May 22, 1956 N. H. GEBHARDT 2,746,809

ASH REMOVAL UNIT

Filed June 24, 1953 2 Sheets-Sheet 1

FIG. 1

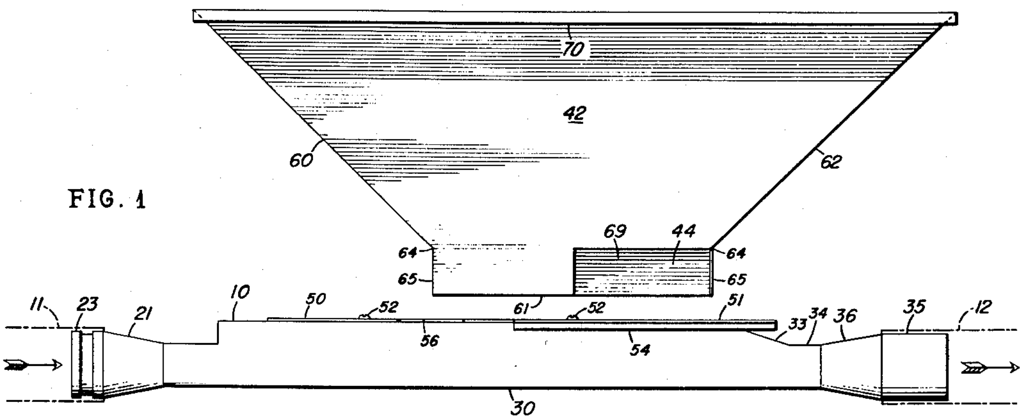


FIG. 2

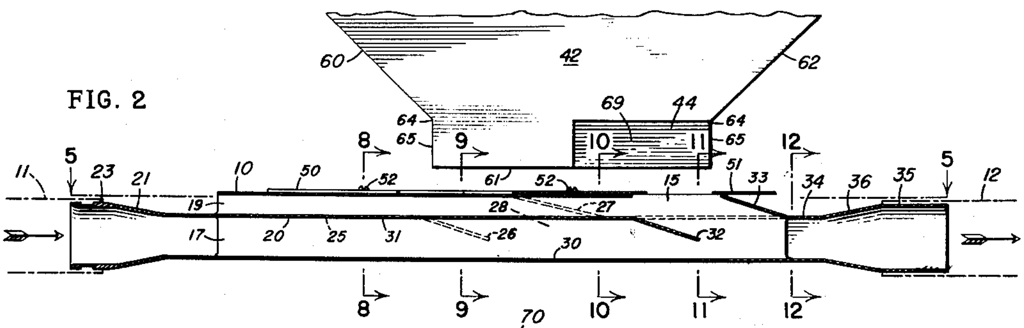
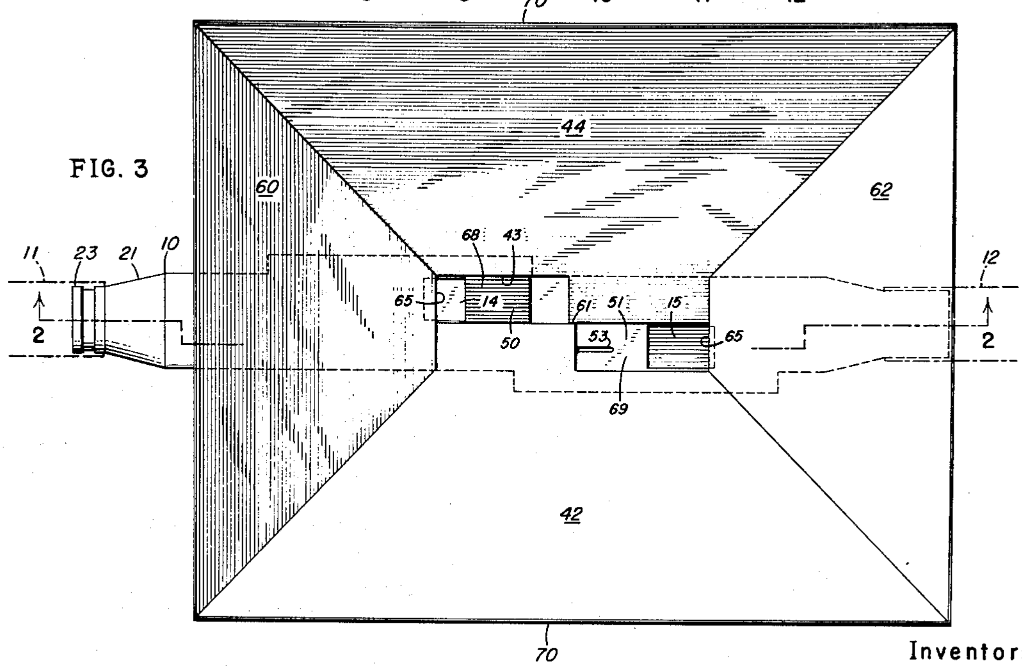


