

[54] **FRUSTO-CONICAL GRID**

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[51] Int. Cl. **F26b 17/10**

[58] Field of Search..... **34/10, 57 R, 57 A; 263/21 A; 432/58**

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[57] **ABSTRACT**

A frusto-conical grid adapted for use between a high pressure chamber and a low pressure chamber for enabling fluid to flow from the high pressure chamber into a low pressure chamber to fluidize a bed of mate-

rial contained therein adjacent the upper surface of the grid characterized by the grid being provided with a plurality of conically shaped passageway having the smaller opening disposed in the high pressure chamber with the enlarged opening disposed in the low pressure chamber. The passageways in one embodiment are formed by frusto-conical tubular members which have their walls joined to adjacent members by a welded intersecting line to minimize any flat surfaces on which the material of the fluidized bed can be built up or accumulated on. By controlling the angle of divergence of a conical tubular member the flow of the gaseous medium through the small end can be either along the inner surface or the center of the tubular member causing different types of mixing and interaction between the particles disposed in the tube and fluid medium passing therethrough. In one embodiment liquid such as water or other material can be mixed with the bed of fluidized materials by being applied to the grid adjacent the small opening and it is carried by the flow of the medium through the small openings of the passageways and is mixed with the materials of the fluidized bed. Such arrangement can be used for adding a fluid to a bed of material and can be used as a means of scrubbing a gaseous medium to remove solid particles therefrom. Another similar arrangement can be used to cause complete combustion of a vaporized fuel such as heavy oils added to the medium adjacent the area grid to produce, in effect, many "burners" by providing a large interface for combustion of fuel with air while passing through the grid.

