The present invention relates to feeders for regulating the discharge of finely divided material, such as pulverized coal or other materials in pulverulent form, from a storage space to a point of use.

Feeders for pulverulent material heretofore in use have not been satisfactory, particularly in installations in which the material is mixed with a gaseous carrier medium, such as air, in that a uniform rate of material discharge has usually been difficult to secure and tends to become more difficult with wear of the feeder parts. The capacity characteristics of such feeders are also subject to rather wide variation with the density of the material in the supply bin.

Pulverized coal stored in a bin for even a short time is subject to a settling action which often results in the formation of coherent masses of pulverized coal. The carrier air receiving the stored pulverized coal from a feeder often entrains these masses and their presence is evidenced by "snow balling" in the burning fuel and air mixture.

Variation in density of stored pulverized material causes a feeder to operate under a variable pressure and this results in a variation in the weight of material discharged through a volume controlling device, such as a feeder wheel or orifice, and a resultant variation in the density of the final mixture of pulverized material and gaseous carrier medium.

Ineffective control and a non-uniform pulverized coal and air mixture have been found particularly disadvantageous in connection with high capacity pulverized coal-fired furnaces requiring a continuous supply of finely pulverized coal uniformly distributed in the carrier or primary air and it is in this field that the present invention finds one of its most effective applications.

The primary object of the invention is the provision of an aerating feeder for delivering pulverized material from a storage space to a point of use in a uniform controllable mixture of pulverized material and gaseous carrier medium. A further object is the provision of a pulverized material feeder capable of discharging a regulable stream of pulverized material and carrier medium of substantially predetermined density over a wide range of discharge capacity. Another object is the provision of feeder apparatus which will so process and handle pulverulent material from a storage container that any coherent masses therein will be disintegrated before discharge from the feeder. Another object is the provision of feeder apparatus in which close clearances between relatively movable parts are avoided so that wear is kept at a minimum and changes in rated capacity due to wear thereby avoided. Another object is to provide a feeder which can be built in relatively low capacity sizes and yet retain its advantageous characteristics of good regulable control. Another object is the provision of an aerating feeder which provides for a recirculation of pulverized coal through the storage container thereby assisting in maintaining the pulverized coal therein in a non-compacted fluid condition.

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

Of the drawings:

Fig. 1 is a sectional elevation of a storage receptacle and aerating feeder constructed in accordance with the invention and taken on the line 1—1 of Fig. 3;

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

Fig. 3 is a horizontal section taken on the line 3—3 of Fig. 1;

Fig. 4 is an elevation partly in section of another embodiment of the invention;

Fig. 5 is a horizontal section taken on the line 5—5 of Fig. 4;

Fig. 6 is a side view partly in section of the apparatus shown in Fig. 4;

Fig. 7 is an enlarged view of the lower portion of the feeder apparatus shown in Fig. 6;

Fig. 8 is an elevation partly in section of another embodiment of the invention;

Fig. 9 is a plan view of the apparatus shown in Fig. 8;

Fig. 10 is a partial side elevation of the Fig. 8 embodiment, showing the driving connections for the aerating feeder shaft (133, and

Fig. 11 is a detail view showing the bevel gears for driving the aerating feeder shaft.

One field of use of the aerating feeder of this invention is in feeding pulverized coal to pulverized coal burners for firing furnaces. Because of its advantageous feeding characteristics it is well adapted for use in pulverized coal firing installations wherein the feeder is used in con-
junction with an air swept pulverizer. In installa-
tions of this type the feeder receives and stores pulverized coal from the operation of the
pulverizer, and when the pulverizer is idle at low furnace ratings or at some particular predeter-
mined furnace rating, the feeder will be operative
on a feed of stored pulverized coal to deliver pul-
verized coal to the furnace. As an alternative
operating procedure, the feeder can be operated
simultaneously with the pulverizer to fire the
furnace.

