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MATERIAL PULVERIZATION

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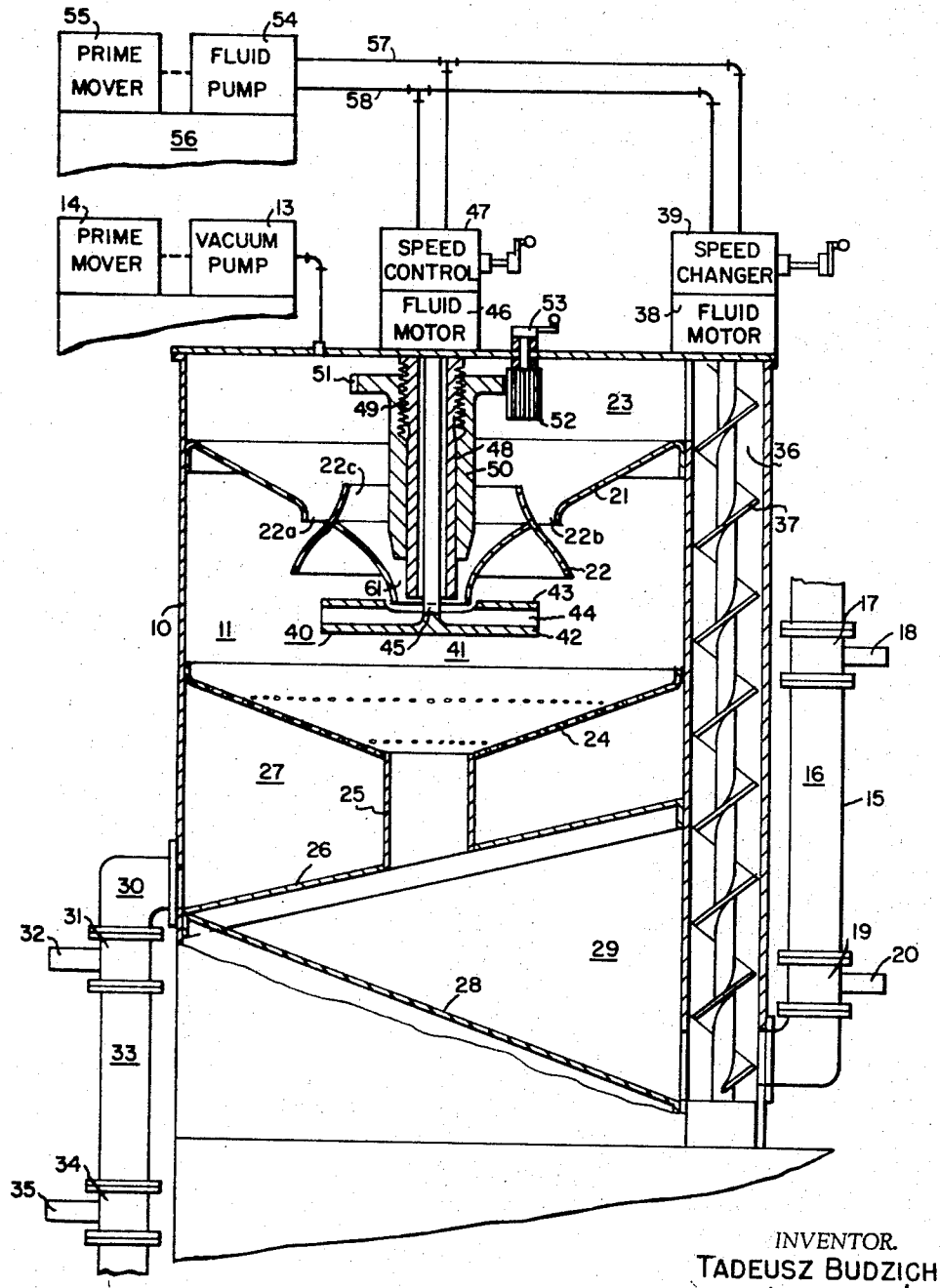

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MATERIAL PULVERIZATION

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ABSTRACT OF THE DISCLOSURE

A material pulverizing device and method for pulverizing material to an extremely small size wherein a vessel is provided which is maintained at a high vacuum. The vessel has a material feeding device which establishes an annular flowing screen of material. A rotary impeller is provided within the flowing screen of material which is adapted to radially discharge particles of material against the flowing screen of materials, thereby causing pulverization by the coaction of the material with itself to reduce lining wear. The high vacuum allows the extremely fine particles of material to obtain the sufficiently high velocity to cause pulverizing action.

This invention relates to machinery used in pulverizing comparatively coarse particles of materials like ores, pigments, metal and ceramic powders, into very fine powders.

