arms 26. The walls of the chamber 21 are secured to the support frame. Below the chamber 21 is a horizontal plate 73 which is fixedly secured to the shaft 2 and which disperses coal leaving the chamber 21 so that it falls onto the upper screen surface at a zone somewhat remote from center for reasons previously described. A flexible cylindrical curtain 74 is provided around the plate 73.

Fixedly mounted on the shaft 2 below the plate 73 are three coaxially arranged, circular screen surfaces 80, 82, 84 comprising radially extending elongated members 88. A row of spokes 90 is provided below each of the screen surfaces 80, 82 which carries a cylindrical curtain 91 which extends from the adjacent upper screen 80 or 82 surface towards the next adjacent lower screen surface 82 or 84 so as to guide oversize material flowing down the screen. Three flexible cylindrical rubber curtains 93 are provided adjacent to the outer periphery of the screen surfaces 80, 82 and 84, respectively.

As in the previously described embodiment the screen surfaces 80, 82 and 84 are located within a casing 52 which is provided with two peripheral outlet chutes 56 for oversize coal falling from around the outer periphery of the screen surfaces and a central outlet chute 58 for undersize coal which has passed through the screen surface 84.

Operation of the second embodiment of sizing screen is similar to that described with reference to the first embodiment except that the screen is not vibrated and that upon leaving the mixing chamber 21 the coal is fed onto the rotating horizontal plate 73 which guides the coal radially so that it falls over the outer periphery of the plate 73 onto the upper screen surface 80 at a zone somewhat remote from the center.

The coal is subjected to the same treatment as in the previous embodiment and undersize material passes through the screen surface 80 and is retreated on the screen surface 82. Subsequently the undersize material passing through the screen surface 82 is retreated on the lower screen surface 84 before being discharged into the central outlet chute 58. The oversize material which is ejected from the two upper screen surfaces 80, 82 is allowed to fall onto the next lower screen surface 82, 84 where it is retreated. Such an arrangement is particularly beneficial because a large proportion of the undersize material passes through the associated screen surface within a short distance of where it falls onto the screen surface. Eventually all the oversize material is ejected from the outer periphery of the screen surface 84 and is fed to the peripheral outlet chutes 56.

With the second embodiment of sizing screen both the undersize material and the oversize material are subjected to retreatment.

Referring now to FIG. 10 which shows a third embodiment of sizing screen which is similar to the second embodiment previously described but which has a different arrangement of screen surfaces, the same reference numerals have been used in FIGS. 9 and 10 for similar parts.

The screen surfaces of FIG. 10 comprise an upper screen surface 100 which is similar to the screen surface 80 in FIG. 9 and an intermediate and a lower screen surface assembly, each of which comprises a row of widely spaced spokes 106 which carry a cylindrical rigid curtain 108 on the outer ends. Screen surfaces 102, 104 are carried on the curtains 108 and extend radially outwardly from the curtains so that the inner diameter of the screen surfaces 102 or 104 is substantially equal to the outer diameter of the next higher screen surface 100, or 102, respectively. Thus in operation undersize material passing through the surface 100 is allowed to fall untreated towards the central chute 58 while oversize material ejected from the outer periphery of the surface 100 falls onto the inner part of the lower screen surface 102 and is retreated.

Undersize material from the screen surface 102 is allowed to fall freely towards the central chute 58 without being retreated and the oversize material ejected from the outer periphery falls onto the screen surface 104 and is retreated before passing towards the periphery chute 56.

With the third embodiment of sizing screen only the oversize material ejected from each surface 100, 102 is retreated on the lower screen surfaces 102, 104, the undersize material being allowed to fall untreated towards the central chute.

In the modification of the sizing screens described one, two or more than three screen surfaces are provided.

In a further modification of the sizing screens described the elongated members constituting a screen surface form spiral patterns extending either with or against the direction of rotation of the screen surface.

In still further modifications the elongated members constituting a screen surface are arranged at an angle to the radius and may be directed either towards or against the direction of rotation of the screen surface.

In still further modifications of sizing screens the screen surfaces may be formed of mesh material or perforated plates etc.

I claim:

1. A sizing screen comprising a hub assembly, a screen surface consisting solely of a plurality of elongated members projecting at one end from the hub assembly and mounted for rotation about a generally vertical axis, said elongated members being unsupported and unobstructed at the other end, means for feeding material onto the surface, first collection means positioned adjacent to the outer periphery of the surface for collecting oversize material, second collection means positioned below the surface for collecting undersize material, and drive means for rotating the surface.

2. A sizing screen as claimed in claim **1**, in which the elongated members are in the form of spring steel rods.

3. A sizing screen as claimed in claim **2**, in which said hub assembly comprises a plurality of radial bores, said one end of said rods being located in said radial bores.

4. A sizing screen as claimed in claim **2**, in which the rods are pivotally connected with respect to the hub assembly for movement about a horizontal axis.

5. A sizing screen comprising a hub assembly, a plurality of coaxially arranged and spaced apart circular screen surfaces, each said surface consisting solely of a plurality of elongated members projecting at one end from the hub assembly and mounted for rotation about a generally vertical axis, said elongated members being unsupported and unobstructed at the other end, means for feeding material onto the uppermost screen surface, first collection means positioned adjacent to the outer periphery of the screen surfaces for collecting oversize material from at least the lowermost screen surface, second collection means positioned below the lowermost screen surface for collecting undersize material, and drive means for rotating the screen surfaces.

6. A sizing screen as claimed in claim **5**, in which the screen surfaces have the same outer diameter with respect to each other.

7. A sizing screen as claimed in claim **5**, in which the screen surfaces have different outer diameters with respect to each other.

8. A sizing screen comprising a hub assembly, a circular screen surface consisting solely of a plurality of elongated members projecting at one end from the hub assembly, said elongated members being unsupported and unobstructed at the other end, said screen surface being mounted for rotation about a generally vertical axis and being arranged to vibrate, means for feeding material onto the surface, first collection means positioned adjacent to the outer periphery of the surface for collecting oversize material, second collection means positioned below the surface for collecting undersize material, and drive means for rotating and vibrating said surface.

9. A sizing screen comprising a hub assembly, a circular screen surface consisting solely of a plurality of elongated members projecting at one end from the hub assembly and mounted for rotation about a generally vertical axis, said elongated members being unsupported and unobstructed at the other end, said surface being inclined to the axis of rotation, means for feeding material onto the surface, first collection means positioned adjacent to the outer periphery of the surface for collecting oversize material, second collection means positioned below the surface for collecting undersize material, and drive means for rotating said surface.

10. A sizing screen comprising a hub assembly, a circular screen surface consisting solely of a plurality of elongated members projecting at one end from the hub assembly and mounted for rotation about a generally vertical axis, said elongated members being unsupported and unobstructed at the other end, means including material mixing apparatus for feeding material onto the surface, first collection means positioned adjacent to the outer periphery of the surface for collecting oversize material, second collection means positioned below the surface for collecting undersize material, and drive means for rotating said surface.

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