An example of this type of application is
shown in the embodiment of the invention illus-
trated in Figs. 1 to 3, wherein the aerating feeder
is positioned in the upper portion of a cylindrical
receptacle 10, the lower portion of which serves
as a storage space for pulverized coal. Airborne
pulverized coal from an air swept pulverizer (not
shown) is introduced into the upper part of the
receptacle through a plurality of tangentially ar-
ranged pipes 11, arranged in pairs at circumfer-
entially spaced positions. The tangential intro-
duction and angular flow of the high velocity
streams effects a centrifugal separation of pul-
verized coal particles and carrier air with the
separated coal dropping to the lower part of the
receptacle 10 which acts as a coal storage reser-
voir, while the separated air is vented from the
upper portion of the receptacle for disposal as
hereinafter described. The diameter of the re-
ceptacle 10 is selected for the desired degree
of centrifugal separation and the vertical dimension
of the receptacle is selected to provide an ade-
quately separating space above the maximum
operating level of separated coal in the lower
portion.

An axially arranged shaft 12 mounted in bear-
ings 13 and 14 in the base and top plates 15 and 16
respectively of the receptacle has its upper end
connected into a gear reducer unit 17 on the top
plate. A pair of agitator blades 18 are attached
to the shaft 12 and on rotation assist the move-
ment of pulverized coal within the receptacle 10
toward the lower end of an elevating screw con-
voyer 19 also mounted on the shaft. The elevat-
ing conveyor 19 operates within a tubular casing
20 open at its lower end to receive pulverized coal
from the reservoir space and at its upper end
to discharge pulverized coal into an chamber 21
defined by a cylindrical casing 22.

The chamber 21 is centrally located in the
upper portion of the receptacle 10, the casing 22
being supported from the top plate 16. The top
of the chamber is connected by outlet pipes 23 to
corresponding pulverized coal burners (not
shown). A horizontally arranged bottom port
plate 24 encircles the upper end of the conveyor
casing 20 and is provided with two circular con-
centrally arranged annular ports 25 having
upwardly extending boundary flanges 26. Each
of the ports 25 and its pair of flanges 26 is covered
in spaced relationship by an annular cap mem-
ber 27 having a pair of depending annular flanges
28 radially spaced from the sides of the flanges
26 and cooperating therewith to form reversed
passages therebetween. The cap members 27 are
attached by radial arms 29 to a vertically ad-
justable hub 30 on the shaft 12 and as pulverized
coil is delivered to the chamber 21 by the con-
voyer 19, the rotation of the arms 29 and the
members 27 tends to keep the air passages free of
coil. Circumferentially spaced overflow ports 31
are provided in the casing 22 at a predetermined
level above plate 24 for the discharge of pulv-
nerized coal from chamber 21 when the bed of coal
therein rises above that level.

A second cylindrical casing 32 is affixed to the
top plate 16 and arranged coaxially of and ex-
teriorly spaced from the casing 22. Two radial
division plates 33 are extended downwardly from
plate 16 and between the casings 22 and 32 to
divide the annular space therein into two passageways 34 and 35. The plates 33 are at-
tached to a plate 36 which is spaced below the
plate 24 and transversely encircles the conveyor
casing 20. The segmental section of the casing
32 bounding the passageway 34 is extended down-
wardly to connect with the plate 36. The seg-
mental section of the casing 32 bounding the passageway 34 is also extended downwardly
to connect with the plate 36. Thus the plates 24
and 36 with the complementary sections of the
casings 22 and 32 define an air distributing cham-
ber 31 communicating with the passageway 35.
An air flow path is thereby provided from an
external source, such as fan 38, through a dis-
charge duct 39 and openings 40 in the plate 16,
downwardly through passageway 35 into cham-
ber 37.

Air passing from the distribution chamber 37
to the chamber 21 will flow upwardly through the
annular ports 25 in the plate 24 and between the
pairs of flanges 26 to the underside of the
rotating cap members 27. Each cap 27 divides a
stream of air into two portions flowing over the
upper ends of the flanges 26 and then down-
wardly between the flanges 26 and 28, with the
air entering the chamber 21 in four annular
streams through annular orifices 41 formed be-
tween the lower ends of flanges 28 and the plate
24.

