Feb. 24, 1948. D. V. SHERBAN 2,436,487

CLOSED-LOOP MATERIAL TRANSPORT SYSTEM, INCLUDING AN IN-CIRCUIT PULVERIZER

Filed Dec. 11, 1943 2 Sheets-Sheet 1

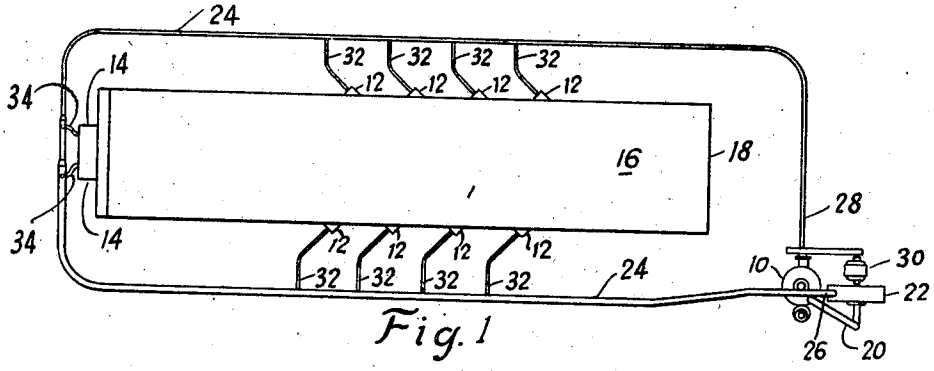

Fig. 1

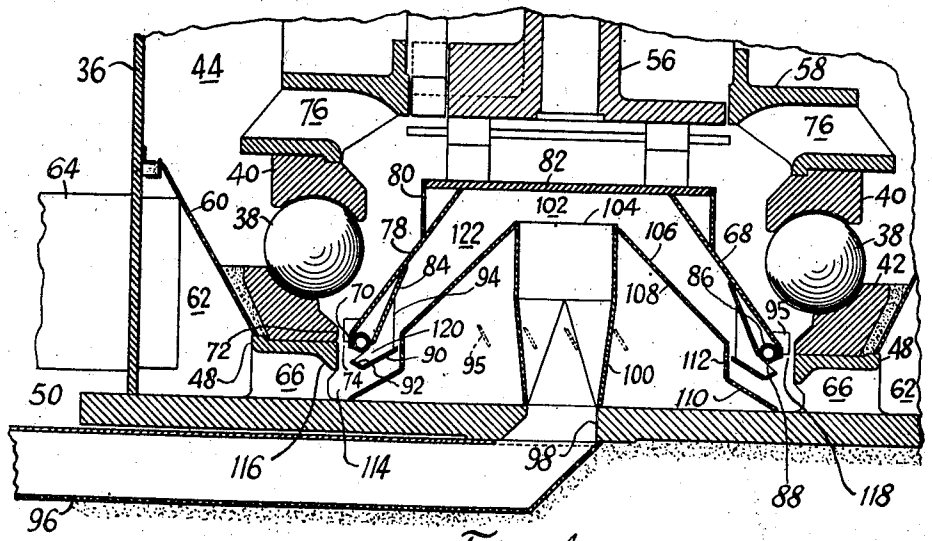

Fig. 4

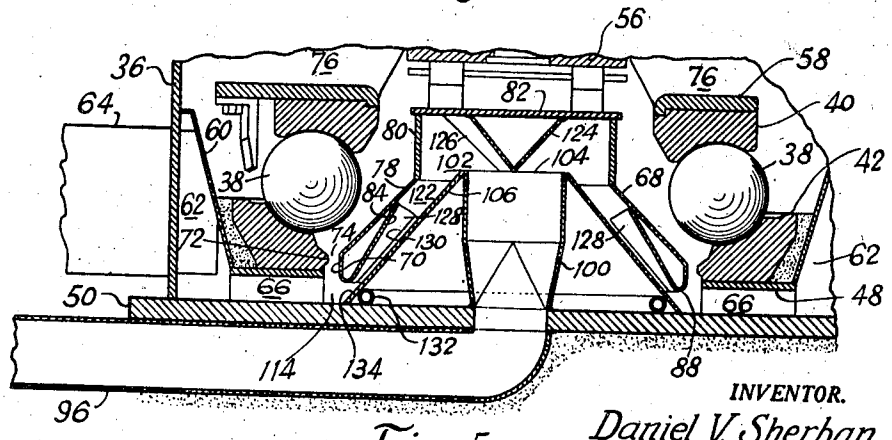

Fig. 5

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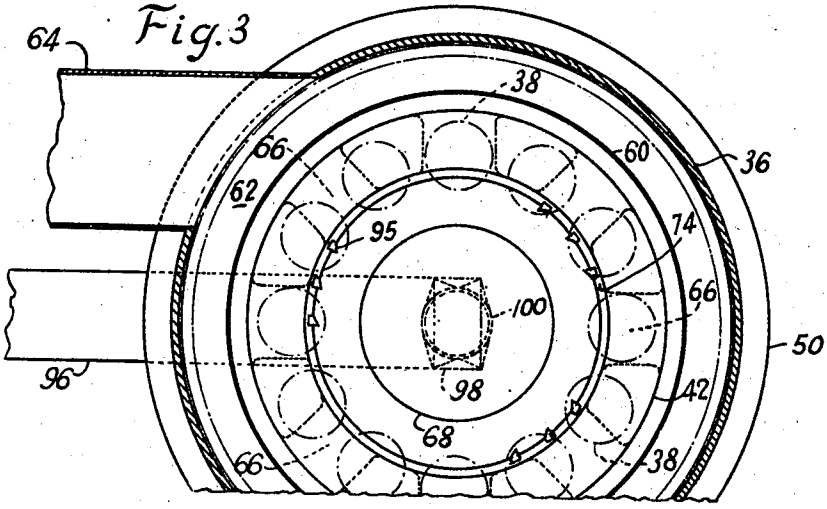
Filed Dec. 11, 1943 2 Sheets-Sheet 2

Fig. 3



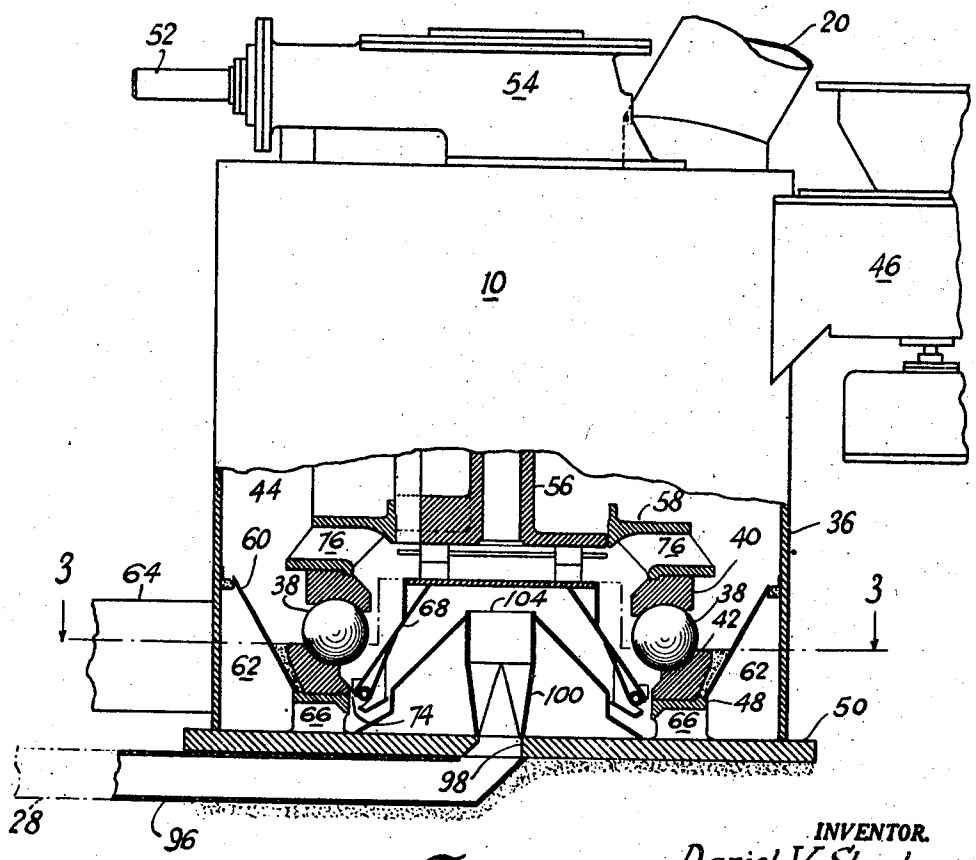


Fig. 2

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Patented Feb. 24, 1948 2,436,487

UNITED STATES PATENT OFFICE

2,436,487

CLOSED-LOOP MATERIAL TRANSPORT SYSTEM, INCLUDING AN IN-CIRCUIT PULVERIZER

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Application December 11, 1943, Serial No. 513,842

11 Claims. (Cl. 241—48)

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The invention herein disclosed relates to a pulverizing apparatus especially adapted for use in a system wherein pulverized products are transported from the apparatus by means of a current of air or other suitable gaseous carrier medium, and varying proportions of such products are returned to the apparatus for recycling. The apparatus and system will be found suitable for use with materials of various composition including, for example, such solids as coal, mineral ores, cement clinker, or other solids of similar physical characteristics.