As it is well known the prior art equipment and methods of obtaining very fine powders from hard materials are quite inefficient. The smaller the desired particle size, the disproportionally greater the power used in grinding and crushing of the material. Furthermore in the prior art methods the wear of surfaces used in crushing or grinding introduces into the powders large amounts of undesirable contaminants. These prior art methods also suffer from the additional disadvantage associated with flotation and settling problems of those particles in atmospheric air due to very low terminal velocities of the small particles.

It is therefore a principal object of this invention to provide a new and improved method and apparatus for pulverizing materials into very small particles.

Another more particular object of this invention is to provide a method and apparatus which by impact will pulverize materials into small particles in partial vacuums, where the velocity of the particle is not affected by air resistance.

Still another more particular object of this invention is to provide a method and apparatus which will pulverize materials preferably in partial vacuum, by impact between particles of the same material thus eliminating the contamination of the resulting powders.

Still a further more general object of this invention is to provide a method and apparatus which will, in a continuous cycle, produce a pulverizing effect by impacting particles of the material against each other.

Other objects and advantages of the present invention will become apparent from the following description, reference being had to the accompanying drawing showing clearly the preferred embodiment.

The single figure shows a somewhat schematic representation of the pulverizing machine of this invention with some of the components diagrammatically disposed for clarity of explanation.

Referring now to the drawing, the pulverizing apparatus of this invention includes a vessel or housing **10**, hermetically enclosing and defining an interior space **11**, from which, through conduit **12**, the air therein is evacuated by a conventional vacuum pump **13**, driven by an engine **14**. The vessel **10** is provided with coarse material feeding

mechanism, generally designated as **15**. The coarse material feeding mechanism **15** includes a material storing chamber **16**, which at one end has an inlet gate valve **17**, operated by an actuator **18**, and at its other end an outlet gate valve **19**, operated by an actuator **20**. The outlet gate valve **19** functionally separates the material storage chamber **16** from space **11**, enclosed within the vessel **10**.

An annular plate is provided within space **11** having an outer portion **21** secured to the vessel **10** and an inner portion **22** secured to the outer portion **21** by several webs one of which is shown and designated **22***a*. The annular space between the inner and outer portions **21** and **22** of the plate serves as a coarse particles feeding gap and is designated by reference character **22***b*. A plurality of guide vanes **22***c* are secured to the inner portion **22***a* of the plate and disposed in the gap **22***b*. The two portions **21** and **22** of the plate define a feeding zone **23** within the space **11**.

An annular screen **24**, and plates **25** and **26** are secured to the vessel **10** and define a fine material storage zone **27** within space **11**. A slanted bottom plate **28** is provided and a coarse material zone **29** is defined between plates **26** and **28** within space **11**.

The fine material storage zone **27** communicates through duct **30** with a fine material outlet gate valve **31**, operable by an actuator **32**. The outlet gate valve **31** is interposed between duct **30** and a fine material storage chamber **33**, which terminates in an outlet gate valve **34**, operable by an actuator **35**.

The coarse material zone **29** communicates with the feeding zone **23** through transfer duct **36**, housing a coarse material elevator **37** which takes the form of a worm screw feed. The coarse material elevator **37** is driven by a variable speed fluid motor **38**, equipped with a conventional speed changing mechanism **39**.

An impeller **40** is positioned in the space **11**. The impeller **40** includes a bottom plate **42**, a top plate **43**, guide vanes **44**, connecting plates **42** and **43** and a shaft **45** which is driven by a variable speed fluid motor **46**, equipped with a conventional speed control mechanism **47**. A shielding tube **48** is spaced circumferentially around shaft **45**, and is equipped with threaded portion **49** and is secured to the top of the vessel **10**. A feeding gap **61** is defined between the inner portion **22** of the plate and shielding tube **48**. A feed regulating sleeve **50** is provided, guided on the shielding tube **48** and threadably engages the threaded bore portion **49** thereof. The sleeve **50** is equipped with a gear **51**, which engages a gear pinion **52** rotatably mounted in respect to the top of vessel **10** and equipped with a crank **53**.

A variable fluid pump **54**, driven by an engine **55** and mounted on a reservoir **56**, is connected to the variable motors **46** and **38** by lines **57** and **58**.

