May 23, 1939. R. M. HARDGROVE ET AL 2,159,629

DISTRIBUTOR FOR PNEUMATICALLY TRANSPORTED SOLID MATERIAL

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Fig. 1

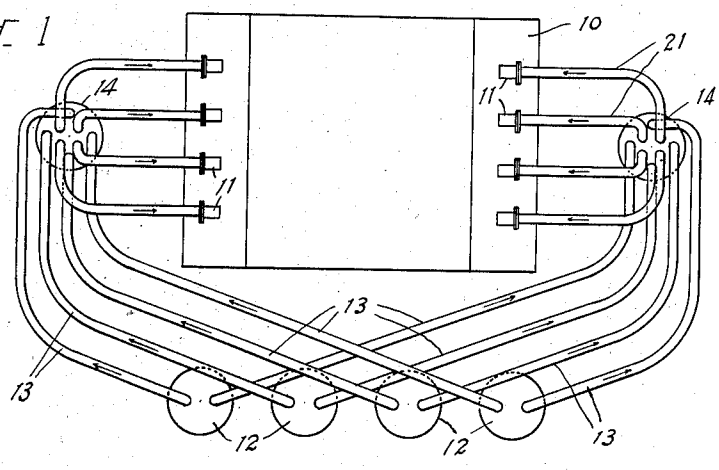


Fig. 2

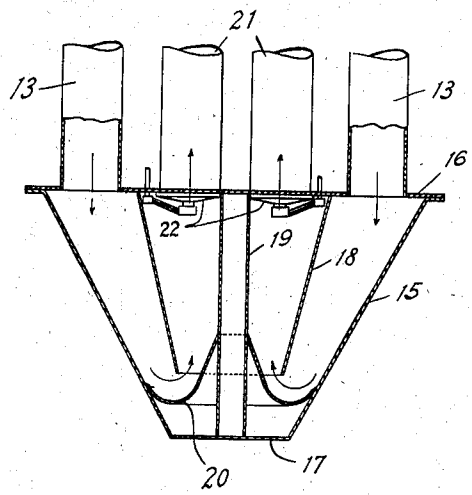


Fig. 3

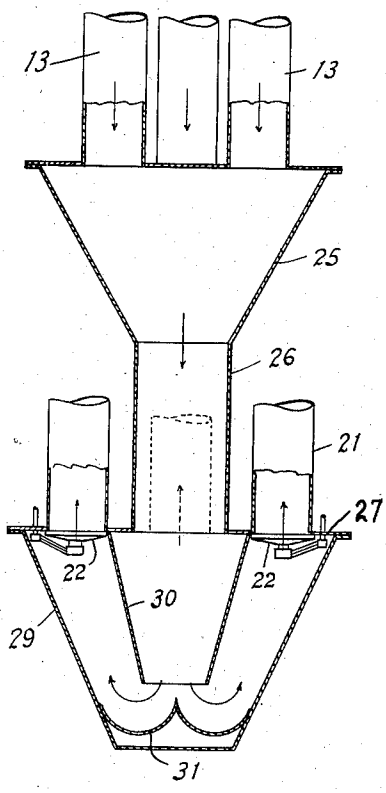
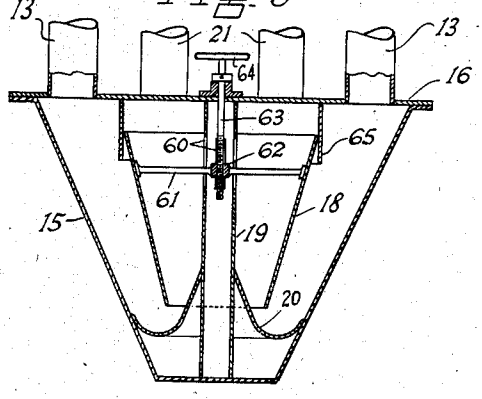


