Sept. 11, 1956 S. K. CULP 2,762,573

AIR-SWEPT PULVERIZERS

Filed April 14, 1952 2 Sheets-Sheet 1

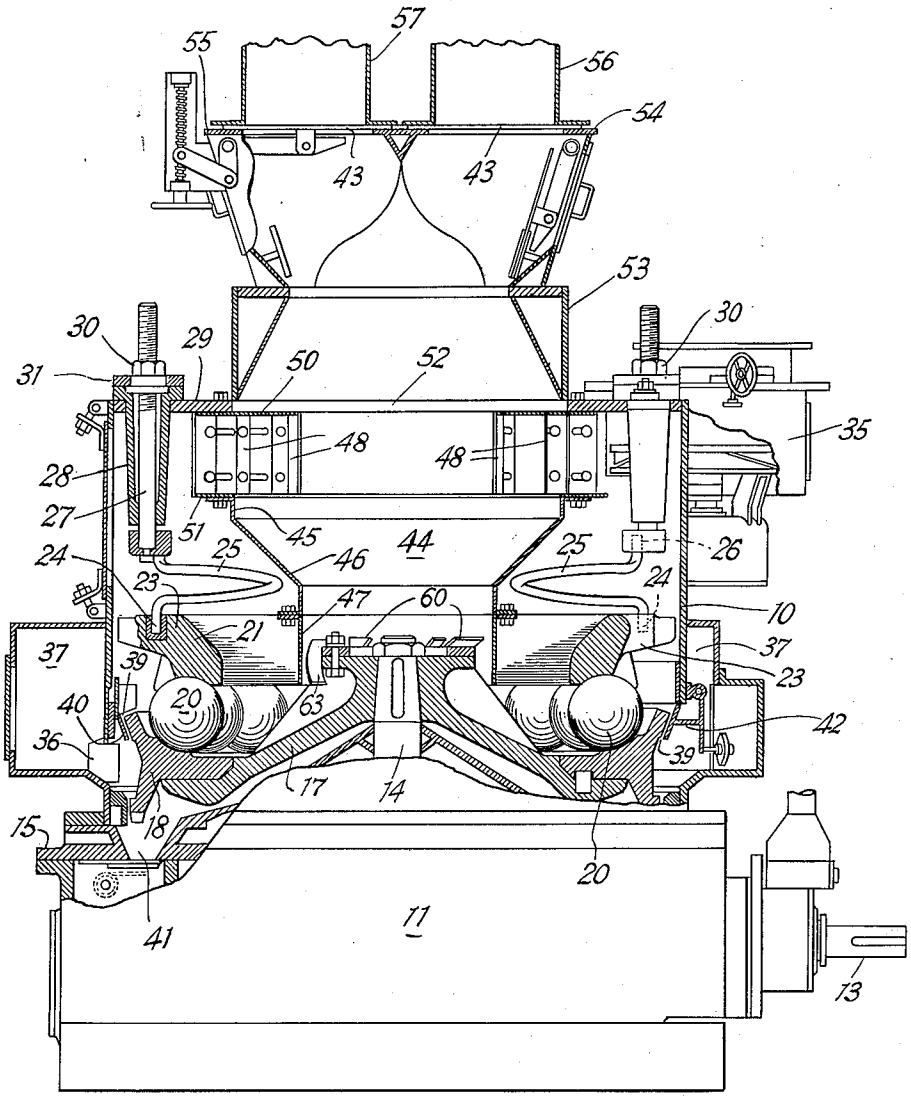


FIG. 1

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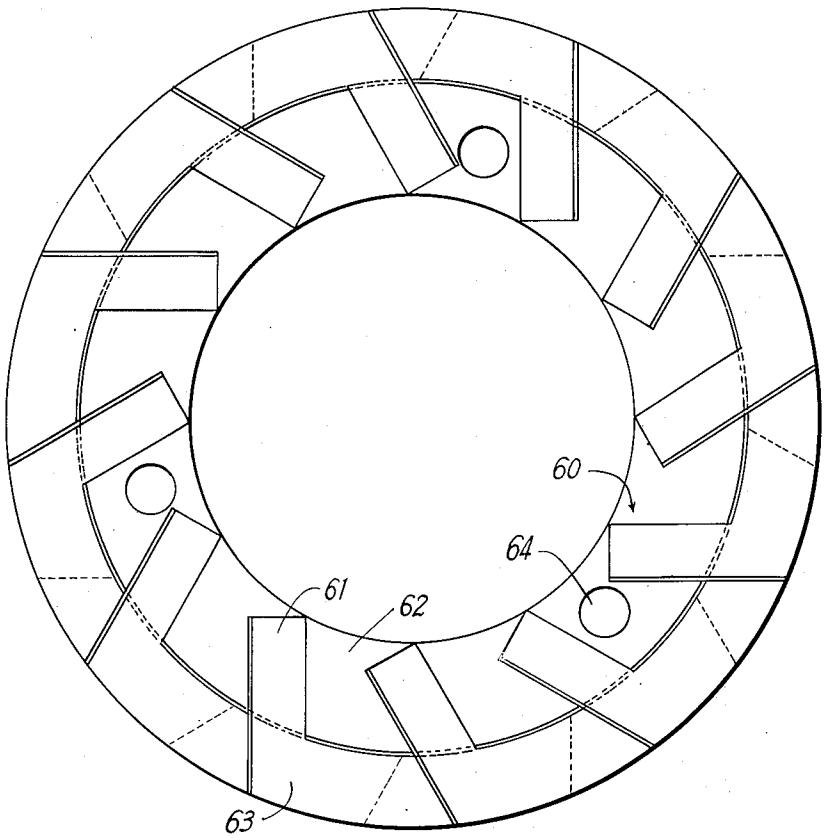


FIG. 2

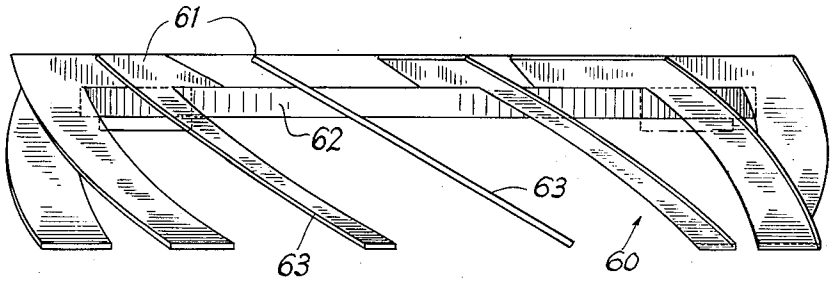


FIG. 3

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2,762,573

AIR-SWEPT PULVERIZERS

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Application April 14, 1952, Serial No. 282,217

3 Claims. (Cl. 241—53)

The present invention relates in general to improvements in the construction and operation of pulverizers, and more particularly to improvements in the pulverizing and classifying zones of an air-swept pulverizer of the general type shown in U. S. Patent No. 2,275,595.

In accordance with the invention, an air-swept pulverizer of the general type disclosed in said patent is provided with a stationary classifier for the separation of oversized materials from the air-borne pulverized material discharged from the pulverizer. The coarse oversized material separated from the carrier air stream in the classifier is returned through a classifier discharge spout to the pulverizing elements for further pulverization. The spout is provided with inclined deflector vanes which direct any material-laden air passing upwardly therethrough toward the walls of the classifier so that oversized coarse material is separated therefrom and returned to the pulverizing elements. Advantageously the deflector vanes are spaced to deflect all of the air passing upwardly therethrough toward the wall of the classifier, and the vanes are rotated to avoid any tendency for pluggage of the space therebetween.

The various features of novelty which characterize my invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, its operating advantages and specific objects attained by its use, reference should be had to the accompanying drawings and descriptive matter in which I have illustrated and described an embodiment of my invention.

Of the drawings:

Fig. 1 is an elevation, partly in section, of a pulverizer embodying the invention;

Fig. 2 is a plan of a part of the apparatus shown in Fig. 1; and

Fig. 3 is a side view of the apparatus shown in Fig. 2.

In general, the pulverizer illustrated includes a cylindrical upper housing section **10** and a lower housing section **11** supported on a foundation. The lower section encloses the pulverizer gear drive which includes a horizontal pinion shaft **13** driven by an electric motor or other drive source (not shown), and arranged to drive a vertical drive shaft **14** axially arranged in the housing. The drive shaft **14** is suitably supported by bearings positioned in a base plate **15** forming the top of the lower housing, and extends upwardly into the lower portion of the upper housing section **10**. The housing section **10** is detachably secured to the base plate **15** and encloses the grinding and classifying parts of the pulverizer.