The reversed air passageways between cham-
bers 37 and 21 impose a resistance to the flow
of air therethrough with the dimensions of the
flanges 26 and 28 as selected and the bottom of
flange 28 so spaced from plate 24 that the great-
est restriction to air flow is through the annular
orifices 41. The air velocity through the orifices
41 will be correspondingly higher than through
other sections of its flow path and the pulverized
coil within the chamber 21 will be swept from the
orifices, so that a minimum abrasive wear of the
coating and relatively modest cleaning will occur.
The flow resistance due to the orifices 41 may
be modified by vertical adjustment of hub
30 on shaft 12, and such adjustments may be
made to compensate for any wear that may occur.

The operation of motor 42 driving the fan 38
will create a flow of air through duct 39 and
passageway 35 into the air distributing chamber
37, with the rate of flow being controlled by a
regulating valve 43 in duct 39. Simultaneously the
motor 42 will drive shaft 12 through gear
reducer 17, causing pulverized coal to be dis-
charged into chamber 21 by the conveyor 19.
Preferably, the rate of pulverized coal discharge
into chamber 21 will be substantially constant
and in excess of the maximum discharge capacity
of the aerating feeder to points of use. The
streams of air entering the aerating chamber 21
will pass through the annular region 36 therein, thoroughly aerating the coal and en-
training a quantity of coal in proportion to the
velocity of the air flow. Since the coal is de-
ivered to the chamber at a greater rate than it
will be entrained and discharged with the air to
the points of use, the surplus coal will overflow
through ports 31, keeping the level of aerated coal
in chamber 21 substantially constant.
The amount of pulverized coal entrained by a stream of air passing through a quantity of pulverized coal will be proportional to the velocity of the air flow and the mass of the pulverized coal. While the depth of aerated pulverized coal within the chamber will be maintained constant by the overflow ports 31, the mass of pulverized coal present therein will vary with variations in the rate of air flow. As the velocity of the air through the aerating chamber increases, the density of the aerated pulverized coal will decrease in proportion to the rate of air flow and the ratio by weight of air to coal in the stream of air-borne coal discharging from the apparatus through ports 31 will also be proportionately reduced. There is a definite relationship between the rate of air flow entering the feeder, the density of aerated coal therein and the density of the air and coal mixture discharged from the feeder apparatus. Moreover these relationships are consistent and reproducible throughout the operating range of the feeder. Therefore, the feed rate of air-borne pulverized coal delivered by the aerating feeder can be determined by measurement of the air flow entering the feeder, and a calibrated air flow meter in duct 30 or the inlet to fan 30 will also indicate the rate of flow of coal from the feeder to points of use. Likewise, since the coal flow is proportional to air flow, the coal laden air delivered by the feeder and secondary air added at the burners for combustion can be coordinated for automatic combustion control. Moreover, it has been found that within the limits usually encountered in operation of air swept pulverizers, the feeder delivery of air and pulverized coal will be consistent with normal changes in the fineness of the pulverized coal handled.

While the agitation of the pulverized coal in the aerating chamber by reason of the passage of air therethrough will tend to break up and disperse any compacted particles of coal delivered by the elevating conveyor 18, any coherent particles of coal that reach the surface of the aerated coal mass will be too heavy to be airborne and will remain near the surface of the coal mass until either dispersed by further action of the air or passed through the overflow ports and returned to the storage space.

In tests of this feeder apparatus it has been found advantageous to keep the height of the overflow ports 31 above the plate 24 at a minimum consistent with maintaining a uniform bed of aerated coal within the feeder chamber and also advantageous to select a position for the overflow ports so that the differential static pressure measured between a position in air chamber 37 and a position in or adjacent the outlet ports 23 will be generally uniform within the normal capacity range of the apparatus. This is accomplished with a proper depth of pulverized coal since the increased pressure drop with increased air flow thru the restricted air passages between chambers 37 and 21 will be compensated by reduced pressure drop through the aerated coal within the chamber 21 because of the decrease in the density of the aerated coal.

