May 30, 1967

L. PALYI

3,322,353

PULVERIZER

Filed Feb. 3, 1964

3 Sheets-Sheet 1

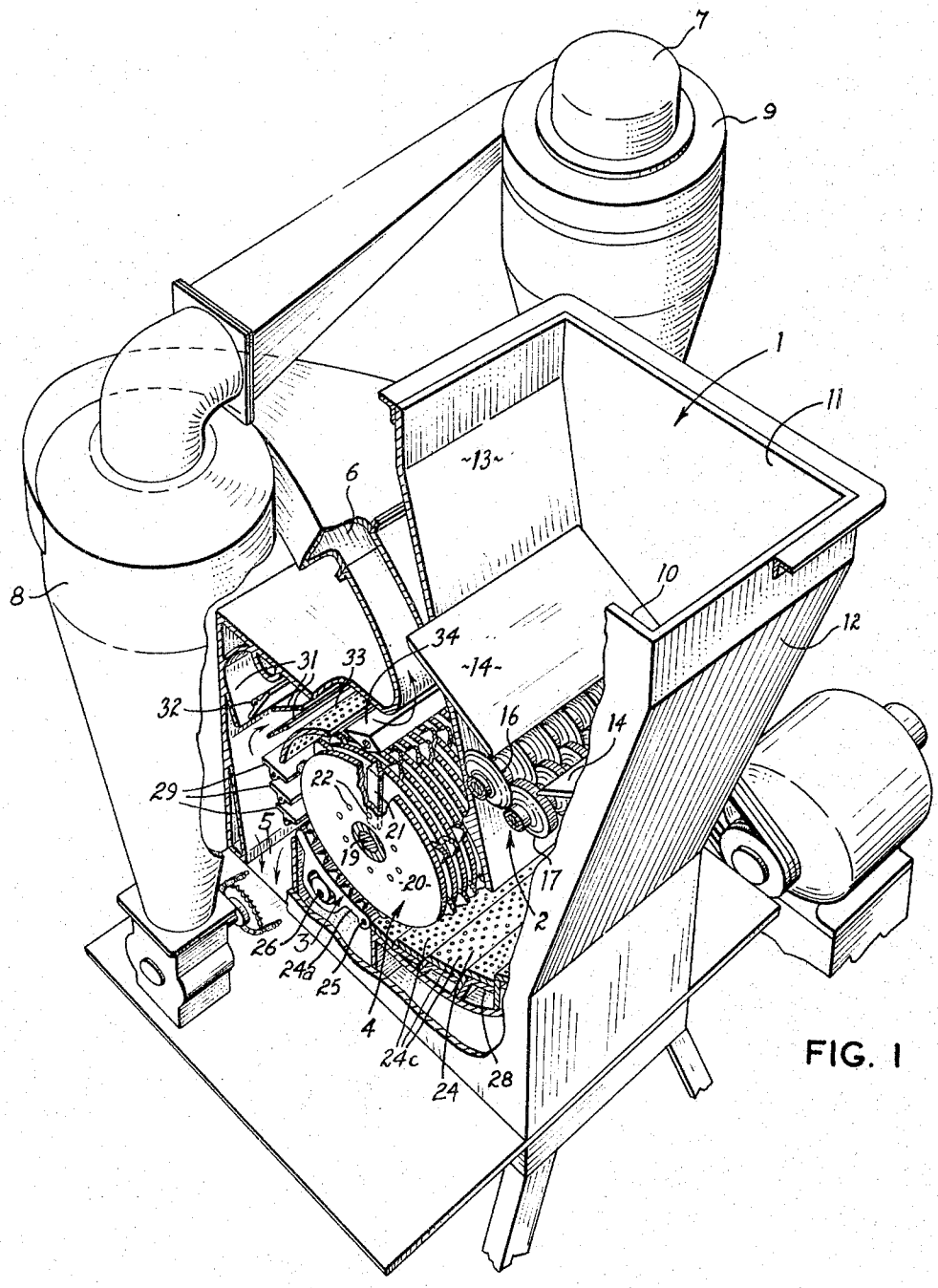


FIG. 1