The grinding parts forming the grinding or pulverizing zone of the pulverizer include a drive yoke **17** of general conical form keyed on the upper part of the drive shaft **14** and an annular lower grinding ring **18** supported on and doweled to a flattened lower portion of the drive yoke. Part of the upper face of the lower grinding ring is shaped to form a circular track or race for a row of rolling grinding elements **20**, preferably balls of a wear-

resistant ferrous alloy. The ball row supports a non-rotating upper grinding ring **21** having a circular ball track formed in its lower face and arranged as hereinafter described.

At four symmetrically spaced points, arms **23** project radially outwardly from the upper ring and are provided with sockets **24** for receiving dual purpose springs **25**. Each spring is formed of a length of spring steel bar stock bent to form a single complete coil turn having a large pitch diameter. The upper ends of the springs **25** fit into corresponding sockets **26** carried by vertical adjusting bolts **27**. Each bolt **27** is supported in a sleeve bracket **28** on the housing top plate **29** by means of a nut **30** and retainer **31**. The springs **25** provide a resilient compressive force for the application of a grinding pressure upon the grinding rings and balls, as well as a resilient torsional force restraining the rotational and radial movement of the upper ring **21** relative to the axis of the lower ring **18**. This dual purpose spring construction is disclosed and claimed in a copending application of L. L. Leach, Serial No. 783,248, filed October 31, 1947, now Patent Number 2,595,587.

The raw material to be pulverized is supplied by a regulable table feeder **35** and a chute (not shown) which extends through the wall of the upper section **10** to a position above the upper grinding ring **21** to discharge downwardly to the inner side of the ring **21** on the upper inclined surface of the yoke **17**. The inclined surface of the yoke and the rotation thereof distributes the material circumferentially into the grinding zone formed by the rings **18** and **21**, and the balls **20**. Due to the effect of centrifugal force the material flows outwardly into the ball race where it is pulverized by the crushing action of the relatively moving grinding balls and rings, and the attrition action of the particles on one another. The material is pulverized to various finenesses and discharges outwardly from the grinding zone at a high speed and tangentially to the periphery of the lower grinding ring, the velocity of discharge depending upon the rotational speed of the lower grinding ring **18**.

The pulverized material is removed from the grinding zone by a high velocity annular stream of a suitable gaseous carrier medium, preferably air; and when coal is being pulverized for combustion purposes, preferably the primary air supply used for combustion in the associated furnace. The air is supplied at a regulated temperature, e. g. up to 600° F., sufficient to evaporate substantially all of the surface moisture on the raw material undergoing pulverization. The air is supplied to an annular wind box **37** surrounding the lower part of the housing section **10** by a pressure blower connected with the windbox or by an exhaust fan connected with the pulverizer discharge. The carrier air passes through passages defined by equi-spaced obliquely arranged vanes **36** opening through the housing wall adjacent the lower outer side of the grinding ring **18**. The vanes **36** effect a swirling movement of the air stream in the same direction as the direction of the lower ring rotation, as the air flows upwardly through a narrow annular passage or throat **39** between the lower grinding ring **18** and a stationary throat ring **40** which is mounted on the housing.

The construction and arrangement of the throat **39** shown in Fig. 1 is disclosed and claimed in a copending application of Lester L. Leach and Walter C. King, Serial No. 124,754, filed Nov. 1, 1949, now Patent Number 2,670,138. As disclosed in said application, the air velocity passing upwardly through the throat is sufficient to suspend practically all of the pulverized material discharged from the pulverizing zone and to carry the materials upwardly adjacent the housing wall. The larger or heavier particles of material swept up by the carrier

air stream tend to drop out of the upflowing stream and to fall inwardly of the housing toward and into the grinding zone inwardly of the ring 21 and to be again subjected to the effects of the grinding zone. Any small particles of dense unpulverized or unpulverizable material, such as pyrites, tramp iron or the like, not swept up by the carrier air stream passing through the throat 39, will drop through the throat to the space 41 below the air entrance passages. Larger particles of unpulverizable material escape from the grinding zone through a weighted relief gate 42, formed as a segment of the throat ring 40.

The material-laden air stream swirls upwardly along the housing wall above the grinding zone and laterally into the classifying zone where the relatively larger sized materials are separated from the smaller sized particles which are discharged in the carrier stream of air from the pulverizer housing 10 through the outlets 43. The separated larger sized particles are discharged by gravity from the classification zone into the pulverizing zone.