FIG. 3



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ASH REMOVAL UNIT

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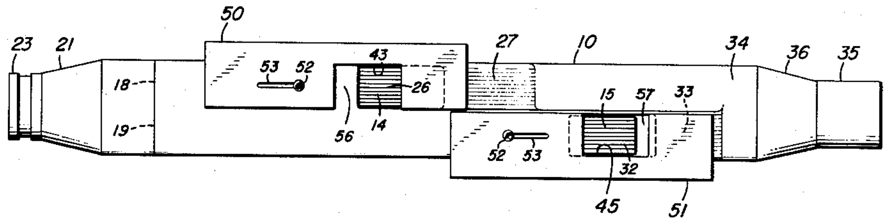


FIG. 4

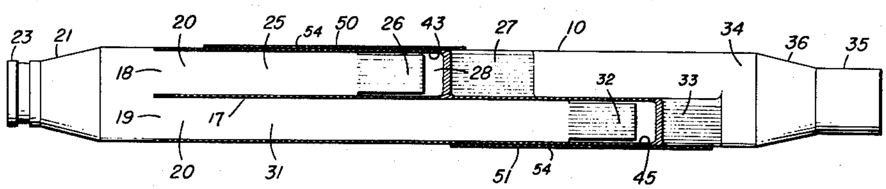


FIG. 5

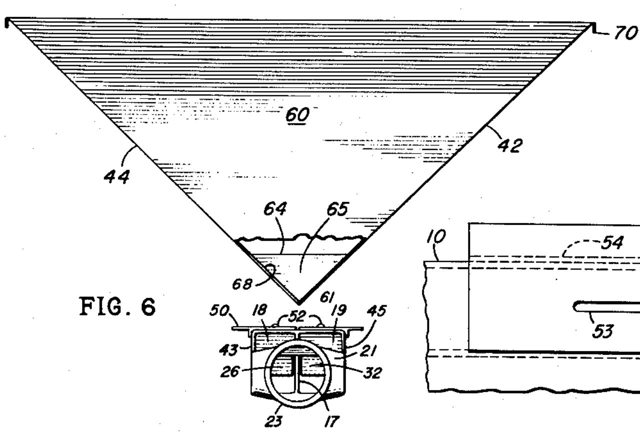
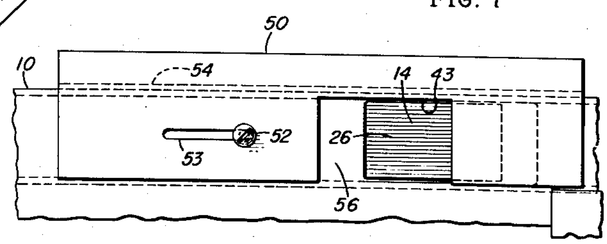


