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2,925,666

GRAIN DRYER

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3 Sheets-Sheet 1

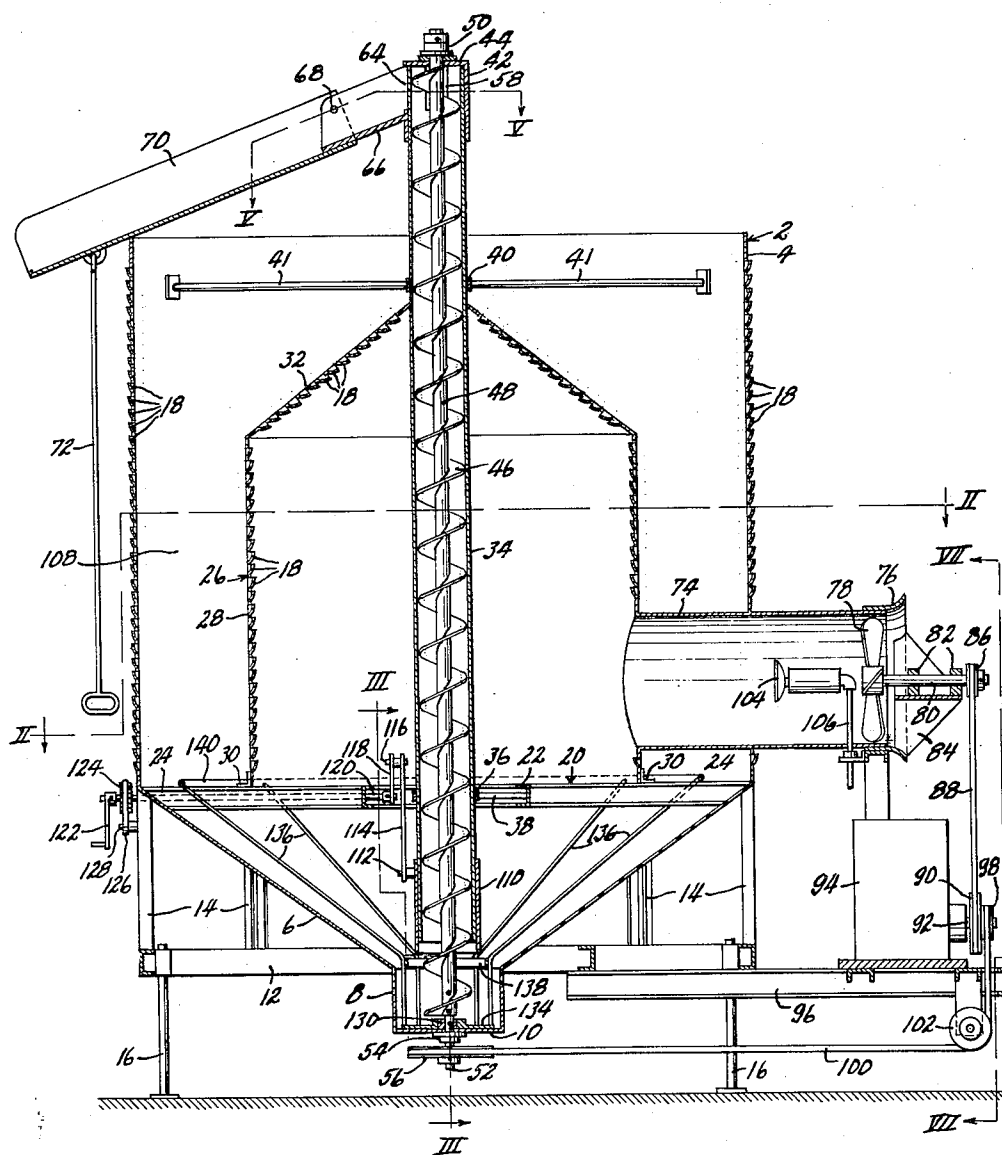


Fig. 1

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3 Sheets-Sheet 2

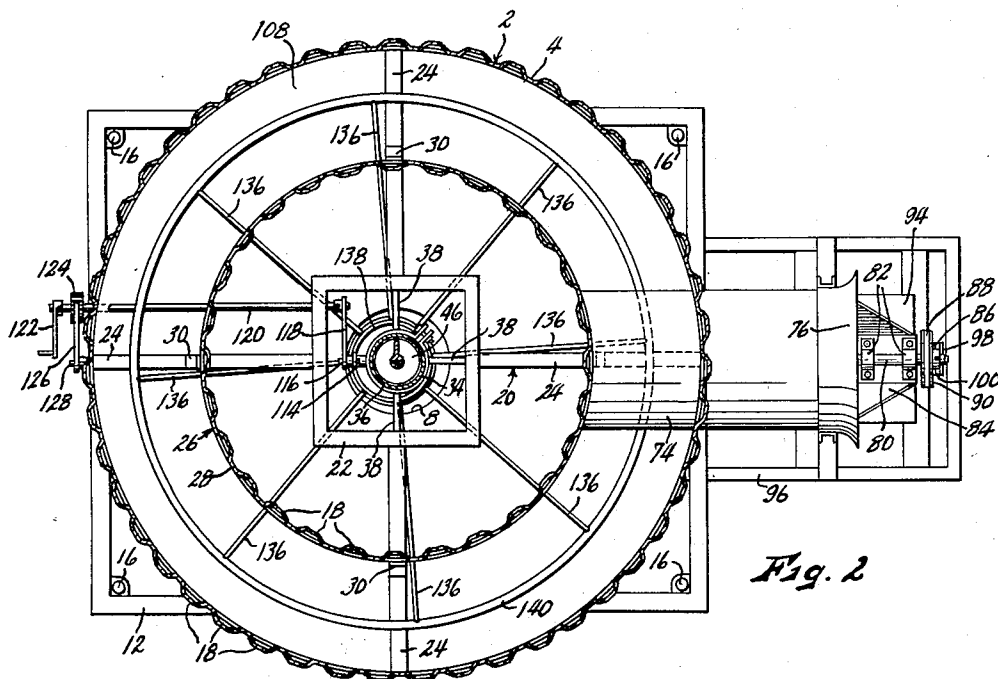


Fig. 2

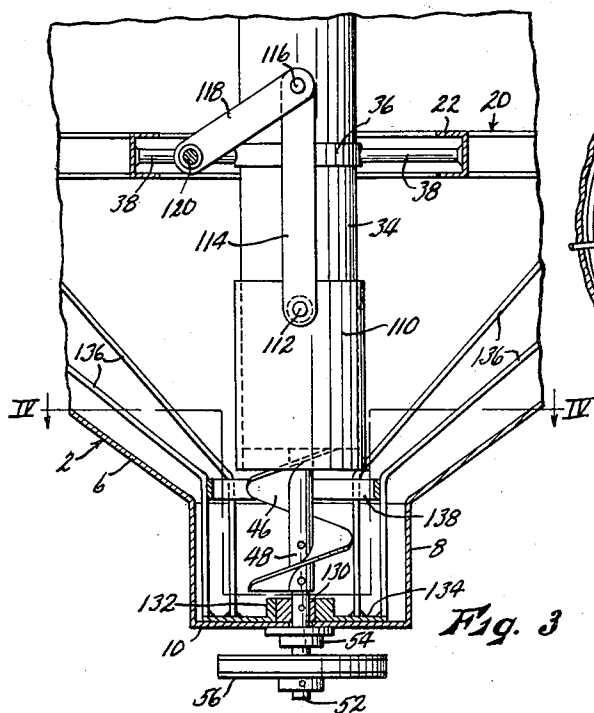


Fig. 3

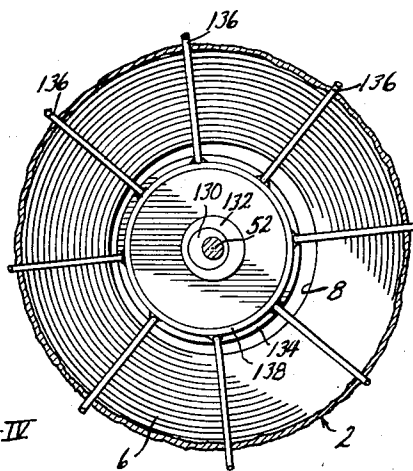


Fig. 4

