April 24, 1934. P. A. HIRSCH 1,955,960

PULVERIZING MACHINE

Filed Dec. 9, 1930 2 Sheets-Sheet 1

Fig.1.

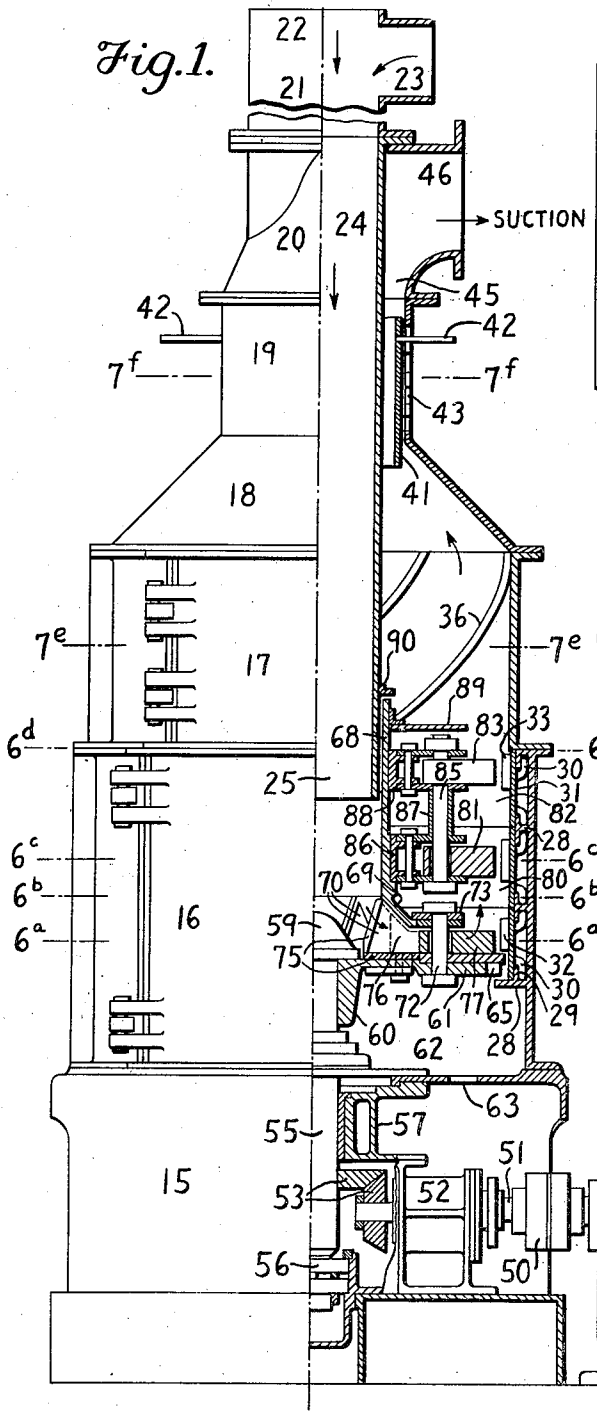


Fig.2.

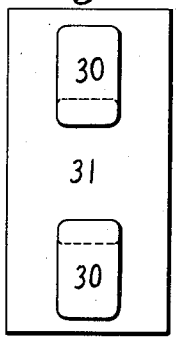


Fig.3.

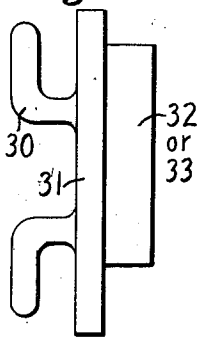


Fig.4.

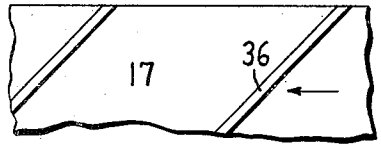
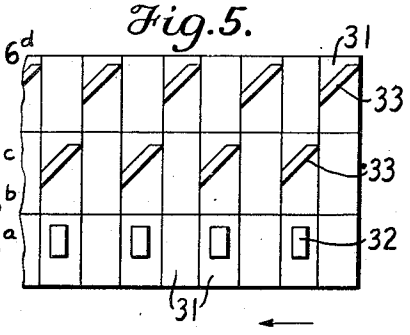


Fig.5.