Fig. 9



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Fig. 4

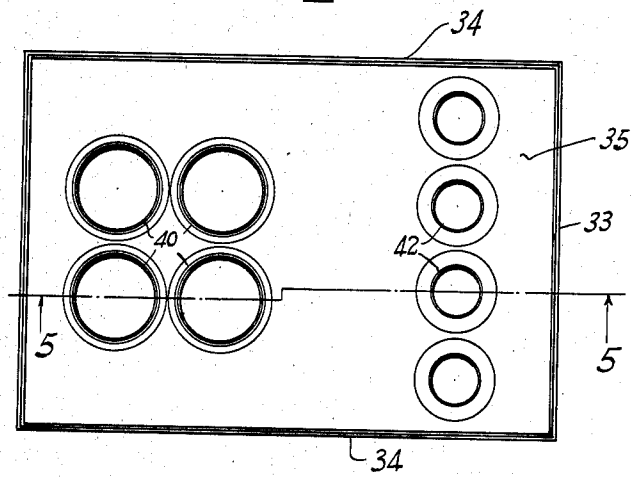


Fig. 5

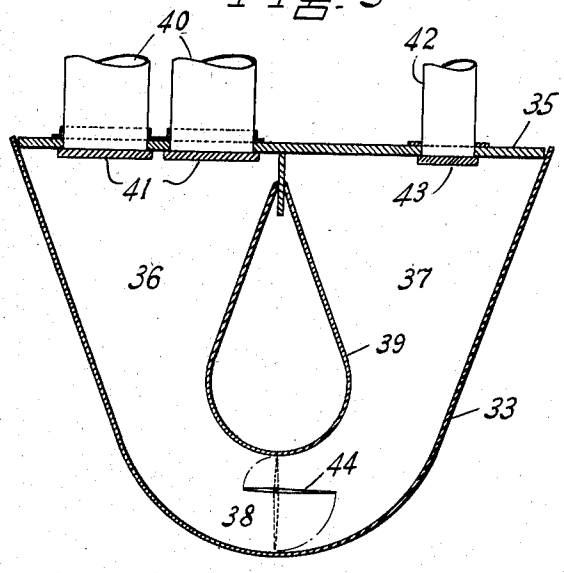
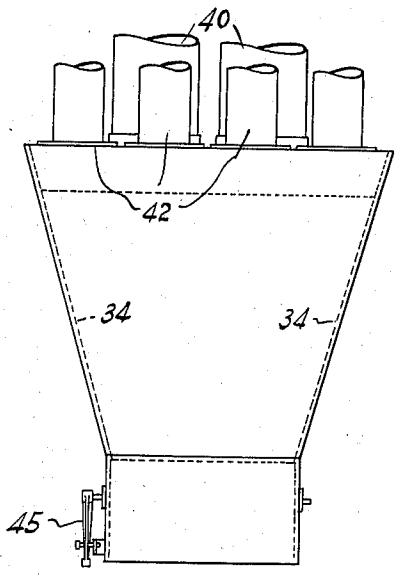