2 Claims, 10 Drawing Figures

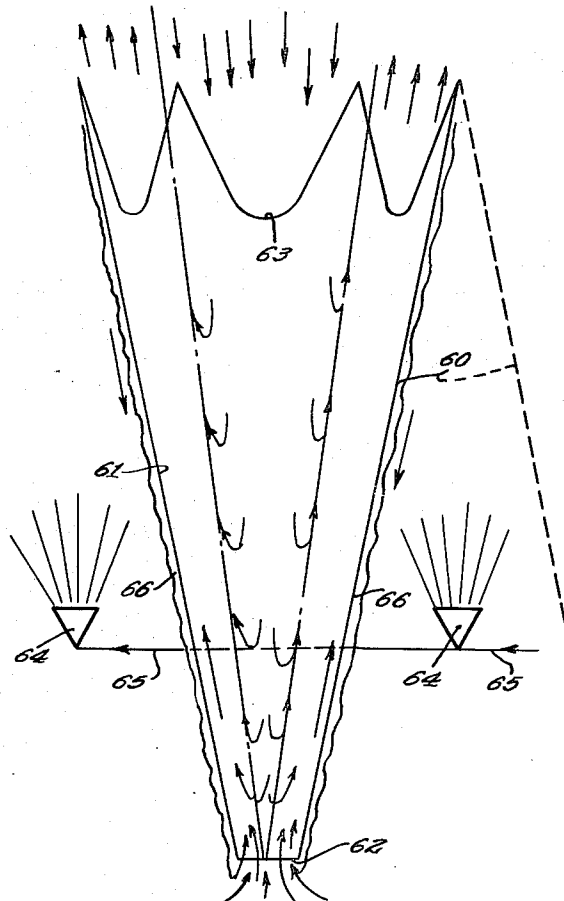


Fig. 1

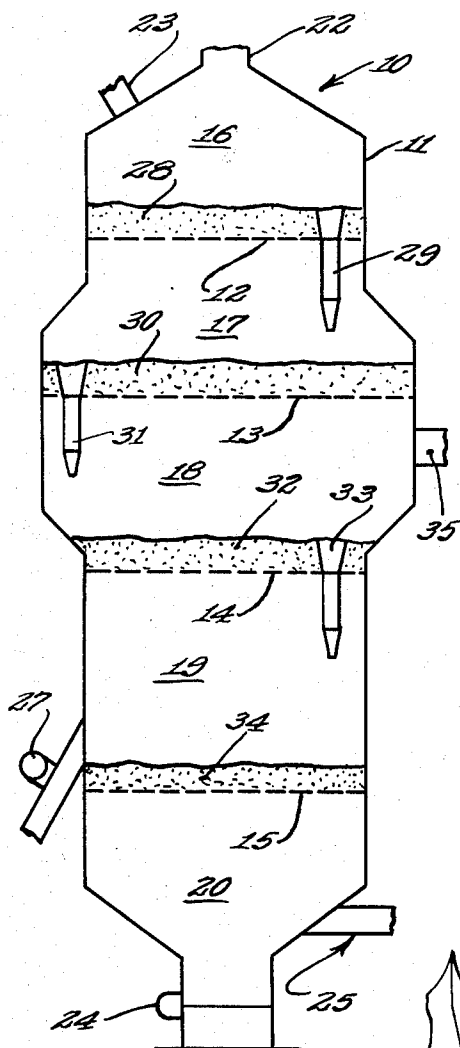


Fig. 2

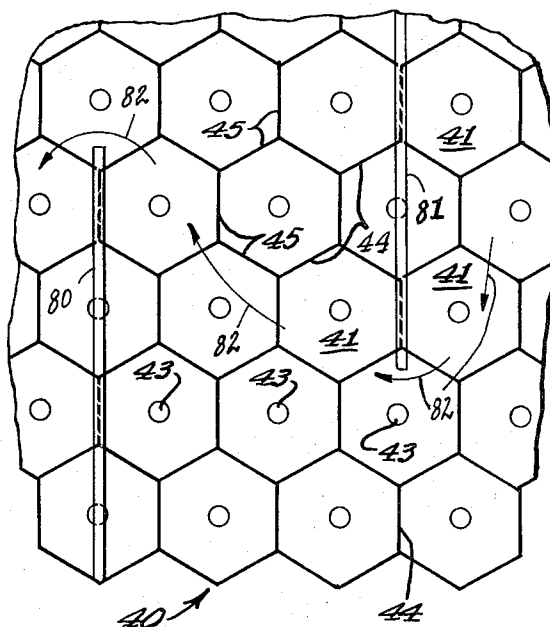
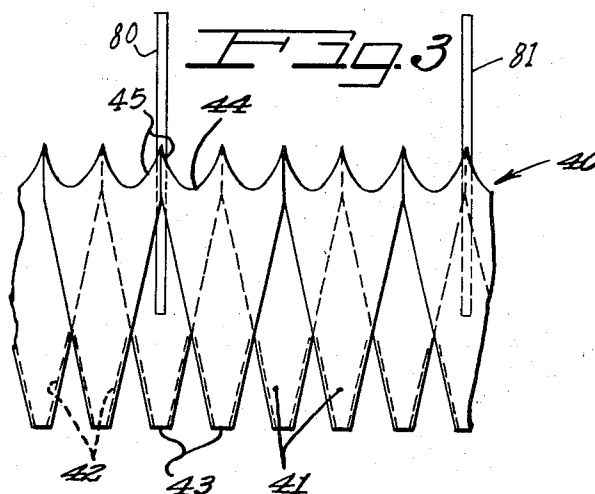