INVENTOR
LESLIE PALYI

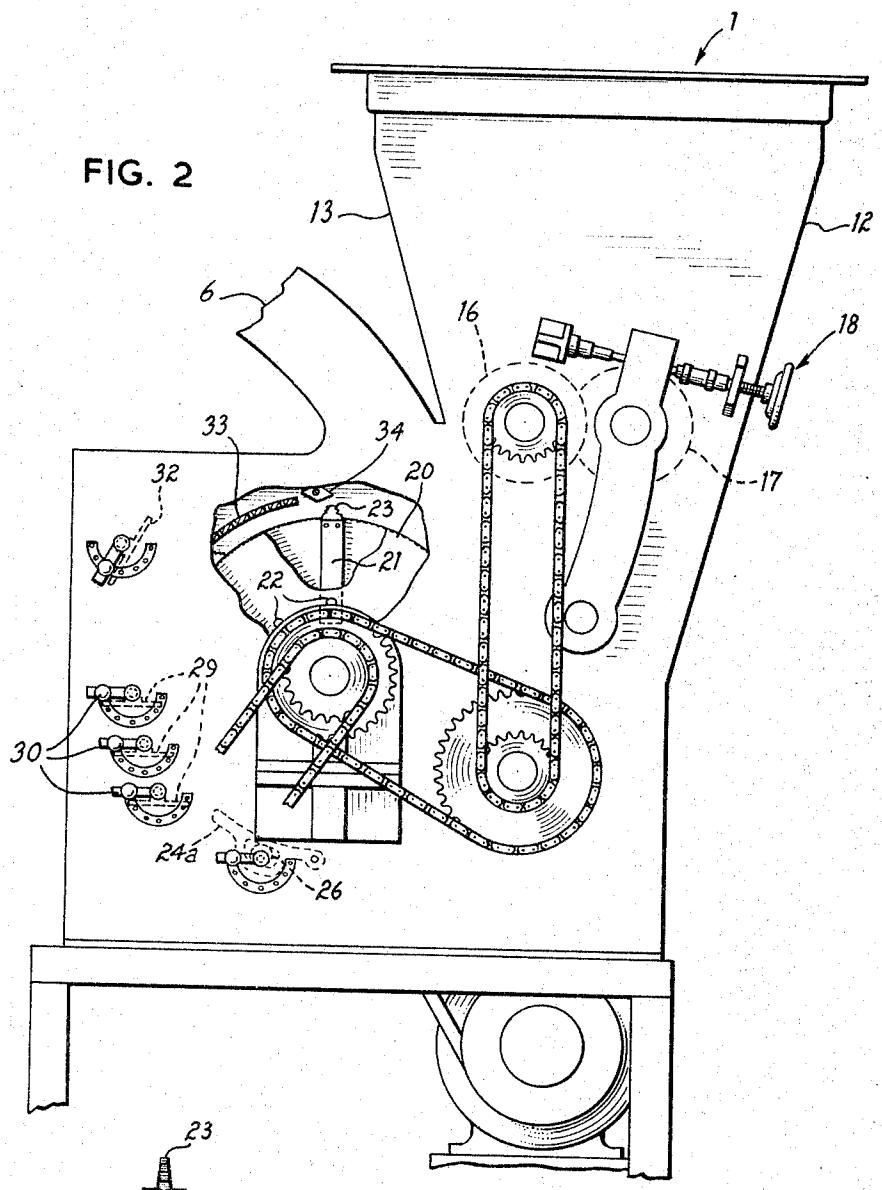
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PULVERIZER