Fig. 6



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Fig. 7

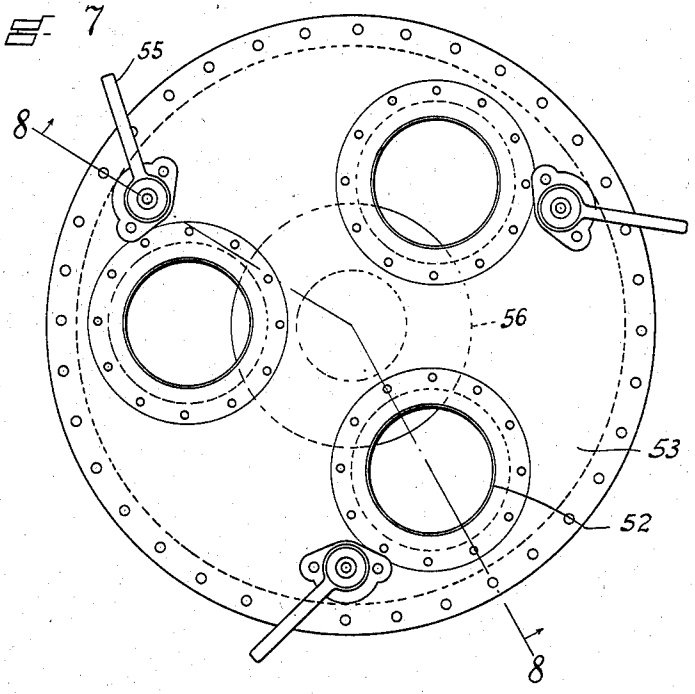
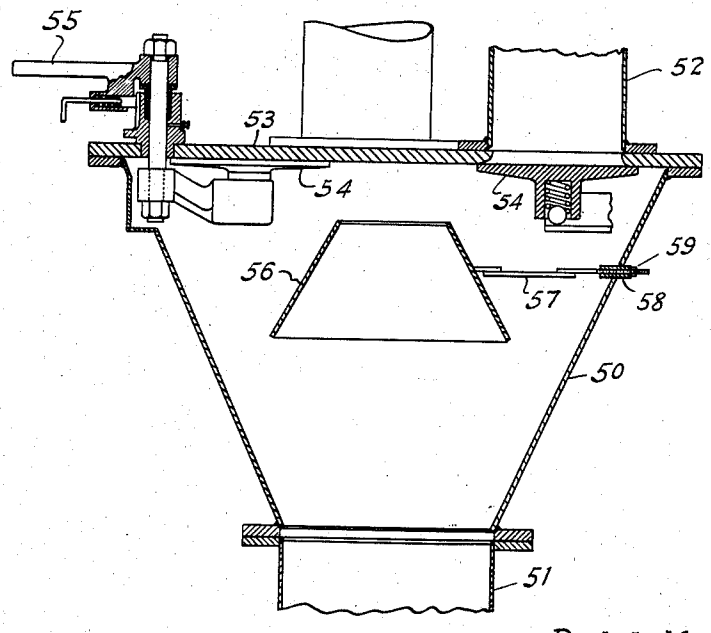


Fig. 8



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DISTRIBUTOR FOR PNEUMATICALLY TRANSPORTED SOLID MATERIAL

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Application June 1, 1936, Serial No. 82,804

9 Claims. (Cl. 302—28)

This invention relates in general to improvements in the construction and operation of distributors for distributing finely divided solid material suspended in a gaseous carrier medium between a plurality of outlet conduits, and more particularly, to distributors especially designed and adapted for use in a system for distributing a mixture of pulverized fuel and air for combustion to a plurality of fuel burners.

The general object of the invention is the provision of improved means for distributing pneumatically transported pulverized material equally in streams of uniform composition between a plurality of conduits, which means are characterized by their simplicity and low cost of construction, high resistance to internal pressures especially those due to accidental explosions, and effectiveness of operation. A further object is the provision of a direct-firing pulverized fuel system including a plurality of fuel pulverizers arranged to supply fuel to a plurality of separate pulverized fuel burners through a common distributing device, permitting the supplying of fuel to any one of the burners from any one of the pulverizers with a simplified arrangement of and low space requirements for the inter-connecting piping.

The various features of novelty which characterize the 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 are illustrated and described pereferred embodiments of the invention.

Of the drawings:

Fig. 1 is a diagrammatic plan view of the direct-firing pulverized coal supply system constructed in accordance with the invention;

Fig. 2 is a sectional elevation of the distributor shown in Fig. 1;

Fig. 3 is a view similar to Fig. 2 illustrating a modification;

Fig. 4 is a plan view of another form of distributor;

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

Fig. 6 is a side view of the distributor shown in Figs. 4 and 5;

Fig. 7 is a plan view of a further modification;

Fig. 8 is a vertical section taken on the line 8—8 of Fig. 7; and

Fig. 9 is a view similar to Fig. 2 illustrating a modification.