The classification zone includes a stationary classifier 44 positioned axially of the upper housing 10 and extending downwardly from the plate 29 to a position upwardly adjacent the yoke 17. The upper portion 45 of the classifier includes a cylindrical section, with the intermediate portion 46 frusto-conical in shape joining the lower circumferential edge of the cylindrical portion 45 with a lower cylindrical portion or discharge spout 47. A circumferentially spaced series of upright angularly arranged blades 48 are positioned between an upper horizontally disposed annular plate 50 detachably secured to the top plate 29 of the pulverizer housing and a lower horizontally disposed annular plate 51 detachably secured to the upper cylindrical portion 45 of the classifier 44. The blades 48 are adjustable, both as to their radial length and as to their angularity with respect to the longitudinal axis of the housing section 10, so that the cross-sectional area between the blades can be changed to change the flow velocity and the flow direction of the streams of carrier air entering the classifier 44. The annular plate 50 has a central opening less in diameter than the upwardly adjoining opening 52 in the top plate 29 and of a turret structure 53 mounted on the top of the pulverizer. As shown in Fig. 1, the turret opens to a pair of symmetrically positioned valve housings 54 and 55 connected with individual discharge pipes 56 and 57.

With the material-laden carrier air entering the classifier rotating in one direction, for example in a clockwise direction as viewed from the turret 53, as caused by the rotation of the parts in the grinding zone, the blades 48 are angularly positioned for the continued rotation in the same direction of the material-laden air at an increased velocity within the classifier body. As a result of this construction, the material-laden air will rotate within the classifier 44 with the heavier particles suspended therein forced outwardly against the wall portions 45, 46 and 47, while the light-weight materials will be retained in air suspension to pass downwardly in the classifier and thence upwardly axially of the classifier to discharge through the opening 52 and the pipes 56 and 57. The separated heavier particles will discharge downwardly between the inner wall of the cylindrical spout 47 and the exterior surface of the yoke 17.

The heavier oversized particles of solid material separated within the classifier 44 and discharged through the cylindrical spout 47 are thus recirculated to the grinding zone, and further pulverized. The recirculated load normally is many times the rate of discharge of the pulverized material from the pulverizer outlets 56 and 57. When grinding bituminous coal the recirculating rate may be of the order of 30 times as great as the pulverized coal delivered by the pulverizer.

With the construction of the pulverizing and classifying zones described there is an operating differential pressure existing between the interior of the classifier 44 and the grinding zone of the rings and balls, as caused by

the resistance to flow of material-laden air through the upper portion of the housing 10 and between the blades 48 in entering the classifier. Since the classifier discharge spout 47 opens to the inner circumference of the grinding zone a relatively small but definite flow of air passes upwardly therethrough and entrains particles of pulverized material, some of which may be of a size which should be recirculated through the pulverizing zone for reduction in size before discharge from the pulverizer. This flow of air upwardly through the classifier discharge spout is restricted, as hereinafter described, without seriously impeding the gravitational flow of rejected coarse particles downwardly therethrough.

In accordance with the invention, a circumferential series of inclined blades or vanes 60 are mounted on the upper end of the yoke 17 and extend substantially across the space between the yoke and the wall of the classifier discharge spout 47. As shown in Figs. 2 and 3, the vanes 60 are formed from relatively light steel plate, for example ⅛ inch plate, in a generally L shape. One leg 61 of each vane 60 is attached to a ring-like plate 62 so that the leg 63 of the vane projects downwardly at an angle of approximately 30 degrees to the horizontal. As shown in Fig. 2, the legs 61 of the vanes 60 are installed non-radially and inclined in a direction tending to force any material encountering the vanes outwardly toward the wall of the spout 47. With the rotation of the yoke 17 in a clockwise direction, as viewed from above and as shown in Fig. 2, the upper edge of the leg 61 is canted with the inner edge of each of the legs 61 leading the outer edge of the same leg. The length of the legs 63 and the spacing of the vanes 60 is such that the vanes overlap whereby all of the material-laden air passing upwardly through the vanes is deflected toward the wall of the classifier 44. The ring 62 is provided with spaced bolt holes 64 so that the ring and vane assembly is bolted to the yoke 17 and rotates therewith. As with the blades 48, the vanes 60 are positioned so that their direction of inclination is such as to correspond with the direction of movement of the swirling air stream passing through the pulverizing and classifying zones of the pulverizer.