FIG. 6

FIG. 7



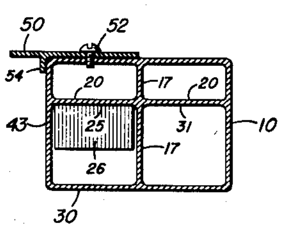


FIG. 8

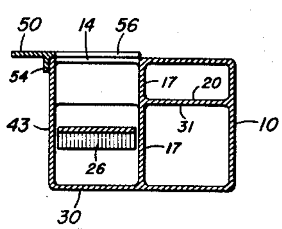


FIG. 9

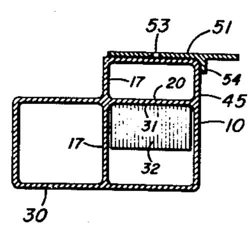


FIG. 10

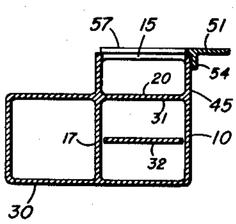


FIG. 11

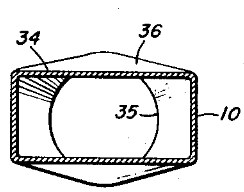


FIG. 12

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ASH REMOVAL UNIT

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Application June 24, 1953, Serial No. 363,871

16 Claims. (Cl. 302—39)

This invention relates to the conveying of loose granular or pulverous material and has for its principal object the provision of means for automatically removing ash from a hopper, conveying it through tubes of a closed vacuum system and depositing it in a vacuum tank, such movement being accomplished without the requirement of manual agitation to start the flow of ash or any other manual attention.

A typical example of an installation would be as follows: As solid fuel is burned the resultant ash is conveyed to, and accumulates in, a receptacle located adjacent to the heating plant. Through outlets in the hopper bottom of the receptacle, ash enters the conveying tube of the closed vacuum system. From the receptacle, permanently installed tubes run to, and usually terminate on, the outside wall of the building.

A truck unit of special design has mechanism mounted on it including a large vacuum tank and a blower or fan. From this truck, two flexible hoses extend to the stationary tube terminals. When the fan is powered, ash is automatically picked up at the receptacle, moves through the vacuum tube in the air stream of this closed vacuum system, and is deposited in the vacuum tank mounted on the truck, the fan supplying pressure through the other flexible hose and its connected pipe.

All this is accomplished without developing a trace of objectionable dust either inside or outside the building. This equipment provides the means for supplying completely automatic heating with solid fuel, a result that has never before been accomplished.

An object of the invention is to provide a means for channelizing ashes flowing from the hopper bottom of the receptacle to an intake pipe below the hopper bottom in such fashion that the intake pipe is never clogged and the system, which includes a fan for providing pressure on one end of the intake pipe and vacuum on the other end, starts the flow of ash immediately upon the starting of the fan.

Another object of the invention is to provide a hopper bottom and a channelizer that delivers all the ash in the receptacle to the intake openings in the ash intake pipe. Over a period of time as an increasing quantity of ash accumulates in the receptacle, the mass in previous arrangements packs to the extent that without initial agitation it will not move through the restricted area that channels it to the openings through which it moves into the air stream. The present hopper bottom is designed to serve as a channelizer that prevents packing and permits free flow of the ash without requiring agitation or manual attention. As ash enters the restricted area immediately above the points of intake, it is guided at an angle to the vertical and firmly supported on one side only. There is no confining wall on the opposite side, hence no possibility of packing. This hopper and channelizer is made of four pieces of sheet metal requiring only two slight bends for the complete bottom. It is coated with porcelain enamel. On this surface, ash is unstable at the angle of slope of the hopper bottom.

An important object of the invention is to provide

means for automatically limiting ash intake to the carrying capacity of the air stream. Secondary air in varying quantity is automatically made available to the system at the points where solids are drawn by vacuum into the air stream. As vacuum increases the supply of seccondary air increases, limiting the proportion of solids in the air stream. This limiting of the proportion of solids in the air stream prevents overloading and resultant blockage that otherwise would develop in the tube.