Fig. 3

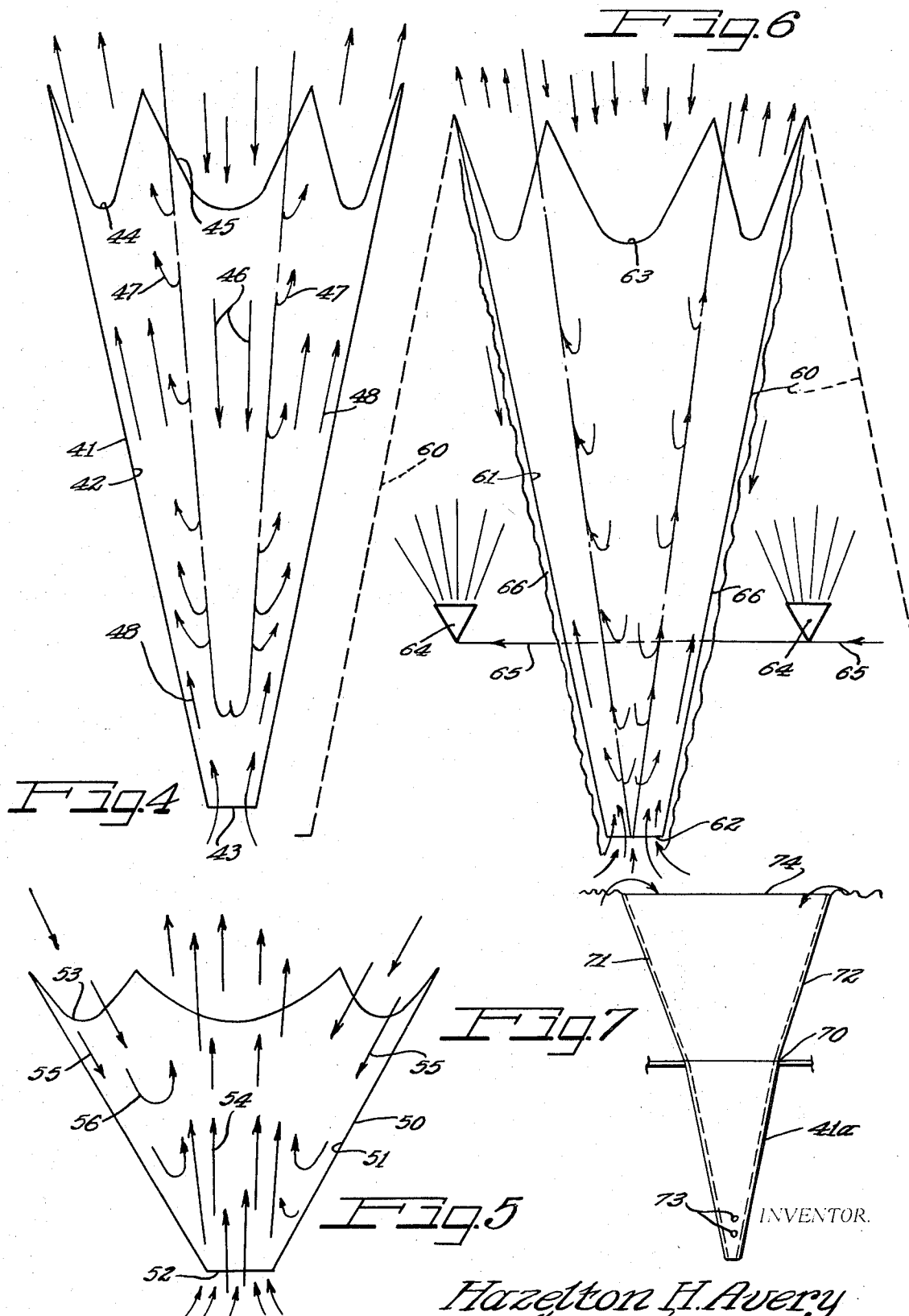


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Fig. 8

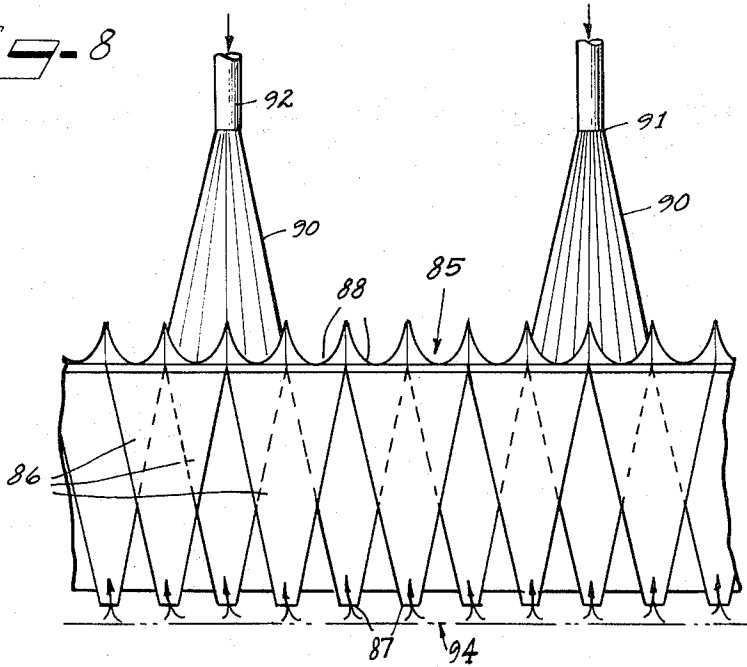


Fig. 9

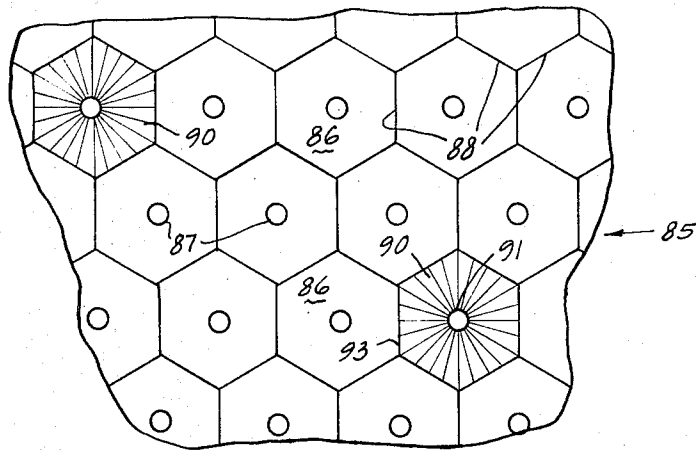
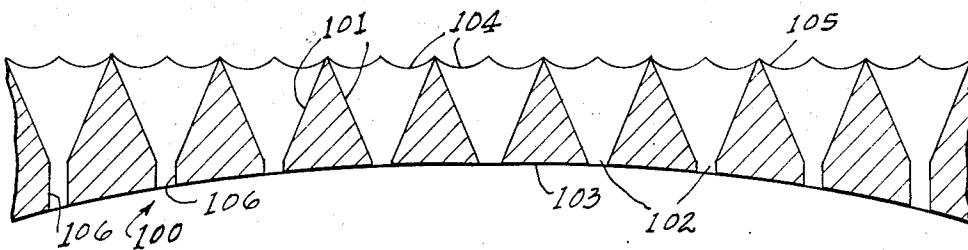


Fig. 10

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FRUSTO-CONICAL GRID**BACKGROUND OF THE INVENTION****1. Field of the Invention**

The present invention is directed to a grid structure for a fluidizing apparatus and a fluidizing apparatus utilizing the grid structure.