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FIG. 2



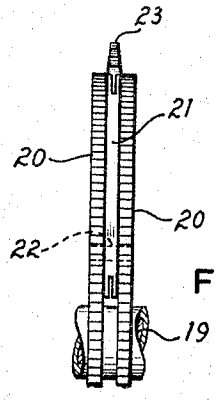


FIG. 3

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PULVERIZER

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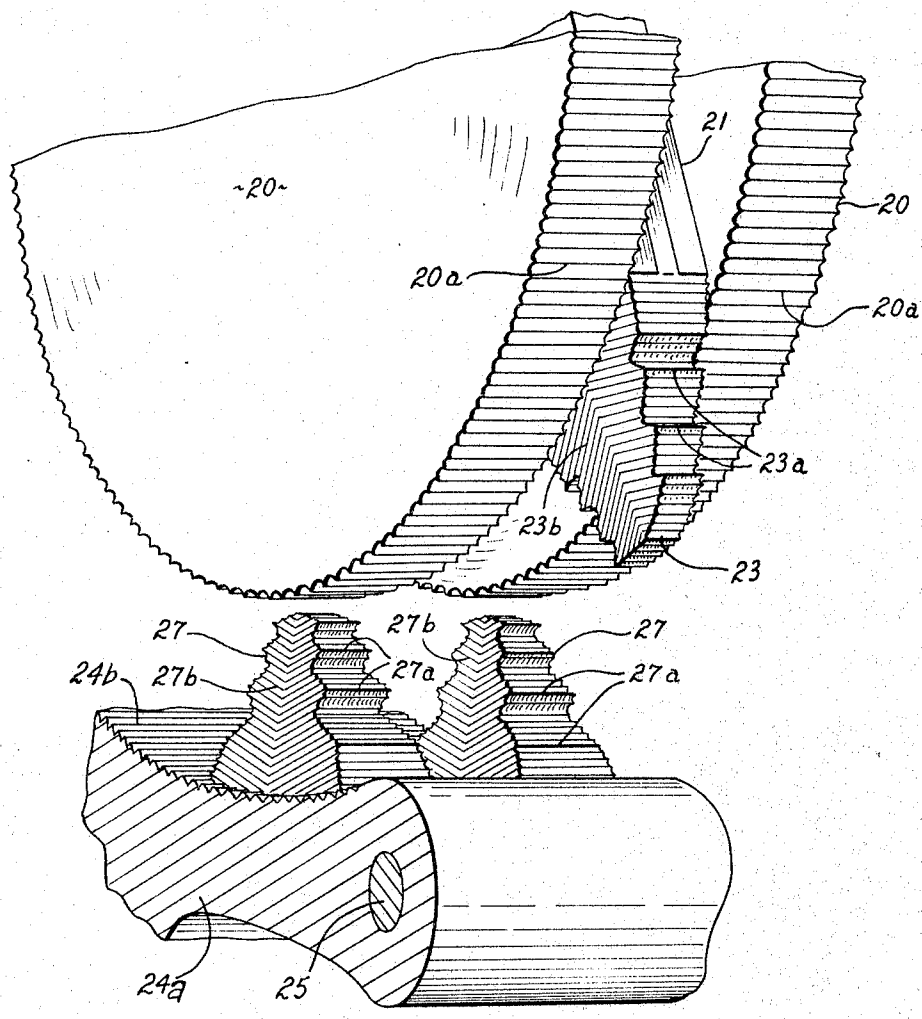


FIG. 4

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3,322,353

PULVERIZER

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Claims priority, application Great Britain, Feb. 4, 1963, 4,448/63
10 Claims. (Cl. 241—49)

This invention relates to an improved apparatus for pulverizing rock, ore, and other solid frangible materials. More specifically, the apparatus of the invention is designed to pulverize particles having maximum dimensions as large as 8 inches and to reduce them to sizes in the range of 30 mesh to 40 mesh or finer. With the apparatus of the invention the size and grading of the pulverized products are adjustable over wide ranges, depending on requirements.

Hitherto, frangible materials were pulverized in hammermills consisting of a series of steel hammers swingably mounted between spacer discs on a central rotor within a steel housing; the axes of the hammers are positioned on the discs in circumferential arrangements concentric with the axis of rotation of the discs. In these known hammermills the material to be pulverized is dropped into the housing where it is struck by the hammers and flung by impact against corrugated surfaces and groovings on the sides of the housing. The pulverized material falls through the grating to an outlet where it is collected.

The rate of wear on the internal parts of conventional hammermills is very high, necessitating frequent maintenance and replacement of the hammers and of the gratings. Furthermore, because large pieces of the material will lodge between the hammers and the spacer discs, as well as between the hammers and the housing, choking and overloading of the apparatus frequently results, and the accompanying abrasions and the large impact forces further increase the high rate of wear. Frequent breakdowns are caused by the breakage of the hammers and even of the driving shafts. The vibrations in these machines are large, thus necessitating heavy foundations and holding-down arrangements. All of the foregoing undesirable or objectionable features up to the present have been considered as accepted incidentals of conventional pulverizing machines.

By the present invention, the undesirable features of conventional hammermills have been reduced. Thus the main object of the invention is to provide an improved pulverizer having a high degree of pulverizing efficiency and possessing great wearing qualities.