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Filed Dec. 9, 1930 2 Sheets-Sheet 2

Fig. 6.

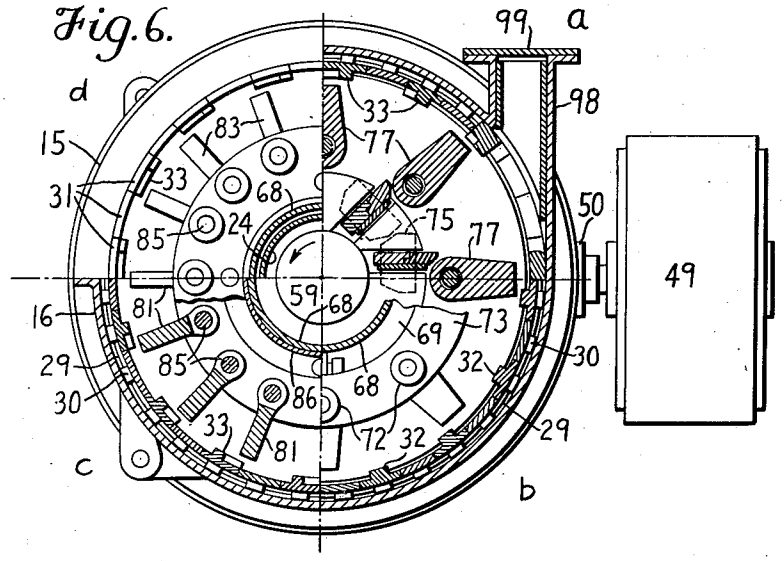


Fig. 7.

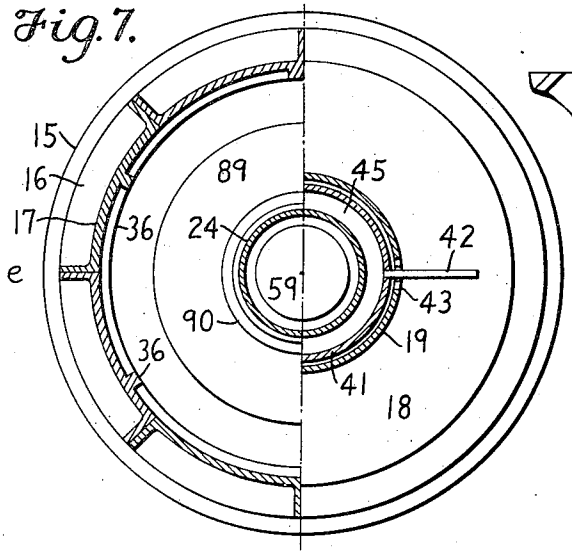


Fig. 8.

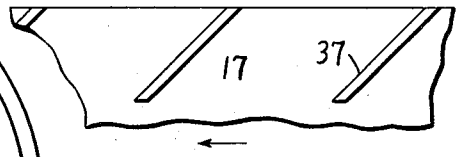


Fig. 11.

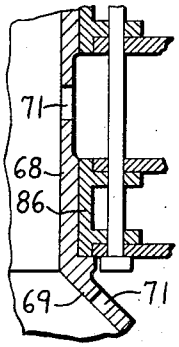


Fig. 9.

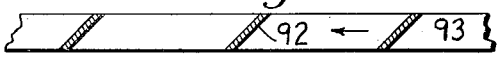
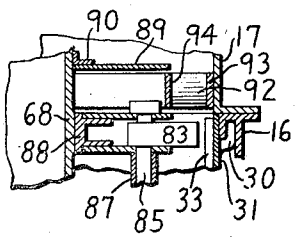


Fig. 10.



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PULVERIZING MACHINE

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Application December 9, 1930, Serial No. 501,028

6 Claims. (Cl. 83—11)

This invention is a novel pulverizing machine, and relates particularly to a pulverizer of the so-called impact type and designed for pulverizing coal or any other fuels or materials to an extremely fine degree of reduction; the impact type referring to a principle of reduction wherein the particles are acted upon by the reducing members or beaters while carried along in a flow of air, as distinguished from a crushing between two machine parts.

