Feb. 5, 1963 W. M. MADSEN 3,076,270

SAND OR FINES FILTERING DEVICE FOR DRYERS

Filed Aug. 11, 1958 2 Sheets-Sheet 1

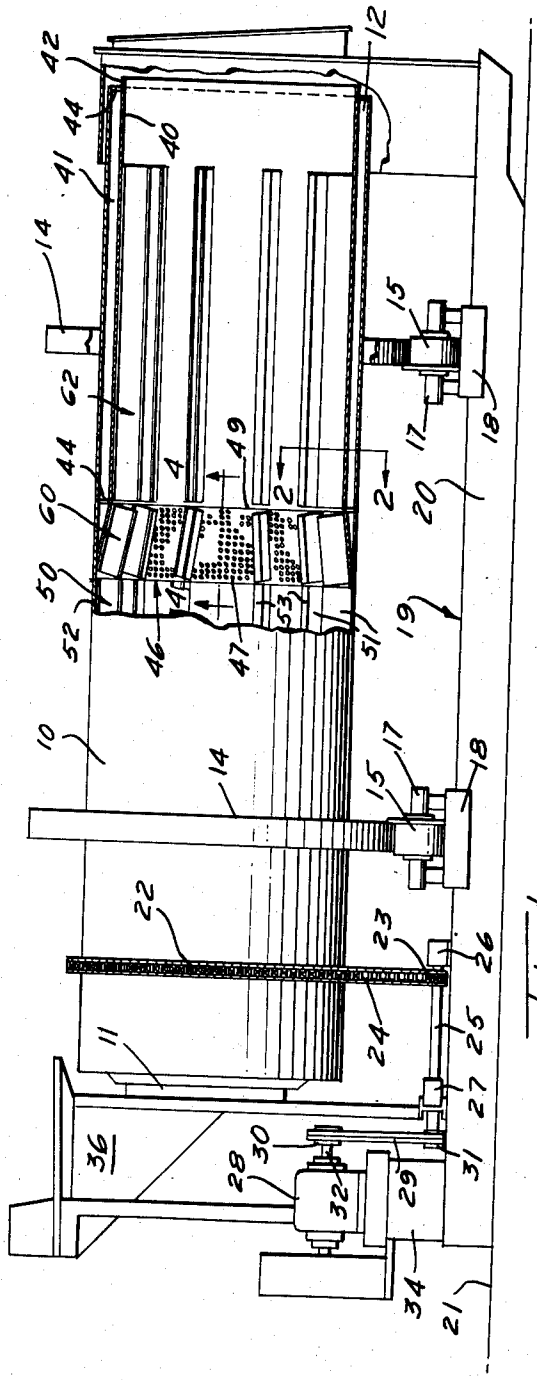


Fig. 1.

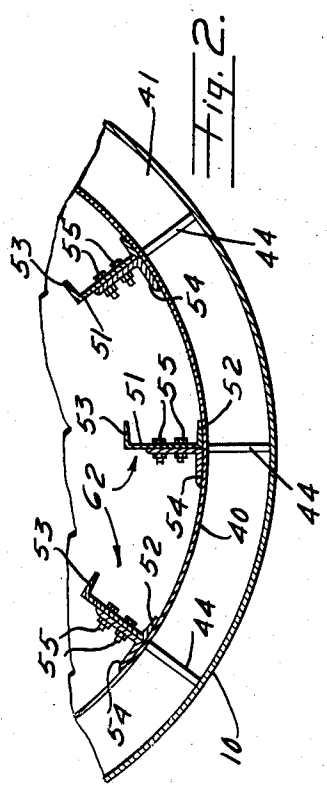


Fig. 2.