Another object of the invention is to provide a plurality of openings through which ash enters the air stream, balance the rate of ash intake at one opening with the intake at another, and permit any one opening to operate independently of the others. Should one opening in the air stream be blocked by a piece of solid ash or multiple pieces of ash that combine to form a mass too large to pass through one opening into the air stream, the other opening or openings will continue to function until all the ash that normally would pass through the unblocked openings has moved out of the receptacle. At such time the unblocked opening draws air only and the obstruction that blocks the one opening is within reach and can readily be removed. The ash remaining in the receptacle on the blocked side will then move through completely emptying the receptacle, even though the other opening is merely drawing air.

Another object of the invention is to provide a means for simultaneously:

1. Controlling the rate of ash intake at each individual opening through which ash enters the air stream of this closed vacuum system.
2. Balancing the rate of ash intake at any one opening as compared with another.
3. Adjusting the intake openings to accommodate ash containing a high percentage of relatively large granules.
4. Using pressure as a means for creating a venturi effect at one opening as compared with the use of straight vacuum at another.
5. Accomplishing all of these results with the fan at all times running at the constant R. P. M. rating for top efficiency.

This combination of advantages results from the design of the opening and the passage through which ash travels as it is drawn by vacuum into the air stream. The positions of the effective openings are movable rather than fixed. The size of each opening area is increased as it is moved downstream and conversely is decreased as it is moved upstream. The vertical cross-sectional area of the passage through which ash moves into the air stream is enlarged as the effective opening is moved downstream and conversely is reduced as the opening is moved upstream.

Additional objects include the provision of a central partition in an intake pipe, independent control of secondary air and friction of flow whereby to control the amount of ashes moving to each point of pick-up, providing slides to shift the location of the entry openings into the intake pipe as well as the effective size of such entry openings, and the specific shape of these slides.

The combination of hopper bottom and the intake pipe about an inch below the lower margin of the hopper bottom provides an ash removal unit which is self-cleaning and is adjustable to take care of either fine or coarse ashes or a combination of both without requiring any change of speed in the fan which provides a pressure at the upstream end of the intake pipe, a vacuum at the downstream end of the pipe and a neutral point between the two openings which are spaced both longitudinally and laterally, one on either side of the central longitudinal partition.

In the drawings:

Figure 1 is a side elevational view of the ash conveyor.

Figure 2 corresponds to Figure 1, but with the intake casing shown in longitudinal section on a plane indicated by line 2—2 of Figure 3.

Figure 3 is a plan view of the ash conveyor.

Figure 4 is a plan view of the intake assembly proper, the slidably adjustable admittance gates being shown at a preferred setting.

Figure 5 corresponds to Figure 4, being a horizontal longitudinal section taken on the line 5—5 of Figure 2.

Figure 6 is a left end elevational view of the ash conveyor, a portion of the hopper being shown fragmentally, better to reveal the construction.

Figure 7 is an enlarged and more detailed plan view of one of the admittance gates.

Figures 8–12 are enlarged transverse vertical sections taken on planes indicated severally in Figure 2 by paired numerals corresponding to the figure numbers.

In Figure 1 the ash removal intake pipe is denoted **10** and is coupled to a pressure pipe **11** at the left and a vacuum pipe **12** at the right, the complete closed system including a fan which provides a pressure upstream and a vacuum downstream so that the portion where it changes from pressure to vacuum is located between the ends of the pipe **10** and preferably between the two intake openings **14** and **15**, the latter being downstream. The pipe **10** is wider than it is deep and for a 3″ diameter pressure pipe a convenient size would be 4¼″ wide and about 3″ deep overall with the area of the air stream exactly equalling the area of the 3″ circle.