The pulverized coal and carrier air delivered to the receptacle 10 through the inlet pipes 11 is separated as described with the coal being deposited within the receptacle. The separated air is vented through a segmental passage 34 formed by casings 22, and 32, and plates 33, and having an open bottom 44 and one or more discharge connections 45. The opening 44 is at a level below the inlet pipes 11. The vent connections 45 are extended by conduits (not shown) to direct substantially dust-free air vented from the upper portion of the reservoir 10 to external points of use or disposal. The vented air may be directed to burners in the furnace served by the feeder apparatus wherein the vented air is combined with pulverized coal to be burned or, alternately, the vented air may be directed to dust separators, or the like, for further cleaning and subsequent discharge of the dust-free vented air to the atmosphere.

Figs. 4-7 illustrate an installation of the aerating feeder in a storage system of pulverized coal firing. In installations of this type the pulverized coal is delivered to a storage tank or reservoir and subsequently fed to burners of a pulverized coal consuming furnace in accordance with the heat requirements of that furnace.

As shown a stream of air-borne pulverized coal is tangentially delivered to a centrifugal type separator 46 in which the mixture is separated by centrifugal force with the coal being deposited within a reservoir or storage bin 47 while the separated carrier air is vented through an outlet 48 to points of disposal. A screw conveyor 49 is transversely positioned across the bottom of the reservoir 47 and is extended within a tubular housing through the bottom part of a cylindrical casing 50 to engage a conventional driving mechanism including a constant speed motor and gear reducer. The speed of rotation of the conveyor 49 is selected to effect a substantially constant movement of coal through at a predetermined rate in excess of the designed capacity of the associated aerating feeder. The tubular housing of conveyor 49 is open to the lower portion of an open-topped cylinder 51. The cylinder 51 is centrally located within the casing 50 and is secured to the inner wall of an inverted truncated cone 52 which is pierced by the housing of conveyor 49 and cooperates with the cylinder 51 to provide a passageway for the upward movement of pulverized coal transferred from reservoir 47 by the conveyor 49. The cylinder 51 extends upwardly to a location approximately 1/2 of the total inside height of the casing 50 and the pulverized coal therein discharges over its upper end into an aerating feeder chamber 53.

The chamber 53 is defined by the cylindrical casing 54 which is coaxially spaced within casing 50. The casing has a top plate 55 with multiple discharge opening 56 therein, and an annular bottom port plate 57 extending between the casing and the cylinder 51. The plate 57 is provided with an annular port opening 59 concentric with and generally equidistant between the adjacent walls. Upwardly extending circular flanges 59 on each side of the port 58 and the passageway therebetween is covered in spaced relationship by a cap member 60 having a pair of depending annular flanges 62 outwardly spaced from the flanges 59 and cooperating therewith to form reversed passages.

As hereinbefore described in connection with Figs. 1, 2 and 3, the cap member 60 is supported by arms 62 which are attached to a vertically adjustable hub 63 on a rotatable shaft 54. The shaft 54 extends upwardly through the chamber 53 to engage an external motor and gear reducer drive 65. The shaft 64 is maintained in axial alignment by vertically spaced bearings 60.
in a bearing housing so as to insure a uniform radial clearance between flanges 59 and 54. Overflow ports 67 are located in the casing 54 above plate 57. As the level of coal in chamber 53 rises to the ports 67 the excess coal will overflow therethrough into an annular chamber 55 between the casings 58 and 54. The excess coal deposited in chamber 55 is returned to the reservoir 47 by means of screw conveyors 69 positioned at opposite sides of the cone 52 and extending in parallel spaced relationship to conveyor 49 in the bottom of reservoir 47. Conveyors 43 and 68 are preferably operated from the same drive mechanism and the combined capacity of the two return conveyors 68 is equal to or greater than the capacity of conveyor 49.