In Fig. 1 is diagrammatically illustrated a pulverized coal supply system for a furnace 10 having rows of separate pulverized coal burners 11 arranged at opposite sides thereof. In the system shown, coal is pulverized in a plurality of pulverizers 12 constructed to discharge a mixture of pulverized coal and carrier air through outlet pipes 13 connected to the upper end thereof. Two outlet pipes are shown for each pulverizer, each delivering fuel to the burners at one side of the furnace. All of the outlet pipes 13 to the same side of the furnace are connected to a common distributor 14, shown in more detail in Fig. 2. The pipes 13 are connected to inlet openings in the top of the distributor 14 at symmetrically arranged points adjacent the sides thereof.

The distributor 14 consists of an inverted frusto-conical outer shell 15, having a top plate 16 closing the upper or larger end thereof and a plate 17 the lower or smaller end. Within the shell 15 is arranged an inner shell or hollow baffle 18 also of inverted frusto-conical shape, but with a base angle greater than that of the outer shell 15 to provide a space therebetween of progressively decreasing flow area toward its lower end. The upper or larger end of the baffle 18 is closed by the top plate 16, while its lower or smaller end terminates above the bottom of the shell 15. The top and bottom plates of the casing are connected to a hollow strut 19 of circular cross-section. An inner concave bottom member 20 formed by a double curved surface of revolution extends across the lowed part of the shell 15 to the strut 19, and provides a curved conical bottom subjacent to the lower end of the baffle 18. A plurality of outlet pipes 21 are connected to outlet openings formed at symmetrically arranged points in the portion of the top plate 16 within the limits of the baffle 18. Valves 22 of the type illustrated in Figs. 7 and 8 are provided at the lower end of the outlet pipes.

It is difficult and sometimes undesirable to continuously maintain similar operating conditions in all of the pulverizers, and consequently the pulverizers may vary, not only in their outputs, but also as to the fineness and coal-air ratio of their outputs. The best conditions of furnace operation are ordinarily obtained by an equal distribution of the coal supply between the burners in coal-air streams of similar composition. It is moreover desirable at times to shut off some burners without disturbing the distribution to the remainder. With the described pulverized

coal supply system in operation, pulverized coal is pneumatically transported from all of the pulverizers to each distributor. The several coal-air streams entering the distributor and flowing downwardly through the inlet pipes 13 into the tapering annular passage between the shell 15 and the baffle 18, are deflected by the impingement plate 20 around the lower end of the baffle 18 and upwardly inside of the baffle 18 to the outlet pipes 21.

With this construction the coal-air stream leaving the distributor through each of the outlet pipes 21 is uniform as to coal-air ratio in spite of any differences in coal-air ratio of the streams entering the distributor through the inlet pipes 13. The coal-air stream entering through each inlet pipe 13 is normally characterized by an unequal distribution of coal to air over its cross-section, and the ratio of coal to air entering one pipe may be different from that entering another. In passing from the top to the bottom of the distributor, each coal-air stream is deflected from its original vertically downward direction, first by the side of the cone 15, and second by the double curvature bottom plate 20, the whole change of direction being 180°. The effect of this deflection is to redistribute the pulverized coal in the carrying air so that the heavier particles concentrate along the deflecting surface or the outer side of the bend of the stream. At the same time there is a sidewise spreading of each stream circumferentially of the deflector surfaces until the stream entering from any one inlet pipe is spread in a thin layer over the whole circumference by the time it reaches the curved bottom plate. When several or all of the inlet pipes are each delivering a stream into the distributor, each separate stream is distributed around the circumference of the deflector 20, and so merges with the others to form a single stream of uniform composition as to coal-air ratio around the circumference of the bottom deflector plate, with the heavier particles concentrated next to the plate and so varying in coal-air ratio across the stream or radial plane section. The distributor therefore comprises a first zone for merging any number of entering streams, of whatever total coal-air ratio, and any cross-sectional distribution of coal-air ratio in each, into a single consolidated stream characterized by a uniform coal-air ratio circumferentially, and a varying coal-air ratio radially but of the same variation in each radial plane. The decreasing cross-section above the bottom deflector plate aids in this action.