Centrally of the pipe **10** is a longitudinal vertical partition **17** which extends almost the entire length of the rectangular portion of the pipe **10**. A horizontal partition **20** extends downstream from the secondary air intake openings **18** and **19** of the pipe on both sides of the central partition **17**. Such horizontal partition **20** on the far side, as seen in Figure 5, extends horizontally as at **25** to a point at the upstream margin of the hole or intake opening **14** and then bends downward as at **26**, the usual angle of bend being such that the portions **26** and **27** are parallel so that there is a uniform opening for ashes passing into hole **14** and discharging at point **28** and falling toward the bottom **30** of the pipe **10**. The side edges of the sloping portions **26** and **32** are not fastened so, under unusual circumstances, the angles may be changed thus providing an additional means of adjustment. On the near side the configuration is the same, the horizontal partition **31** being longer than the similar portion **25** as the former extends to a point proximate the upstream margin of hole **15**. The downturned portion **32** is usually parallel to the sloping roof portion **33** to provide uniform flow. In its lowest part, the pipe **10** is entirely free on both sides of the partition **17** from upstream to downstream, from the bottom **30** up to the horizontal partitions **25** and **31** and is unobstructed except for the two downwardly projecting members **26** and **32** which discharge the ashes into the conveying air stream at an angle of about 20° to horizontal.

In Figure 6 I have indicated at **42** a sloping surface or wall of the hopper bottom for deflecting ashes toward the outside wall **43** of the pipe **10**, that is the surface **42** would deflect ashes thru the opening **14** and toward the side wall **43** while ashes coming in thru intake opening **15** are deflected by a similar sloping surface **44** toward the opposite wall **45**. A flattened conical portion **21** connects the rectangular pressure portion to the proximate cylindrical end **23** and the rectangular vacuum portion **34** is joined to the cylindrical end **35** within the vacuum pipe **12** by a flattened conical portion **36**.

The ash entry holes **14** and **15** are respectively restricted by left and right slides **50** and **51** shown in Fig. 4 at opposite extremes of their movements as permitted by screws **52** in slots **53** and by vertical guides **54** engaging the side walls **43** or **45**. The slides **50** and **51** each have at one edge a recess forming an ash entry inlet **56** and **57** respectively, of a lateral dimension about equal to that of the opening in the top of the pipe but appreciably shorter lengthwise of the pipe than the openings **14** and **15**. Thus while the slides may control the size of the spaces thru which the ashes may pass to the pipe **10** they also control the location of the effective ash entry passages with respect to the beginning and end of the downwardly sloping portions **26** or **32** of the horizontal partition **25**—**27**. The construction stated permits a single screw (with the guide) to hold a plate in accurate position while adjusting a slide and to lock it in place when properly located.

Referring particularly to Figure 3, the hopper bottom which is a portion of the ash removal unit, is composed of four perfectly plane sheets of metal **60**, **44**, **62** and **42**, except for a slight bend as at **64** to provide a vertically directed end portion **65** of each end wall extending, for example, to the bottom **61** of sheet **42**, which is at exactly the same level as the bottom of wall **44**. As best seen in Figures 3 and 6 the ashes are supported at the bottom of the hopper by one wall only, there being no support opposite this wall, hence no packing. A portion is cut out in each of the two longer sloping sides **44** and **42**, thus providing holes **68** and **69** thru which the ashes pass respectively to openings **14** and **15** in the pipe **10** which is located a wee bit more than an inch below the bottom **61** of the channelizer or hopper bottom. As a consequence of this construction the ashes which rest unstable on the four plates of the channelizer, are directed by walls **42** and **44** toward the far sides of the pipe **10**. While the pipe **10** will operate without the channelizer, the latter is a valuable unit in the combination and prevents any clogging except under extraordinary conditions such, for example, as the presence of a piece of ash too large to pass thru the various openings. If desired, the channelizer or hopper bottom may have a top flange **70** embracing the discharge portion of the receptacle above.