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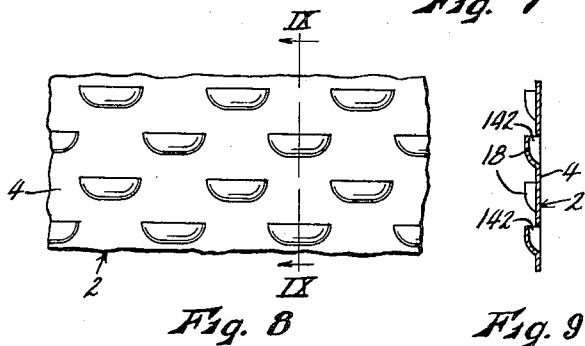
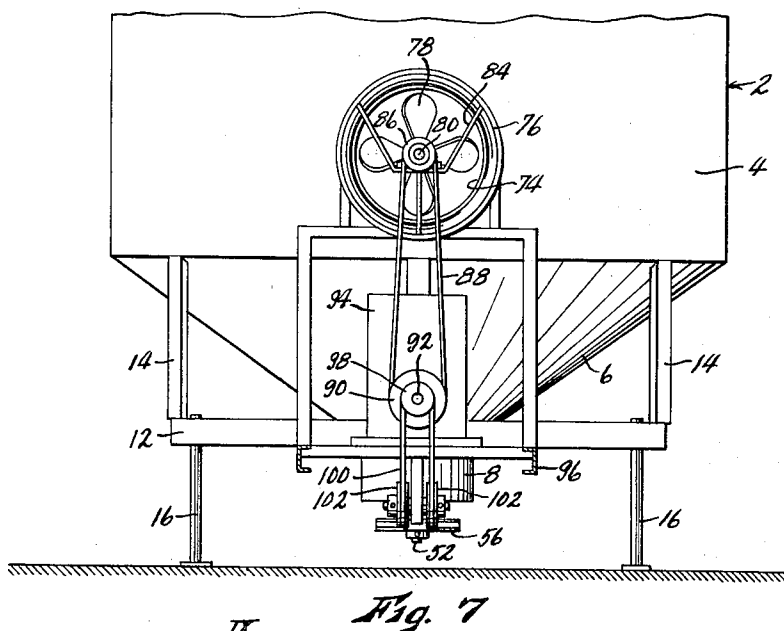
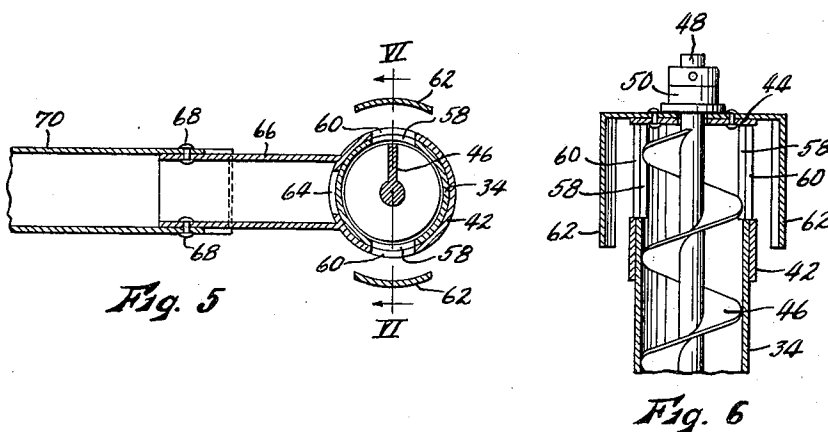
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1

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GRAIN DRYER

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11 Claims. (Cl. 34—102)

This invention relates to new and useful improvements in grain dryers, and has particular reference to grain dryers wherein grain is circulated continuously through a chamber through which heated air is forced.

An important object of the present invention is the provision of novel means whereby the thickness of the layer or bed of grain through which the heated air is forced is maintained uniform over its entire area, whereby the heated air passes uniformly through all parts of the grain bed and the efficiency and speed of the drying operation is thereby enhanced.