The foregoing and still further objects and advantages of the invention will become apparent from a study of the following specification, taken in conjunction with the accompanying drawings, in which like reference characters indicate corresponding parts throughout the several views, and in which:

FIG. 1 is a broken away perspective view of a pulverizer embodying the invention;

FIG. 2 is a side elevation thereof;

FIG. 3 is a fragmentary detail view of two spacer discs with a hammer therebetween; and

FIG. 4 is a fragmentary perspective view, to an enlarged scale, of segments of the rotor assembly and of the hinged plate which cooperates therewith, showing particularly the hammers and the bits thereon.

In general the pulverizer forming the subject matter of the invention comprises an inlet hopper 1 into which is fed the material to be pulverized. After passing at a controlled rate through a primary crusher generally indicated at 2, the coarsely crushed material drops into the passage between a pulverizer element generally indicated at 3 and a rotor assembly generally indicated at 4; this passage converges in a downstream direction relative to the direction of rotor rotation. Serrated bits at the ends of hammers of the rotor assembly strike and cause additional pulverization of the material. The larger pulverized particles then are directed to an outlet 5; this is the "first size" of product. The remaining particles are carried upwardly through an extension of the aforementioned passage provided by a duct 6, by means of an air flow which is created by a vacuum fan 7 mounted at the top of the second of a pair of cyclones 8 and 9 arranged in series. The coarsest materials in the air flow are separated out by centrifugal force and fall to an outlet at the bottom of the first cyclone 8; this is the "second size" of product. The remainder of the dust-laden air passes by way of a connecting pipe to the second cyclone 9 at the bottom of which the "third size" of product is collected, whilst the dust-free air is exhausted to atmosphere.

The apparatus will now be discussed in greater detail. The inlet hopper 1 preferably is an open funnel of rectangular cross-section having opposed parallel side walls 10 and 11, and downwardly tapering front and rear walls 12 and 13. In the lower part of the hopper are a pair of converging spaced leader plates 14, and underneath the gap between these plates are rollers 16 and 17 of the primary crusher 2.

The two crusher rollers are interconnected by gears (not shown) to revolve in opposite directions and at different speeds, the roller 16 revolving at a faster rate than the roller 17. The roller 16 is mounted in fixed bearings, whilst the roller 17 is adjustably mounted relative to the roller 16 by a mechanism generally indicated at 18 so as to provide for variation of the gaps between the rollers and hence to control the maximum size of particles which can pass therethrough.

Preferably the supporting shafts of the rollers 16 and 17 are of composite construction, each composite shaft consisting of a solid inner core and of an outer sleeve, which are pressed together. The resistance to impact of the resulting composite shafts is superior to that of a solid section of the same cross-sectional area.

The material to be pulverized is fed into the inlet hopper 1, and it is crushed by the crusher rollers 16 and 17, which control the effective rate of feed of material into the downstream parts of the apparatus.

The rotor assembly generally indicated at 4 comprises a shaft 19 mounted on bearings provided in the opposed side walls 10 and 11. Onto the shaft 19 are keyed a series of spacer discs 20 having serrated or grooved peripheries 20*a*. Bit-holder arms or hammers 21 are swingably mounted at one end on shafts or axes 22 which extend through the spacer discs (see FIG. 3), the shafts 22 being positioned in a circular arrangement which is concentric with the shaft 19. The clearances between the spacer discs 20 and the hammers 21, and the clearances between the two outermost spacer discs 20 and the walls 10 and 11, are only sufficient to permit free relative movement of these parts.

Removable and replaceable milling bits 23, which project beyond the peripheries of the spacer discs 20, may be secured to the free ends of the hammers 21, instead of providing hammers having integral milling bits. The edges of the milling bits may be stepped, as indicated at 23*a*, and these stepped edges as well as the side faces 23*b* are serrated or corrugated, as particularly shown in FIG. 4.

The pulverizer element 3 is constituted by stepped crusher plates 24 and by another plate 24*a* which is hinged for limited pivotal movement on an axis 25 so that the effective distance between the hinged plate 24*a* and the

periphery of the rotor may be varied by an adjustment of an eccentric shaft mechanism **26**. The working surface of the plate **24***a* is serrated or corrugated at **24***b* and from it extend a plurality of teeth **27** arranged in spaced rows parallel to the rotor axis. Each tooth in a row is directly opposite the periphery of one of the rotor discs **20**, and the corresponding teeth in the various rows opposite a given disc thus constitute a group of teeth, each group being spaced from the next adjacent groups. The bits **23** are positioned to register with and pass in the spaces between the groups of teeth **27**. The teeth **27**, like the bits **23**, may have stepped edges **27***a* which are serrated or corrugated, and they also have side faces **27***b* which are serrated or corrugated.