The operation of the device is as follows: As solid fuel is burned, ash accumulates in a receptacle which is constructed with a hopper bottom as shown in Figures 1, 2, 3 and 6. The angle of slope of this hopper bottom is steep enough that ash is unstable on its porcelain enamel surface. Consequently, it serves as a self-cleaning bottom and all the ash accumulated in the receptacle will move through the openings provided, **68** and **69**, Figure 3. In passing through these openings in the hopper bottom, ashes are deflected by sloping walls **42** and **44** and in part by end walls **60** and **62** so that the discharge is directed to openings **14** and **15** in the top wall of pipe **10**, the pipe openings being of the same size and each opening controlled by its individual slide plate **50** or **51**, Figure 4. As ash accumulates in the receptacle, pressure from the weight above would normally cause ash to pack in the restricted area immediately above the openings where it enters pipe **10**. As it accumulates in, and later passes through, this restricted area, the ash is firmly supported by side wall **42** at opening **14** and by side wall **44** at opening **15**. Immediately above each of these openings, however, there is no confining opposite wall against which the ash could pack. Consequently, the ash remains loose and moves freely through openings **14** and **15** in response to the pull of vacuum.

The pressure of air, moving through pipe **11** from left to right in Figure 1 develops a venturi action as it passes through the restricted area below sloping plate **26** in Figure 2. This venturi action develops suction in the area above the sloping plate **26**. Ash moves by gravity as far down as plate **26**. This suction pulls ash off the plate into the air stream and discharges it through vacuum pipe **12**.

At opening **15**, direct vacuum pulls ash off sloping plate **32** into the air stream and discharges it through vacuum pipe **12**.

Openings **14** and **15** in the top wall of pipe **10** are of the same shape and size and each has its individual slide plate, **50** for opening **14**, and **51** for opening **15**. The rate of ash intake at each opening is individually controlled by the position of the slide plate.

When either plate is moved as far as possible upstream, that is towards pressure end **23**, the effective opening is square and about two inches each way and the ash must flow through the restricted size of the opening. In such position the effective opening is as far from the drop-off, i. e. the downstream edge of sloping plate **26** or of sloping plate **32**, as it is possible to obtain. As a natural consequence of the restricted size of the square opening and the friction resulting from the movement of ash through the maximum possible distance to the edge of the sloping plate, resistance to the flow of ash into the air stream is at a mixmum. In Figure 4, slide plate **50** is shown in the position just described.

In Figure 4, slide plate **51** is shown at the opposite end of its travel so that both the upstream and downstream margins of hole **15** are partly covered. In this position, the size of the effective opening has been increased by elongating the square to a rectangle. The effective opening is as close to the drop-off, i. e. the downstream edge of sloping plate **32** as it is possible to obtain. Therefore, friction of movement is reduced to a minimum. With the slide plate in this position the depth of the passage, between the downstream edge of the opening and the sloping plate directly below, is increased. This increase in the depth of the passage further reduces friction of movement through it. Set at this position, slide plate **51** permits maximum rate of ash intake. It further permits the handling of larger granules of ash.

The adjustment of each individual slide plate for any installation is readily fixed at any point between the extremes as indicated. The screws, **52**, are loosened and each slide plate is placed in as near accurate position as can be guessed. After having been positioned, we will assume that we find upstream hole **14** is drawing less solids than downstream opening **15**; consequently, plate **50** is moved downstream and as it is moved the effective opening moves in the same direction, the size of the opening increases and the friction of movement decreases, thus increasing the rate of ash movement through this entry into the air stream.

It might be mentioned here that, in most installations, the natural tendency is to get greater volume of flow through opening **15**, which is downstream, near the vacuum or suction and as compared with opening **14**. It is also found that coarser ash flows more freely as both slide plates **50** and **51** are moved downstream towards the vacuum end. This movement increases the distance from the source of secondary air that moves through this relatively coarse pulverous mass.