Another important object is the provision of novel agitating means for maintaining uniform flow of grain in all parts of the grain bed. The increase in volume of the air due to the heating thereof, plus the added volume of the moisture vapor removed from the grain itself, often creates localized pressure zones or areas within the body of the grain mass, and these pressure zones often inhibit and sometimes completely shut off the flow of grain in those zones, with the result that the capacity and efficiency of the machine is seriously reduced, and with the danger that the grain will be "cooked" and damaged by prolonged or excessive exposure to heat without free circulation of air thereabout.

Still another object is the provision of novel means whereby the rate of circulation of the grain through the drying chamber may be closely regulated, whereby to provide optimum conditions for grains of different types, or for grains of different degrees of wetness.

Another object is the provision of a power driven device for recirculating the grain in the dryer, said circulating device being operable also to discharge the grain, after it has been dried, to a truck or the like for transportation.

Other objects are simplicity and economy of construction, in order that the device may be sold for a much smaller price than comparable equipment of similar capacities, efficiency and dependability of operation, and adaptability for use in a wide variety of applications and conditions.

With these objects in view, as well as other objects which will appear in the course of the specification, reference will be had to the drawing, wherein:

Fig. 1 is a central vertical sectional view through a grain dryer embodying the present invention, with parts left in elevation,

Fig. 2 is a sectional view taken on line II—II of Fig. 1,

Fig. 3 is an enlarged fragmentary sectional view taken on line III—III of Fig. 1,

Fig. 4 is a sectional view taken on line IV—IV of Fig. 3,

Fig. 5 is an enlarged fragmentary sectional view taken on line V—V of Fig. 1,

Fig. 6 is a sectional view taken on line VI—VI of Fig. 5, Fig. 7 is a fragmentary sectional view taken on line VII—VII of Fig. 1,

Fig. 8 is a face view, to an enlarged scale, of a portion of one of the louvered walls of the drying chamber, and Fig. 9 is a sectional view taken on line IX—IX of Fig. 8.

2

Like reference numerals apply to similar parts throughout the several views, and the numeral 2 applies generally to an outer housing having an upper cylindrical portion 4 open at the top, and a lower conical portion 6; said conical portion terminating at its lower end in a cylindrical well 8 of reduced diameter, said well having a horizontal bottom wall 10. Said outer housing is supported above a rectangular angle iron frame 12 by legs 14, and said frame is in turn supported by ground-engaging legs 16. Substantially the entire area of cylindrical wall 4 of the outer housing has louvers 18 formed therein as best shown in Figs. 8 and 9, said louvers being formed by slitting the wall horizontally at spaced intervals, and forcing the wall area immediately below each of said slits outwardly as shown. Said louvers open upwardly and outwardly from the general plane of the wall, for a purpose which will presently appear.

Supported within outer housing 2, at the juncture of the cylindrical portion 4 and conical portion 6 thereof, is a horizontal spider 20 which is formed of channel irons and which may be of any suitable design. As shown, it comprises a square central frame 22 having four arms 24 extending radially outwardly therefrom and secured at their outer ends to conical wall 6 at the upper edge thereof.

An inner housing 26 is disposed within housing 2 and is supported on spider 20. Said inner housing comprises a cylindrical portion 28 disposed concentrically with wall 4 of housing 2 and supported at its lower end on spider arms 24, being affixed thereto by brackets 30, and an upper portion 32 of conical shape, said conical portion being disposed below the top of wall 4 of the outer housing. Substantially the entire area of the inner housing, including both the cylindrical and conical portions thereof, has louvers 18 formed therein, these louvers being identical to those formed in outer housing wall 4 except that the louvers of the inner housing open inwardly.