Operation

The space **11** within the vessel **10** is maintained at a partial vacuum. The coarse material from coarse material zone **29** is elevated by the elevator **37** to the feeding zone **23**. There the coarse material, following the incline of the plate portion **21** is circumferentially fed into the coarse material feeding gap **22***b*. Under the force of gravity and being deflected and guided by guide vanes **22***c*, the coarse material forms a substantially continuously flowing cylindrical curtain, surrounding the impeller **40**. Although in the figure only one elevator **37** is shown a number of these elevators may be circumferentially spaced around the vessel **10** with appropriate modifications being made to the shape of the bottom plate **28**. The feeding rate of the elevators **37**, driven by variable fluid motors **38**, is selected so that it exceeds the flow capacity

of the feeding gap 22*b*. The coarse material accumulating in the feeding zone 23, overflows the guide vanes 22*c*, falling by the force of gravity through gap 61 into vanes 42 of impeller 40. The impeller 40, driven by the variable fluid motor 46, revolves at a high velocity and radially accelerates the coarse material particles. These coarse material particles, after attaining high velocity when leaving the impeller 40, impinge against the encircling curtain of the flowing coarse material, supplied from the feeding gap 22*b*. The kinetic energy of the material particles supplied from the impeller, on impact with the material particles forming the curtain, provide the pulverizing action, with the flowing curtain of the material effectively shielding the walls of the vessel 10 against wear. The coarse and pulverized material particles, in the continuously flowing curtain, drop on the inclined surface of screen 24 which may be vibrated to increase the screening efficiency by a suitable vibrating mechanism (not shown). The mixture of coarse and pulverized material, following the inclined surface of the screen 24, is passed to the coarse material zone 29, where it is continuously recirculated back to the feeding zone 23, by elevator 37. The pulverized material of desired size is passed through the screen 24 and by following the inclined plate 26 is passed to the fine material storage zone 27.

The rate of feed of the coarse material through gap 61 into the impeller 40 is regulated by the vertical position of the feed regulating sleeve 50. The position of the feed regulating sleeve 50 can be changed by rotation of pinion 52, which through gear 51 will advance or retract feed regulating sleeve 50 in respect to shielding tube 48 by the action of the threaded engagement.

When pulverizing very small particles, which attain a very low terminal velocity under ambient atmospheric pressure, the space 11, of the vessel 10, is maintained at higher vacuum by vacuum pump 13. In this way even extremely small particles, accelerated by the impeller, can impinge with the maximum velocity at the flowing surrounding curtain of the material. The fine material inlet gate valve 31 is normally left open until the storage chamber 33 becomes filled. Then the inlet gate valve 31 is closed and outlet gate valve 34 is opened to first raise the pressure in storage chamber 33 to atmospheric level and then to permit the discharge of the fine material into a suitable container.

The coarse material inlet gate valve 17 normally remains closed. When the addition of materials is desired, the chamber 16 is filled with coarse material and the gate valve 17 is closed. The valve 19 is then opened which will subject chamber 16 to vacuum and then permit the coarse material to be transferred, under force of gravity, to coarse material zone 29. Closing of the gate valve 19 and then opening of the gate valve 17 will at first introduce air at atmospheric pressure to material storing chamber 16 and then permit its filling with a new charge of the coarse material. The gate valves 17, 19, 31 and 34, operable by suitable actuators 18, 20, 32 and 35, can be synchronized so that discharge cycle of the pulverized material from the storage chamber 33 is automatically followed by feeding cycle of the coarse material from the storage chamber 16. The above cycle can be originated by a weight sensitive device, responsive to selected weight of the pulverized material in storage collecting in chamber 33, or other automatic synchronizing and cycling devices.

Since the magnitude of the pulverizing action depends upon the maximum velocity that the particle attains on leaving the impeller, which velocity in turn is proportional to the diameter and speed of rotation of impeller 40, the speed of rotation of the fluid motor 46, driving the impeller, is adjustable to adjust the speed of the impelled particles. By adjustment in rate of feed of the material to the impeller and adjustment of the speed of rotation of the impeller the power supplied to the pulverizing machine can be regulated for best pulverizing action when working with any specific type of material. At any selected speed of rotation of the impeller the rate of feed of the material into the impeller is directly proportional to the power used by the impeller. Since in a fluid motor at any selected motor speed the fluid pressure is proportional to the power developed by the fluid motor, rotation of the pinion 52 by a motor attached to crank 53 with its angular displacement proportional to pressure, well known in the art, will automatically maintain a desired rate of feed of the material into the impeller, to maintain a constant preselectable horsepower level used by the impeller.

While one embodiment of my invention has been shown and described, various other modifications and rearrangements may be resorted to by those skilled in the art without departing from the scope of the invention as defined in the appended claims.

What is claimed is:

1. Apparatus for pulverizing material comprising, vessel means defining a hermetically sealed internal chamber, energy imparting means disposed within said chamber to impart kinetic energy to a portion of the material particles contained within said chamber, means to provide a flowing screen of material particles intersecting the path of that portion of material having kinetic energy imparted thereto, means to produce a high vacuum within said chamber and prevent withdrawal of fine particles, whereby high terminal velocity of small particles from said energy imparting means can be attained within said chamber causing impact pulverization between said particles to obtain an extremely fine size.

2. The combination of claim 1 characterized by means to intermittently feed and discharge material to and from said vessel while continuing operation thereof.