For handling fine ash, on the other hand, it is usually best to move the slide plates upstream towards the pressure end. This decreases the size and the distance of the effective opening from the source of secondary air that moves through a relatively dense mass to enter the air stream and consequently permits entry of a greater proportion of secondary air than if the slides were set farther downstream. In the one (upstream) position of the slides the secondary air must travel through ash for the two inches of length of the effective opening for this setting, while the other (downstream) setting of the slides the secondary air must pass through ash the three inch distance of the length of the effective opening for this setting, which is the length of the inlet portion of the slide. The width of the ash channel in either setting is the same, that is, two inches.

The secondary air, introduced through open ends **18** and **19**, limits the proportion of solids to the carrying capacity of the air stream, since such secondary air dilutes the solids to the extent necessary to prevent plugging of the system by overloading, arching, or otherwise. The amount of secondary air supplied is controlled by the position of the slide plate at each individual point of pickup.

Within limits, it seems immaterial how high and, consequently, how large these secondary air passages are. Perhaps half the depth of the lower passage of the pipe is normally sufficient and advisable but the height of these secondary air passages and, of course, the top of pipe **10** can be moved materially upward and, as a result, increasingly larger granules of ash could be handled through the intake entries. The height of the passages should not be greater than the height between bottom **30** and horizontal partition **20** in pipe **10**.

When pipes **11** and **12** are required to extend a particularly long distance in order to make connection with the outside couplings for the hoses which connect with the truck-mounted unit, increased friction obviously develops in the line and, in such case, slides **50** and **51** are moved downstream towards the vacuum side. This reduces the vacuum required to pull solids into pipe **10** and compensates for the reduction of vacuum available at point of pickup due to friction in the long line.

The fan or blower operates at the steady speed which develops its maximum efficiency. There is no need to alter this speed for any given load. In previous experimental models, gates have been placed before passageways **18** and **19**; but with the present arrangement of slide plates and the ability to move the effective opening either upstream or downstream, the two passageways **18** and **19** are fully open at all times and the central vertical partition merely divides the air stream below the horizontal partition **20** into side by side paths so that when ashes are pulled through the openings into each of the two air paths, the proper relation between ash weight and air volume is secured by the design of the entry modifying the dilution of pressure air by the amount of atmospheric air entering through openings **18** and **19** as further regulated and modified by the positions of slides **50** and **51**, permitting either opening to admit a greater or lesser quantity of secondary or atmospheric air into the two main paths at the bottom of the pipe as well as controlling the degree of resistance to the flow of ash entering from above.

What I claim is:

1. An intake pipe for a fluid current conveyor system for ashes comprising a pipe having a vertical central partition, an intake opening at the top of the pipe on each side of said partition, a horizontal partition extending from the pressure side of the pipe to points adjacent the proximate intake opening on each side providing a pressure air conduit below the horizontal partition and a secondary air conduit above the horizontal partition, said secondary air conduit being open to the atmosphere at the pressure end, and discharging into the pressure air conduit within the pipe and means for separately controlling the flow of air and ashes on each side of the central partition.

2. The device of claim 1 in which the means controls the effective locations of the intake openings with respect to the two ends of the pipe.

3. The device of claim 1 in which the horizontal partition at each side at its downstream end slopes downwardly below the proximate intake opening to discharge material to the pressure air conduit above the bottom of the pipe.

4. The intake pipe of claim 1 with means for directing ashes thru the two intake openings toward the two side walls of the pipe.

5. The device of claim 4 with a slide having a discharge inlet, shorter longitudinally than the length of the opening covered by the slide whereby to adjust the location of the effective amount of opening with respect to the ends of the pipe.

6. The device of claim 1 in which the pipe is rectangular in cross-section, wider than high, and the openings are rectangular each opening being about one-half the width of the pipe, and the means includes two plates slid-

ing longitudinally on the upper surface of the pipe above the intake openings.