The invention may be usefully applied in a pulverized fuel firing system wherein pulverized coal is discharged from the pulverizer or mill in a stream of carrier air, and the resulting fluent mixture delivered to a burner, or to a number of burners, with any surplus quantity of the mixture being returned to the mill to provide continuous circulation. In such a system, provision is made for feeding raw coal to the pulverizer at rates sufficient to replace the amounts taken by the burner or burners, and for supplying fresh or make-up air to the pulverizer at rates sufficient to maintain a current of air therethrough at all loads while providing an output mixture having the particular fuel-to-air ratio desired for any given load.

In certain types of pulverizers wherein grinding elements are relatively rotatable about a vertical axis, the coal and make-up air are conveniently supplied to the pulverizing zone from opposite sides, that is, the raw coal being fed from the upper side for discharge by gravity into the zone, and the fresh air being supplied from the under side for admission to the zone in an annular stream. Since the fuel-air mixture is fluent in character, any surplus of the mixture to be returned to the mill may be mingled with the incoming supply of make-up air, prior to admission of the air to the grinding zone, thereby producing a carrier medium of modified density which may be admitted to the grinding zone through the passage or passages normally provided for the fresh air alone.

Under normal operating conditions, the coal and air are supplied to the pulverizer in such proportions that the resulting output mixture contains a smaller quantity of air than is necessary for complete combustion; thus, the mixture with its normal content of primary air may be transported from the pulverizer without risk of premature combustion or explosion, and the required amount of secondary air may be added at the burners to provide a suitably combustible mixture.

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When a surplus of the mixture is returned to the pulverizer, as in the circulating system herein disclosed, the fuel and air content of the returning mixture remains essentially the same as when originally discharged from the pulverizer, a relatively high velocity of flow being maintained throughout the return conduit system to prevent any appreciable quantity of pulverized coal from settling out of the returning stream. When the return mixture and the make-up or primary air are combined for flow through the grinding zone, the proportion of air in the resulting mixture is appreciably higher than in the returning fuel air mixture, thereby tending to provide an atmosphere capable of supporting combustion of the entrained coal particles. It is considered important therefore to avoid any condition which might lead to ignition of such a mixture to cause a possible explosion, either through the coking of pulverized coal accumulations in or adjacent the zone of mixing, or as a result of hot coke particles being carried into the mixing zone and allowed to accumulate therein. When a heated supply of primary air is employed, the hazard of the mixture becoming ignited is somewhat increased, due to a certain amount of heat being retained in the returning coal-air mixture which would tend to promote coke formation.

It is a purpose of the invention therefore to maintain the fluid flow passages leading to the grinding zone clear of all coal or coke accumulations, and to cause the make-up air and the returning coal and air to be mixed in a zone where there is the least tendency for coal or coke to collect.

An additional object is to maintain velocities of fluid flow into the mixing zone high enough to keep the adjoining passages clear of any pulverized coal or coke that might tend to settle therein.

Another object is to cause the respective streams to enter the mixing zone in such directions and at such velocities as to promote thorough mingling of the streams throughout the zone.

A further object is to provide a mixing zone having an outlet direct to the grinding zone or adjoining region where the issuing stream will pick up additional coal particles, thereby increasing the proportion of coal to air in the mixture and providing a relatively non-explosive mixture for flow through and from the pulverizer,

the area of flow from the mixing zone into the grinding zone to be small enough to maintain flow velocities at least as high as the velocities prevailing within the mixing zone, and higher than the rate of flame propagation for the fuel-and-air mixture in transit at that location.

Among other objects, it is proposed to maintain the passages leading to and from the mixing zone clear of oversize particles or other foreign materials which might tend to obstruct the flow of air and pulverized coal.

More specific objects include the admission of coal-free air and coal-laden air to the pulverizer through concentrically arranged inlet areas; the mixing of both bodies of air in an annular zone closely adjacent the grinding zone; and the admission of the coal-laden air through an opening arranged out of the path of solids falling from the grinding zone.

The foregoing objects and others not specifically mentioned are more fully set forth in the description to follow, together with various advantageous features of construction as illustrated in the accompanying drawings, in which:

Fig. 1 is a layout, in plan, of a pulverized coal circulating system embodying apparatus of my invention;

Fig. 2 is an elevational view, partly in section, of the pulverizer included in the system of Fig. 1;

Fig. 3 is a plan section of the pulverizer, taken along line 3—3 of Fig. 2;

Fig. 4 is an enlarged fragment of Fig. 2;

Fig. 5 is an enlarged fragmentary section, similar to Fig. 4, showing a modification.