Pulverizers of the type referred to are illustrated by certain prior patents of mine including Patent No. 1,479,540 of January 1, 1924 characterized by certain whirl obstructing vanes beyond each of the sets of impacting or beating members and its companion Patent No. 1,479,541 disclosing a vertically arranged machine with upflow of the air and material being pulverized whereby the action of gravity tends to produce a differentiation and separate out the larger and heavier particles. My Patent No. 1,636,693 of July 26, 1927 shows a horizontal form of pulverizer with certain features including conically shaped outlet. My Patent No. 1,744,895 of January 28, 1930 shows another horizontal pulverizer containing certain refined features of construction and operation.

The general object of the present invention is to afford a pulverizing machine of superior efficiency, fineness of pulverization, and uniformity of action. A particular object is to afford an improved pulverizer which, like said Patent 1,479,541, is of a vertical type with upward flow against the flow of gravity, and which affords an improved pulverizing action, separation or classification of particles, and uniformity of result. A further object is to afford an effective means of regulating at will the degree of fineness of pulverization by adjustment of the apparatus and action and without impairing the uniformity of results.

Other and further objects and advantages of the present invention will be explained in the hereinafter following description of an illustrative embodiment thereof or will be understood to those conversant with the subject. To the attainment of such objects and advantages the present invention consists in the novel pulverizing machine and the novel features of operation, combination, construction and arrangement herein illustrated or described.

In the accompanying drawings Figure 1 is a combined side elevation and central verical section of a pulverizing machine embodying the present invention.

Fig. 2 is an exterior elevation view of one of the lining elements mounted inside the casing wall and having in some cases projecting lugs or ribs.

Fig. 3 is a right elevation of the lining member shown in Fig. 2.

Fig. 4 is a partial development, in interior view, of the upper part of the casing.

Fig. 5 is a similar development of the lower part of the casing, showing one of many possible arrangements of lining elements.

Fig. 6 is in part a top plan view and otherwise a series of horizontal sectional views, as marked at the four quadrants *a*, *b*, *c* and *d*, taken respectively on the horizontal section lines 6^a, 6^b, 6^c and 6^d of Fig. 1.

Fig. 7 is a similar top plan view with one portion *e* taken on the horizontal section line 7^e of Fig. 1, and another portion *f* taken on the section line 7^f of Fig. 1.

Fig. 8 is a development view similar to Fig. 4, but showing a modification wherein the projections or ribs extend less than the full height of the upper section of the casing.

Fig. 9 is a development view of a further modified construction, shown also in Fig. 10.

Fig. 10 is a central vertical sectional view, corresponding to a part of Fig. 1, showing a modified construction of certain rotary parts.

Fig. 11, in similar section, shows a modification of another portion of the rotary parts.

Corresponding reference characters designate corresponding parts in the several figures of the drawings.

Referring first to Figs. 1, 6 and 7, the machine is shown as substantially circular with extended vertical dimension and occupying relatively small floor space. Considered from the bottom upwardly the outer wall parts may be divided into successive sections commencing with a base section 15 resting on the foundations. Supported on and attached to the base section by suitable peripheral flanges is a lower casing section 16 within which much of the pulverizing is effected, and on top of that, secured by outward flanges, is an upper casing 17, within which classification or separation takes place, and both of the casings 16 and 17 preferably being openable, for example by having one half hinged to the other half, giving access for assembling, repairing or replacing interior parts. On top of the upper casing section 17 is shown attached by flanges an inwardly trending or conical section 18, the upper part of which is continued as a cylindrical section 19 of reduced diameter and flanged at the

top to receive a section 20 which may be designated the outfeeding section, above which in turn is secured what may be termed the infeeding section 21.

The topmost section 21, which is preferably concentric with the vertical axis of the machine, is shown as having a top entrance 22 into which crushed coal or other material may be fed methodically from any supply and by any known feeding means, delivering in uniformly measured quantities. It is desirable that a certain amount of air be drawn in with the coal and an air entrance 23 is indicated at one side of the section 21. From the infeed section the crushed coal and air may descend centrally through a fixed feed tube 24 which is shown as flanged at its upper end and hung from the top of the section 20, its flange being secured between the flanges of sections 20 and 21, attaching bolts being understood at this and other flanged points of the machine. The central feed tube 24 extends down through the delivery section 20, the reduced section 19, the cone section 18 and the upper casing section 17 and preferably part way into the lower section 16, where the lower end 25 of the feed tube delivers to the rotary parts subsequently to be described.