2. Prior Art

In presently known apparatus utilizing a fluidized bed created by passing gaseous medium under pressure through a perforated sheet to cause solid particles or liquid to be suspended in a flow of the medium in a manner similar to a liquid suspension are known in the art. The grids of these apparatus are provided with a plurality of openings therethrough for enabling the flow of a pressurized medium between the pressure chambers. In the presently known apparatus, the spacing between openings provides a large flat surface area therebetween on which material will accumulate and will not be properly agitated by the flow of the medium through the grid. The structure of the presently known fluidizing beds are particularly ineffective in handling sticky or wet materials such as foundry sands which tend to accumulate or pile up in those areas of the grid between the grid openings. Another difficulty with the presently known grid structures for fluidizing beds is that at the time of shut down, a complete removal of the material of a fluidized bed by allowing the material to flow through the grid into the chamber therebelow is prevented by the large percentage of flat surface areas of the grid. Whereas complete removal of the material is a problem only upon shut down for a continuous flow operation, the need for removal occurs at the end of each process cycle in batch type operations.

Grids have been formed from flat metal sheets and in high temperature application have experienced problems with warping, due to the expansion of the grid material. In some high temperature applications, grids have been made out of a refractory material having metal inserts for the grid openings. The presently known structure of high temperature refractory grids are expensive to manufacture and their expense has limited the use of high temperature fluidized beds.

SUMMARY OF THE INVENTION

The present invention is directed to a grid for fluidizing apparatus which grid prevents the piling and accumulation of material on an upper surface thereof. To reduce the flat areas and thus to reduce the tendency of piling or accumulation of material in a fluidized bed, the grid of the present invention utilizes a plurality of passageways which have small openings into the high pressure chamber but diverge or flare into an enlarged opening adjacent the low pressure chamber to cause a better mixing of the gaseous medium passing through the grid and to limit the amount of flat areas between the passageways of the grid. In one embodiment, the grid is composed of a plurality of conically shaped tubular members which have the flared or enlarged ends joined together in substantially intersecting line contact to form a grid which can withstand temperature changes. In another embodiment, the grid is a non-metal grid having conically shaped passageways therethrough with the enlarged portions of each conically shaped passageway being on one surface to minimize the flat surface area of the grid. Another embodiment of the present invention includes providing a grid and

providing means for applying a liquid adjacent to the openings through which the air passes so that the liquid is drawn into the passageways and mixed with the material therein to facilitate removal of solid particles contained in the medium as it passes through the fluidized bed adjacent the grid or to mix the liquid with the material of the fluidized bed. One embodiment of the present invention includes means to introduce fuel to the gaseous medium passing through the grid to obtain combustion in the passageway of the grid.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross section of a material treatment apparatus utilizing the grid of the present invention;

FIG. 2 is an enlarged top view of a portion of the grid of the present invention;

FIG. 3 is an enlarged side elevation of a portion of the grid illustrated in FIG. 2;

FIG. 4 is an enlarged cross sectional view of a cone member utilized to form the embodiment of the grid illustrated in FIG. 3;

FIG. 5 is an enlarged cross sectional view of a cone member utilized to form another embodiment of the grid of the present invention;

FIG. 6 is an enlarged cross-sectional view of cone members having means for spraying fluid to form an embodiment of the present invention;

FIG. 7 is a view of a modification of a cone member to form transfer valves of the present invention;

FIG. 8 is a side elevation of a portion of an embodiment of the grid of the present invention;

FIG. 9 is a top view of the embodiment of FIG. 8; and

FIG. 10 is a cross section of another embodiment of the grid structure of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Although the principles of the present invention have utility for any grid means utilized with a fluidized bed, they have particular utility in a grid means disposed between a pair of pressure chambers for passing a fluid medium therebetween as illustrated in a multi-stage treatment apparatus generally indicated at 10 in FIG.

1. The apparatus 10 has a container or chamber 11 having a plurality of grid means 12, 13, 14 and 15 which subdivide the container or chamber 11 into pressure chambers 16, 17, 18 and 19 and 20. The uppermost pressure chamber 16 has an outlet generally indicated at 22 for exhausting the gaseous or fluid medium from the apparatus 10 and an inlet 23 for adding material to the multi-stage apparatus 10. The lowermost chamber 20 is provided with a drain means 24 which has proper control means for the opening and closing the drain means to control removal of material there-through and means for supplying a gaseous medium under pressure generally indicated at 25. Adjacent the lower grid means 15 the chamber 19 has a material removing means 27 which has suitable control means such as a gate valve.