This consolidated stream of such coal-air composition characteristics flows up from the bottom deflector plate 20 around the central cylindrical strut 19 to the top plate 16 which deflects it horizontally and radially outward to the inside face of the inner cone 18 which again deflects it downward, to the bottom where it meets the entering stream above the bottom plate, so that a circulation of the consolidated stream is established in the second zone of the distributor. The consolidated stream formed in the first zone and circulating in the second zone retains its characteristics during the circulation in this second zone, the coal-air ratio being circumferentially uniform and varying over a radial cross-section, but the same in each radial cross-section.

The outlets from the distributor are disposed across the path of the circulating consolidated stream, as shown in Fig. 2, in the top plate 16, and on different radii so that the coal would sweep past with the outlet valve closed and be withdrawn when the valve is open, and each outlet stream will have the same coal-air ratio because this is the same in each radial plane of the circulating stream in the second zone.

Closure of a valve 22 of an outlet opening will leave that part of the circulating stream flowing outward on its radius unchanged beyond the valve while that flowing outward on radii of open valves has been changed beyond the opening, so that the circumferential distribution will no longer be uniform beyond the outlet openings. However the circumferential distribution is again equalized before the stream completes another circuit and returns to the open outlets, because of the deflecting effect of the inner cone 18 with its circumferential spreading of the stream, and the second deflection of the curved bottom plate which has the same effect and which merges the circulating stream with the entering feed stream at the bottom to restore the circumferentially uniform consolidated circulating stream.

In direct-firing pulverized coal systems heretofore it has been customary to connect the pulverizers directly to separate burners or separate groups of burners so that in such cases when one pulverizer is taken out of operation the corresponding burners will also be out of use and exposed to the high temperature conditions in the furnace frequently with disadvantageous results. With the present supply system, the presence of "dead" burners is eliminated as all the burners can be maintained in use even though all but one of the pulverizers be out of operation.

In the construction shown in Fig. 3, all of the pulverizer discharge pipes 13 are directly connected to symmetrically arranged inlet openings in the top plate of an auxiliary collector section of the distributor formed by an inverted frusto-conical shell 25 having a single bottom discharge pipe 26 connected to an opening in the central portion of the top plate 27 of a lower distributor section. The distributor section is of the same general construction as that shown in Fig. 2, having an inverted frusto-conical outer shell 29, a similarly arranged steeper frusto-conical baffle 30 having its lower end terminating above and symmetrically arranged relative to a concavely curved conical bottom plate 31, and outlet pipes 21 connected to symmetrically arranged outlet openings adjacent to the periphery of the top plate 27 so as to communicate with the annular chamber formed between the shell 29 and the baffle 30. The auxiliary collecting section in effect forms a continuation of the chamber enclosed by the baffle 30, causing the coal and air streams discharged by the inlet pipes 13 to consolidate into a single stream, the composition of which becomes more uniform as it descends through the pipe 26 and baffle 30. The stream impinges on the bottom of the plate 31 and is converted into an upwardly directed stream of annular cross-section flowing through the annular chamber between the shell 29 and baffle 30. The impingement on the shell 29 and the plate 31 causes a circumferential distribution of the material, tending to promote a whirling of the ascending material and uniform distribution of the material in the annular chamber.

The construction shown in Fig. 3 permits the use of smaller shell members for a given number of connected conduits, reducing the cost of construction necessary to withstand predetermined internal explosion pressures. The sectional construction also provides a more uniform mixture of coal and air entering the distributor section.