The portion of casing 54 around cylinder 51 and below the port plate 57, defines an air distributing chamber 70 which is connected by a duct 71 extending through the wall 66 to the outlet of a constant speed fan 72. A control valve 73 in the fan inlet duct 74 regulates the flow of air drawn to the fan and delivered to the chamber 70. Preferably, as shown in Fig. 6 an air seal pipe 75 is connected between the fan outlet and the bearing housing to prevent flow of coal laden air into the bearings 66.

An operation conveyor 49 transfers pulverized coal from the reservoir 47 to the aerating chamber 53, while the conveyors 68 return any excess coal overflowing through ports 67 into the conveyors, back to the reservoir 47. The coal within chamber 53 is thoroughly aerated by the streams of air delivered thereto and a portion of the coal so aerated is swept up by the passing air to be discharged from the feeder to points of use. The operation of the motor and gear drive 65 will cause the slow speed rotation of the arm 61 and the cap member 68 which will assist in distributing the pulverized coal in the aerating chamber as well as assist in keeping the annular orifice 76 clear of coal.

The modified construction illustrated in Figs. 8 and 9 is especially designed for mounting in a locomotive tender. For this purpose a storage receptacle 105 is elongated longitudinally of the tender and provided with rounded end portions to effectively utilize the available tender space, and the aerating feeder section of the unit is mounted on the top of the receptacle. Air-borne pulverized coal is delivered to a pair of centrifugal type separators 106 on the top of the receptacle by the tangentially arranged pipes 107. The coal and air of the mixture are separated within the separators 106 with the coal being deposited within receptacle 105 and the air being vented through a centrally located, open ended pipe 108 divided into branches 109 leading to points of disposal (not shown).

A conveyor-elevator 110 of a well known bulk flow type is used to transport pulverized coal from the bottom of the receptacle 105 to an aerating feeder chamber 111 mounted on the top of the receptacle 105. The conveyor 110 operates within a housing 112 of rectangular cross section and is driven by a sprocket 113 within a dust-tight casing 114 mounted at one end and on top of the receptacle 105. The sprocket 113 is driven at a constant speed by a conventional drive mechanism including a gear motor 116.

The conveyor housing 112 is extended from one side of the drive casing 115 into and through the receptacle 105 in a closed circuit returning to another side of the casing 115. The top of the conveyor housing 112 is open along the bottom of the receptacle 105 to receive stored pulverized coal and has an opening in the bottom of its upper horizontal section to provide a discharge port 117 communicating with the aerating feeder through a spout 118 conveying the discharged material to the lower intermediate part of the aerator chamber. The conveyor 110 is operated to discharge into the feeder chamber 111 at a predetermined rate in excess of the designed capacity of the aerating feeder. The vertical upward run of the conveyor 110 is supported by an idler drum 119 positioned on the top of the receptacle 105. A casing 120 encloses the discharge 115 and is connected with the receptacle 105 through a port 121 so that any spillage of coal in passing over the drum 119 will be returned to the storage space.

The aerating feeder chamber 111 is defined by a cylindrical wall 123, a top plate 124 with two outlet ports 125 therein, and a horizontally arranged bottom port plate 126. The plate 126 is provided with two circular concentric ports 127 having upwardly extended boundary flanges 128 and the passageways therebetween are covered in spaced relationship by the cap member 129 having pairs of depending circular flanges 130 radially spaced from flanges 128 and cooperating therewith to form reversed passages therebetween. As hereinafter described in connection with Figs. 1, 2, and 3 the cap 129 is supported by arms 131 attached to a vertically adjustable hub 132 on shaft 133. The shaft is centrally located within chamber 111 and is maintained in axial alignment by the bearings 135. The shaft 133 engages a bevel gear drive 136 mounted on the top plate 124 and is variably oscillated by the horizontal shaft 137 which is driven by a crank 138, a connecting rod 139 and an eccentric 140 on the shaft 141 of the motor 116. The oscillatory movement of the shaft 135 may be for a part of one revolution or for several revolutions. Circumferentially spaced overflow pipes 142 are located within chamber 111 with their upper or inlet ends at a predetermined level above plate 126 for the discharge of pulverized coal from the chamber 111 when the bed of coal therein rises above that level. The pipes 142 extend through the top of the receptacle 105 and coal passing therethrough is returned to the storage space of the receptacle 105. The walls of spout 118 are extended below the surface of the bed of pulverized coal within chamber 111 to provide a seal against the flow of air or aerated coal into the conveyor-elevator 110.