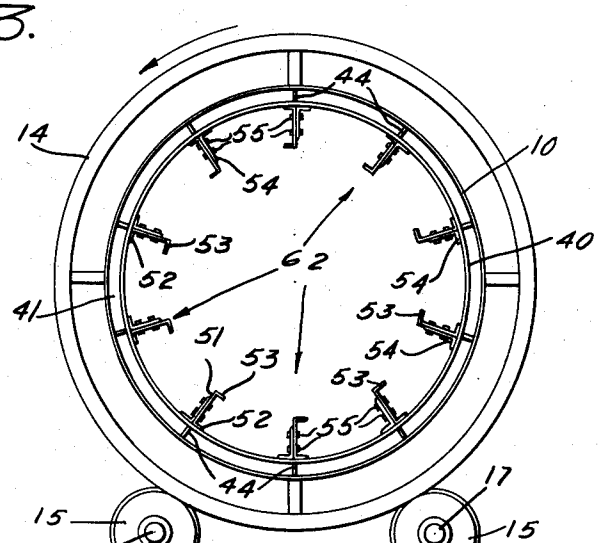
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Fig. 3.



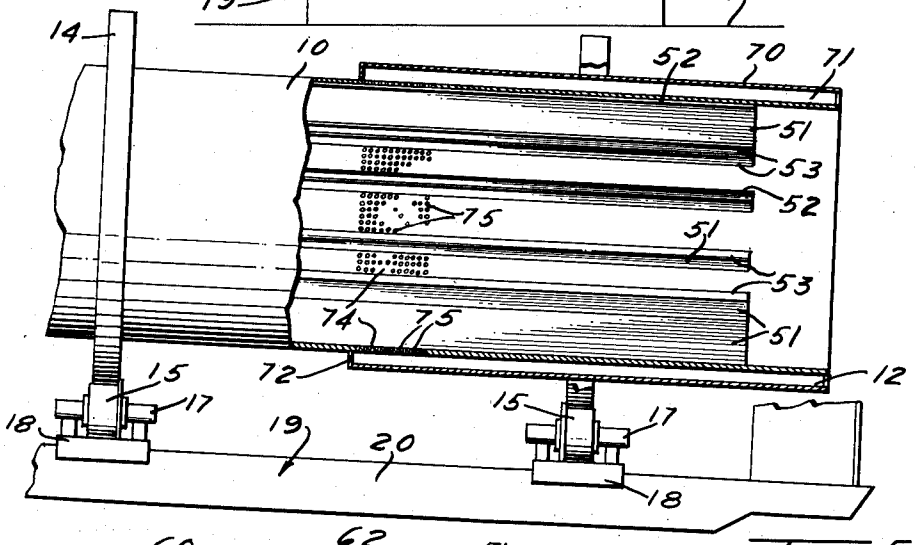


Fig. 5.

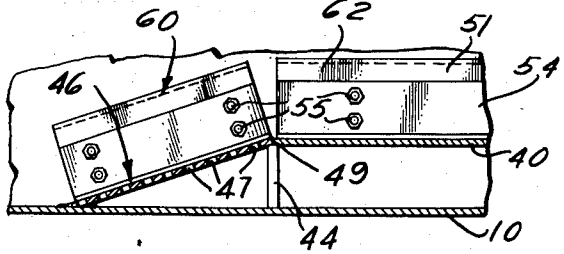


Fig. 4.

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SAND OR FINES FILTERING DEVICE FOR DRYERS

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10 Claims. (Cl. 34—128)

This invention relates generally to drying apparatus and relates more particularly to apparatus for drying various types of aggregates used in the paving industry and the like.

While the present apparatus has particular utility in the heating and drying of aggregates, such as rock, sand, dust, etc. used in the asphalt paving industry, and is shown and described in connection with drum type dryers used in said industry for the heating and drying of such aggregates, it is to be understood that its utility is not confined thereto.

In the production of bituminous bound paving mixtures, the aggregate, which may range from 2½" rock downwardly to sand and rock dust, is dried in a cylindrical type dryer which rotates and drops the rock and sand through hot gases passing through said dryer. Such dryers are usually of the counter-flow type, that is, the rock and sand are fed into one end of the dryer and the fire is directed into the opposite end of said dryer. Thus, the aggregates pass through the cylindrical shell in one direction and the hot gases from the fire pass through in a directly opposite direction. The dryers are usually pitched in an inclination downwardly toward the firebox end. In other words, the aggregate inlet end of the dryer shell or kiln is higher than the discharge end.

In such dryers various forms and shapes of lifters or buckets are used and are so placed on the shell interior that in combination with the rotation of the shell or kiln, the lifters or buckets raise the material to the top of the shell and throughout this portion of the shell movement, the buckets or lifters carry the material upwardly, dropping same when the angle of repose of the material contained within or on the lifters or buckets is such as to cause such material to fall off. This falling off action, once it starts, becomes continuous with further rotation of the shell resulting in an action that is termed in the parlance of the trade as "aggregate curtains."