The modification shown in Figs. 4, 5 and 6 in-

corporates many of the functional advantages of the construction shown in Fig. 2 and comprises a casing or shell formed by a plate 33 having a curved bottom and upwardly diverging side portions, a pair of downwardly converging side plates 34, and a flat top plate 35. The shell space is divided into two similar serially connected chambers 36 and 37 of progressively decreasing cross-sectional area towards a bottom connecting throat 38 by means of an aeroform baffle or filler member 39 extending downwardly from the top plate between the opposite side plates 34. Inlet pipes 40 are connected to the chamber 36 through symmetrically arranged inlet openings in the top plate controlled by slidable disc valves 41 and a plurality of outlet pipes 42 are similarly connected to outlet openings from the chamber 37 controlled by valves 43. A damper 44 is located in the throat 38 to regulate the effective flow area thereof in accordance with variations in flow so that the velocity through the throat can be maintained sufficiently high to keep the bottom clear of deposited material. The position of the damper is controlled by an external lever 45 which may be manually or automatically adjusted to maintain a fixed or variable pressure differential, as desired, between opposite sides of the damper. The incoming streams of coal and air converge in the chamber 36 into a single stream at the throat and its direction is reversed 180° in passing upwardly through the chamber 37.

In the modification shown in Figs. 7 and 8 the distributor is formed by an inverted frusto-conical shell 50 having a single supply connection 51 to the bottom thereof, and outlet pipes 52 connected to openings symmetrically located in the top plate 53. Each of the outlet openings is provided at its inner side with a sliding disc valve 54 externally operable by levers 55. When the pipe 51 is connected, for example, to a pulverizer (not shown) discharging a mixture of pulverized coal and air, the larger coal particles will tend to be concentrated along one side of the pipe. To provide a uniform distribution of the coal particles to the several outlet pipes 52, a frusto-conical baffle 56 having its larger or lower end of substantially the same diameter as the inlet pipe 51 and normally concentric therewith, is positioned in the upper part of the shell 50 in the path of the discharge from the pipe 51. The baffle 56 is advantageously supported by radial link supports 57 having threaded outer ends extending through sleeves 58 in the shell and carrying nuts 59 through the adjustment of which the baffle 56 may be shifted within certain limits to provide for small changes in direction of the stream passing out of the upper end thereof. Most of the coarse coal particles discharged from the pipe 51 will enter the lower end of the baffle 56 and be caused to impinge against the lower side of the top plate 53 adjacent the center of that plate and be deflected towards the sides of the casing below the outlet openings. The converging form of the baffle 56 causes the various portions of the fuel stream either directly or recirculated from the upper section to be circumferentially distributed therein so that the streams of coal and air subsequently issuing through the several outlet pipes 52 will be of substantially similar uniform composition.

In the modification illustrated in Fig. 9, the inner cone baffle 18 of Fig. 2 is made vertically adjustable to vary the effective flow area through the annular throat formed between the lower end of the baffle and the curved bottom plate 20, and thereby control the velocity of the coal-laden air through the throat. For this purpose, the strut 19 is provided with narrow vertical slots 60 through which pass the arms 61 of a spider secured to the baffle 18. The hub 62 of the spider is located within the strut and threaded to receive the lower threaded end of a shaft 63 rotatable by an external hand wheel 64. A cylindrical sleeve 65 depends from the top plate 16 to close the space between the top of the baffle 18 and top plate.

We claim:

1. A distributor for pneumatically transported solid material comprising an outer shell having an inlet opening arranged in the top thereof for the entry of the material to be distributed, a baffle arranged within said shell with its upper end extending to the top of said shell and its lower end terminating above the bottom of said shell, said baffle being arranged to divide said shell into serially connected inlet and outlet chambers, each of decreasing cross-sectional area toward its lower end, and a series of branch pipes opening through the top of said shell and communicating with the upper end of said outlet chamber.

2. A distributor for pneumatically transported solid material comprising an outer shell having a plurality of inlet openings symmetrically arranged in the top thereof for the entry of the material to be distributed, a baffle arranged within said shell with its upper end extending to the top of said shell and its lower end terminating above the bottom of said shell, said baffle being arranged to divide said shell into serially connected inlet and outlet chambers, each of progressively decreasing cross-sectional area toward its lower end, and a series of branch pipe connections symmetrically arranged in the top of said shell and communicating with the upper end of said outlet chamber.