A cylindrical auger tube 34 extends vertically and axially through inner housing 26, extending at its upper end well above outer housing 2, and terminating at its lower end just above the cylindrical well 8 of the outer housing. Adjacent its lower end, said tube passes centrally through the square frame 22 of spider 20, and is supported by a clamp ring 36 affixed thereto, and a plurality of radial arms 38 fixed at their inner ends to said clamp ring and at their outer ends to frame 22. Adjacent its upper end, auger tube 34 extends through the upper end of the conical portion 32 of the inner housing, and is supported by a clamp ring 40 affixed thereabout, and a plurality of radial arms 41 affixed at their inner ends to said clamp ring and at their outer ends to wall 4 of the outer housing. At its extreme upper end, tube 34 has an inverted cup-shaped cap 42 fitted rotatably thereover. Said cap has a top end wall 44, and is adapted to serve as a valve as will presently be described. An auger 46 is carried rotatably in tube 34, and is operable to propel grain upwardly through said tube when rotated. The shaft 48 of said auger extends upward through end wall 44 of the cap, and is journaled in a bearing 50 affixed to said cap. At its lower end, the auger is provided with a reduced extension shaft 52 which projects downwardly through the floor wall 10 of well 8, and is journaled in a bearing 54 affixed to the lower surface of said wall. Attached to the lower end of said extension shaft is a belt pulley 56, by means of which the auger may be operably driven. It will be apparent that as the auger is turned, grain will be elevated thereby from well 8 through tube 34.

Referring principally to Figs. 5 and 6, it will be seen that the upper end of auger tube 34 is provided with a pair of diametrically opposite openings 58 formed in the wall thereof within the vertical limits of cap 42. A cor-

3

responding pair of operings 60 are formed in said cap, and are adapted to be brought into registering relation with openings 58 by turning the cap on the auger tube. Thus grain brought up through the tube is discharged outwardly through openings 58 and 60, and is deflected downwardly into housing 2 by a pair of deflectors 62 affixed to the cap and being spaced outwardly from openings 60 of said cap. A third opening 64 is formed in cap 42 intermediate openings 60, opening 64 communicating with a spout 66 which is angled outwardly and downwardly and which is rigidly affixed to cap 42. Pivoted at 68 to the outer end of spout 66 is a trough-like spout extension 70 which extends outwardly from outer housing wall 4 and rests by gravity on the upper edge thereof. Adjacent the outer end of said spout extension, a depending handle 72 is attached thereto which extends downwardly to a point such that it may be reached by a person standing on the ground. It will be seen therefore that spout 66 and its extension 70 may be moved to extend in any direction from auger tube 34, and that in so doing, cap 42 is turned on said auger tube. Referring to Fig. 5, it will be seen that when cap 42 is turned 90 degrees from the position shown, one of the openings 58 of the auger tube will be closed off by the cap and cap opening 64 will be brought into registry with the other of tube openings 58. Thereupon grain elevated by the auger will be discharged into spout 66. This setting of the cap, which may also be termed a valve, is of course used when the drying of the grain is complete and it is desired to discharge said grain into a truck or the like.

A large tubular air conduit 74 is interconnected into inner housing 26 adjacent the lower edge of the cylindrical wall 28 of said housing. Said conduit extends horizontally outwardly through the cylindrical wall 4 of the outer housing 2, and outwardly from said outer housing, being provided at its outer end with a flared air intake ring 76. Within the mouth of said conduit is disposed a blower fan 78 which is mounted on a shaft 80 journaled in bearings 82 mounted on a spider 84 which bridges intake ring 76. Mounted on the outer end of said shaft is a pulley 86 which is operatively connected by a belt 88 with a pulley 90 fixed on the output shaft 92 of a gasoline engine 94. Said engine is mounted on a horizontal extension 96 of frame 12. It will be apparent that the blower also could be operated by an electric motor or other prime mover mounted on the frame, or by a belt connection to the usual power take-off of a farm tractor or the like. A second belt pulley 98 is also mounted on engine shaft 92. A belt 100 is trained around pulley 98, extends downwardly and is trained about a pair of pulleys 102 carried rotatively by frame extension 96, and then extends horizontally and is trained about pulley 56 mounted on auger extension shaft 52. Thus it will be seen that both the blower 78 and auger 46 are powered by engine 94. The relative speeds of the blower and auger are governed by the relative sizes of the various pulleys engaged by belts 88 and 100. Also mounted in conduit 74, just inwardly from blower 78, is a burner 104 which is supplied with gas or other suitable fuel through pipe 106. The flame of this burner is adapted to heat the air forced inwardly through conduit 74 by blower 78.