The bulk of the pulverizing action is intended to be performed in the lower casing section 16 which for this purpose may have a removable liner construction, for example as follows. The outer casing wall is shown as formed with a number of inwardly extending flanges 28, four being shown, preferably continuous around the interior of the casing. These several flanges enclose between them recesses into which extend a system of lugs 29 formed above and below the flanges, which lugs preferably are continuous in the form of flanges and affording undercut recesses adapted to receive outwardly extending lugs 30 in the nature of hooks formed on a system of liner plates 31, which may thus readily be threaded into place when the section is open and are held locked when the section is closed and bolted.

Some of the liner plates may be of plain interior surface, while others may be formed with projections or ribs, for example simple rectangular ribs 32 on certain of the lower liner plates, or inclined ribs 33 on others of the liner plates, all of which perform particular functions in operations of the machine as will be described. The various liner plates take the wear of the pulverizing action and are replaceable individually or in groups when they become so worn as to impair their action.

Within the upper casing section 17 are shown a series of ribs 36 which may be inclined in a direction similar to the inclination of the ribs 33 so as to tend to throw downwardly the heavier particles which tend to the periphery. These ribs 36 may extend clear from the top of the section wall to the bottom thereof, as shown also in the development in Fig. 4, or they may be terminated at an intermediate point as indicated by the modified ribs 37 of Fig. 8.

Within the space between the reduced section 19 and the central feed tube 24 is shown a slidable sleeve or tube 41, fitting snugly against the casing wall 19 and adjustable vertically at will so that the lower end of the sleeve may be made to project more or less below the upper end of the converging or conical section 18. For this purpose the adjustable sleeve 41 may be provided with radial pins 42 extending to accessible points, these pins passing through slots 43 in the section wall 19, such slots formed with a succession of notches to hold the pins at various heights. By this arrangement the sleeve can be dropped considerably lower than shown in Fig. 1, each lower position giving a greater exclusion of heavy particles and therefore a greater degree of fineness in the product.

Beyond or above the annular passage within the sleeve 41 is an outgoing space 45, partially annular, and leading out to one side by a final exit 46 by which the pulverized materials, carried in a stream of air, are delivered from the machine. As is well understood a suction fan may be employed beyond the outlet to maintain an updraft through the pulverizer, the amount of air drawn through depending upon the speed of the fan, and the product being delivered to a storage space, or directly to a furnace for combustion, or elsewhere as may be required.

Referring next to the rotary parts of the machine there is shown a driving means in the form of an electric motor 49 which may be connected through a clutch 50 to an extension shaft 51 mounted within the base of the machine, for example by a heavy roller bearing 52. The inner end of the power shaft 51 may be connected by bevel gears 53 with a vertical drive shaft 55. The gears may be in such proportions that with a motor rotating at 1800 R. P. M. the vertical shaft and reducing mechanism to be described will rotate at about 1250 R. P. M.

The vertical drive shaft of the machine may be mounted and supported by a strong radial and thrust bearing 56 at the bottom, and a heavy anti-friction bearing 57 near the upper part of the base section 15. The shaft is shown extending through the base section into the lower casing section 16 of the machine and at the top of the shaft is shown a rounded or dome like deflector block or cap, which receives much wear, due to the infed material striking upon it, and it therefore should be renewable. The coal descending by the fixed central feed pipe 24 is deflected outwardly in all directions by the block 59 and thereby delivered to the beating mechanism to be described.

An important feature of this invention is a substantially closed plate or table underlying the beating mechanism and rotating with the shaft 55. The hub 60 keyed to the shaft carries the rotating plate or table 61 which extends outwardly nearly to the lining of the casing, but leaving a safe clearance. If desired a forced air flow may be maintained upwardly through the clearance space and for this purpose the chamber 62 below the table is shown as connected by air openings 63 from the interior of the base section 15. A fan 65 may be employed to drive air through the base section and opening 63 and thence through chamber 62 and upwardly around the periphery of the table 61.