The system according to Fig. 1 of the drawings, includes an air swept pulverizer 10 arranged to supply pulverized coal and primary air to burners 12 and 14 associated with a form of metallurgical furnace 16, here indicated as a billet heating furnace, although as will be understood, other types of furnaces may be employed and, if desired, the burners arranged for firing separate furnaces.

The pulverizer 10 is shown as being located adjacent the charging end 18 of the furnace 16 and its output of pulverized coal and primary air is discharged through pipe 20 to the inlet of an exhauster fan 22 from which the mixture is delivered to a main distributor conduit 24 at its inlet end 26, the opposite end or return length 28 of the conduit being connected to the air inlet side of the pulverizer to form a closed circuit or loop as will be explained more in detail hereinafter. The pulverizer and fan are conveniently operated by a single motor 30.

The loop conduit 24 is tapped at successive positions along its length to supply a mixture of pulverized coal and air to any one of the burners, or group of burners, that it may be desired to maintain in operation; the burners 12 along one side of the furnace being supplied through burner lines 32 leading from the conduit 24, the larger burners 14 at the discharging end of the furnace remote from the location of the pulverizer being supplied through burner lines 34, and the remaining side burners 12 through additional burner lines 32. Suitable valves, not shown, may be installed in each of the burner lines 32 and 34 to positively cut off the supply of fuel and primary air to any burner not in operation, and to regulate the supply of fuel to the various burners during operation. Any surplus quantity of the total pulverizer output above that diverted to the burner or burners in operation is returned to the inlet side of the pulverizer 10 for recycling in view of the looped arrangement of the conduit 24 which provides a closed circulatory system. A secondary supply of air may be admitted to the burners or to the furnace or furnaces for complete combustion of the fuel, but the details of such secondary supply are not included in the present invention, and further disclosure is therefore considered unnecessary.

The references to coal as the material being pulverized, and to air as the carrier medium, are not to be taken literally, but are to be interpreted as embracing other solids, combustible or otherwise, and other gaseous media, capable of adaptation to the system described. In a broad sense, also, the burners 12 and 14 become selected points of delivery or use, for example, bins or other containers, irrespective of whether the material transported is a fuel or is a material of non-combustible character.

Referring to Fig. 2, the pulverizer 10, is by way of example, of a known ball-mill type having its grinding zone located in the lower portion of an enclosing casing or housing 36 generally circular in cross-section about a vertical axis. The grinding elements include a circular series of grinding balls 38 which cooperate with upper and lower grinding rings 40 and 42 respectively to reduce the coal to the desired degree of fineness; the raw coal being delivered to the pulverizing chamber 44 above the level of the grinding rings by means of a known type of motor driven feeder 46 mounted on the pulverizer casing 36.

In this form of pulverizer, the lower grinding ring 42 is maintained stationary, being mounted on an annular support 48 integral with the base plate 50 which forms the bottom wall of the casing or housing 36. The upper grinding ring 40, concentric with the lower grinding ring 42, is rotated about its central vertical axis to cause the balls 38 to roll relative to both grinding rings; the upper grinding ring 40 being driven by motor 30 operating through pinion shaft 52 and suitable gearing within housing 54 to rotate the drive member 56 and drive ring 58. Grinding pressure between the balls and rings may be resiliently and adjustably maintained by means well known in the art.

A conical wall 60 surrounding the lower grinding ring 42 and flaring upwardly toward the casing 36 serves to guide the incoming raw coal into the zone of action of the balls 38; the wall 60 extending upwardly from the annular support 48 to define an annular compartment 62 in which fresh make-up air is admitted through conduit 64 and from which such air is discharged inwardly through a series of circumferentially spaced ports 66 in the annular support 48. The air admitted through conduit 64 may be heated or unheated, as desired, and the conduit fitted with the usual regulating damper or dampers, as desired.

A downwardly flaring cup-like member 68, rotatable with the drive member 56 and constituting in effect an integral extension thereof, terminates in a cylindrical outer surface portion 70 adjacent its lower edge at a level corresponding to the reduced inner edge portion 72 of the lower grinding ring 42, thereby forming a relatively narrow annular passage or throat 74 through which carrier air is admitted to the grinding zone above. The coal is fed to the region exteriorly of the circle of balls 38 and as the coal becomes pulverized, the particles are swept upwardly by the stream of carrier fluid admitted to the grinding zone through the throat 74, the majority of the pulverized particles being carried upwardly

in the region interiorly of the circle and discharged laterally through a circumferential series of ports 76 in the drive ring 58. The finer particles continue upwardly through the chamber 44 and are discharged from the pulverizer through the outlet 20, while the coarser particles drop out of the current and are returned to the pulverizing zone for further reduction.