The gaseous medium supplied through the inlet 25 passes through the grid 15 to the chamber 19 thereabove. The grid means 15 creates a pressure differential so that the pressure in the chamber 19 is less than that in chamber 20. The grid means 14 which separates chamber 19 from chamber 18 causes a pressure drop in the gaseous medium flowing from the chamber 19 to the chamber 18 and the grid means 13 causes pressure

drop in the gaseous medium flowing from the chamber 18 to the chamber 17. The grid means 12, which is disposed between chambers 16 and 17, causes a pressure drop between the chambers 17 and 16. Thus each of the chambers above a grid means has a lower pressure than the chamber therebelow so that the pressure in the chambers 16-20 decreases as the distance from the sub-chamber 20 increases.

Material added through the material input means 23 will form a bed 28 of fluidized material adjacent the upper surface of the grid means 12 in the sub-chamber 16. The material in the fluidized bed 28 is maintained in a fluidized suspension by the flow of the gaseous medium passing through the grid means 12. While in the fluidized bed 28, the material is mixed and contacted by the gaseous medium passing therethrough.

To transfer the material out of the grid means 28, a transfer valve 29 is provided and transfers that material from the bed 28 into the next lower chamber 17. The material transferred by the valve 29 to the chamber 17 forms a second fluidized bed 30 adjacent grid means 13 which has transfer valve 31 for transferring material from the fluidized bed 30 into the next lower chamber 18 to form a fluidized bed 32 which is adjacent the grid means 14. The grid means 14 also has a transfer valve 33 for transferring the material from the fluidized bed 32 into the lowermost fluidized bed 34 which is adjacent the upper surface of grid means 15. The material removing means 27 removes material from the bed 34 and from the apparatus 10. The transfer valves 29, 31 and 33 are substantially the same as the transfer valve disclosed and claimed in my U.S. Pat. No. 3,558,111, assigned to the assignee of this application; reference is made to that patent for a description of the operation of the transfer valves.

In the apparatus illustrated in FIG. 1, the purpose is to treat a material such as foundry sand to remove contaminants therefrom. In order to treat the sand, a burner generally indicated at 35 creates heat that is added to the gaseous medium in the pressure chamber 18 and which will work on or react with the materials in the fluidized bed 30 adjacent the grid means 13. Thus material introduced through the inlet 23 to the bed 28 will be heated by the hot gases passing through the grid 12 and the bed 28 is a preheating bed. As the material is transferred to the bed 30 from the bed 28, it is entering the treatment bed which has the highest temperature due to the combustion that occurs at the burner 35. When the material has been transferred by the transfer valve 31 to the next lower bed 32 it will begin to be cooled by the flow of gases from the chamber 19 and the material gives up its heat to the gas to act as a preheating bed for the gas as the material of the bed 32 is cooled from the temperature of the treatment bed 30. The next lower bed 34 is a second cooling bed and the first preheating bed for the gaseous medium added through the supply means 25.

Thus material such as sand is preheated to the maximum temperature and then cooled in the lower fluidized beds while the gaseous medium added through the supply means 25 is heated as it passes through the fluidized beds 34 and 32. As the gaseous media reaches the chamber 18, it is combined with the heat created by the burner means 35 to roast or otherwise treat the material in the beds 30 adjacent the grid means 13 and then is subsequently cooled by the material that is in the bed 28 adjacent the grid 12.

The present invention is particularly directed to the construction of the grid means 12, 13, 14 and 15, which improves the interreaction between the gaseous medium and the material disposed in the fluidized bed adjacent the upper surface of each of the grid means. It will be understood that the grid construction hereinafter to be described in detail constitutes each of the aforementioned grid means 12, 13, 14 and 15. As illustrated in FIGS. 2 and 3, the grid means, generally indicated at 40, is formed of a plurality of members 41. Each of the members 41 has a passageway 42 extending from a small or restricted opening 43 and flares or diverges to an enlarged opening 44. The members 41 are joined together at an upper peripheral edge 45 which defines the enlarged opening 44 by weld joints to form a grid having substantially no flat surfaces since the upper peripheral edges 45 have been contoured to provide a line intersection between adjacent members 41. Thus, the peripheral edge 45 does not lie in a plane and has a wavy configuration, as best illustrated in FIG. 4. The members 41 of FIGS. 2 and 3 are of a frusto-conical shape and the peripheral edge 45 with its wavy configuration present a hexagonal shape when viewed from top as illustrated in FIG. 2. While the members 41 have been illustrated with a hexagonal shape when viewed from the top or axial direction, other shapes such as a triangle and rectangle can be provided with the proper contour of the peripheral edges of the frusto-conical members.