In use, the grain to be dried is dumped into the top of outer housing 2, whereby it fills the annular chamber 108 between the cylindrical portions of the inner and outer housings, and also passes downwardly through the conical portion 6 of the outer housing into well 8. The grain should also cover the upper conical portion 32 of the inner housing to a depth equal to the radial thickness of chamber 108 for a purpose which will appear. Valve cap 42 is positioned as shown in Figs. 5 and 6. Engine 94 is then started to drive blower 78 and auger 46, and burner 104 is lighted. Heated air will thereupon be forced through conduit 74 into the interior of inner

4

housing 26, outwardly through the louvers 18 of said inner housing, through the bed of grain in chamber 108 and over the top of the inner chamber, and thence to the atmosphere either through the top of the outer housing, or through the louvers 18 of said outer housing, and the grain will be subjected to the drying action of the heated air.

At the same time, grain is continuously elevated from well 8 through auger tube 34 by auger 46, and is discharged from the upper end thereof for recirculation. The grain is thus in constant circulation downwardly through chamber 108 and upwardly through the auger tube, and this circulation is maintained until the grain has reached the desired degree of dryness. It will be understood that the generating angle of the conical upper portion 32 of the inner housing is equal to the normal angle of repose of grain deposited in a pile, so that grain discharged from the upper end of the auger tube will arrange itself in a layer of substantially uniform thickness, and further that the normal grain load of the dryer is such that the thickness of the grain bed over cone 32 is substantially equal to the radial thickness of annular chamber 108 between the inner and outer housings. In this manner, the heated air passes at all points through a grain bed of uniform thickness, and will therefore be distributed evenly over the entire area of said grain bed. This even distribution of air is essential to efficient drying, since the drying action could not proceed evenly if portions of the grain bed received deficient quantities of hot air, and further since excessive hot air concentrated at "thin" portions of the bed would create a danger of burning or "cooking" the grain in those portions.

Since the drying rate best suited for different grains, or for grains of different degrees of wetness, may vary substantially, there is provided also a means for closely regulating the rate of circulation of the grain in the dryer. This means includes a tubular extension 110 for auger tube 34, said extension tube being fitted telescopically about the lower portion of said auger tube and being vertically slidable thereon. Pivoted at 112 to the upper portion of said extension tube is the lower end of a link 114, the upper end of said link being pivoted at 116 to the free end of a crank 118 which is fixed to a horizontal shaft 120. Said shaft extends horizontally outwardly to a point external to outer housing, being journaled in the central frame 22 of spider 20, and in the lower conical portion 6 of the outer housing. Said shaft has affixed to its extended end a manually operable crank 122 and a toothed wheel 124, the latter being releasably engaged by a dog 126 pivoted at 128 to one of legs 14 of the outer housing. It will be seen that by releasing dog 126 and turning crank 122, extension tube 110 may be selectively raised and lowered between an upper position, as shown, wherein the lower end thereof is disposed above well 8, to a lower position wherein it extends substantially to the bottom of said well, or to any of a series of intermediate positions. In this manner the amount of grain picked up by the auger in each revolution may be varied, and the circulation rate of the grain through the dryer very closely regulated. Another use of extension 110 occurs when, for any reason, it is desired to stop the auger while the dryer is loaded. In this case, while the auger is still turning, extension 110 is fully lowered, and auger 46 is continued in operation until the auger tube is emptied. Then, when it is eventually desired to again start the auger, it may be started under a no-load condition. When the auger tube is full, great power is required to start the auger, with the result that engine 94 is overloaded or stalled.

The air delivered by blower 78 is of course increased in volume by the fact that it is subsequently heated by burner 104, with a subsequent increase of pressure in inner housing 26. Furthermore, moisture evaporated from the grain as the hot air passes therethrough adds a great volume of vapor which adds still further to the

5

internal pressure within the mass of grain. It is believed to be this pressure which has heretofore created inefficient circulation of grain in dryers of this general type. That is, the increased pressure tends to create localized zones of high pressure which inhibit and actually completely shut off the flow of grain. This of course reduces the efficiency of the drying operation, and creates a danger of burning or cooking the grain, as previously described. As a matter of fact, in the present dryer, before provisions were made to correct it, circulation of grain was found to be decreased gradually during operation, sometimes to the point of almost complete cessation, due to the above described pressure increase. The effect is most noticeable and apparent when the grain being dried is quite wet. It also occurs principally at points of flow restriction, namely in the lower portion of chamber 108 where it empties into the conical portion 6 of the outer housing. Another point of stoppage has been found to exist in the well 8, where the outward pressure of the auger on the grain has a tendency to pack the grain against the walls of the well in a hard, non-circulating mass which prevents the entry of other grain.