Preferably the rotary table 61 carries all of the rotating parts of the machine. A tubular hub 68 is shown, partly surrounding the fixed feed tube 24 and supported concentrically upon the table. This rotary sleeve or tube is in the nature of a hub carrying certain reducing or pulverizing elements. Its lower end is extended at 69 in flared form, thus facilitating the passage of descending material to the reducing elements. Arranged between the sleeve extension 69 and the table are a series of downwardly extending walls or webs 70 which maintain these parts in spaced relation. The sleeve 69 and its flared part are shown as closed in Fig. 1, but may be

formed with openings 71 as shown in Fig. 11, permitting the introduction of additional air at these points.

The tubular hub or sleeve 69 may be secured to the table 61 as follows. A system of vertical bolts 72 is shown, with their lower ends or heads underlying the table, and their upper ends or heads overlying an annular plate or ring 73 which in turn rests upon the outer edge of the flared part 69. When the bolts are tightened the sleeve and table are rendered rigidly unitary.

Since the table, the flared part 69, and the vertical webs or walls 70 are subject to continuous wear and abrasion by the advancing material, they are preferably protected by lining members, and for this purpose a box like liner 75 may be employed having a bottom wall underlying the webs 70, vertical walls adjacent the webs 70 and upper walls in contact with the inclined portions 69. Each of these box like liners 75 may be removed and replaced, and each of them contains a radial passage 76 of ample dimensions leading to the hammers or beating elements next to be described.

The pulverizing of this invention is preferably performed in several successive stages with substantial and distinctive separating or classifying actions between the reducing or beating actions, and the reduction may be by a combination of the impact beating by the hammers or beaters and attrition or friction against the fixed or lining parts of the machine. The first reducing or pulverizing device may be considered as including the entire series of beaters or hammers 77 located above the table 61 and preferably swingable for example by mounting on the vertical bolts 72, these hammers cooperating with the heavy or square liner ribs 32 for the initial reducing of the crushed material.

Above the first beater set 77 is shown an annular space 80 constituting a gap above the heating zone of the hammers, this gap having substantial vertical dimension, preferably greater than the width of the hammers, and affording a separating or classifying zone wherein the particles, subject to the lifting force of the updraft, are subject also to centrifugal force tending to throw the heavier particles toward the periphery, and subject further to gravity tending to carry the heavier particles downwardly and return them towards or to the beaters.

Following the annular classifying space 80 is shown a second set of beaters 81 and above that a second separating space or gap 82 and above that a third set of beaters 83; which of course could be repeated to a further extent.

The second and third beater sets 81 and 83 may be mounted swingingly, namely upon vertical bolts 85 of sufficient length to support both sets of beaters. The bolts 85 are shown rigidly held by a lower annular device or structure 86 which may be built up as shown and includes a pair of spaced plates between which the hammers are mounted. Above the structure 86 is shown a spacing sleeve 87, and thereabove an upper annular device or structure 88 accommodating the beaters 83. Both of the supporting structures 86 and 88 surround the rotary sleeve 68 and receive their support and rotation from it through suitable shoulders, keys and the like.

Above the final set of beaters is shown a ring or plate 89 outstanding from the sleeve 68 so as to close the inner part of the intermediate space and compel the ascending materials to travel near the periphery, so as to insure their being subjected to the action of the beaters. At the top end of the sleeve 68 is shown a ring 90 for closing the small annular space between the sleeve and the inner fixed feed tube 24.

Instead of having a clear ascending passage from the final beating zone upwardly past the plate 89 as shown in Fig. 1, the arrangement may be modified as shown in Figs. 9 and 10 by introducing in or adjacent to the upward passage a system of fixed vanes 92 extending substantially radially between outer and inner rings 93 and 94, the outer ring being attached to the casing 17. The use of vanes of this general character is indicated in one or more of said prior patents. In the present disclosure the vanes operate to retard somewhat the whirling motion and at the same time subject the solid materials to further impact. Also as shown in Fig. 9 the vanes are so inclined as to give an additional separating action, since whirling particles of substantial weight, striking the vanes, will be deflected back toward the beaters.

Adjacent to the first beating zone, just above the whirling feed table 61, there may be provided an exit for tramp iron or other hard materials accidentally entering the pulverizer. Thus in Fig. 6 there is shown a tangential outlet passage 98, the extremity of which is closed by a removable cover 99 by which collected pieces may be removed from time to time.