3. The combination of claim 1 further characterized by means to separate particles of less than a given size and recirculate those greater than said given size.

4. The combination of claim 1 wherein said material supplied to the energy imparting means and to said means to provide said flowing screen are supplied from a common source.

5. Apparatus for pulverizing material comprising vessel means defining an internal chamber, energy imparting means disposed within said chamber to impact kinetic energy to a portion of the material particles contained within said chamber, means to provide a flowing screen of material particles intersecting the path of that portion of material having kinetic energy imparted thereto, means to feed said particles to said energy imparting means and said means to provide a flowing screen of particles including material flow priority means disposed to provide full material feed to the means to provide a screen material before material is supplied to said energy imparting means, whereby material particles emitted from said kinetic energy imparting means are always effectively shielded from the walls of said vessel.

6. The combination of claim 5 further characterized by said energy imparting means having means to vary the amount of kinetic energy supplied to the particles emitted from said kinetic energy imparting means.

7. The combination of claim 6 further characterized by means to vary the amount of material supplied to said energy imparting means whereby ratio of the material emitted from said energy imparting means and screen material can be varied.

8. Apparatus for pulverizing material comprising, vessel means, means to evacuate air from said vessel means, loading means disposed to introduce coarse material particles into said vessel means, unloading means disposed to extract fine material particles from said vessel means, kinetic energy imparting means disposed within said vessel means to impart kinetic energy to a portion of material particles within said vessel means, means to vary the speed imparted to the material by said kinetic energy imparting means, first material feeding means to supply material to said kinetic energy imparting means, first material flow regulating means in said first material feed

means, means to provide a flowing screen of material particles intersecting the path of that portion of material having kinetic energy imparted thereto, second material feeding means to supply material to said means to provide said flowing screen of material, second material flow regulating means in said second material feeding means, material flow priority means interposed between said first and second material feeding means to fully supply said second feeding means before supplying said first feeding means, means to maintain a high vacuum within said chamber, whereby high terminal velocity of small particles from said energy imparting means can be attained within said chamber causing impact pulverization between said particles to obtain an extremely fine size.

9. Apparatus for pulverizing material comprising, vessel means defining a hermetically sealed internal chamber, impeller means disposed within said vessel to impart kinetic energy to a portion of the particles within said vessel, aperture means disposed to provide a substantially continuous flowing screen of particles of the material on a path surrounding said impeller means and intersecting the path of said portion of the particles having kinetic energy imparted thereto, means to produce a high vacuum within said chamber and prevent withdrawal of fine particles, whereby high terminal velocity of small particles from said impeller means can be attained within said chamber causing impact pulverization between said particles to obtain an extremely fine size.

10. The combination of claim **9** further characterized by means to vary the speed of rotation of said impeller means.

11. The combination of claim **9** wherein said means to establish the flowing screen of material includes inclined plate means having aperture means therein.

12. The combination of claim **11** wherein the material is supplied from a single source to said impeller means and said aperture means by supply means and wherein said supply means is disposed to deliver the material to said aperture means prior to materials being delivered to said impeller means.

13. The combination of claim **12** further characterized by means to regulate the flow rate of material to said impeller.

14. The combination of claim **13** wherein said supply means includes worm screw feed means.

15. The combination of claim **14** further characterized by screen means disposed to screen and separate particles less than a given size.

16. The combination of claim **15** further characterized by means to intermittently supply and withdraw material to and from said vessel.

17. Apparatus for pulverizing material comprising, a vessel defining a hermetically sealed internal chamber, means to evacuate air from said vessel, loading means to introduce coarse material particles into said vessel, unloading means to extract fine material particles from said vessel, centrifugal impeller means within said vessel arranged to radially accelerate material particles, means to vary the rotational speed of said centrifugal impeller means, first material feeding means to supply material to said centrifugal impeller means, first material flow regulating means in said first material feed means, means arranged to provide a cylindrical flowing screen of particles of said material flowing under force of gravity and surrounding said centrifugal impeller means, second material feeding means to supply material to said means to supply said flowing screen of particles, second material flow regulating means in said second material feeding means, material flow priority means interposed between said first and second material feeding means, means to produce a high vacuum within said chamber and prevent withdrawal of fine particles, whereby high terminal velocity of small particules from said impeller means can be attained within said chamber causing impact pulverization between said particles to obtain an extremely fine size.

18. The method of pulverizing particles of material comprising the steps of first producing a high vacuum within a vessel and preventing withdrawal of fine particles, providing a first stream of particles having kinetic energy imparted thereto, and establishing a second flowing stream of said particles intersecting the path of said first stream of particles.

19. The method of claim **18** wherein said stream of particles is traveling on a radial path and said second stream is flowing in a generally annular pattern intersecting said first path.

20. The combination of claim **5** wherein said material flow priority establishing means includes vane means.

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