Regardless of the type of lifters used in dryers of the above described character, the action of these lifters is generally about the same. Some lifters may tend to hold the aggregate a little longer in its circular elevation conforming to the kiln or shell interior diameter and thereby cast the aggregate therefrom a little further toward the down side of the shell, but in general, the lifters conform in manners inherent in their basic concept which is specifically to block off a given amount of material when they are positioned at the bottom of the shell and as the rotation of the shell to which the lifters are attached continues the aggregate thus caught by the lifters is carried upward and gradually dropped.

The aggregate is fed into the dryer as a composite, such composite consisting of rock, sand, rock dust, or other fine material. It naturally follows that these various aggregates in a composite combination continue their passage through the shell, being lifted by the lifters and dropped through the hot gases, and as the shell is inclined downwardly toward the fired end, these aggregates move to the low end of the shell in a continuing composite manner and are discharged from said low end. As the aggregates approach the fire, they naturally become hotter and, therefore, drier.

As is well-known in the art, these aggregates as fed into the dryer may contain considerable moisture. Such moisture content may be seven, eight or nine percent and are known to run as high as 15% and sometimes even higher, depending upon the type of aggregate being fed and the point from which the aggregate may have been taken. For example, sand freshly dragged out of the river, together with silt and clay, could contain a very high percentage of moisture if it had no opportunity to air dry for a substantial period prior to being fed into the dryer. As the aggregates, coarse and fine alike, are of substantially the same specific gravity more or less, they pass through the shell together, there being no appreciable segregation occurring as the result of the lifting of the aggregate by the lifters and the dropping of same therefrom as said lifters move through their circular path.

Should there be any moisture present in the aggregate the mixture, which includes the asphalt etc. sticks to the implements used in connection with the preparation and laying of the asphalt paving so that it is absolutely necessary for the aggregate to be practically bone dry, and it is, therefore, an object of the present invention to provide a dryer that will remove substantially all of the moisture from aggregate material supplied thereto so that when said material is discharged therefrom, it has the required degree of dryness.

The difficulty encountered in drying composite aggregates apparently is due to the fact that the sands and fines, ranging in size upwardly to a quarter inch and even slightly larger, are robbers of heat. These aggregates, and particularly the finer components thereof such as the 200 mesh rock dust and coarser material up to and including sand, steal the heat from the fire or flame or hot gases and reach fantastically high temperatures while at the same time act as an insulator which prevents the coarser stone from receiving the direct effect of the heat. It is well known that a rock of a given size, say a rock having a weight of one ounce and a surface area perhaps of one square inch, could be broken into particles of sand which would have a surface area many thousands of times larger than the rock from which it was made.

As pointed out above, aggregate mixtures used in bituminous paving material may consist of various grades of rock. The variation in the grade of such rock may be from a quarter inch to three-quarters inches, and even as large as two and one-half or three inches in heavy base mixtures. The sand in such aggregate mixtures may range from as low as 15% or 20% upwardly to a high of 50% to 55% of such mixture. That is, the sand and fines of an aggregate composite combination may go from a low of 15% to a high of 50% of the total mix. Probably the average normal sand content of the aggregate mix would run in the neighborhood of 35% of the total mix contained in the average bituminous specifications.

When using the term "sand" herein, it is intended to include various ranges of fines which may be contained in the sand and these will run from micron sizes up to six or eight mesh.

As above stated, the sand and fines are stealers of heat and insulators, creating a fog within the kiln or shell which prevents the larger pieces of gravel and rock from being adequately heated and dried. It is, therefore, another object of the invention to provide drying apparatus which will thoroughly dry all of the grades of material of such composite aggregates.

Another object of the invention is to provide apparatus of this character which will separate the sand from the gravel and rock in the kiln so that the rock receives the full effect of the blast of the fire, out of the presence of the stealer of heat.

Still another object of the invention is to provide apparatus of this character which will so segregate the sand from the larger particles of gravel and rock of the

composite aggregate in the kiln that said larger particles will be uninsulated and will be thoroughly dried.