The operation of the machine may be summarized as follows. Assuming that the sleeve 41 has been adjusted to the proper position for the desired classification, current may be supplied to drive the motor 49. Thus, through the extension shaft 51 and gears 53, the vertical drive shaft 55 is rotated in a counterclockwise direction as shown by the arrow in Fig. 6. The table 61, tubular member or hub 68, and the several beater sets rotate with the shaft.

The material to be pulverized is then fed down through the central feed tube 24 to the deflector at the central portion of the rotary table 61, whereupon centrifugal force will act to feed the material radially outward in all directions and through the passages 76 between the webs or vanes 70 and into the zone or range of the first set of hammers or beaters 77. Some air has, of course, been infed with the stream of material as it passed the intake 23. The velocity of the hammers 77 is so high as to reduce the particles by impact, and this desired effect is enhanced by the particles striking the heavy stationary liner lugs 32, and by attrition against the surfaces of the hammers and liner plates 31. Additional air from the chamber 62 passes upwardly around the periphery of the rotating table and mixes with the whirling materials, assisting in advancing the particles upwardly into the space 80. The lighter particles are here entrained and carried upward while the heavier ones tend to descend by gravity to be acted upon again by the hammers 77, giving a classification in the space 80.

Those particles which do rise to the top of the free annular space 80 then pass through the zone of the hammers 81 constituting the second stage and are thus further reduced. In this stage, wherein the impact action may be less than in the first stage, the heavier particles are thrown outwardly by centrifugal force, and upon whirling into contact with the inclined liner lugs or ribs 33 are forced or cammed down toward the first set of hammers, while the body of the air carrying the lighter particles passes up and into the free annular space 82, where further gravity classi-

fication takes place. Then continuing upward the reduced particles pass through the zone of the third set of hammers or beaters 83 where they are again reduced in the same way, and the heavier particles thrown out and cammed down. The upward travel of the whirling material and air is, of course, continuous and progressive, with a substantial degree of gravity classification between the successive beater sets.

After the whirling materials pass the ring or plate 89 they travel upwardly through the upper casing 17, wherein again the centrifugal force throws all but the lightest particles outwardly against the inner surface of the casing and into contact with the inclined ribs 36 which return some of them to the beaters while also continuing the attrition action. The downward projection of tube 41 makes it impossible for the heavier particles to enter the tube, so that the reduced materials passing to the final outlet 46 are of very fine degree of reduction and substantially uniform in character.

The great bulk of the reduction work is done in the first beater zone, since the hammers 77 strike the material into whirling motion, and the ribs 32 receive the heavy particles with greatest impact. The later beater stages involve less impact action and more attrition and separation. At every point the mixture of heavy and light particles is subjected to three distinct forces. First, centrifugal force, keeping the particles in the peripheral zone near the casing or lining, with greater effect on the heavier particles. Second, air advance gives a lifting action, the whirl taking a slow helical path with upward trend. Third, gravity, acting with slight force on the finest, but with strong force on the heavier particles, causing them to descend while moving toward the periphery, postponing their exit from the mill, and subjecting them to repeating reductions by the beaters. The lightest particles, in suspension in the air, rise easily with the flow, and keep nearer the center, while the heavier are moved out and down by centrifugal force and gravity and come in the path of the inclined ribs which further throw them down. Thus a peripheral counterflow of heavy and coarse particles is maintained at various points, bringing them back again into range of the hammers.

The section 18 is shown conical but any free and open shape will serve, such as cylindrical. No rotary parts are present, but the whirling matters have a slow rise and are allowed good opportunity to separate, the heavies being projected outwardly and moving downwardly, back toward the beating elements, as before. The ribs in section 17 are optional, and when used assist the downward return of the heavies. In both these sections the ascending air may fill the entire section, being not confined to the periphery, the lighter particles only moving inward and onward with the air, and to the central tube 41, against the head created by the centrifugal force, thus affording a highly efficient separation at this final point.

The apparatus may be made in various sizes and proportions. As shown designed, for example one commercial size may have a radius of 24½ inches from the axis to the tip of the hammers, giving a peripheral speed of about 8000 feet per minute, assuming a rotation of 2450 R. P. M.

It is occasionally necessary to inspect the inner working parts of the machine and to adjust or replace such parts as have become excessively worn, and this can easily be done by unfastening and separating the longitudinally parted sections of the casing members 16 and 17. When this is done any or all of the liner plates 31 may be removed and replaced by new ones, as can also the box like liners 75 on the rotary table.