7. The pipe of claim 1 in which the downstream ends of the horizontal partition are free of the side walls of the pipe whereby such ends may be bent downward toward the bottom of the pipe to a chosen angle, whereby to form an additional means for controlling the flow of material into the pressure air conduit.

8. The pipe of claim 1 in which the pipe has a flat top, the intake openings are rectangular, and the controlling means includes a slide damper having an opening therein about as wide and about half as long as the intake opening, whereby by sliding the damper the effective opening may be altered in size and be moved nearer or farther from the upstream end of the pipe.

9. The pipe of claim 8 in which the pipe is generally rectangular, the horizontal partition has a downwardly bent sloping portion below each intake opening, and the slide dampers may move upstream to make the effective opening smallest and bring it entirely above the sloping portion or may move downstream to make the effective opening largest by permitting some of the conveyed material to fall freely downstream of the sloping free end of the horizontal partition as well as to fall on the sloping portion.

10. The pipe of claim 9 in which the system is a closed one, the neutral point between pressure and suction being within the pipe whereby the secondary air is pulled into the conveying stream by venturi action at the upstream intake opening and by vacuum at the downstream opening.

11. An intake conduit for conveying material and divided longitudinally into four parallel passageways by a vertical partition and a horizontal partition to provide a pressure air conduit below and a secondary air passageway above, and having an inlet opening above one upper side secondary air passageway and an inlet opening above the other upper side passageway and located further downstream than the first opening, a downwardly sloping terminal in the horizontal partition under each of the two inlet openings leading to the lower conduit and an independent closure for each inlet opening for restricting the flow of ashes and secondary air whereby to proportion the quantity of secondary air flowing in each passageway to a suitable relation with the quantity of material entering its intake opening.

12. In combination, a hopper bottom having four walls sloping downward to two laterally and longitudinally spaced adjacent discharge openings, and an intake pipe having ash receiving holes beneath the openings, the side margins of the openings being vertically above the side margins of the ash receiving holes, one such margin being vertically further from the intake pipe than the other, whereby the ashes will be deflected sideways into the intake pipe.

13. A rectangular hopper bottom having four walls sloping at an angle of about 40° from a large upper mouth to a lower and smaller rectangular central discharge portion, each of the two longitudinal side walls having a rectangular recess at its lower end extending about half the longitudinal length of said central discharge portion, the upper and the lower margins of the two recesses being respectively at the same level, the front and the back walls having within said discharge portion downturned flanges extending to the level of the lower edges of the side walls each flange forming a wall of the proximate opening.

14. An ash intake pipe for a closed system of ash removal from an ash receptacle, comprising a pressure-vacuum intake pipe divided longitudinally into two parallel paths, a sloping member extending into one path, a second sloping member extending into the other path downstream of the first member, a passage conveying secondary air to the first member, a second passage conveying secondary air to the second member, and means for delivering ashes laterally at an angle of between 30° and 50° to each of the sloping members.

15. The device of claim 14 in which the means includes two walls sloping at an angle of about 40°, one of these walls terminating lower than the other and both terminating directly above the side margins of the proximate sloping member, whereby the first sloping wall directs ashes toward the outside wall of the pipe and the second sloping wall directs ashes vertically downward toward the said outside wall of the pipe.

16. An ash intake pipe for a closed system of ash removal comprising a rectangular pipe having a plurality of lateral and longitudinally spaced openings in the top thereof, a slide for each opening, each slide having a vertical member to engage the side of the pipe and having a horizontal member to engage the top of the pipe, said horizontal member having a recess to expose the opening or to restrict its effective size as the slide is moved longitudinally of the pipe, said slide having a pin and elongated slot connection with the top of the pipe whereby the vertical member and the pin hold the slide parallel to the pipe in various adjusted positions of the slide.

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