The extension member 68, as shown, comprises an assembly of plate members including, for example, a downwardly flaring conical side wall plate 78, a cylindrical upper side wall plate 80, and a circular top or closure plate 82. A conical plate 84 arranged inwardly of the conical plate 78 and diverging downwardly therefrom provides an effective thickness for the lower side wall portion of member 68 of gradually increasing cross section toward the bottom; a pipe 86 formed as a ring being positioned between the downwardly diverging plates 78 and 84 and being welded to their lower edges to afford rigidity to the assembly and to provide a rounded bottom edge or rim 88. A downwardly flaring conical plate 90 having an upturned circumferential lip portion 92 is positioned below the rim 88, being secured to the inner plate 84, for example, by means of circumferentially spaced ribs 94.

The member 68 is provided exteriorly with a series of circumferentially spaced vanes 95 adjacent its lower edge, such vanes extending downwardly to provide portions within the throat 74 and serving to maintain the throat area clear of coarse, heavy particles of material that might interfere with free fluid flow therethrough; the vanes 95 being inclined to the vertical at an angle of about forty-five degrees, the direction of inclination being determined by the direction of rotation of the member 68 which for the structure illustrated will be assumed to be clockwise.

The surplus fuel-air mixture returned to the pulverizer through conduit length 28 is delivered through a rectangular continuation section 96 to a rectangular opening 98 in the base plate 50, formed symmetrically about the axis of rotation of the cup-like member 68. A vertically disposed conduit section 100 extends from the base plate opening 98 into the upper portion of the space 102 interiorly of the member 68, the section 100 terminating in an open upper end 104 of circular cross section constituting the area of admission for the returned fuel and air at a level above the throat 74. A downwardly flaring conical member 106 extends from the upper end 104 of the conduit section 100 to the base plate 50, the member 106 being formed of upper and lower conical portions 108 and 110 joined by an intermediate cylindrical portion 112 to provide an outer wall surface of stepped formation; the cylindrical portion 112 being disposed at the level of the conical plate 90, and being of a diameter slightly less than the inner edge of the plate 90 to provide an annular clearance space of suitable width for relative rotation.

In the operation of the system described, the supply of make-up air admitted to the pulverizer through conduit 64 is distributed throughout the annular compartment 62 from which it is directed through the circumferentially spaced ports 66 to the annular space 114 disposed between the ring support 48 and the conical baffle member 106, the upper wall of each port 66 being inclined downwardly at its inner end, as at 116, to afford entrance to the space 114 at a level below the outer edge of plate 90. The air then passes upwardly to the annular zone 118 immediately

below the throat 74 where it is mingled with fluid entering from the passage 120 formed between the rim 88 and plate 90 of the rotating member 68, the mixture of the two bodies of fluid then passing upwardly through the throat 74 and grinding zone above.

The stream of coal and air returned to the pulverizer by means of conduit sections 96 and 100 is caused to flow upwardly to enter the space 102 centrally of the rotating member 68, whereupon the direction of its flow is reversed and the stream converted to one of annular form directed downwardly through the passage 122 between the conical side wall portions of the rotating member 68 and the stationary member 106. The downward flow of the returned fuel and air is continued through the annular passage 120 where the stream is deflected upwardly by the lip 92 into impingement with the upwardly flowing stream of make-up air within the mixing zone 118.

In this arrangement of pulverizer, the central inlet 104 for the returning fuel-and-air mixture is above the level of the throat 74 and therefore out of the path of any material such as pyrites or other coarse, heavy particles that might fall through the throat and interfere with normal fluid flow conditions in the fluid circulation system. Such an arrangement is particularly desirable in circulation systems wherein a measure of fluid flow conditions is utilized in the automatic control of the feed of raw material to the pulverizer. It will be noted that the distance between the side walls 78, 84 and 108, 90 is progressively decreased as the diameter of the passages 122 and 120 is increased, thereby maintaining a substantially constant flow area and a relatively high velocity of flow throughout, the velocity of discharge through the outlet passage 120 being sufficient to effect thorough mingling of the coal-laden air with the coal-free air within the annular zone 118. The two bodies of air of different densities thus delivered to the zone 118 are combined to form a fluid mixture of modified density in which the solid particles are substantially uniformly distributed throughout and in which under certain conditions the air content may be sufficient to provide an explosive mixture. The hazard of a fire or an explosion of the mixture is substantially eliminated however by effecting the mixture of the two bodies in a zone of high fluid flow velocities where there is the least tendency for coke to collect, and where velocities are preferably higher than the rate of flame propagation for the fuel and air mixture in transit; in the embodiment disclosed, the mixing being effected in an annular zone of restricted dimensions closely adjacent the pulverizer throat 74 where velocities are maximum, in practice, a suitable mixing level being at a distance below the throat 74 of approximately two times the width of the throat or corresponding passage where maximum velocities are initiated, such velocities being maintained into the grinding zone or adjacent region where additional fuel particles are immediately picked up to restore the normal fuel content and thereby render the mixture relatively non-explosive for discharge from the pulverizer. The downward flow of fluid at high velocity through the passages 122 and 120 also serves to overcome any tendency for coal to work up toward and into the inlet opening 104.