It will be noted particularly from FIG. **1** that the stepped crusher plates **24** are formed with perforations **24***c*, thus providing discontinuities or "edges" against which the particles of material can strike and be split. Underneath the crusher plates **24** are solid backing plates **28** which prevent the passage of the pulverized material therethrough.

The coarse material which has passed at a controlled rate through the rollers **16** and **17** of the primary crusher **2** passes into the converging passage between the pulverizer element **3** and the rotor assembly **4**. The rotor assembly revolves so that the linear speed of its periphery is of the order of 390 feet/second to 600 feet/second. As viewed in FIG. **1**, the rotor assembly rotates in a clockwise direction; its bits **23** pass or mesh between the groups of teeth **27** projecting from the hinged plate **24***a*.

The coarse material passing into the converging passage between the pulverizer element **3** and the rotor assembly **4** is reduced in size by impact with the bits **23** and with the edges of the stepped crusher plates **24** provided by the perforations **24***c*, and by abrasion and impact between the particles. The rotating bits **23** at the ends of the hammers **21** impart an indiscriminate turbulence or tumbling movement to the particles as they are pulled into the converging passage. The convergence of the passage limits the size of particles progressing along the stepped crusher plates, and thus prevents overloading of the rotor assembly; particles which are too large cannot progress until they have been reduced to the correct size.

Finally, the rotating bits **23** pull the particles between the stationary teeth **27** of the hinged plate **24***a*, to complete the pulverizing process. In this last stage, the directions of movement of the particles become uniform and coincide with the direction of rotation of the rotor, as the particles are pulverized between the side faces of the rotating bits **23** and of the stationary teeth **27**. Some pulverizing also takes place between the serrated peripheries **20***a* of the spacer discs **20** and the serrated stepped edges **27***a* of the stationary teeth **27**, and between the serrated stepped edges **23***a* of the moving bits **23** and the serrated surface of the hinged plate **24***a*. Thus, a large pulverizing surface area is provided within a relatively small volume. The apparatus of the invention produces a high proportion of granular material as distinguished from "floury" material.

As the pulverized particles pass between the moving bits **23** and the stationary teeth **27** and are projected in directions generally tangential to the rotor assembly **4**, the larger particles are intercepted by three classifier plates **29** which cause the coarse material to be deflected into the outlet **5**, to provide the first of three sizes of product, as mentioned previously. The plates **29** are arranged side by side adjacent the downstream edge of the hinged plate **24***a*, and they are hinged on axes which are parallel to the rotor axis; their orientation is controlled by settings **30** (see FIG. **2**).

As the remaining particles are carried upwards by a flow of air created by the fan **7**, three stationary diverter plates **31** and an adjustable diverter plate **32** create turbulence in the airstream and cause an additional amount

of coarse material to drop to the outlet **5**. A curved grating **33** acts as a classifier by allowing the finest material to pass through it while deflecting coarse particles which either drop to the outlet **5** or are carried around by the rotor assembly **4** for re-grinding.

An adjustable vane **34** enables the terminal part of the air passage to be varied in size, thus to vary the characteristics of the air flow. The vane **34** in effect constitutes a fineness regulator, for varying the proportion of fine material (known in the art as "fines") carried over to the cyclones.

Air laden with fines passes into the first cyclone **8**, which is a conventional cyclone separator. The coarsest material remaining in the air flow is separated by centrifugal force and falls to the outlet at the bottom of the cyclone **8**; this is the second size of product. The remainder of the dust laden air passes by way of the connecting pipe to the second cyclone **9**, where the material is separated by centrifugal force and falls to the outlet at the bottom; this is the third size of product. Finally, dust free air is exhausted through an exhaust pipe to the atmosphere.

It will be understood that the form of the invention herewith shown and described is a preferred example of the same and that various changes in the shape, size and arrangement of the parts may be resorted to without departing from the spirit of the invention or the scope of the subjoined claims.