It is a further object of the present invention to provide apparatus of this character that will function properly over relatively long periods of time and will withstand the relatively high temperatures required to effect proper drying of the aggregates.

A still further object of the invention is to provide apparatus of this character that will require a minimum amount of servicing and repair.

Another object of the invention is to provide apparatus of this character that is simple in construction and reliable in operation.

It is still another object of the invention to provide mechanism of this character that is relatively inexpensive to manufacture.

The characteristics and advantages of the invention are further sufficiently referred to in connection with the following detailed description of the accompanying drawings which represent certain embodiments. After considering these examples, skilled persons will understand that variations may be made without departing from the principles disclosed, and I contemplate the employment of any structures, arrangements or modes of operation that are properly within the scope of the appended claims.

Referring to the drawings:

FIG. 1 is a diagrammatic or schematic side view of drying apparatus embodying the present invention with a portion broken away to show the interior construction;

FIG. 2 is a fragmentary sectional view taken on line 2—2 of FIG. 1;

FIG. 3 is a diagrammatic end view of the shells and operably mounted on rollers;

FIG. 4 is an enlarged sectional view taken on line 4—4 of FIG. 1; and

FIG. 5 is a schematic side view, partially in section, of a portion of the drying apparatus showing an alternative arrangement.

Referring more particularly to FIGS. 1 and 2, there is shown a kiln comprising a cylindrical shell **10** arranged substantially horizontally but with the inlet end **11** higher than the outlet end **12**. The shell **10** is provided with a plurality of rings **14** which are secured concentrically on the exterior of said shell and which are spaced apart longitudinally thereof. Rings **14** are secured to the shell by any suitable well-known means such as welding, bolts or the like and are operably disposed on rollers **15** rotatably mounted on support means **17** attached to members **18** which in turn are secured, by any suitable means, to a supporting frame, indicated generally at **19** and which include longitudinally extending beams **20** which rest on a supporting surface, such as a floor, foundation or the like indicated at **21**. A gear ring **22** is secured on the exterior of the shell **10** and is connected to a driving sprocket **23** by means of a chain **24**. Sprocket **23** is attached to a drive shaft **25**, the front end of said shaft **25** being operably disposed in a bearing **26** secured to the frame member **20** while the opposite end of said shaft is operably mounted in a bearing **27**. Shaft **25** is driven by any suitable means such as an electric motor **28** which is connected to said shaft **25** by means of a belt **29** mounted on pulleys **30** and **31** secured to the motor shaft **32** and the adjacent end of a shaft **25** respectively. The motor **28** is suitably mounted to a base **34** which in turn is attached to the frame **19** in the well-known manner.

Material to be heated and dried by the apparatus is delivered to the inlet end **11** of the shell **10** by any suitable means shown as comprising a chute **36** which projects into the inlet end of said shell **10** in the well-known manner.

The device is of the counter flow type wherein the fire is directed into the shell from the discharge end **12** so that the hot combustion products, including gases, from the fire flow in the direction opposite the direction of movement of the aggregate delivered into the inlet end of said shell.

Within the shell **10** and at the discharge end there is an interior, cylindrical shell **40** of smaller diameter than the shell **10** so as to provide an annular chamber **41** between the shell **40** and shell **10**. Shell **40** projects outwardly beyond the discharge end of the shell **10**, as indicated at **42** and extends inwardly from said discharge end a predetermined distance, the length of shell **40** being substantially less than the length of the shell **10** as best shown in FIG. 1. Shell **40** is supported in spaced relationship to the shell **10** by means of struts **44** adjacent the inner and outer ends of said shell **40**, the struts at the respective ends of the shell **40** being annularly spaced apart, as best shown in FIG. 2. At the inner end of said shell **40**, there is a grizzly, indicated generally at **46** having perforations **47** and formed of segments. The outer ends of said segments are welded or otherwise suitably secured to the inner edge **49** of the shell **40** while the inner ends of said segments are welded to the shell **10**. Thus, the grizzly connects the shell **10** with the inner end of the shell **40** and the perforations **47** of said grizzly provide openings through which sand and fines of smaller size than said openings may pass into the annular space **41** between the shells **10** and **40**. While the openings or perforations **47** may be of any suitable, desired size, a diameter of approximately a quarter of an inch has been found satisfactory.