In Fig. 5, showing a modification, parts corresponding to those included in Fig. 4 are identified by the same reference characters. In this embodiment of the invention, the inner conical wall

84 of the rotatable member 68 is formed as an integral extension of the outer wall 78, thereby dispensing with the pipe ring 86 while providing the rounded lower edge or rim 88 as previously described. A distributing cone 124 having its apex centrally of the circular inlet opening 104 is attached to the top plate 82 of member 68 to facilitate mushrooming of the upflowing central stream and provide an annular stream of substantially uniform density for flow into the surrounding passage 122. An impeller 126, or a plurality, if desired, extending outwardly from the cone 124 and attached thereto, may be employed to further improve distribution, and to assist in overcoming a part of the entrance pressure drop. Blades 128, circumferentially spaced and secured to the inner side wall portion 84 of member 68, tend to further induce air flow and prevent coal from working up toward the inlet 104, particularly when the amount of coal in the mill is above normal; the blades 123 being pitched forwardly and having their free edges 130 closely adjacent and substantially parallel to the outer surface of the stationary cone 106 whose slope, in this form, is continuous from the rim of the inlet opening 104 to the base plate 50. A manifold 132, in the form of a ring and provided with openings 134 about its circumference, may be suitably connected to a source of high pressure air or other fluid for the purpose of clearing the space 114 of pyrites or other debris that might have accumulated, the openings 134 registering with corresponding openings in the cone 106 to provide jets directed toward the ports 66 so that the obstructing material may be dislodged and forced into the chamber 62 from which it may be readily removed.

I claim:

1. In a pulverizer having grinding elements in the lower portion of an enclosing housing, said housing having an outlet leading from its upper portion, said elements comprising a member formed with a grinding surface arranged annularly about a vertical axis and a circle of grinding members arranged coaxially with said surface and adapted to cooperate therewith for pulverizing material fed into said housing at a location above said grinding elements, means forming an annular throat concentric with and adjacent a circumference of said annular grinding surface, means for causing a stream of carrier air to flow upwardly through said throat for transporting pulverized material particles to and through said outlet, means for admitting a portion of said carrier air to a zone within said housing displaced inwardly and upwardly from the entrance to said annular throat, means for directing said portion to a surrounding annular zone below and adjacent said throat, means for separately admitting another portion of said carrier air to said annular zone, means for causing said portions to become mingled within said annular zone, and means for directing said mingled portions upwardly through said throat to provide said stream of carrier air.

2. In an air swept pulverizer adapted for inclusion in a circulation system such as described, means forming a grinding zone in the lower portion of the pulverizer housing, said means including a ring member having an annular grinding surface formed about a vertical axis and spaced above the inside bottom wall of said housing, means including a downwardly expanding conical baffle for defining an annular throat adjacent the inner circumference of said grinding member, said baffle terminating in a lower rim portion forming the inner circumferential boundary of said throat, means for admitting material-laden air to said pulverizer comprising a conduit arranged centrally of said conical baffle and extending upwardly therein beyond the level of said lower rim portion and throat, a conical baffle coaxial with said conduit and sloping downwardly therefrom to the base of said housing to define an annular space below and adjacent said throat, said baffles being spaced throughout to form an annular passage for conducting material-laden air from said conduit to said annular space, a support for said ring member formed with a series of circumferentially spaced ports for directing material-free air to said annular space, means for causing said streams of air to be mixed within said annular space at a location closely adjacent said throat, and means for causing the resulting mixture to flow upwardly through said throat into said grinding zone.