In the grid 40, the percentage of the area of the grid which is opened to the higher pressure chamber such as 20 is substantially 2 to 5 percent of the total area of the grid and is composed of the sum of the areas of the small openings 43. However, due to the diverging or flaring configuration of the passageway 42 of the members 41, the upper surface is substantially the sum of the area of the enlarged openings 44.

As best illustrated in FIG. 4, the particles in the fluidized bed will move down into the interior of the passageway 42 in the direction of arrows 46. The flow of the gaseous medium such as air entering the restricted opening 43 contacts the particles moving downward through the passageway 42 and causes these particles to be forced upward in a direction indicated by the arrows 47. When the included angle of the cone is substantially small as illustrated in FIG. 4, the gaseous medium entering the restricted orifice 43 moves along the surfaces of the passageway 42 in the direction of the arrows 48. Thus material entering the cone will move down through the center of the cone as indicated by the arrows 46 until it is contacted by the flow of the gaseous medium which is passing in the opposite direction. When the material hits the flow of air, the material is forced upward with a good mixing effect and carried or spouted back into the bed above the grid means. The flow of the gaseous medium while in the passageway 42 along the surface of the passageway is known as the coanda effect and causes a good scrubbing action of the particles of the bed which have entered the passageway and are carried back to the bed above the grid means. Since the passageway 42 is frusto-conical, the fluid or gaseous medium entering the opening or orifice 43 expands as it travels through the passageway 42 with a corresponding drop in its velocity and pressure.

In the member 41 the included angle of the cone is approximately 24°. If the included angle of the cone is increased to be between 30° and 90°, a certain angle is

reached at which the air entering the restricted orifice such as 43 will move centrally or axially through the cone instead of following the surfaces of the passageway. As best illustrated in FIG. 5, a member 50 which is a frusto-conical shaped tubular member having a passageway 51 terminating at the apex of the cone with a restricted opening or orifice 52 and diverging or flaring outwardly to an enlarged opening 53. The frusto-conical member 50 has an included angle of approximately 60° and a gaseous medium such as air entering the restricted orifice 52 will move as indicated by the arrows 54 along the axis of the passageway 51. The material of the fluidized bed will move downwardly through the passageway 51 towards the restricted orifice 52 as indicated by the arrows 55. When the material moving downward in the passageway 51 contacts the column of upwardly moving air or gaseous medium, it is carried upwardly out of the passageway as indicated by the curved arrow 56.

Each of the above described flows of the gaseous medium through the frusto-conical members 41 and 50 illustrate two different types of pumping action occurring in the passageways of the frusto-conical members caused by the interaction of the air flow and the solid particles in the cone. The pumping action causes a good scrubbing of the particles by the flow of the gaseous medium and a good transfer of heat between the particles and the gaseous medium. The interaction between gaseous medium, whether it is following the side walls of the cone or is moving substantially in an axial column, causes an interaction between the particles and the medium and limits the possibility of particles being accumulated in a space or area on the grid which is not subjected to the gaseous flow. Unlike previously known grids, the flow of the gaseous medium along the wall surface such as in a cone element 41 spreads the gaseous medium to effectively act on material across the entire area of the upper surface of the grid. In cone structure such as 50, the movement of the particles downward into contact with the upflowing gaseous medium causes a mixing and contacting of all particles across the entire area of the grid with the gaseous medium. Thus both cone configurations remove dead spots which were present in previously known grid structures.

In both of the described structures of the grid, a shutting down of the device such as 10 of FIG. 1, by stopping the flow of the gaseous medium allows the particles or material of the various beds 28, 30, 32 and 34 to drain through their respective grids 12, 13, 14 and 15 to the next chamber therebelow. The material will continue to drain through each lower grid means until it reaches the chamber 20 below the lowermost grid means 15. Once the material reaches the chamber 20, it is removed from the apparatus 10 through the drain means 24. Since the grids do not have any flat surfaces, the draining or removal of the particles is rapid and substantially complete. In the previously known grids, areas between the openings would accumulate small piles of material and a complete cleanout of each bed was accomplished only after using additional means such as manual cleanup.

When it is desirable to add a liquid or fluid to the particles in the various beds, the conical grid can be utilized with means for applying liquid. As best illustrated in FIG. 6, a grid formed of frusto-conical members 60 which are substantially the same construction as the

frusto-conical members 41 and have diverging passageways 61 extending from a restricted opening 62 to an enlarged opening 63 are joined together to form a grid. Liquid dispensing means such as spray nozzles 64, connected to a fluid supply means by supply lines 65, spray fluid on the outer surface 66 of the frusto-conical member 60. The liquid contacting the outer surface 66 runs down the cone toward the opening 62 where it is picked up by the gaseous medium entering the opening. As illustrated, the frusto-conical member 60 has a small conical angle of substantially 24° and the gaseous medium flows along the surfaces of the passageway 61 with the coanda effect. The liquid carried by the gaseous medium is mixed with the particles which are coming into contact with the upwardly moving gaseous medium to be mixed with the particles in the passageway and in the fluidized bed immediately adjacent the upper surface of the grid means.