In the embodiment of the invention shown in Fig. 1 the direction of rotation of the yoke 17 is clockwise, when viewed from above, and the rotation of the vanes 60 would tend to force the material-laden air passing between the yoke and the classifier discharge spout 47, downwardly. However, the speed of rotation of the relatively slow speed pulverizer illustrated is insufficient to create sufficient pressure by reason of vane rotation to overcome the pressure differential tending to cause air movement upwardly into the lower end of the classifier. The vanes nevertheless force the material-laden air outwardly against the wall of the portion 47 and into the main stream of air swirling downwardly in the classifier, so that the coarser particles are separated and return to the pulverizing zone.

While the vanes 60 are mounted on the yoke 17 and their rotation effectively maintains a continuous discharge of coarse materials downwardly therethrough under the high recirculated load conditions described, the vanes can be supported on the wall of the classifier discharge spout 47 under conditions of a lower recirculated load of solid materials.

While in accordance with the provisions of the statutes I have illustrated and described herein the best form of the invention now known to me, those skilled in the art will understand that changes may be made in the form of the apparatus covered by the claims, and that certain features of my invention may sometimes be used to advantage without a corresponding use of other features. In the claims, the word "air" is intended to cover generically any other gaseous carrier medium suitable for conveying pulverized material in the manner described.

I claim:

1. An air-swept pulverizer comprising a housing in-

closing a rotary lower grinding ring, means for rotating said lower grinding ring including a yoke directly supporting said lower grinding ring, a circular row of grinding balls supported on said lower grinding ring, a non-rotary upper grinding ring supported on said grinding balls, means for delivering material to be pulverized to the inner circumference of said row of grinding balls, means for directing an annular stream of air upwardly past the outer side of said grinding rings and row of grinding balls to sweep up pulverized material discharging therefrom, stationary centrifugal classifier means positioned in the upper portion of said housing arranged to separate coarse and fine material in said air stream including an upper cylindrical section having a circumferential series of spaced blades defining a plurality of non-radial openings therein, a downwardly tapering body portion merging into a lower cylindrical spout portion radially spaced from and surrounding the upper end of said yoke for discharge of separated coarse material downwardly into said row of grinding balls, and a circular series of L-shaped vanes mounted on said yoke with one leg of each vane extending between the lower cylindrical spout portion of said classifier and the yoke to deflect material-laden air tending to pass upwardly therethrough toward the wall of said classifier means and in the same direction as the material movement within said classifier, the other leg of each of said vanes projecting at a non-radial angle across the top of said yoke.

2. An air swept pulverizer comprising a housing enclosing horizontally disposed grinding surfaces, a rotatable yoke supporting said grinding surfaces, means for delivering material to be pulverized to the inner circumference of said grinding surfaces, means for directing an annular stream of air upwardly past the outer side of said grinding surfaces to sweep up pulverized material discharging therefrom, centrifugal classifier means positioned in the upper portion of said housing arranged to separate coarse material from said air stream including a downwardly tapering body portion merging into a lower cylindrical spout radially spaced from and surrounding the upper end of said yoke for discharge of separated coarse material to the inner circumference of said grinding

surfaces, and a series of vanes positioned in a circula row between the lower cylindrical spout of said classifie and said yoke, said vanes being inclined to whirl the air borne material in the same direction as the movement o materials within said centrifugal classifier means and hav ing inwardly extending non-radial leg portions across th top of said yoke.

3. An air swept pulverizer comprising a housing enclos ing a rotary lower grinding ring, means for rotating saic lower grinding ring including a yoke directly support ing said lower grinding ring, a circular row of grinding balls supported on said lower grinding ring, a non-rotary upper grinding ring supported on said grinding balls, means for delivering material to be pulverized to the inner circumference of said row of grinding balls, means for directing an annular stream of air upwardly past the outer side of said grinding rings and row of grinding balls to sweep up pulverized material discharging therefrom, centrifugal classifier means positioned in the upper portion of said housing arranged to separate coarse and fine material in said air stream including a downwardly tapering body portion merging into a lower cylindrical spout portion radially spaced from and surrounding the upper end portion of said yoke for discharge of separated coarse material to the inner circumference of said circular row of grinding balls, and a circular series of inclined L-shaped vanes positioned in the annular discharge space between the lower cylindrical spout portion of said classifier and the yoke to deflect material-laden air passing upwardly therethrough toward the wall of said classifier means and in the same direction as the movement of materials within said centrifugal classifier means, said vanes including inwardly extending non-radial leg portions across the top of said yoke.

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