An air chamber 144 defined by plate 126, the top of the receptacle 105 and the section of cylindrical wall 123 therebetween, receives air from a fan 145 through a connecting duct 146. The fan 145 is driven at constant speed by the motor 116 and the rate of flow of air thereto is regulated by a flow control valve 147 in the fan inlet duct 148.

In operation the conveyor-elevator transfers pulverized coal from the storage space to the aerating feeder chamber 111 while the overflow pipes 142 will return any excess coal therein, back to the storage space. Air flowing through the chamber 111 will aerate the coal and entrain a portion of the aerated coal for discharge from the feeder to points of use. The reversing rotational movement of the cap member 129 will keep the reversed passages of the air inlet ports clear of coal.

It is recognized that the weight of pulverized material in a storage reservoir will subject the
material in the bottom of that reservoir to a variation in pressure which will influence its density and degree of aeration, and is dependent upon the height of the material stored. Since a feeder is usually arranged to receive pulverized material withdrawn from the bottom of a storage reservoir, the feeder will usually handle a material having a variable density. Furthermore, if the reservoir is subjected to vibration, as would be true when the reservoir is associated with a railroad locomotive, the pulverized coal would be compacted due to that vibration and the density thereof would be greatly increased. However, it will be noted in the feeder of the present invention, that a change in the rate of pulverized material delivery to the aerating chamber as caused by variations in the density of the material withdrawn from the reservoir, will not affect the feeding characteristics of the aerating feeder. This is accomplished by air flotation of the pulverized material from a bed of aerated material having a substantially uniform depth within the feeder chamber and by compensating for any variation in the delivery rate thereto by an increase or decrease in the overflow rate of surplus material rejected therefrom.

It will also be noted that the aerating feeder is superior to other types of pulverized coal feeders in its ability to deliver a stream of air-borne pulverized coal wherein the weight of the pulverized coal entrained will be proportional to the rate of air flow delivered to the feeder and since the air flow can be metered, the air flow measurement will also be an indication of the rate at which the aerating coal is being delivered by the feeder.

As the flotation effect of the air passing through the aerating feeder chamber is a function of the size of the particles, oversize masses of pulverized coal will not be entrained, and the aerating feeder thus insures the delivery of an air-borne stream of pulverized coal particles of the desired uniform size characteristics which is so desirable in burning pulverized coal efficiently at high rates of heat liberation per unit of furnace volume as required in locomotive firing.

In the claims, the word “air” is intended to generically cover any gaseous carrier medium suitable for removing pulverized material in the manner described.

We claim:

1. Apparatus for feeding pulverized material comprising walls defining an aerating chamber having multiple air-borne material outlet ports in the top wall thereof, conveying means for delivering pulverized material into the lower portion of said chamber, means for limiting the height of pulverized material within said chamber, walls forming an air distributing chamber beneath said aerating chamber and receiving air from an outside source, a plate member between said aerating chamber and said distributing chamber having an opening therethrough for passage of air, flanges attached to said plate extending upwardly on each circumferential side of said opening, and a rotatable cap member having depending flanges superimposed in spaced relationship to said opening and upwardly extending flanges.

2. Apparatus for feeding pulverized material comprising walls defining an aerating chamber having an air-borne material outlet port in the upper part thereof, a conveyor arranged to deliver pulverized material into said chamber, walls defining an air distributing chamber beneath said aerating chamber, a plate member between said aerating chamber and said distributing chamber having an opening therethrough for passage of air, flanges attached to said plate extending upwardly on each side of said opening, a cap member having depending flanges superimposed in spaced relationship to said opening and upwardly extending flanges, and means for imparting a reversing rotational movement to said cap member.