The system illustrated in FIGS. 6 can be utilized to add a liquid, such as a resin to foundry sand or to add any other liquid to a particulate matter and to mix a liquid with that particulate matter in a desired quantity. The grid means formed with the conical member 60 as illustrated in FIG. 6 could also be used as a means of removing particles from the gaseous medium passing through the grid. For example, if a gaseous medium having a high concentration of particulate matter carried therewith contacts the liquid at the opening 62, the scrubbing action, caused by the particles in the passageway and the fluidized beds thereabove, with the liquid present tends to scrub the gaseous medium to remove particulate matter therefrom and thus the device could be used as a means of cleaning a gaseous medium such as air prior to being released to the atmosphere or used in subsequent operations.

As mentioned in the discussion of the device 10, transfer valve means 29 are provided for transferring the material from one bed such as 28 to the next lower bed such as 30. As illustrated in FIG. 1 the transfer valves 29 are individual units extending through the grid. However, the frusto-conical grid means 40 can have a transfer valve provided therefor by modifying one of the frusto-conical members 41. A modified frusto-conical member 41a (FIG. 7) has a planar upper periphery 70. A frusto-conical extension 71 is attached to the upper periphery 70 of the member 41a to form a valve 72. The frusto-conical member 41a is also provided with bleed orifices 73 adjacent the lower opening. The frusto-conical extension 71, which can be either of the same conical angle as the frusto-conical member 41a or of a slightly larger conical angle, has a height which will determine the height of the bed above the grid means. As discussed in the above-mentioned co-pending application, the material entering an enlarged opening 74 of the transfer valve 72 is greater than the material being ejected or spouted therefrom and will move through the valve and be discharged through the restricted orifice into the next lower bed. The presence of the bleed orifice 73 causes an interruption in the coanda effect of the gases entering the restricted orifice which facilitates the movement of the material through the transfer valve 72.

In the device 10, which is a continuous flow multi-stage device, the material being treated should remain in each of the beds such as 28, 30, 32 or 34 a sufficient time for the material to be treated if a treatment bed or to reach the desired temperature if a cooling or heating

bed. By placing the material inlet means such as transfer valve 29 (FIG. 1) diametrically opposite to the outlet means such as transfer valve 31, the material added to the bed 30 must move across the bed before it will be discharged. Usually the time required for the material to move across the bed is sufficient for the material to be treated or reach the desired temperature. However, in some instances it is desirable to cause the material to flow in a tortuous path across the bed and baffle means such as plates 80 and 81 (FIG. 2) are provided and the material will follow a path indicated by the arrows 82. As shown in FIG. 3, the plates 80 and 81 of the baffle means have a height to extend above the upper surface of the grid a distance equal to or greater than the height of the fluidized bed and the plates extend into the members 41 to prevent the majority of the material being acted on in the members 41 from bypassing the baffle means. The location of the plates such as 80 and 81 does not interfere with the flow of the gaseous medium through the grid or with the clean out or drain out of the material when the device is shut down.

As mentioned above, the grid of the present invention may be used in a device or system in which fuel is burned to increase the temperature of the gaseous medium flowing through the grid. One means of adding heat to the gaseous medium is the burner 35 of FIG. 1. In FIGS. 8 and 9, an embodiment of the grid is generally indicated at 85 includes means for introducing a fuel to the gaseous medium that is passing through the grid 85 to obtain combustion of the fuel as it and the medium are passing through the grid.

The grid 85 is substantially similar to the construction of the grid 40 and has a plurality of hollow members 86 with restricted or small openings at one end and enlarged openings 88 at the other end. The members 86 are joined together in the same manner as the members 41 of the grid 40 are assembled with the small openings 87 all facing one side of the grid.

To introduce a fuel to the gaseous medium, the means for introducing fuel includes several fuel nozzles 90 which are members having a small end 91 which is connected to a fuel conduit 92 that extends to a source of fuel which is outside of the device. The nozzle 90 diverges from the small end 91 to a large end 93 which has the same configuration as the large opening 88 of the members 86. The nozzles 90 are assembled in the grid 85 by replacing a hollow member 86 and as illustrated discharge the fuel into the space surrounding the apex or small openings 87 of the members 86. The fuel, whether a gas or a vaporized liquid, comes into contact with the gaseous medium entering the small opening 87 of the grid 85 and forms an ignition interface generally indicated at 94 which is below the plane of the small openings 87. In some applications it may be desirable to place a metal screen or ceramic cloth screen across the device at the ignition interface 94 to aid in the combustion of the fuel.