3. In an air swept pulverizer adapted for inclusion in a circulation system such as described, upper and lower grinding rings together with an intermediate circle of rollable grinding elements cooperating therewith to form an annular grinding zone within the lower portion of the pulverizer housing, means including a downwardly expanding conical baffle for defining an annular throat adjacent the inner circumference of said lower grinding ring, said baffle terminating in a lower rim portion forming the inner circumferential boundary of said throat, means for admitting material-laden air to said pulverizer comprising a conduit arranged centrally of said conical baffle and extending upwardly therein beyond the level of said lower rim portion and throat, a conical baffle coaxial with said conduit and sloping downwardly from the upper end thereof to the base of said housing to define an annular space below and adjacent said throat, said conical baffles being spaced throughout to form an annular passage for conducting material-laden air from said conduit to said annular space, said first named baffle having a conical inner surface portion diverging downwardly from a conical outer surface portion to provide an effective wall thickness progressively greater towards its lower edge thereby progressively decreasing the distance between said baffles at increasing diameters to provide a relatively high velocity of discharge of material-laden air into said annular space, means for separately directing material-free air into said annular space and causing said air to become mingled with said material-laden air within said space, and means for inducing upward flow of the resulting material and air mixture through said throat.

4. In an air swept pulverizer adapted for inclusion in a circulating system such as described, upper and lower grinding rings together with an intermediate circle of rollable grinding elements cooperating therewith to form an annular grinding zone within the lower portion of the pulverizer housing, means for admitting material-laden air to said pulverizer comprising a conduit arranged centrally of said grinding zone and terminating in an open upper end at approximately the level of said circle of grinding elements, means for directing said material-laden air from the upper end of said conduit to an annular mixing zone below and adjacent said grinding zone, said last named means comprising a downwardly flaring conical baffle disposed over the upper open end of said conduit and terminating in a lower rim portion defining an annular throat adjacent

the inner circumference of said lower grinding ring, said baffle forming the outer wall of an annular passage for said downwardly directed material-laden air and having impeller means thereon for inducing a downward current of flow through said passage, means for mixing an additional supply of air with said material-laden air in said mixing zone, and means for causing the resulting modified mixture to flow upwardly through said throat.

5. In an air swept pulverizer adapted for inclusion in a circulation system such as described, upper and lower grinding rings together with an intermediate circle of rollable grinding elements cooperating therewith to form an annular grinding zone within the lower portion of the pulverizer housing, means for admitting material-laden air to said pulverizer comprising a conduit arranged centrally of said grinding zone and terminating in an open upper end at approximately the level of said circle of grinding elements, means for directing said material-laden air from the upper end of said conduit to an annular mixing zone below and adjacent said grinding zone, said last named means comprising a downwardly flaring conical baffle disposed over the upper open end of said conduit and terminating in a lower rim portion defining an annular throat adjacent the inner circumference of said lower grinding ring, said baffle including a top portion formed as a cone having its apex pointed downwardly toward the open end of said conduit, means for mixing an additional supply of air with said material-laden air in said mixing zone, and means for causing the resulting modified mixture to flow upwardly through said throat.

6. In a closed circulating system of the type described, an air swept pulverizer having a normal output of pulverized combustible material and air in a ratio providing a substantially non-explosive mixture, said pulverizer having a grinding zone within an enclosing housing having an outlet at one side of said zone through which said mixture is discharged, means defining said grinding zone comprising a member providing an annular grinding surface having an inlet and an outlet marginal circumference, means at the side toward said outlet feeding combustible material to said grinding zone adjacent said inlet circumference, means for returning to said pulverizer a portion of said output mixture composed of pulverized combustible material and air in substantially the aforesaid ratio, said last named means being arranged to direct said portion to an annular mixing space disposed adjacent the side of said grinding zone remote from said outlet, said mixing space terminating in an annular outlet passage of restricted flow area adjacent said outlet circumference, means for supplying material-free carrier air to said pulverizer arranged to direct said air into said mixing space thereby combining said material-free air with the combustible-material-laden air returned from said outlet and producing a modified mixture of potential explosive character, means for causing said modified mixture to flow through said outlet passage for transporting pulverized combustible material from said grinding zone to provide said normal output mixture, and means for maintaining the velocity of flow of said modified mixture within and from said mixing space higher than the rate of flame propagation of said mixture as produced in said space.

7. In a closed circulating system of the type described, an air swept pulverizer having a normal output of pulverized combustible material and air in a ratio providing a substantially non-explosive mixture, said pulverizer having an annular grinding zone formed about a vertical axis within the enclosing pulverizer housing, said housing having an outlet at the upper side of said zone through which said mixture is discharged, means defining said grinding zone comprising a member providing an annular grinding surface between an inner and an outer marginal circumference disposed at different radial distances from said axis, means feeding combustible material to the upper side of said grinding zone adjacent said outer circumference, means for returning to said pulverizer a portion of said output mixture composed of pulverized combustible material and air in substantially the aforesaid ratio, said last named means being arranged to direct said portion to an annular mixing space disposed adjacent the lower side of said grinding zone, said mixing space terminating in an annular outlet passage of restricted flow area adjacent said inner circumference, means for supplying material-free carrier air to said pulverizer arranged to direct said air into said mixing space thereby combining said material-free air with the combustible-material-laden air returned from said outlet and producing a modified mixture of potential explosive character, means for causing said modified mixture to flow through said outlet passage for transporting pulverized combustible material from said grinding zone to provide said normal output mixture, and means for maintaining the velocity of flow of said modified mixture within and from said mixing space higher than the rate of flame propagation of said mixture as produced in said space.