3. In apparatus for feeding pulverized material, walls defining an aerating chamber having an air-borne material outlet in the upper part thereof, conveying means continuously delivering pulverized material into said chamber, means limiting the height of pulverized material within said chamber, walls forming an air distributing chamber beneath said aerating chamber and receiving air from an outside source, a plate member between said aerating chamber and said distributing chamber having an opening therethrough for passage of air, flanges attached to said plate extending upwardly on all sides of said opening, a cap member having depending flanges superimposed in spaced relationship to said opening and said upwardly extending flanges to define therewith an air flow path therebetween of predetermined dimensions, and means for moving said cap member relative to said opening while maintaining substantially the predetermined dimensions of said air flow path.

4. In apparatus for feeding pulverized material, walls defining an aerating chamber having an air-borne material outlet in the upper part thereof, conveying means operable from above the chamber and continuously delivering pulverized material into said chamber and upwardly through the bottom thereof, means limiting the height of pulverized material within said chamber, walls forming an air distributing chamber beneath said aerating chamber and receiving air from an outside source, a plate member between said aerating chamber and said distributing chamber having an opening therethrough for passage of air, flanges attached to said plate extending upwardly on all sides of said opening, a cap member having depending flanges superimposed in spaced relationship to said opening and upwardly extending flanges to define therewith an air flow path therebetween of predetermined dimensions, and means for turning said cap member relative to said opening while maintaining substantially the predetermined dimensions of said air flow path.

5. In apparatus for feeding pulverized material, walls defining an inner casing presenting an aerating chamber having an air-borne material outlet in the upper part thereof, conveying means continuously delivering pulverized material into said chamber and upwardly through the bottom thereof, means including an outer casing limiting the height of pulverized material within said chamber, walls forming an air distributing chamber beneath said aerating chamber and receiving air from an outside source, a plate member between said aerating chamber and said distributing chamber having an opening therethrough for passage of air, flanges attached to said plate extending upwardly on all sides of said opening, a cap member having depending flanges superimposed in spaced relationship to said opening and said upwardly extending flanges to define therewith an air flow path therebetween of predetermined dimensions, and means for turning said cap member relative to said opening while main-
taining substantially the predetermined dimensions of said air flow path.

6. Apparatus for feeding pulverized material comprising walls defining an aerating chamber having in its upper part an air-borne material outlet port through which there is a normally continuous flow of air-borne material, pulverized material delivery means normally continuously delivering pulverized material into said chamber at a rate in excess of the rate of flow of pulverized material through said port, said aerating chamber having an opening at its lower part beneath the mass of pulverized material in the chamber, the wall of said chamber being provided with an overflow port through which the excess of pulverized material flows from said chamber to limit the head of pulverized material above said opening, and means causing the flow of aerating and carrier air through said opening and upwardly through the mass of pulverized material at a predetermined rate to maintain predetermined ratio of pulverized material and carrier air for flow through said first mentioned port.

7. Method of feeding gas-borne pulverized material which comprises, normally continuously delivering pulverized material to a confined zone at a rate in excess of the rate of gas-borne discharge of materials from that zone, fluidizing said material within said zone and effecting the gas-borne discharge of the material from the upper part of said zone by causing the flow of aerating and carrier gas upwardly through the mass of pulverized material within said zone, and causing an overflow discharge of the gas fluidized pulverized material from said zone and thereby limiting the head of pulverized material and determining the ratio of gas to pulverized material in the gas-borne delivery from said zone.

8. Apparatus for feeding pulverized material comprising walls defining an aerating chamber having an air-borne material outlet port in the upper part thereof, a conveyor for delivering pulverized material into the lower intermediate portion of said chamber to maintain a mass of the material in the chamber, a bottom for said aerating chamber having an opening therethrough for the passage of air into said chamber, means causing air to flow upwardly through said opening and then upwardly through the mass of pulverized material in the chamber, means for maintaining a substantially uniform depth of pulverized material on said bottom plate member, and a cap member superposed relative to the air opening in said bottom and the mass of pulverized material.