What I claim as my invention is:

1. A pulverizer comprising a casing including opposed side walls, a rotor extending transversely between the side walls and having spaced apart hammers projecting from its periphery, a pulverizer element positioned adjacent the rotor and extending between the side walls, the side walls with the pulverizer element and the periphery of the rotor together defining a passage which converges in a downstream direction relative to the direction of rotor rotation, the pulverizer element including a series of stepped crusher plates and another plate adjacent the downstream end thereof, and spaced apart teeth projecting from the other plate, the hammers of the rotating rotor meshing in the spaces between the teeth and the teeth correspondingly meshing in the spaces between the hammers.

2. A pulverizer comprising a casing including oppposed side walls, a rotor extending transversely between the side walls and having spaced apart hammers projecting from its periphery, a pulverizer element positioned adjacent the rotor and extending between the side walls, the side walls with the pulverizer element and the periphery of the rotor together defining a passage which converges in a downstream direction relative to the direction of rotor rotation, the pulverizer element including a series of stepped crusher plates and another plate adjacent the downstream and thereof, the other plate being hinged on an axis parallel with the rotor axis for limited pivotal movement so that the effective distance between the hinged plate and the periphery of the rotor may be varied, and spaced apart teeth projecting from the hinged plate, the hammers of the rotating rotor meshing in the spaces between the teeth and the teeth correspondingly meshing in the spaces between the hammers.

3. A pulverizer comprising a casing including opposed side walls, a rotor extending transversely between the side walls, the rotor including a plurality of spacer discs and hammers swingably mounted between the discs at one end about axes which are positioned in circular arrangements concentric with the axis of rotation of the rotor, the free ends of the hammers projecting beyond the peripheries of the discs, a pulverizer element positioned adjacent the rotor and extending between the side walls, the side walls with the pulverizer element and the periphery of the rotor together defining a passage which converges in a downstream direction relative to the direction of rotor rotation, the pulverizer element including a series of

stepped crusher plates and another plate adjacent the downstream end thereof, and spaced apart teeth projecting from the other plate, the hammers of the rotating rotor meshing in the spaces between the teeth and the teeth correspondingly meshing in the spaces between the hammers, the pulverizer element, the peripheries of the discs, the teeth and the free ends of the hammers being serrated.

4. A pulverizer comprising a casing including opposed side walls, a rotor extending transversely between the side walls and having spaced apart hammers projecting from its periphery, a pulverizer element positioned adjacent the rotor and extending between the side walls, the side walls with the pulverizer element and the periphery of the rotor together defining a passage which converges in a downstream direction relative to the direction of rotor rotation, the pulverizer element including a series of stepped crusher plates and another plate having a serrated surface and being adjacent the downstream end thereof, the other plate hinged on an axis parallel with the rotor axis for limited pivotal movement so that the effective distance between the hinged plate and the periphery of the rotor may be varied, and spaced apart teeth projecting from the hinged plate of the pulverizer element, the hammers of the rotating rotor meshing in the spaces between the teeth and the teeth correspondingly meshing in the spaces between the hammers.

5. A pulverizer comprising a casing including opposed side walls, a rotor extending transversely between the side walls and having spaced apart hammers projecting from its periphery, a pulverizer element positioned adjacent the rotor and extending between the side walls, the side walls with the pulverizer element and the periphery of the rotor together defining a passage which converges in a downstream direction relative to the direction of rotor rotation, the pulverizer element including a series of stepped crusher plates and another plate adjacent the downstream end thereof, the other plate being hinged on an axis parallel with the rotor axis for limited pivotal movement so that the effective distance between the hinged plate and the periphery of the rotor may be varied, the peripheral surface of the rotor and the surface of the hinged plate being serrated, and spaced apart teeth projecting from the hinged plate, the hammers of the rotating rotor meshing in the spaces between the teeth and the teeth correspondingly meshing in the spaces between the hammers.

6. A pulverizer comprising a casing including opposed side walls, a rotor extending transversely between the side walls and having spaced apart hammers projecting from its periphery, a pulverizer element positioned adjacent the rotor and extending between the side walls, the side walls with the pulverizer element and the periphery of the rotor together defining a passage which converges in a downstream direction relative to the direction of rotor rotation, the pulverizer element including stepped crusher plates having discontinuities in their surfaces and also including a plate which is hinged on an axis parallel with the rotor axis and adjacent the downstream edge of the crusher plates for limited pivotal movement so that the effective distance between the hinged plate and the periphery of the rotor may be varied, and spaced apart teeth projecting from the hinged plate of the pulverizer element, the hammers of the rotating rotor meshing in the spaces between the teeth and the teeth correspondingly meshing in the spaces between the hammers.