Within the shell **10** there are a plurality of longitudinally extending, annularly spaced lifters, indicated generally at **50**. These lifters may be of various designs but are shown herein as being channels, that is, said lifters are in the shape of a wide, shallow U in cross section, there being a radially extending bottom portion **51** connecting the outer and inner sides or walls **52** and **53** respectively, which are normal to said bottom portion **51**. The outer wall **52** of each lifter is secured to the inner side of the shell **10** by means of welding, bolts, or other suitable means, and at the back of said lifters are angle irons or members **54** which are also secured to the inner side of the shell by any suitable means such as welding or the like, said members **54** serving to strengthen said lifters **50**. The members **54** are also secured to the bottom walls or portions **51** of the lifters by means of bolts **55** although the parts may be welded or otherwise suitably secured together. The inner side walls **53** of the lifters extend in the same direction as the side walls **52** and both extend from the side edges of the bottom **41** in the direction of rotation of the shell. At the outer ends of the lifters **50** are lifter sections **60** which are in longitudinal alignment with the lifters **50** and which are secured to the inner side of the grizzly **46** by any suitable means such as the means described in connection with the attachment of the lifters **50** to the shell **10**. Lifters **60** are of the same shape and arrangement as the lifters **50** and at the outer ends of said lifters **60** are lifters **62** which are in longitudinal alignment with the lifters **60** and of the same shape. The lifters **62** are secured to the interior side of the shell **40** by any suitable means such as, for example, the means described in connection with the attachment of the lifters **50** to the shell **10**.

As viewed in FIG. 3, the shells **10** and **40** rotate counterclockwise. The lifters **50** pick up the aggregate at the bottom of the shell and carry same upwardly as the shell rotates aggregate material being dropped from said lifters when the angle of repose of the material contained therein is such that said material will fall off. This falling off action, once it starts, becomes continuous and develops aggregate curtains.

The aggregate works toward the discharge end and is initially dried. When the aggregate reaches the grizzly **46** the sand and fines will pass through the openings **47** therein and separates same from the coarser aggregates. The latter will enter the smaller diameter cylinder **40** and work toward the outlet or discharge end. The sand and fines will pass into the annular space or chamber **41** be-

tween the shell 40 and the adjacent portion of the shell 10 and will move toward the discharge end of said shell 10. The coarser aggregates within the shell 40 will be free of the insulating action of the fines and sand and will be thoroughly dried by the hot combustion products passing through the shell 40 from the lower end thereof.

The sand discharged at the lower end of the shell 10 may be dropped into a chute or the like and be recombined with the coarser aggregates which have been thoroughly dried in the shell 40 and discharged therefrom. The sands and coarser aggregates may then be mixed into an aggregate mixture in any suitable manner and with any suitable means.

Referring to FIG. 5 an arrangement is shown wherein the lower or discharge end portion of the shell 10 is provided with a jacket 70 of larger internal diameter than the external diameter of the shell 10 to thereby provide an annular chamber 71 between the jacket 70 and the adjacent portion of said shell 10. The jacket 70 is concentric with the shell 10 and at the upper end of said jacket there is an annular wall 72 between the upper end of said jacket and the exterior of the shell 10 so as to close the upper end of said chamber 71. Downstream of the plane of the wall 72 there is a cylindrical grizzly 74 with perforations 75 therein, said grizzly being of substantially the same diameter as the diameter of the shell 10 and connects the part of said shell 10 upstream thereof with the part of said shell 10 downstream thereof.

The operation of the arrangement shown in FIG. 5 is substantially the same as the arrangement shown in FIGS. 1 and 3.

It is thought that the invention and many of its attendant advantages will be understood from the foregoing description and it is thought that it will be apparent that various changes may be made in the form, construction and arrangement of the parts of the invention without departing from the spirit and scope thereof or sacrificing all of its material advantages.