9. Apparatus for feeding pulverized material comprising walls defining an aerating chamber having an air-borne material outlet port in the upper part thereof, a conveyor for delivering pulverized material into the central part of the lower portion of said chamber to maintain a mass of the material in the chamber, walls defining an air distributing chamber beneath said aerating chamber receiving air from an outside source, a bottom for the aerating chamber disposed between said distributing chamber and said distributing chamber having an opening therethrough for the passage of air into said aerating chamber.

REFERENCES CITED

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

**UNITED STATES PATENTS**

<table>
<thead>
<tr>
<th>Number</th>
<th>Name</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>238,891</td>
<td>Greiner</td>
<td>Mar. 15, 1881</td>
</tr>
<tr>
<td>258,419</td>
<td>Duckham</td>
<td>Oct. 30, 1894</td>
</tr>
<tr>
<td>635,318</td>
<td>Heavey</td>
<td>Oct. 24, 1899</td>
</tr>
<tr>
<td>1,160,233</td>
<td>Hay</td>
<td>Nov. 16, 1915</td>
</tr>
<tr>
<td>1,162,221</td>
<td>Caven</td>
<td>Nov. 30, 1915</td>
</tr>
<tr>
<td>1,165,520</td>
<td>Laissier</td>
<td>Dec. 28, 1915</td>
</tr>
<tr>
<td>1,172,745</td>
<td>Short</td>
<td>Feb. 22, 1916</td>
</tr>
<tr>
<td>1,193,010</td>
<td>Heyl</td>
<td>Aug. 1, 1916</td>
</tr>
<tr>
<td>1,241,437</td>
<td>Plan</td>
<td>Sept. 25, 1917</td>
</tr>
<tr>
<td>1,364,360</td>
<td>Cooper</td>
<td>Apr. 30, 1918</td>
</tr>
<tr>
<td>1,330,977</td>
<td>Pruden</td>
<td>May 11, 1920</td>
</tr>
<tr>
<td>1,383,371</td>
<td>Barnhurst</td>
<td>July 5, 1921</td>
</tr>
<tr>
<td>1,559,810</td>
<td>Trent</td>
<td>Nov. 3, 1925</td>
</tr>
<tr>
<td>1,616,547</td>
<td>Pontoppidan</td>
<td>Feb. 6, 1927</td>
</tr>
<tr>
<td>1,697,585</td>
<td>Backer</td>
<td>Jan. 1, 1929</td>
</tr>
<tr>
<td>1,804,593</td>
<td>Conrath</td>
<td>May 12, 1931</td>
</tr>
<tr>
<td>1,917,266</td>
<td>Lissman</td>
<td>July 11, 1933</td>
</tr>
<tr>
<td>1,939,176</td>
<td>Leiman</td>
<td>Dec. 13, 1933</td>
</tr>
<tr>
<td>1,971,352</td>
<td>Goebels</td>
<td>Aug. 28, 1934</td>
</tr>
<tr>
<td>2,027,697</td>
<td>Nielsen</td>
<td>Jan. 14, 1935</td>
</tr>
<tr>
<td>2,111,053</td>
<td>Graeminger</td>
<td>Mar. 22, 1938</td>
</tr>
<tr>
<td>2,129,537</td>
<td>Marr</td>
<td>July 12, 1938</td>
</tr>
<tr>
<td>2,221,741</td>
<td>Vogel-Jorgensen</td>
<td>Nov. 12, 1940</td>
</tr>
<tr>
<td>2,274,708</td>
<td>Kenedy</td>
<td>Mar. 3, 1942</td>
</tr>
<tr>
<td>2,327,337</td>
<td>Burch</td>
<td>Aug. 24, 1943</td>
</tr>
</tbody>
</table>

**FOREIGN PATENTS**

<table>
<thead>
<tr>
<th>Number</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>325,544</td>
<td>Great Britain Feb. 21, 1930</td>
</tr>
</tbody>
</table>