8. In a pulverizer adapted for inclusion in a circulating system such as described, said pulverizer having a grinding zone of annular formation about a vertical axis, said housing having an outlet therefrom at the upper side of said grinding zone, means defining said grinding zone comprising a ring member concentric with respect to said axis and providing an annular grinding surface between an inlet and an outlet marginal circumference each disposed at a different radial distance from said axis, means feeding coal to the upper side of said grinding zone adjacent said inlet circumference, means forming an annular throat concentric with and adjacent said outlet circumference, means for causing a stream of carrier air to flow upwardly through said throat for transporting pulverized coal to and through said outlet, means for admitting a portion of said carrier air to a zone within said housing displaced radially and upwardly from the entrance to said annular throat, means for directing said portion to an annular mixing zone below and adjacent said throat, means for combining an additional carrier air portion with said first named portion within said mixing zone, said carrier air portions consisting of coal-free and coal-laden air respectively, and means for effecting flow of said respective carrier air portions into said mixing zone and of said combined portions within and from said zone at velocities high enough to maintain the associated flow passages clear of coke accumulations.

9. In an air swept pulverizer adapted for inclusion in a closed circulating system of the type disclosed, said pulverizer having grinding elements in the lower portion of an enclosing hous-

ing, said housing having an outlet leading from its upper portion, said elements comprising a member formed with a grinding surface arranged annularly about a vertical axis between an inner and an outer marginal circumference each at a different radial distance from said axis, means defining an annular throat adjacent said inner circumference, means defining an annular space below and adjoining said throat, means for directing separate bodies of air into said space in streams distributed substantially throughout its circumference, one of said bodies of air comprising a material-laden portion of the total pulverizer output and one substantially clean air from a separate source, means for causing one of said bodies of air to flow outwardly from said axis to enter said space, means for causing the other of said bodies to flow inwardly toward said axis to enter said space to effect a mixture with said oppositely entering body of air, and fan means causing upward flow of said mixture into and through said throat.

10. In a pulverizer having grinding elements in the lower portion of an enclosing housing, said housing having an outlet leading from its upper portion, said elements including a member formed with a grinding surface arranged annularly about a vertical axis between a material inlet circumference and a material outlet circumference disposed at different radial spacings from said axis, means forming an annular throat adjacent said outlet circumference means for causing air to flow through said throat for transporting particles of pulverized material to and through said outlet, means for admitting said air to said pulverizer in separate streams of which one stream is composed of relatively clean air and another is composed of air in which pulverized material particles are suspended, said streams being admitted to the interior of said housing in concentric relation relative to said vertical axis, means defining an annular space in the region below and adjacent said throat, means for causing said streams to become mingled in said annular space, and means for directing the resulting mixture upwardly through said throat.

11. In an air swept pulverizer adapted for inclusion in a circulation system such as described, means forming an annular grinding zone within the lower portion of the enclosing pulverizer housing, means including a downwardly expanding bell-shaped member for defining an annular throat adjacent the inner periphery of said grinding zone, said member terminating in a rounded lower rim portion forming the inner circumferential boundary of said throat, means for supplying fluid streams of different densities to said pulverizer for subsequent mingling and flow through said throat, means for admitting one of said streams to the interior of said pulverizer comprising a pipe arranged centrally of said bell-shaped member and extending upwardly therein beyond the level of said lower rim portion and throat, means for admitting the other of said streams to the interior of said pulverizer annularly of said upwardly extending pipe, means for reversing the flow of said first named stream to form an annular stream flowing downwardly adjacent the interior wall of said bell-shaped member toward an annular zone below and adjacent said throat, a deflector ring surrounding said pipe having an upper surface portion formed to deflect said downwardly flowing stream into mixing relation with the other of said streams in said zone, and means for causing the resulting mixture to flow upwardly through said throat.

DANIEL V. SHERBAN.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,778,755	De Wolf	Oct. 21, 1930
684,152	Wheildon	Oct. 8, 1901
2,403,976	Harvey	July 16, 1946
2,071,380	Bailey et al.	Feb. 23, 1937

FOREIGN PATENTS

Number	Country	Date
547,500	France	Sept. 23, 1922
362,491	Great Britain	Dec. 2, 1931
154,112	Germany	Aug. 6, 1904