3. A distributor for pneumatically transported solid material comprising an outer shell of inverted frusto-conical shape having a top plate forming the larger base thereof, a hollow inverted frusto-conical baffle arranged within said shell with its larger end extending to the larger base of said shell and its smaller end terminating above the bottom of said shell, said baffle and said shell being arranged to provide an annular flow space therebetween of progressively decreasing cross-sectional area toward its lower end, a curved impingement plate at the bottom of said flow space arranged relative to the lower end of said baffle to deflect material around the lower end of said baffle, and a series of inlet and outlet openings arranged in said shell top plate at opposite sides of said baffle respectively.

4. A distributor for pneumatically transported solid material comprising an outer shell of inverted frusto-conical shape having a top plate forming the larger base thereof, a hollow inverted frusto-conical baffle arranged within said shell with its larger end extending to the larger base of said shell and its smaller end terminating above the bottom of said shell, said baffle having a greater base angle than said shell providing an annular flow space therebetween of decreasing cross-sectional area toward its lower end, a concavely curved impingement plate at the bottom of said flow space symmetrically arranged relative to the lower end of said baffle, and inlet and outlet openings arranged in said shell top plate at opposite sides of said baffle.

5. A distributor for pneumatically transported

solid material comprising an outer shell of circular cross-section having a plurality of inlet openings arranged in the upper end thereof for the entry of the material to be distributed, a hollow circular baffle arranged concentric with said shell with its upper end extending to the top of said shell within said inlet openings and its lower end terminating above the bottom of said shell, said baffle and shell being arranged to provide an annular flow space therebetween of decreasing cross-sectional area toward its lower end, an impingement plate at the bottom of said flow space symmetrically arranged relative to the lower end of said baffle, and a series of branch pipe connections arranged in the upper end of said shell and communicating with the space within said baffle.

6. A distributor for pneumatically transported solid material comprising an outer shell of inverted frusto-conical shape having a plurality of material inlet openings symmetrically arranged in a top plate forming the larger base thereof, a hollow inverted frusto-conical baffle arranged concentric with said shell with its larger end extending to said top plate within said inlet openings and its smaller end terminating above the bottom of said shell, said baffle having a greater base angle than said shell providing an annular flow space therebetween of progressively decreasing cross-sectional area towards its lower end, a curved impingement plate at the bottom of said flow space symmetrically arranged relative to the lower end of said baffle to cause material to flow upwardly within said baffle, and a series of outlet openings symmetrically arranged in said top plate within said baffle.

7. A distributor for pneumatically transported solid material comprising an outer shell having a plurality of inlet openings symmetrically arranged relative to one another in the top thereof for the entry of the material to be distributed, a baffle structure arranged within said shell with its upper end extending to the top of said shell and its lower end terminating above the bottom of said shell, said baffle structure being arranged to divide said shell into an inlet chamber communicating with said inlet openings and an adjacent serially connected outlet chamber, and a series of outlet branch connections symmetrically arranged relative to one another in the top of said shell and communicating with the upper end of said outlet chamber.

8. A distributor for pneumatically transported solid material comprising an outer shell having a plurality of inlet openings arranged in the top thereof for the entry of the material to be distributed, a baffle arranged within said shell with its upper end extending to the top of said shell and its lower end terminating above the bottom of said shell, said baffle being arranged to divide said shell into inlet and outlet chambers, each of decreasing cross-sectional area toward its lower end, a passage of reduced cross-sectional area connecting the lower ends of said chambers, damper means for regulating the material velocity through said passage, and a series of outlet openings arranged in the top of said shell and communicating with the upper end of said outlet chamber.

9. A distributor for pneumatically transported solid material, comprising an outer frusto-conical shell having one or more openings in a base thereof for the entry of the material to be distributed, a frusto-conical baffle in the path of the entering material arranged to provide a converging flow path therethrough for the material, a plurality of material outlet openings symmetrically arranged in a base of said outer shell, and means forming an impingement surface receiving the impact of the material from the smaller end of said baffle and arranged to direct said material towards said outlet openings.

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