In order to overcome this difficulty, we have utilized a novel agitator powered by the rotation of auger 46. Fixed rigidly to auger shaft extension 52, just above the floor 10 of well 8, is a circular eccentric cam 130 (see Figs. 3 and 4). Said cam is engaged rotatably in the hub 132 of a flat circular plate 134 which rests slidably against the upper surface of floor 10. Cam 130 is eccentric to shaft 52, but concentric with plate 134. Thus as shaft 52 rotates to turn the auger, cam 130 imports an orbital movement to plate 134. Fixed to the edges of plate 134, at regularly spaced intervals about the periphery thereof, are the lower ends of a plurality of rods 136. Said rods extend vertically upwardly through well 8 to a point above the upper end of said well, and are welded or otherwise fixed to the external surface of a horizontally disposed ring 138 just above said well. Above ring 138, rods 136 are angled radially outwardly and upwardly, extending upwardly through conical portion 6 of the outer housing, between the arms 24 of spider 20, and are fixed at their upper ends to a horizontally disposed circular agitator ring 140 resting on the upper edges of arms 24. Said agitator ring surrounds inner housing 26, its diameter being intermediate that of the inner and outer housings. Agitator ring 140 of course moves orbitally together with plate 134, and therefore agitates or stirs the grain in the lower portion of chamber 108. This has been found quite effective in breaking up any pockets or zones of high pressure in the grain in this area, and to promote the free flow of grain. The dryer has been thoroughly tested with this agitator, and grain circulation has been found to remain free and continuous even with grains far wetter than would normally ever be encountered. The lower portions of rods 136, between ring 138 and plate 140, form an open cage-like formation which orbits in the zone directly adjacent the auger, and effectively prevents the packing or lodgement of grain in the well. The diameter of ring 138, and the degree of eccentricity of cam 130, must of course be such that auger tube extension 110 will not interfere with the movement of said ring even when said extension is partially or completely lowered.

Another feature promoting free circulation of air is the formation of louvers 18 in the housing walls. Referring to Fig. 9, it will be seen that each louver provides a narrow slit opening 142 which is too narrow for the grain to enter or become jammed therein, which would of course tend to shut off the flow of air. Moreover, referring to Fig. 1, it will be seen that the louvers open outwardly from the general planes of the walls forming chamber 108 through which the grain circulates, and upwardly in a direction opposite to the travel of the grain. Thus the grain always travels away from, not

6

toward, the openings 142. This further prevents the grain from being jammed or clogged in the air openings.

While we have shown and described a specific embodiment of our invention, it will be readily apparent that many minor changes of structure and operation could be made without departing from the spirit of the invention as defined by the scope of the appended claims, and it is accordingly desired that our patent protection extend and cover all subject matter falling properly within the scope of said claims.

What we claim as new and desire to protect by Letters Patent is:

1. A grain dryer comprising a frame, an outer cylindrical housing carried by said frame, said outer housing being open at the top and having a bottom closure with a central well of reduced diameter formed therein, an inner cylindrical housing supported concentrically within said outer housing whereby to form an annular chamber between said housings, the lower end of said inner housing being spaced above the bottom closure of said outer housing and having a top closure, a tube open at both ends supported vertically and concentrically in said housings with its lower end adjacent said well and its upper end extending above the top closure of said inner housing, a conveyor disposed within said tube with its lower end extending below said tube and operable to elevate grain from said well and to discharge said grain from the upper end of said tube, means carried by said frame and including a blower operable to deliver heated air under pressure to the interior of said inner housing, the walls of said inner and outer housings being perforated whereby to permit the passage of said air therethrough, and a prime mover carried by said frame and operable to drive said blower and said conveyor.