I claim:

1. In apparatus for drying various aggregates used in the paving industry and the like: a cylindrical shell having an inlet at one end and an open outlet at the other end, the outlet end of said shell being lower than the inlet end; means for rotatably supporting said shell; means operably connected to said shell for effecting rotation thereof; means for supplying a composite aggregate material to the inlet end of said shell; means defining with a portion of said shell at the outlet end thereof, an annular chamber concentric with said shell, said chamber having an outlet end adjacent the outlet end of said shell and having a closed upstream end spaced from its outlet end; an annular grizzly adjacent the upstream end of said chamber and having perforations communicating at the interior side of said grizzly with the interior of said shell and communicating at the opposite side with said annular chamber adjacent to the closed end thereof; and a plurality of annularly spaced lifters secured within said shell and extending longitudinally thereof upstream of said grizzly, across said grizzly and downstream of said grizzly.

2. In counter-flow, drum type apparatus for drying various aggregates used in the paving industry and the like, comprising: a main cylindrical shell having an inlet at one end and an outlet at the other end, the outlet end of said shell being lower than the inlet end, said outlet being adapted to have delivered therein hot combustion products from a suitable source thereof; means for rotatably supporting said shell; means operably connected to said shell for effecting rotation thereof; means for supplying a composite aggregate material to the inlet end of said shell; an auxiliary cylindrical shell concentrically mounted relative to the main shell and defining, with a portion of said shell at the outlet end thereof, an annular chamber, the outlet end of said chamber being adjacent the outlet end of said main shell, said chamber having an upstream end spaced from its outlet; a grizzly adjacent the upstream end of said chamber and having

perforations communicating at the interior side of said grizzly with the interior of said shell and communicating at the opposite side with said chamber so that material particles passing through said perforations and into said chamber are removed from the direct heat of combustion products delivered into said main cylindrical shell; and a plurality of annularly spaced lifters secured within said shell and extending longitudinally thereof upstream of said grizzly, across said grizzly and downstream of said grizzly.

3. Apparatus for drying various aggregates used in the paving industry and the like, comprising: a first cylindrical shell having an inlet at one end and an outlet at the other end, the outlet end of said shell being lower than the inlet end; means for rotatably supporting said shell; means operably connected to said shell for effecting rotation thereof; means for supplying a composite aggregate material to the inlet end of said shell; a second cylindrical shell shorter and of smaller external diameter than said first shell and concentrically mounted therein so as to define, with a portion of said shell at the outlet end thereof, an annular chamber between said shells, the outlet end of said chamber being adjacent the outlet end of said first shell; a frusto-conical grizzly extending between the interior end of the second shell and the inner surface of the first shell and having perforations communicating at the interior side of said grizzly with the interior of said first shell and communicating at the opposite side with said chamber; and a plurality of operably mounted, annularly spaced lifters extending longitudinally of the first shell upstream of said grizzly, across said grizzly, and longitudinally of the second shell.

4. In counter-flow, direct-fired apparatus for drying various aggregates used in the paving industry and the like: a cylindrical shell having an inlet at one end and an outlet at the other end, the outlet end of said shell being lower than the inlet end; means for rotatably supporting said shell; means operably connected to said shell for effecting rotation thereof; means for supplying a composite aggregate material to the inlet end of said shell; a cylindrical jacket of larger inside diameter than the outside diameter of said shell but shorter than said shell, said jacket being concentrically mounted on the lower end portion of said shell to define therewith an annular chamber concentric with said shell, the outlet end of said chamber being adjacent the outlet end of said shell; means closing the end of said chamber at the end opposite the outlet end; a grizzly interposed in said shell adjacent the closed end of said chamber and having perforations communicating at the interior side of said grizzly with the interior of said shell and communicating at the opposite side with said chamber; and a plurality of annularly spaced lifters secured within said shell and extending longitudinally thereof throughout substantially the entire length of said shell.

5. In aggregate drying apparatus: a cylindrical shell having an inlet at one end and an outlet at the other end; means for supplying a composite aggregate material to the inlet end of said shell; means defining with a portion of said shell at the outlet end thereof, an annular chamber concentric with said shell, said chamber having an upstream end spaced from its outlet end, the outlet end of said chamber being adjacent the outlet end of said shell; an annular grizzly adjacent the upstream end of said chamber and having perforations communicating at the interior side of said grizzly with the interior of said shell and communicating at the opposite side with said annular chamber adjacent to the inner end thereof, said chamber extending longitudinally outwardly of the grizzly and being closed at its inner end; and a plurality of annularly spaced lifters secured within said shell and extending longitudinally thereof upstream of said grizzly, across said grizzly and downstream of said grizzly.