A pulverizing machine has thus been described wherein the material will be reduced in successive stages by a combined impact and attrition action, with gravity classification between stages. The construction is simple, lending itself to economical production, and the resultant machine is highly efficient in operation. Various changes may be resorted to in the construction, operation and arrangement of parts, and the invention is not intended to be limited to the particulars or details as shown except to the extent set forth in the claims.

What is claimed is:

1. A pulverizing machine comprising an upright casing, a rotary table adjacent to the lower end of the casing, a tubular hub mounted above the table and rotatable therewith and terminating in a flared extension on its lower end, said extension being spaced from the table, radial webs between the table and said flared extension and defining between them radial passages, means for feeding material to be pulverized into the tubular hub on the table whereby the material will be fed centrifugally through said radial passages and against the interior of the casing, a set of reducing elements carried by the table to pulverize the material, additional reducing elements carried by the tubular hub, said additional reducing elements being spaced a substantial distance above the first set of reducing elements to permit gravity classification of the material between the successive stages, and a discharge passage above said reducing elements.

2. A pulverizing machine as in claim 1, and wherein the casing is formed of longitudinally parted removable sections to give access to the interior, and wherein the inner surfaces of said sections are provided with readily removable wearing liners having inwardly extending stationary ribs to further promote the reducing action.

3. A pulverizing machine comprising an upright casing, means for feeding material to be pulverized downwardly into the casing, a rotary table to receive the infed material and to spread it centrifugally adjacent the lower end of the casing, a set of beater elements pivoted on the rotary table in spaced relation about the periphery thereof to effect reduction of the material by impact, means for supplying air to be mixed with the material, additional beater elements arranged in spaced sets above the first-mentioned set and past which the material is progressively advanced upwardly with a whirling action, the several beater sets being separated by unobstructed passages permitting gravity classification between the sets, additional classifying means above the last set of beater elements, and a discharge passage above said additional classifying means.

4. A pulverizing machine comprising an upright casing having separable sections, means for feeding material to be pulverized downwardly into the casing, a rotary table to receive the infed material, said table being disposed within the casing adjacent the lower end thereof, a tubular hub mounted above the table and rotatable therewith and terminating in a flared extension on its lower end, said extension being spaced from the table, radial webs between the table and

said flared extension and defining between them radial passages, through which the material is fed by centrifugal force, a set of beater elements pivoted on the rotary table in spaced relation and about the outer edge thereof to effect reduction of the material by impact, a plurality of additional sets of beater elements carried by the tubular hub, and past which the material is progressively advanced upwardly with a whirling action, the several beater sets being separated by unobstructed annular spaces permitting gravity classification, a plurality of fixed ribs on the inner surface of the casing and adjacent the paths of the beater sets, some of said ribs being inclined, additional classifying means above the last set of beater elements, a discharge passage above said additional classifying means, and adjustable means for selectively controlling the fineness of pulverization.

5. In a pulverizing machine of the impact type, the combination of a vertical casing having at its upper part an inlet for material to be pulverized and an outlet for air carrying pulverized material, and enclosing an annular reducing zone, a feed table rotatable on a vertical axis within the lower part of the casing, and extending outwardly nearly to the casing, with an air flow space between, a central tube above the table for conducting infed material from the inlet downwardly to the middle of the table, reducing means comprising a plurality of superposed series of impact beaters rotatable within the casing above the periphery of the table, and means for maintaining upward air flow from beneath the table through the air space between table and casing and upwardly through the reducing zone to the outlet; the table carrying a rotary hub and the table and hub carrying the beater series, the lower end of the hub being shaped outwardly, and a series of webs subdividing the space between the table and hub for imparting rotation to the received material and directing the same outwardly.

6. In a pulverizing machine a substantially horizontal table within the lower part of the pulverizing chamber rotatable on a vertical axis, means for feeding material upon the middle part of the table, reducing means upon the peripheral part of the table, comprising beaters pivoted upon the table, means for maintaining peripheral upflow of the whirling air and reduced material, the middle part of said table being adapted for receiving the material from the feeding means, and webs upon the table for throwing the material into rotation to cause centrifugal advance thereof to the peripheral reducing means.

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