2. A grain dryer as recited in claim 1 wherein the perforations in said housing are formed by portions of the walls of said housings offset outwardly with respect to the annular chamber between said housings to form outwardly and upwardly opening apertures narrower than the average diameter of the kernels of grain to be dried, whereby to prevent clogging or jamming of said apertures by said grain.

3. A grain dryer as recited in claim 1 wherein the top closure of said inner housing is shaped conically coaxially with the housing, and with its apex up, said closure being louvered to permit the passage of air therethrough, and the angle of the wall thereof to the horizontal corresponding substantially to the angle of repose of the grain, whereby when the dryer is charged with the proper amount of grain, a layer of grain of uniform thickness will be disposed at all times over said top closure, said thickness being equal to the radial thickness of the annular chamber between said housings.

4. A grain dryer as recited in claim 1 wherein said conveyor comprises a vertical auger disposed in said tube and extending substantially to the bottom of said well, and with the addition of means operable to extend the lower end of said tube adjustably from a position substantially at the top of said well to a position substantially at the bottom of said well, whereby the amount of grain picked up by said auger in each revolution thereof may be adjusted.

5. A grain dryer as recited in claim 1 wherein said conveyor comprises a vertical auger carried rotatably in said tube and extending substantially to the bottom of said well, and with the addition of a tubular extension fitted telescopically about the lower portion of said tube and being vertically slidable thereon, and means carried by said frame and operable to lower said extension adjustably to a position extending substantially to the bottom of said well.

6. A grain dryer as recited in claim 1 with the addition of a horizontal agitator ring encircling said inner housing and disposed in the lower portion of said annular chamber, and means operable by said prime mover

7

to impart a circular orbital movement to said agitator ring.

7. A grain dryer as recited in claim 1 with the addition of a plurality of rods forming a cylindrical open cage disposed movably within said well concentrically with said tube but of larger diameter than said tube, and wherein said conveyor constitutes a vertical auger disposed in said tube and extending substantially to the bottom of said well, and means operable by rotation of said auger to impart a circular orbital movement to said cage.

8. A grain dryer as recited in claim 1 with the addition of a plurality of rods forming a cylindrical open cage disposed movably within said well concentrically with said tube but of larger diameter than said tube, and wherein said conveyor constitutes a vertical auger disposed in said tube and extending substantially to the bottom of said well, an eccentric cam fixed to and rotatable with said auger, and a member driven by said cam and affixed to said cage, whereby a circular orbital movement is imparted to said cage.

9. A grain dryer as recited in claim 1 with the addition of a plurality of rods forming a cylindrical open cage disposed movably within said well concentrically with said tube but of larger diameter than said tube, and wherein said conveyor constitutes a vertical auger disposed in said tube and extending substantially to the bottom of said well, an eccentric cam fixed to and rotatable with said auger, and a member driven by said cam and affixed to said cage, whereby a circular orbital movement is imparted to said cage, and an agitator ring encircling said inner housing in the lower portion of said

8

annular chamber, said cage rods extending upwardly and outwardly from said well and being fixed at their upper ends to said agitator ring, whereby the movement of said cage is imparted also to said agitator ring.

10. A grain dryer as recited in claim 1 with the addition of a valve cap fitted rotatably over the upper end of said tube and having a spout affixed thereto and extending horizontally outwardly past the upper edge of the outer housing, said valve cap being operable by rotation thereof to deliver grain discharged by said conveyor selectively downwardly into said outer housing, or to said spout.

11. A grain dryer as recited in claim 1 wherein said tube is provided at its upper end with a discharge opening, and with the addition of a tubular cap fitted rotatably over the upper end of said tube and having a plurality of openings formed therein, and a spout fixed to said cap and communicating with one of the openings thereof, said spout extending outwardly over the upper edge of said outer housing and serving as a means whereby said cap may be manually rotated, said cap being operable in one position to register the spout opening thereof with the tube opening, whereby grain discharged by said conveyor will be conveyed through said spout, and in another position to register another of the cap openings with the tube opening, whereby grain discharged by the conveyor will fall into said outer housing.

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