As the fuel is drawn into the small openings 87 of the members 86 of the grid 85 by the gaseous medium, it is burned to raise the temperature of the medium. The expansion of the medium and the coaction with the material of the fluidized bed in the passageways of the members 86 causes a complete combustion of the fuel due to the continuous mixing of the fuel with the medium. The particles of the fluidized bed provide additional combustion surfaces which aid in the combustion

of the fuel and the coaction of the medium and the material in the passageways of the grid insure a rapid and good heat transfer from the medium to the material of the bed. If the fuel is a liquid, such as heavy oil, the nozzle can be arranged, as illustrated in FIG. 6, to spray the fuel against the underside of the grid which is hot and will vaporize the oil to produce the desired but gaseous fuel with a burning inter-face.

In the above description of the frusto-conical grid means whether it is made with the small angle cones or frusto-conical members such as illustrated in FIGS. 2, 3 and 4, or with the large angle cone of FIG. 5, the frusto-conical members either 41 and 50 are formed of metal and are joined together to form the grid. As illustrated, the upper periphery of the enlarged opening such as 53 are formed to nest together in a substantially hexagonal shape. Other geometric shapes of nesting members such as triangles and rectangles can be provided by appropriately contouring the upper peripheral edge of the frusto-conical members.

While the structure of the frusto-conical grid means has been described as being formed from tubular members, the principle of the invention can be used in a solid metal or non-metal grid means 100 (FIG. 10) which has a plurality of passageways 101 which have restricted orifices or openings 102 on one side 103 and diverge or flare to an enlarged opening 104 on the other side 105. Depending upon the expected temperature range during its use, a non-metal grid means can be molded or formed from concrete or refractory materials. During molding of the non-metal grid means the passageways are formed by using mold inserts or forms which correspond to the shape of passageway 101 and are placed in the cavity of the mold form. The inserts can have a geometrically shaped base such as a hexagon triangle or rectangle which merges with a frusto-conical portion to produce a molded grid means having an upper surface and passageway of the configuration illustrated for the grid means 40 in FIGS. 2 and 3. If reinforcing means are required, structural reinforcement can be arranged around the mold insert before the material is molded. If a non-metal grid means is to have a substantial flat surface and an arched lower surface, a simple multiple cone insert utilizing a cone and cylindrical insert can be properly selected and the material molded with one surface provided with the desired shape. Thus, each of the passageway 101 run the same conical shape and the passageway in the thicker part of the grid has a cylindrical extension 106 of different lengths.

The molding of the non-metal grid means provides an inexpensive process for producing the grid means. In low temperature application, a non-metal grid means molded from concrete or reinforcing concrete is inexpensive to produce. High temperature operation may require the use of refractory material and the grid means such as 40 can be used in high temperature applications where expansion of the metal grid was a problem.

Although various minor modifications might be suggested by those versed in the art, it should be understood that I wish to employ within the scope of the patent warranted hereon all such embodiments as reasonably and properly come within the scope of my contribution to the art.

I claim as my invention:

1. A material fluidizing apparatus having a grid means disposed between a high pressure chamber of fluid medium and a low pressure chamber of fluid medium for maintaining a pressure differential therebetween, said grid means allowing the passage of the fluid medium from the high pressure chamber into the low pressure chamber thereby to create a fluidized bed of material contained in the latter adjacent an upper surface of the grid means, the improvement comprising, said grid means being defined by a plurality of upstanding frusto-conical formations each diverging in an upward direction and being open at its upper and lower ends, the upper portions of each of said formations intersecting the adjacent ones of said formations to form a pattern of edge surfaces, the internal walls of said frusto-conical formations and said edge surfaces solely constituting said upper surface of the grid means thereby to prevent piling and accumulation of material of the fluidized bed on said upper surface of said grid means, at least one fuel nozzle mounted in said low pressure chamber above said grid means, said nozzle having its outlet communicating with an opening in said grid means which is defined by a continuous series of said edge surfaces thereby to discharge fuel through said opening and to the area immediately below said grid means whereupon the fuel comes into contact with the fluid medium entering the lower ends of said frusto-

conical formations to form an ignition interface immediately below said grid means.

2. A material fluidizing apparatus comprising a high pressure chamber of fluid medium and a low pressure chamber of fluid medium disposed above said high pressure chamber and a grid means disposed between said chambers maintaining a pressure differential therebetween and passing the fluid medium from said high pressure chamber into said low pressure chamber to create a fluidized bed of material contained therein adjacent an upper surface of said grid means, the improvement comprising, said grid means having a plurality of passageways extending therethrough for allowing passage of the fluid medium from the high pressure chamber to the low pressure chamber, each of said passageways having a restricted orifice adjacent the high pressure chamber and diverging to an enlarged area passageway at the upper surface of the grid means to prevent material in the fluidized bed from accumulating on the upper surface of the grid means, means for supplying a liquid at said grid means adjacent said restricted orifices so that the liquid mixes with the fluid medium as it enters said orifices to mix with material in said passageways whereby material carried by said fluid medium is removed from said medium as it passes through said fluidized bed.

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