6. In rotary, counter-flow, drum type aggregate drying apparatus: a main cylindrical shell having an inlet

at one end and a substantially open outlet at the other end; an auxiliary cylindrical shell concentrically mounted relative to the main shell and defining, with a portion of said shell at the outlet end thereof, an annular chamber, the outlet end of said chamber being adjacent the outlet end of said main shell, said chamber having an upstream end spaced from its outlet end; a grizzly adjacent the upstream end of said chamber and having perforations communicating at the interior side of said grizzly with the interior of said shell and communicating at the opposite side with said chamber; and lifter means operably secured within said shell and extending longitudinally thereof upstream of said grizzly, across said grizzly and downstream of said grizzly.

7. Apparatus for drying composite aggregates used in the paving industry and the like, comprising: a first cylindrical shell having an inlet at one end and an outlet at the other end; a second cylindrical shell shorter and of smaller external diameter than said first shell and concentrically mounted therein so as to define, with a portion of said shell at the outlet end thereof, an annular chamber between said shells, the outlet end of said chamber being adjacent the outlet end of said first shell; a frusto-conical grizzly extending between the interior end of the second shell and the inner surface of the first shell and having perforations communicating at the interior side of said grizzly with the interior of said first shell and communicating at the opposite side with said chamber; and a plurality of operably mounted, annularly spaced lifters extending longitudinally of the first shell upstream of said grizzly, across said grizzly, and longitudinally of the second shell.

8. Drum type, counter-flow drying apparatus for drying various aggregates used in the paving industry and the like, comprising: a cylindrical shell having an inlet at one end and an outlet at the other end; means for supplying composite aggregate material to the inlet end of said shell; said shell having hot combustion gases admitted into the outlet end to contact the aggregate material, a cylindrical jacket of larger inside diameter than the outside diameter of said shell but shorter than said shell, said jacket being concentrically mounted on the outlet end portion of said shell to define therewith an annular chamber concentric with said shell, the outlet end of said chamber being adjacent the outlet end of said shell; means closing the end of said chamber at the end opposite the outlet end; a grizzly interposed in said shell adjacent the closed end of said chamber and having perforations communicating at the interior side of said grizzly with the interior of said shell and communicating at the opposite side with said chamber; and a plurality of annularly spaced lifters secured within said shell and extending longitudinally thereof in both directions from said grizzly.

9. In counter-flow, direct-fired apparatus for drying various aggregates used in the paving industry and the like: a cylindrical shell having an inlet at one end and an outlet at the other end, means for supplying aggregate material to the inlet end, said shell having hot combustion gases admitted into the outlet end to contact the aggregate material, the outlet end of said shell being lower than the inlet end; means for rotatably supporting said shell; means defining with a portion of said shell at the outlet end thereof, an annular chamber concentric with said shell, said chamber having an outlet end adjacent the outlet end of said shell and having an upstream end spaced from its outlet end; an annular grizzly adjacent the upstream end of said chamber, said grizzly having perforations communicating at the interior side of said grizzly with the interior of said shell and communicating at the opposite side with said annular chamber; and a plurality of annularly spaced lifters secured within said shell and extending longitudinally thereof in both directions from said grizzly.

10. Apparatus for drying composite aggregates used in the paving industry and the like, comprising: a first cylindrical shell having an inlet at one end and an outlet at the other end; means for supplying aggregate material to said first cylindrical shell at the inlet end, said first cylindrical shell having hot combustion gases admitted into the outlet end to contact said aggregate material; a second cylindrical shell shorter and of smaller external diameter than said first shell and concentrically mounted therein so as to define, with a portion of said first shell at the outlet end thereof, an annular chamber between said shells, the outlet end of said chamber being adjacent the outlet end of said first shell; a frusto-conical grizzly extending between the interior end of the second shell and the inner surface of the first shell and having perforations communicating at the interior side of said grizzly with the interior of said first shell and communicating at the opposite side with said chamber, and a plurality of annularly spaced lifters secured within said shell and extending longitudinally thereof in both directions from said grizzly.

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