7. A pulverizer comprising a casing including opposed side walls, a rotor extending transversely between the side walls and having spaced apart hammers projecting from its periphery, a pulverizer element positioned adjacent the rotor and extending between the side walls, the side walls with the pulverizer element and the periphery of the rotor together defining a passage which converges in a downstream direction relative to the direction of rotor rotation, a hopper in registration with the upstream end of the passage, the pulverizer element including stepped crusher plates having discontinuities in their surfaces and also including a plate which is hinged on an axis parallel with the rotor axis and adjacent the downstream edge of the crusher plates for limited pivotal movement so that the effective distance between the hinged plate and the periphery of the rotor may be varied, and spaced apart teeth projecting from the hinged plate, the hammers of the rotating rotor meshing in the spaces between the teeth and the teeth correspondingly meshing in the spaces between the hammers.

8. A pulverizer comprising a casing including opposed side walls, a rotor extending transversely between the side walls and having spaced apart hammers projecting from its periphery, a pulverizer element positioned adjacent the rotor and extending between the side walls, the side walls with the pulverizer element and the periphery of the rotor together defining a passage which converges in a downstream direction relative to the direction of rotor rotation, the pulverizer element including stepped crusher plates having discontinuities in their surfaces and also including a plate which is hinged on an axis parallel with the rotor axis and adjacent the downstream edge of the crusher plates for limited pivotal movement so that the effective distance between the hinged plate and the periphery of the rotor may be varied, spaced apart teeth projecting from the hinged plate, the hammers of the rotating rotor meshing in the spaces between the teeth and the teeth correspondingly meshing in the spaces between the hammers, and a series of classifier plates arranged side by side adjacent the downstream edge of the hinged plate and being hinged on axes which are parallel to the rotor axis so that their orientation may be varied thus to vary the amounts of pulverized material which they deflect.

9. A pulverizer comprising a casing including opposed side walls, a rotor extending transversely between the side walls and having spaced apart hammers projecting from its periphery, a pulverizer element positioned adjacent the rotor and extending between the side walls, the side walls with the pulverizer element and the periphery of the rotor together defining a passage which converges downstream relative to the direction of rotor rotation, means to induce a flow of air through the passage, the pulverizer element including stepped crusher plates having discontinuities in their surfaces and also including a plate which is hinged on an axis parallel with the rotor axis and adjacent the downstream edge of the crusher plates for limited pivotal movement so that the effective distance between the hinged plate and the periphery of the rotor may be varied, spaced apart teeth projecting from the hinged plate, the hammers of the rotating rotor meshing in the spaces between the teeth and the teeth correspondingly meshing in the spaces between the hammers, a series of classifier plates arranged side by side adjacent the downstream edge of the hinged plate and being hinged on axis which are parallel to the rotor axis so that their orientation may be varied thus to vary the amounts of pulverized material which they deflect, and diverter plates downstream of the classifier plates to create turbulence in the flow of air through the passage.

10. A pulverizer comprising a casing including opposed side walls, a rotor extending transversely between the side walls, the rotor including a plurality of spacer discs and hammers swingably mounted between the discs at one end about axes which are positioned in circular arrangements concentric with the axis of rotation of the rotor, the free ends of the hammers projecting beyond the peripheries of the discs, a pulverizer element positioned adjacent the rotor and extending between the side walls, the side walls with the pulverizer element and the periphery of the rotor together defining a passage which converges downstream relative to the direction of rotor rotation, means to induce a flow of air through the pas-

sage, the pulverizer element including stepped crusher plates having discontinuities in their surfaces and also including a plate which is hinged on an axis parallel with the rotor axis and adjacent the downstream edge of the crusher plates for limited pivotal movement so that the effective distance between the hinged plate and the periphery of the rotor may be varied, spaced apart teeth projecting from the hinged plate, the hammers of the rotating rotor meshing in the spaces between the teeth and the teeth correspondingly meshing in the spaces between the hammers, the hinged plate, the peripheries of the discs, the teeth and the free ends of the hammers being serrated, a series of classifier plates arranged side by side adjacent the downstream edge of the hinged plate and being hinged on axes which are parallel to the rotor axis so that their orientation may be varied thus to vary

the amounts of pulverized material which they deflect, and diverter plates downstream of the classifier plates to create turbulence in the flow of air through the passage.

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